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3.3.1 List of research papers published per teacher in the Journals in 2022-23

(July-2022 to June-2023)

Sl No	Title of the Article	Name of Author	Publication Journal name	ISSN No	Year of Publication	Page No
01	Mining and its Impacts on Environment and Health with Special Reference to Ballari District, Karnataka, India	Gavisiddappa Gadag	International Journal of Advanced Engineering Research and Science (IJAERS)	2349-6495(P) | 2456-1908(O)	Mar, 2023	01 - 07
02	Atmospheric Aerosols and their Effect on Human Health: A Review	Gavisiddappa Gadag	Middle East Journal of Applied Science & Technology (MEJAST)	2582-0974	16 July 2023	08 - 17
03	Problems Faced By Readymade Garments Workers In Ballari District, Karnataka.	Gangadhara K	International Journal of Research and Analytical Reviews (IJRAR)	E-ISSN 2348-1269, P- ISSN 2349-5138	April 2023	18 - 22
04	A Study On Role Of Government In Fostering Unorganized Workers	Gangadhara K	EPRA International Journal of Environmental Economics, Commerce and Educational Management	2348 – 814X	August 2023	24 - 28

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3.3.1 Number of research papers published per teacher in the Journals notified on UGC CARE list during the last five years (2022-23)

Title of paper	Name of the author/s	Department of the teacher	Name of journal	Calendar Year of publication	ISSN number	Link to the recognition in UGC enlistment of the Journal /Digital Object Identifier (doi) number		
						Link to website of the Journal	Link to article / paper / abstract of the article	Is it listed in UGC Care list
Mining and its Impact on Environment and Health with Special References to Ballari District, Karnataka,India	Gavisiddappa Gadag	Commerce	International Journal of Advanced Engineering Reseach and Scieence (IJAERS)	Mar-23	2349-6495(P)/ 2456-1908(O)	www.ijaers.com	https://dx.doi.org/10.22161/ijaers.103.11	No
Problems Faced by Readymade Garments Workers in Ballari District , Karnataka	Gangadhara K	Commerce	International Journal of Research and Analytical Review (IJRAR)	Apr-23	E-2348-1269, P-2349-5138	http://www.ijrar.org	https://ijrar.org/download.php?file=IJRAR23B1710.pdf	Yes
Atmospheric Aerosols and their Effect on Human Health: A Riview	Gavisiddappa Gadag	Commerce	Middle East Journal of Applied Science & Technology (MEJAST)	Jul-23	2582-0974	www.mejast.com	https://mejast.com/data/uploads/84241.pdf	No
A Study on Role of Government in Fostering Unorganised Workers	Gangadhara K	Commerce	EPRA International Journal of Environmental Economics, Commerce and Educational Management	Aug-23	2348-814X	www.eprajournals.com/IJCM	https://eprajournals.com/IJCM/article/11189/download	No

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Mining and its Impacts on Environment and Health with Special Reference to Ballari District, Karnataka, India

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Keywords—Airborne dust, Crop productivity, Environmental issues, Mining activities, Mining waste.

Abstract— *Mining has played a significant role in the development of a country. The financial progress of various nations depends on the production and use of minerals which leads to the expansion of mining activities. Ballari district has rich mineral resources and is known for iron ore deposits. As iron ore is an essential raw material for the iron and steel industry, many Iron and Steel plants are established in Ballari district. In this study, the impacts of iron ore mining on environmental issues such as air, water, soil, and health on the population are reviewed. The review reports that the concentrations of NO_2, SO_2, PM_{10} and $PM_{2.5}$ are greater in the core zone of Subbarayanahalli iron ore mine located in Hospet-Ballari sector. The PM_{10} level exceeds the NAAQS limits of 100 $\mu g/m^3$ at different locations of 10kms radius of Ballari city. The surface water bodies around Sandur, Torangallu and Taranagar are silted and contaminated by mining waste. The airborne dust produced during mining activities decreased crop productivity and affected human health. The main conclusion from the review is that more research should be needed to assess the environmental impacts and emphasize sustainable mining operations in association with Government and mining research activities.*

I. INTRODUCTION

Mineral resources play an essential role in the economic development of a nation. This is vital, particularly for developing countries like India. These resources are base for increased industrialization and generate many employment opportunities for the people of the mining regions [1]. The increase in mining activities results from the fact that the financial progress of various nations is dependent on the production and use of minerals, including fuel minerals [2].

With the rapid industrialization due to mining, society also gets the benefits such as the establishment of schools, hospitals, hotels, construction, transportation, communication, and other infrastructure facilities. In India, mining activities bring huge revenues to the State Governments and thus enable the Governments to use the revenue for the welfare and well-being of people in the society [1].

Thus, minerals are an indispensable part of the economy of a nation. Fortunately, India is blessed with huge deposits of mineral resources. It is estimated that more than 0.8 million hectares of land are under mining, however, a major portion lies in the forest area. There are 20,000 known mineral deposits in India and as many as 89 minerals (4 fuel, 10 metallics, 22 non-metallic and 55 minor minerals. As per the annual report of the Ministry of Mines, 2021-22, the 1st Advanced Estimate of Gross Value Added (GVA) of the mining and quarrying sector during 2021-22 at 2011-12 prices is Rs. 336859 crore, which shows a growth of 14.33% as compared to a provisional estimate of GVA during 2020-21 at Rs. 294644 crores. The States which have indicated a major

increase in the value of mineral production are Orissa (93%), Jharkhand (87%) and Karnataka (65%) [3].

II. METHODOLOGY

The Study is based on secondary data published in journals and magazines in the form of articles. It also covers the information provided by the Annual Reports of the Ministry of Mines, Indian Bureau of Mines, Central Pollution Control Board, and other Government organisations. In this study, the impacts of mining iron ore particularly resulting from open-cast mining are covered with special reference to environmental issues (such as Air, Water, Soil), and health hazards on the population of the mining region. The Study area is confined to the Ballari District of Karnataka State.

III. ABOUT BALLARI

The state of Karnataka is abundant in mineral resources. It is said to be one of the most mineral-rich states of India. The mineral belt covers an area of 1.92 lakhs sq. km including 29 districts of the state. Karnataka is also endowed with the green stone belt with valuable mineral resources such as gold, silver, copper, iron ore, manganese, limestone, dolomite, asbestos, bauxite, chromite, kaolin, and granite rock. The Ballari district is enriched with a wide variety of Major and Minor minerals. Major minerals include Iron ore, Manganese, Red Ochre, and Yellow Ochre (as per schedules 11 of MM(RD)1957 and minor mineral includes Building stone such as Granitic gneiss, Gneises and steatite (soapstone), Quartz and Granite. Ballari District has 125 Mining leases of Major minerals of which 30 leases are working and 92 quarry leases of minor minerals [4].

3.1 Iron Ore

The Geological Survey of India (GSI) has estimated a reserve of about 1876 million tonnes of iron ore with about 63% of total iron in the Sandur belt. Large deposits of lateritoid haematitic iron ore in association with manganese ore are from prominent ridges of the Sandur schist belt. There are six ranges carrying iron ore deposits viz., Donimalai, Kumaraswamy, Ramandurga, Yeshavanthanagar, Devagiri and Thimmappanagudi. The Ramandurg deposit is about 10,400 m long and 150 m wide with 62.3 to 62.6% Fe. In Donimalai, six ore bodies with sizeable reserves of 65.2% Fe have been estimated. In Kumaraswamy, the Geological Survey of India has estimated iron ore over a strike length of 2.5 km and width of 465 m [4].

3.2 Manganese Ore

The bimetallic (Fe-Mn) low-phosphorus manganese ore deposits as discontinuous bodies occur all along the western and southern margin of the Sandur schist belt over a strike length of about 40 km with an average width of about 500m. The deposits in Deogiri hill are the largest. The manganese horizon is stratigraphically confined to Deogiri Formation whose thickness varies from 975 to 1000 m consisting of metagreywacke, carbonates with minor interbeds of quartzites, arkose, meta-chert, basic and acid volcanic rocks.

Exploration by large-scale mapping and drilling carried out by GSI has identified three distinct manganese horizons over a strike length of 15 km viz., (i) top lateritoid horizon (ii) middle reef-like manganese ore and (iii) bottom clay mixed zone. Pyrolusite, cryptomelane, and psilomelane are the principal ore minerals. Hausmanite, hollandite and mangano-magnetite have also been recorded. The probable reserves of manganese ore in the entire belt are estimated to be 107.36 million tonnes [4].

IV. SIGNIFICANCE OF IRON ORE MINING AND ITS OPERATIONS

Iron ore is an essential raw material for the Iron and Steel Industry. It is significant among all mining activities and influences largely the economic status of the country. India is one of the leading producers of iron ore with a total reserve of over 33.276 billion tonnes of haematite (Fe_2O_3) and magnetite (Fe_3O_4). About 79% of haematite ore deposits are found in Assam, Bihar, Chhattisgarh, Jharkhand, Odisha and UP and 93% of magnetite ore deposits occur in Andhra Pradesh, Goa, Karnataka, Kerala, and Tamil Nadu. Interestingly, Karnataka alone contributes 72% of the magnetite deposit in India.

The production of iron ore constituting lumps, fines and concentrates was 246.08 million tonnes in the year 2019-20 and is given in table-1.

Table 1: State-wise Production of Iron Ore

Sl.No.	State	Production (in million tonnes)	Percentage
1.	Odisha	146.77	59.64
2.	Chhattisgarh	34.72	14.11
3.	Karnataka	31.40	12.76
4.	Jharkhand	26.89	10.92
5.	Other States	6.30	2.57
	Total	246.08	100.00

Source: Indian Minerals Year Book 2020

From the above table, it is evident that Karnataka stands in third place in terms of the production of iron ore with 12.76 per cent of the total production in the country. The other states in the above table include Andhra Pradesh, Goa, Madhya Pradesh, and Telangana [5].

4.1 Iron ore operations

Depending on the mode of extraction of minerals, mines can be surface mines, underground mines, or a combination of both [6]. Iron ore mining is carried out by open cast method through manual, semi-mechanised and mechanised operations. Generally, mining is done by digging the ore with pick axes, crowbars, chisel, and spades. The mined material is screened manually to separate +10mm float ore which is stacked separately. The waste is backfilled into the pits. In some cases, 150-200 gm of gunpowder or special gelatine cartridges are filled and blasted. The blast tonnage per kg of gunpowder is 2.5 to 3 tonnes. On the other hand, in the case of mechanised mining, hydraulic excavators, Ripper Dozers, Shovels, Dumpers and heavy machines are used. They also use explosives such as Ammonium nitrate–fuel oil (ANFO), Site Mixed Slurry (SMS) and emulsion explosions for blasting the mines.

However, the processing of iron ore involves crushing, screening, washing and in some cases beneficiation and agglomeration. Dry and Wet grinding is also carried and this processed ore is mainly used for manufacturing pig iron, sponge iron and steel and is also used in cement, coal washers, ferro alloys, foundry, vanaspati and glass industries [5]. In the present day, nearly all industrial establishments consume at least one of the minerals in their process of production. This speaks about the significance of mines and minerals in the world [7]. Rapid industrialisation has led to an ever-increasing demand for iron ore resources. The unabated exploitation of iron ore resources led to the ecological imbalance in the natural ecosystem and has caused environmental deterioration [8].

There are 266 iron ore mines in Karnataka, out of which 134 are in forest areas. In the Bellary District, 148 mines (out of which 98 are in forest areas) cover 10,598 hectares of land. The Indian Bureau of Mines in 2005 estimated the total iron ore mineral reserves to be about 1148 million tonnes [9]. The Supreme Court Central Empowered Committee has assessed that even at conservative estimates, at the present rate reserves in the State will be exhausted in about 20 years. Iron ore mining in Bellary took off in 1999, paved by the 1993 National Mineral Policy that began encouraging private players to participate in iron ore mining [10,11]. It received a further push when the Karnataka State Mining Policy in the year 2000 outlined a policy of "Export Oriented Development". Finally, in March 2003, the state government de-reserved 11,620 square km for private mining that was formerly marked for mining by state entities alone [12]. The changes in mining policy went hand in hand with increasing demand from China due to the Beijing Olympics which caused iron ore prices to soar from around Rs. 1,300 per tonne in 2000 it crossed Rs. 4,500 per tonne in 2005-06 [13].

V. IMPACTS OF IRON ORE MINING

Mineral resource extraction and mining often have a significant negative influence on the environment, including the land, water, air, and biological resources as well as the socioeconomic situation of the local population [14]. The degree of impact depends on the methods, scale, and concentration of mining activities, as well as the geological and geomorphological environment [15].

Mining activities certainly affect all the components of the environment. The ill effects may be permanent or temporary, beneficial, or harmful, repairable, and sometimes go irreparable. In this paper, the study area is chosen as the Ballari District of Karnataka State. In recent years, there has been increased production of iron ore due to the usage of heavy machinery and equipment, particularly in open-cast mining. This open-cast mining results in the dumping of a huge volume of unmined land in addition to a pit-scarred landscape.

The major problem of iron ore mining is the disposal of tailings and other deleterious silica minerals and phosphorus. The mining regions are highly prone to the siltation of agricultural fields, nallahs, riverbeds, and creeks due to the wash off from iron ore dumps in rainy seasons. Apart from loss in crop yield and reduction in fish population in streams are caused by silting. It also results in dust concentration (suspended particulate matter) which poses environmental problems.

The iron ore mining activities in Ballari District threaten severe impact on the community and environment in one of the highly exploited iron ore belts of Karnataka State i.e., Sandur-Hospect-Ballari Belt [16]. Sandur -Hospet region has abundant reserves of Iron ores from which many fines are generated during mining, crushing, and screening processes. Nearly 50-60% of the total burden removed from the surface is below 10mm in size and these fines are dumped at mine sites as waste. During the rainy seasons, these fines, carried by runoff water, spread to the surrounding agricultural land thereby reducing the fertility of the soil and productivity of the pedosphere and leading to deforestation. The dissolved constituents from the mining process pollute the surface and groundwater of the region [17].

5.1 Air Pollution

The deterioration of air quality is a significant problem in mining areas [18,19,20]. The primary causes of air pollution in mining regions include drilling, blasting, loading, and unloading of minerals, transportation, as well as dust generation by wind at stockyards. Many meteorological factors such as wind speed, wind direction, temperature, amount of rainfall, and atmospheric stability in mining areas have a great impact on the environment [21]. The National Ambient Air Quality Standard was developed in India in 1994 to evaluate and compare the degree of air pollution in various places (CPCB, 1998) [14]. Particulate matter is one of the major pollutants released during different operations (drilling, blasting, loading, transporting, and unloading of ore) in open-cast mining [22,23]. The levels of NO_2 and SO_2 produced due to mining activities generally remain within the standard limit. Thus, controlling dust emission is crucial for every mining location, as it contains free silica and respirable particulate matter that can lead to respiratory illnesses [21].

Jaswanth Gowda (2016) reported that the activities of the Subbarayanahalli iron ore mine located in Hospet-Ballari sector contribute to air pollution in and around the mine areas. The pollutant concentrations, namely Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Suspended Particles (PM_{10}), and Respirable Suspended Particulate Matter ($PM_{2.5}$), observed in the mining region are greater in the core zone and within the National Air Quality Standards in the buffer zone. Due to variations in rainfall, humidity, temperature, wind speed and direction, the values are quite high in the summer and very low in the rainy season [24].

The particulate matter released at the mining site is carried from their place of production to a long distance by winds and upper-level circulation in the atmosphere. Patel et al. (2017) studied the impact of mining and associated industries on the Air Quality of the Bellary region. The study reported that the PM_{10} levels exceed the National Ambient Air Quality Standards (NAAQS) limits of $100\mu g/m^3$ at different locations of 10kms radius of Bellary city. This was due to the transportation of vehicles on unpaved roads and the contribution from industries [25].

5.2 Water Pollution

Over 98% of the fresh water on the earth lies below its surface. The remaining 2% is what we see in lakes, rivers, streams and reservoirs. Of the freshwater below the surface, about 90% satisfies the description of "groundwater". This groundwater contamination is generally irreversible i.e., once contaminated, it is difficult to restore the original water quality. Unfortunately, the mining operations result in wastes containing oil, grease, and toxic metals, and are run-offs during the rainy season which causes pollution in the ground water . The residual material of mines is dumped into water bodies and as a result of which the colour of the water bodies becomes reddish and the depth of water bodies decreases [26].

Nayak (2016), measured the colour and siltation of water bodies which are located within a radius of 5 and 10km of mining area which lies in the part of Bellary, Hospet and Sandur taluks. The study reported that the impact on any components decreases with an increase in distance from the mining area. The area of the water bodies got silted within a radius of 10 km [27].

Kumar et al. (2012) studied the surface and groundwater quality in the parts of the Sandur Schist belt, Bellary district. The study reported that nitrate, fluoride, magnesium, sodium, and total hardness are high in Narihalla Stream and are polluted and not suitable for drinking or agriculture. Most of the surface water bodies around Sandur, Torangallu and Taranagar are silted and contaminated by the mining waste [28].

5.3 Soil Pollution

Life on earth relies directly on the soil and aquatic ecosystem of rivers. Food would not grow, objects would not decompose, and nutrients would not be recycled if there was no fertile soil and microbial fauna to occupy it. Without fertile soil and microbial fauna that inhabit it, food would not grow, dead things would not decay and nutrients would not be recycled. A significant contributing cause to soil pollution is the disposal of industrial waste as a result of mining operations. The chemical and biological characteristics of soil are affected by these pollutants. The sludges resulting from surface mining which contains several toxic chemicals if untreated pollute the soil. Near the mining region, soil fertility has been negatively impacted. In a few instances, agricultural yield also falls [26].

There have been devastating environmental consequences of the unbridled iron ore mining in Bellary – the largest hit being to agriculture, with once-fertile lands turning red with iron ore silt and bore wells drying up across the entire region. The Supreme Court CEC report also states that nearly 45% of the forest cover in the region has been lost to mining – "As a result of mining and associated activities, what was once an area with green, scenic, undulating hilly terrain, today presents a barren and dismal picture akin to a war-ravaged zone with huge ugly scars" [29].

Suresh Kumar et al. (2017) assessed the soil Loss in Sandur Taluk due to Mining Activities in and Around Bellary district. They adopted Geographical Information System (GIS) based on the Revised Universal Soil Loss

Equation (RUSLE) to study the parameters like Land use, Land cover, Soil, Geomorphology, and catchment boundary. The study found that the areas of Ramgad Forest Block, Devagiri Hills, Northern Donimalai Village, North Eastern Block Hills, and Middle Eastern Taluk encompassing Taranagar Village and Bommagatta Village have considerable soil loss. Due to the ongoing sediment deposition in these places, the water tanks are severely affected [30].

Srinivasa Sasdhar Ponnaluru(2019) did an empirical analysis of the impacts of mining dust on crop productivity in the Bellary district in India. The study found that ore transportation and mining produce airborne dust that has an impact on agricultural productivity. It adopted a change in crop productivity modelled by regressing crop productivity on fertilizer consumption, amount of rainfall, and on mining activity over the study period. The study found that mining drastically decreased crop productivity and this decline in crop yield may be due to airborne dusts [31].

Nayak et al. (2015) evaluated the spatial variation in soil contamination by iron ore Mining of Bellary district using linear discriminate analysis and partial correlation analysis. The study reported that different types of acidic chemicals are concentrated in agricultural soil and affected areas of the Bellary district; simultaneously mining eruption damaged the fertility of the soil [32].

5.4 Noise Pollution

Noise has come to be regarded as a major urban pollutant capable of causing annoying hearing loss, and sometimes even adverse physiological and psychological effects. The unwanted sound emanating from the blasting, crushing, and processing of plants in the mining areas results in either temporary or permanent hearing loss. Due to this noise, the workers get tired and the quality of efficiency will come down. Noise also results in an unnecessary interruption in the communication process. Above all, the high incidence of sound invariably causes circulating problems, irregularities in heart rates, lack of concentration, nausea, headache, loss of appetite etc. [33].

5.5 Health Effect

The particulate matter produced during mining activities is of different sizes and is harmful to human health and the environment. The particles of size 30 μm and above (also known as total suspended particulate matter, TSPM) will settle down quickly near the source of emission. The particles between 30 and 10 μm in size are suspended in the air for a short time and they pose no health risk because when they are swallowed after becoming stuck in the mouth or nostrils. The particles of size less than 10 μm (PM_{10}) enter the respiratory tract when inhaled and the particles less than 2.5 μm in size ($PM_{2.5}$) enter deep into the lungs and results in adverse health effect. The increased level of particulate matter results in diseases such as asthma, black lung disease and cardiovascular diseases. Thus, the study on PM_{10} and $PM_{2.5}$ emissions in the mining area is of more importance as it poses severe health problems [34,35,36].

Veerendra Kumar et al. (2020) studied the health status of mining labourers in the Bellary district by collecting data from the Primary Health Centre (PHC) of Bellary, Hospet and Sandur taluks. The study reported the number of patients treated or registered for diarrhoea, respiratory infections and other diseases [37].

VI. CONCLUSION

India is the leading producer of iron ore in the world. Apart from the basic Iron and Steel industry, sponge iron, pig iron, the ferrous industry and even the cement industry are also considered the major consumer of iron ore. Therefore, a long-term policy is needed to preserve and conserve iron ore deposits for the country's long-term consumption. The Indian steel sector is set to achieve a global benchmark in terms of quality, standard and technology. This requires huge demand for iron ore. To augment this demand, intensive and deeper exploration needs to be promoted. The underground mining techniques with optimum utilisation of iron ore deposits should be eco-friendly. The main conclusion of the review is that further research is required to assess environmental impacts of iron ore mining activities. Thus, the emphasis should be placed on sustainable mining operations in association with Government and mining research institutes.

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Atmospheric Aerosols and their Effect on Human Health: A Review

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ABSTRACT

Atmospheric aerosols are one of the main pollutants which are harmful to human health and environment. Atmospheric aerosols emitted from different sources are of different sizes and depending upon the size of the aerosol particle, it deposits in different parts of the body and cause varying health problems. Fine Particulate ($PM_{2.5}$) is associated with more severe health consequences than coarse particulate (PM_{10}) which might be short-term acute symptoms like coughing, shortness of breath, wheezing, respiratory diseases, to more serious problems like asthma, Chronic Obstructive Pulmonary Disease (COPD), bronchitis, pneumonia and long-term chronic irritation and inflammation of the respiratory tract, which may eventually result in lung cancer. Inhalation of ultrafine particles (<0.1 μm) may also contribute to cardiovascular effects due to their ability to penetrate deep into the lungs and enter the bloodstream. Exposure to traffic emissions for a long time has been linked to coronary arteriosclerosis, while short-term exposure has been linked to hypertension, stroke, myocardial infarctions, and heart failure. Prolonged exposure to carcinogenic substances such as certain heavy metals and organic compounds, particularly in industrial or heavily polluted areas, may increase the risk of lung cancer and other types of cancer. However, the risk factor depends on the exposure of different groups of the population to these aerosols. Thus, highlighting the need for continued research, monitoring, and effective air pollution control strategies are required to safeguard human health and well-being.

Keywords: Asthma; Atmospheric aerosols; Cardiovascular disease; Chronic obstructive pulmonary disease (COPD); Fine particulate; Hypertension; Pneumonia; Respiratory diseases.

1. Introduction

The development in the field of science and technology has provided comforts to the entire humanity, however, man being greedy has a tempered ecosystem. The environment is deteriorating due to various kinds of pollution viz., air, water, soil, sound, etc., and hence the need for protecting the environment has emerged as an essential study. Among the different types of pollution, the most hazardous is air pollution. One of the primary pollutants that air contains is fine suspended particles known as atmospheric aerosols.

Atmospheric aerosols are solid or liquid particles suspended in the air. They include sea salt, dust, volcanic ash, soot, sulfates, nitrates, and other particles generated by human activity. Since aerosol sources are found on the earth's surface, these particles are mostly found in the lower layers of the atmosphere (1.5 km). However, certain aerosols, mainly volcanic aerosols which are ejected into the high-altitude layers are found in the stratosphere [1]. Aerosol particles come in a wide range of chemical compositions, shapes, and morphologies, and as a result, they have optical characteristics that vary greatly depending on the source, as well as production and ageing processes in the atmosphere [2], [3]. Aerosol particles range in size from a few nanometers to several tens of micrometres, except for cloud droplets and ice crystals [4]. Depending on their sizes and compositions, aerosol particles can stay in the troposphere for days to weeks [5]. Aerosols emitted from natural and anthropogenic sources scatter and absorb sunlight and terrestrial radiation. Increased atmospheric aerosol concentrations from anthropogenic activities like burning fossil fuels and burning biomass change Earth's energy balance and hence affect climate [6]. Aerosols have increased enormously over the past two decades due to population growth, rapid economic growth, and the system of energy consumption [7]. In recent years aerosols have been under significant consideration due to

their ability to affect the energy budget and their negative impact on agriculture and human health. Aerosols, from human sources, have recently been identified as an essential component of the climate system [8], [9]. More than 80% of individuals who live in metropolitan areas are exposed to air that is of lower quality than what the World Health Organisation (WHO) advises. People who live in metropolitan regions may be at an increased risk of developing chronic and acute respiratory illnesses, including asthma, as well as stroke, heart disease, lung cancer, and other health issues [10].

2. Sources of Aerosols and Classification

The sources of aerosols are either natural or anthropogenic (human-made). Natural sources of aerosols include plants, extraterrestrial or planetary dust, forests, deserts, forest fires, volcanoes, and the ocean. Burning of biomass, industrial processes, human-caused fires, transportation, and combustion of fossil fuels are anthropogenic sources [1]. After the production of aerosols in a place, they are transported away from their sources [11]. The amount of natural sources that contribute to ambient aerosols varies with time and also depends on the distance from the source areas [12]. The concentration of aerosol is relatively high close to the Earth's surface due to the presence of the sources near the surface.

Aerosols are classified into two types based on their origin- primary and secondary. Aerosols may be emitted directly into the atmosphere (primary aerosols) or created in the atmosphere from precursor gases through a chemical reaction (secondary aerosols). Primary aerosols are made up of both organic and inorganic components. The main sources of inorganic primary aerosols are sea spray, mineral dust, and volcanoes. These aerosols are relatively large (> 1 μm) and hence have a very short residence time (a few days). The primary aerosols are carried into the atmosphere by strong winds, erupting volcanoes, or smoke or fires [13].

2.1. Natural Primary Aerosols

Natural primary aerosols include sea salt particles, mineral dust, volcanic aerosols and bioaerosols. Sea-salt aerosols are generated over the ocean by many physical processes [14]. The amount of sea salt produced and its concentration depends on the wind speed and the size and phase (liquid or dry sea salt) of the sea salt aerosols that are produced after the evaporation of sea spray droplets depending on relative humidity [11]. Mineral dust aerosols are emitted due to wind friction on continental surfaces and are generated in regions where there is a strong wind and little vegetation, particularly in arid, semiarid, and desert regions. The reduced soil humidity and weaker cohesive force between the soil particles cause the emission of soil particles. Volcanoes release gases such as CO_2, SO_2, H_2S and hydrogen halides and dust particles and they enter the atmosphere [1]. The sulphur dioxide released during volcanoes reflects the incoming solar radiation, thus cooling the planet. Contrarily, carbon dioxide may contribute to global warming, but the emission of it during volcanoes is lower than that released by human activity. Living and non-living elements (fungi, bacteria, viruses, algae), dispersal units (pollen, spores), excrement of biological organisms, and plant detritus discharged from both terrestrial and marine ecosystems into the atmosphere make up bioaerosols [1], [15], [16]. Additionally, some species of the marine environment are included in this group, such as phytoplankton that emits dimethyl sulphide (DMS), a precursor to secondary natural sulphate aerosols, plants and algae that release volatile organic compounds (VOCs), and some types of trees that produce terpenes. The primary bioaerosols have an impact on atmospheric processes including cloud drop formation [17],

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[18], [19] and ice nucleation [19], [20], [21], [22], [23]. The dispersal of pathogens and allergens from plants, animals, and humans has a significant impact on agriculture, public health, and the environment.

2.2. Natural Secondary Aerosols

Natural secondary aerosols are produced in the atmosphere as a result of gas-to-particle conversion processes that occur with aerosols of natural origin. Sulphates and nitrates, which are produced by the condensation of gases containing sulphur and nitrogen, are the most common natural secondary aerosols. Condensation may take place on already-existing particles, increasing their mass (but not their number), or forming new particles smaller than 0.01μm. The natural sulfate particles are produced from the dimethylsulfide (DMS) from biogenic sources (phytoplankton) and the SO_2 emitted by volcanoes. Volcanic eruptions contribute around 7% and DMS-derived aerosols roughly 19%, respectively, to the overall amount of sulphate aerosols in the atmosphere [11]. Biomass burning and forest fires are also natural sources of tropospheric sulfur dioxide [5]. The sulfate aerosols scatter the solar radiation and thereby increasing the earth's albedo and serving as cloud condensation nuclei. Nitrogen oxides, volatile acids containing nitrogen, and gaseous nitrates are the precursor gases of nitrate aerosols. Nitrogen dioxide is oxidized to nitric acid, which then reacts with ammonia or sodium chloride to form nitrate particles. Secondary organic aerosols (SOA) and carbonaceous aerosols (EC & OC) formed from gas-to-particle conversion processes from biogenic volatile organic compounds are also secondary aerosols [11].

2.3. Anthropogenic Primary Aerosols

The major primary anthropogenic aerosols that come from different sources include industrial dust, carbonaceous particles (soot) from the combustion of fossil fuels, and particles from the burning of waste and biomass. Besides carbonaceous compounds (both EC and OC), polycyclic aromatic hydrocarbons (PAH), mercury, and volatile chemical that form ground-level ozone are also emitted during the combustion of fossil fuels. The major atmospheric pollutant of biomass burning is carbonaceous aerosols which include both organic carbon (OC) and elemental carbon (EC) [24]. Environmental quality is significantly affected by the industrial dust that is released from sources such as transportation, coal or fuel combustion sectors, cement production facilities, metallurgy, and waste incineration. Anthropogenic emissions have significantly increased during the past 50 years in areas of the world where industrialisation has progressed without any pollution control measures, particularly in Asia. This growth in industrialization is expected to lead to a significant rise in industrial dust [5], [10]. The concentration of organic aerosols in the atmosphere is close to that of industrial sulfate aerosols, and these particles influence both the environment and human health [24]. The open burning significantly increases aerosols emissions into the atmosphere and have great impact on the environment and health [25].

2.4. Anthropogenic Secondary Aerosols

Secondary anthropogenic aerosols are formed through the gas-to-particle conversion of primary particles from anthropogenic sources in the atmosphere. Hydrocarbons and compounds containing sulfur and nitrogen are the main chemical species involved in the formation of secondary aerosols. The oxidation of sulfur dioxide and nitrogen dioxide gives secondary sulfate and nitrate aerosols in the atmosphere [26]. Secondary organic aerosols (SOA) are mainly formed by the atmospheric oxidation of volatile organic compounds such as trimethyl benzenes, xylenes, toluene, and alkanes emitted primarily from anthropogenic sources (gasoline) [27].

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3. Chemical Components of Atmospheric Aerosols

The chemical components of the aerosols present in the atmosphere are incredibly numerous, with variable concentrations. The type of aerosol present in the atmosphere depends on its source, its formation process, and the photochemical processes. The constituents of atmospheric aerosols include water-soluble and insoluble inorganic aerosols such as anions – nitrates (NO_3^-), sulfates (SO_4^{2-}), chlorine (Cl^-), and halides and cations –ammonium (NH_4^+), sodium ions of alkali and alkaline earth elements. It also, contains trace metals (Cu, Fe, Al, Cr, Mn, Ni, Cd, Co, Li, Zn, Pb), crustal elements (Si, Al, Fe, Ca, Na, Mg, K) [11], [19], [28] and the carbonaceous aerosols, which consists of different forms of carbon like elemental carbon (EC), black carbon (BC) and organic carbon (OC)which are released from the incomplete combustion of fossil and biomass-based fuels [29], [30]. Several aerosols are non-volatile and remain in the atmosphere in the aerosol phase until they are gradually removed from the atmosphere [31]. The mass concentration of total carbon with particle size ranging from 15 to 600 nm varies from 45% to 90% depending on the source of emissions. These carbonaceous aerosols constitute the largest portion of the atmospheric aerosols and since they do not well mixed in the atmosphere, remain suspended in the air and contribute to cloud formation until it settles down or is washed out by rain [30].

4. Health Effects of Atmospheric Aerosols

Atmospheric aerosols emanating from a variety of sources are a major component of National ambient air pollution (United States Environmental Protection Agency 2002). Aerosols emitted from different sources are of different sizes: Fossil fuel combustion releases particles in the range of 100-300 nm size, whereas the dust particles are of size above 1μm [32]. Based on the size, aerosol particles are classified as coarse, fine, and ultrafine particles. Coarse particles (PM_{10}) generally accumulate in the upper respiratory tract and have an aerodynamic diameter of less than 10μm. Both fine particles ($PM_{2.5}$) of aerodynamic diameter less than 2.5μm and ultrafine particles ($PM_{0.1}$) of aerodynamic diameter less than 100 nm are deposited mostly in the lower respiratory tract, where the exchange of gases takes place [33]. Fine particulate ($PM_{2.5}$) is associated with more severe health consequences than coarse particulate (PM_{10}) [34]. Depending upon the size of the aerosol particles, it deposits in different parts of the body and cause varying health problems [32]. The studies reported that the transmission of the COVID-19 illness may be significantly impacted by PM in various size fractions (PM_1, $PM_{2.5}$, and PM_{10}) as well as gaseous air pollutants (ozone,O_3, nitrogen dioxide, NO_2, sulphur dioxide, SO_2, and carbon monoxide). Studies on epidemiology have linked respiratory and cardiovascular illness and higher death rates to outdoor acute and chronic exposure to high levels of air pollution in big cities because of their enhanced oxidative toxicity [35].

4.1. Respiratory Problems

The area of the respiratory system that is impacted by particulate matter depends on the particle size. PM_{10} affects the upper respiratory tract, whereas ultrafine particles (0.1 mm in diameter) impact the lung alveoli. Atmospheric aerosols can worsen asthma, decrease lung function, irritate the airways, cause coughing fits and other breathing difficulties, as well as cause premature death in people with lung or heart illness [36]. Atmospheric aerosols have a variety of negative health effects, including both short-term acute symptoms like coughing, shortness of breath, wheezing, respiratory diseases, to more serious problems like asthma, Chronic obstructive pulmonary disease

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(COPD), bronchitis, pneumonia and high hospitalization rates and long-term chronic irritation and inflammation of the respiratory tract, which may eventually result in cancer [37], [38]. There is a strong relationship between hospital admissions for chronic respiratory disorders and $PM_{2.5}$ and PM_{10} levels [39]. Polycyclic Aromatic Hydrocarbons (PAHs) such as benzopyrene, acenaphthylene, anthracene, and fluoranthene present in coal and sediments of tar, are generated through incomplete combustion of organic matter such as motor exhaust, incineration, and forest fires. These PAHs are toxic, mutagenic, and carcinogenic and hence significantly increase the risk of developing lung cancer [38], [40]. Exposure to heavy metals such as arsenic, lead and nickel is responsible for asthma, emphysema and even lung cancer [41], [42]. Exposure to bioaerosols cause respiratory diseases such as asthma, hay fever, organic dust toxic syndrome, hypersensitivity pneumonitis, and chronic bronchitis [43]. The industrial emission and coal mining activities produce atmospheric pollutants including certain heavy metals and they pose health risk especially chromium (Cr). The concentration of these metals increases during sandstorm days. Long-term exposure to Cr can lead to lung cancer and respiratory tract inflammation because it can precipitate certain blood proteins [44].

Endotoxin which is an organic dust and a significant component of bioaerosols is released into the atmosphere from agricultural operations, in animal housing and in food processing industries, has great impact on human health. Long-term exposure to bacterial endotoxin raises the danger to respiratory health, with endotoxic shock being the most frequent complication. Endotoxin intensifies respiratory symptoms including coughing and wheezing with shortness of breath as concentration rises [45].

After the COVID-19 pandemic epidemic, several investigations revealed the presence of SARS-CoV-2 in Particulate Matter (PM) due to the potential role that PM might play as a carrier of pathogenic bacteria and viruses. High concentrations of these PM might have a detrimental impact on the respiratory system [46].

4.2. Cardiovascular Problems

Exposure to aerosols, especially $PM_{2.5}$ and smaller ultrafine particles (UFPs), has been linked to cardiovascular issues. exposure to $PM_{2.5}$ and other aerosol components is associated with an increased risk of cardiovascular diseases, including heart attacks, strokes, and high blood pressure [47], [39]. Inhalation of ultrafine particles (<0.1 μm) may also contribute to cardiovascular effects due to their ability to penetrate deep into the lungs and enter the bloodstream [48]. The cardiovascular system is known to be negatively affected by prolonged exposure. Long-term exposure to pollutants changes the blood cells and may impair heart functioning. Exposure to traffic emissions for a long time has been linked to coronary arteriosclerosis [49], while short-term exposure has been linked to hypertension, stroke, myocardial infarctions, and heart failure. According to reports, prolonged exposure to nitrogen oxide (NO_2) can cause ventricular hypertrophy in humans [50], [51]. The presence of preexisting coronary heart disease, and heart failure may also elevate short-term cardiovascular mortality risk [52].

4.3. Cancer Risk

Some components of atmospheric aerosols, such as certain heavy metals and organic compounds, have been classified as carcinogens. Prolonged exposure to these substances, particularly in industrial or heavily polluted areas, may increase the risk of lung cancer and other types of cancer [53]. Dioxins, heavy metals, and other contaminants are harmful because they bioaccumulate and obstruct cellular processes [54], [55]. The particles

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released from diesel engines have mutagenic and carcinogenic properties and hence exposure to these particles leads to lung cancer [56].

4.4. Other Effects

Particulate matter entering the body can harm the immune system and reduce the immune capacity of the body, increasing the risk of a variety of diseases [57]. The fine particles enter the respiratory system by inhalation and respiratory, and cardiovascular problems, as well as reproductive and central nervous system disorders, and cancer. In addition, air pollutants that are harmful to human health include nitrogen oxide, sulphur dioxide, volatile organic compounds (VOCs), dioxins, and polycyclic aromatic hydrocarbons (PAHs). Depending on the exposure, heavy metals like lead can either cause acute poisoning or chronic intoxication when absorbed into the human body [38].

The impact of these aerosols on human health can be decreased by reducing emission by human activities and improving the air quality. The study reported that during COVID-19 pandemic, the quality of air was improved due to the imposition of lockdown. the COVID-19 shutdown decreased human activity, which led to lower air pollution concentrations being measured over all of India [58].

5. Conclusion

Atmospheric aerosols have a significant negative health effect, including both short-term acute symptoms like coughing, shortness of breath, wheezing, respiratory diseases, to more serious problems like asthma, Chronic obstructive pulmonary disease (COPD), bronchitis, pneumonia and high hospitalization rates and long-term chronic irritation and inflammation of the respiratory tract, which may eventually result in cancer. It is important to note that the health effects of atmospheric aerosols can vary depending on factors such as the composition of the aerosols, the duration and intensity of exposure, and individual susceptibility. Vulnerable populations, such as the elderly, children, and individuals with pre-existing respiratory or cardiovascular conditions, are particularly at risk. Implementing air quality legislation, reducing emissions from industrial and transportation sources, promoting the use of renewable energy sources, and increasing public awareness about the value of both indoor and outdoor air quality are all ways to lessen these consequences.

Overall, the health effects of atmospheric aerosols are a significant public health concern. There is need for continuous research work both at urban and rural areas to monitor the atmospheric aerosols to better understand their health effects. Efforts to reduce air pollution and promote cleaner energy sources can help minimize exposure to harmful aerosols and protect public health.

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Consent for Publication

The authors declare that they consented to the publication of this study.

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Authors' Contribution

All the authors took part in literature review, research, and manuscript writing equally.

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A STUDY ON ROLE OF GOVERNMENT IN FOSTERING UNORGANIZED WORKERS

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ABSTRACT

The present study deals with analysis the role of government in fostering unorganized workers .The main objective of the study is to find out the problems faced by the unorganized labours in their working place and the central and state government schemes for the labours especially unorganised workers. The study is based on secondary date collected from the various websites, journals, articles newspapers etc..The Government played an important role in fostering unorganized workers.

KEY WORDS: *Unorganised workers, Labour structure, working place, Govt. Schemes.*

I. INTRODUCTION

Most of the industries in India are in the unorganized sector and the majority of the economy consists of the informal or unorganized sector. According to a survey conducted by the National Sample Survey Institute in 2009-10, out of a total of 46.5 crore jobs in the country, about 2.8 crore are in the organized sector, while the remaining 43.7 crore workers are in the organized sector. They are working in every sector of the economy, mostly under one employer, under contract, as self-employed or as home-based workers. Although the informal or unorganized sector is an economic activity it is not taxed by the government and the output of this sector is not included in the gross national product. Yet it contributes significantly to the country's net domestic product.

The nature of the labor force in developed countries differs from that of a developing country like India in several respects. In developed countries, it is highly organized and such workers enjoy all social security benefits 'from cradle to grave'. But the labor force in developing countries like India is highly unorganized, unskilled and insecure. As a result wages, terms of employment and other social benefits are largely unavailable to unorganized workers in India.

II. LABOR STRUCTURE IN INDIA

A large number of workers in India are in the unorganized sector, such as proprietorship shops, street vendors, and those working in unregistered industries. Most of India's total workers are in the unorganized sector. Organized sectors obtain licenses and pay Goods and Services Tax. It includes companies, registered firms, factories, hotels and large enterprises, banks, railways, insurance companies, government employees and so on. The unorganized sector is usually self-employed without a permit. They do not pay any kind of goods and services taxes. Includes handicraft workers, handloom workers, readymade garment industry workers, village traders, agricultural laborers etc.

According to the Ministry of Labour of India 2008 report, unorganized workers are divided into four groups namely

a) Occupation Group: - Labours are on the occupation basis Stone Quarry Workers, Saw Mill Workers, Bricklayers Includes labourers, oil mill workers etc.

b) Nature of employment: - Labours are on the nature of the work or employment basis. It includes agricultural labour, casual labour, contract labour, migrant labour, bonded or indentured labour.

c) Detached Class: - labours are only on temporary social works includes threshers, porters, bullock cart drivers, jadamalis or scavengers, loaders and un loaders.

d) Service segment:- Labours are on the service basis includes midwives, barbers, fruit and vegetable sellers, domestic workers, newspaper sellers, street vendors, handcart pullers.

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III. OBJECTIVES OF THE STUDY

1. To understand the problems faced by the workers of readymade garment industry.
2. To know the social security programs undertaken by the governments for the welfare of workers.

IV. CHARACTERISTICS OF UNORGANIZED SECTOR WORKERS

- ✓ Workers in the unorganized sector do not have a specific job, location and a specific market for their output.
- ✓ Unorganized sector workers are socially and economically backward class.
- ✓ Unorganized sector workers go to work when they want and do not go to work when they don't want. Because they don't have a specific salary, there is no wage.
- ✓ In the unorganized sector there is no relationship between the workers and the employer. Their relationship is only till the employer pays them after the completion of their work.
- ✓ Daily wages, weekly wages and contract wages are high in the unorganized sector.
- ✓ Unorganized sector workers do not have any kind of training.

V. CLASSIFICATION OF WORKERS

Workers based on nature of employment

Based on the nature of employment is divided into two sectors organized and unorganized. According to the Economic Survey of India, it is clear that about 93 percent of the workforce works in the unorganized sector while 7 percent of the workforce works in the organized sector.

1. Organized Sector Workers:-

The organized sector consists of certain companies or workplaces in which the duration of employment is regular and the employees are guaranteed employment. They are authorized by the government and follow the laws and regulations laid down in various laws including the Minimum Wages Act, Factories Act, Payment of Gratuity Act, Shops and Establishments Act, etc. Government employees, government schools and colleges, registered industrial workers and banks are examples of organized sector.

2. Unorganized Sector Workers:-

The unorganized sector is generally an unregulated sector with rules and regulations laid down by the government relating to employment status. Construction companies, hotel management, farming and domestic work are various examples of unorganized sector. Individuals engaged in manufacturing, selling of products, self-employed, certain types of services and sectors with less than 10 employees are identified as unorganized workers or workers.

"Unorganized workers include those who work in the unorganized sector or households, other than workers in the formal sector with social security benefits provided by employers".

The term unorganized workers is defined as workers who are unable to organize themselves to pursue their common interests due to certain constraints such as casual nature of employment, ignorance and illiteracy, small and scattered organizations etc. It means home based worker, self employed or unorganized sector wage earner. According to the National Labor Commission, "It is very difficult to define unorganized workers. But persons unable to organize in pursuit of a common purpose include casual and irregular employment, ignorance and illiteracy, marginalization and small size establishment with low capital investment per employed person, widespread and dispersed nature of organizations and those acting singly or in combination".

"Unorganized workers include workers in the unorganized sector or households other than ordinary workers who enjoy social security benefits provided by employers". The difference between organized and unorganized sectors is mentioned in Table 3.1.

VI. CLASSIFICATION OF WORKERS IN INDUSTRY

Labor is divided based on many factors and many natures. The structure of working labor in India is made up of multiple layers. Classification of labor sector based on skill and area of operation The Ministry of Labour, Government of India has classified unorganized workers into three groups based on skill and area of operation.

a) Unskilled labour

Refers to workers who have no specific skills and no formal education. This type of work usually involves simple duties that are not required. In some cases, unskilled labor requires physical strength and endurance. Unfortunately, unskilled labor jobs are shrinking due to technological advances leaving fewer and fewer jobs for this type of worker. Eg: grocery clerks, maids, laborers, janitors and parking lot attendants etc.

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(a) Semi-skilled labour

Unskilled labor refers to workers who have no specific skills and no formal education. Semi-skilled labor does not require advanced training or specialized skills, but it requires more skills than unskilled labor employment. People who perform semi-skilled labor usually have more than a high school diploma, but less than a college degree. The types of skills required for this are not complex but often include the ability to supervise and perform repetitive tasks. These types of skills are more likely to be transferable and useful in other jobs. Example: Drivers, Retailers, Waiters, Waiters and Security Guards etc.

e) Skilled labour

Skilled labor refers to workers with specialized training or skills. These workers are able to exercise judgment and have knowledge of the specific trade or industry in which they work. People who perform skilled labor often have a college degree. Some examples of these types of jobs are law enforcement officers, financial technicians, nurses, sales representatives and electricians etc.

VII. WORKERS OF UNORGANIZED SERVICE SECTORS

Workers such as nurses, domestic workers, barbers, fruit sellers, vegetable sellers, paper sellers etc. fall into this category.

Besides these categories, there are some other categories which can be grouped under the category of unorganized workers. For example (a) home based activities like masala making, food processing, poultry and sale of milk and milk products. (a) Home based producers using small skills such as handloom weavers, handicraft artisans, sericulture workers, carpenters and tailors. (e) Retail trade and butchers or butchers, cobblers and rickshaw pullers, auto drivers, second-hand clothes sellers, flax etc. service providers.

Types of Wages

What a person receives in return for his services is called wages. Wages go by different names. For example salary to higher staff, wages to lower staff like clerks and typists, wages to laborers, fees to persons in independent profession like lawyers and doctors, commission to middlemen, brokers etc., and special work allowance or traveling allowance, tutti allowance etc. Payment of money or accommodation, travel allowance, entertainment allowance etc. in lieu of money to a person who renders services to the enterprise. These are temporary jobs. There are two types of concept of wages. They are as follows.

1. **Nominal wages or money wages**

An employer receiving services from an employee and paying for those services in the form of money is called wages. In other words, nominal or money wages are payments made by an employer to workers in the form of money without taking into account any other market conditions. The money given by a worker in exchange for services rendered to his enterprise is called nominal wages..

2. **Actual salary :**

Real wages are the amount of money or the amount of necessaries of life, comforts and luxuries etc. that money can buy, etc., which the worker or laborer receives in return for his services. Actual salary also includes additional fringe benefits along with cash salary.

Nominal wages are paid in money amounts. But real wages are paid in terms of necessities of life. Hence money wages are expressed in money terms as real wages in terms of goods and services.

3. Minimum wage rate in India

There are basically two methods of fixation of minimum wages under Section 5 of the Minimum Wages Act, 1948. They are committee method and notification method. The revision of minimum wages should not exceed an interval of 5 years. Section 3 empowers the appropriate Government to fix minimum rates of wages in specified occupations.

4. Fixed duration of work

The working period for a day is nine hours including a one hour lunch break. There is one day off in a week. The last day of the week is paid by the employer. Employers pay workers a full day's wages if they work more than four hours and less than eight hours.

VIII. PROBLEMS OF UNORGANIZED SECTOR WORKERS

The workers or laborers working in the unorganized sector are deprived of many benefits as compared to those working in the unorganized sector. The reasons for that are that workers suffer from various types of problems in their work. They are as follows:

1. **Job Insecurity:** Insecurity occurs in the workplace as a person pursues different jobs. They have more or less workload at work depending on the occasion, for example, readymade garments are in high demand during festivals, so the workers there have more work to do on festive days. When there is no work, they are fired.

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2. **Absence of regular earnings**: They are employed seasonally and periodically. Because of this only in such case there is more work and more money is possible. In later days they get less money due to less work.
3. **Variety in tasks:** They do different types of work. If you go to work in the morning, then you go to work at home and so on. Thus his work is diverse.
4. **Lack of training:** As they are highly illiterate they are unfit to work in any kind of big jobs and are engaged in menial jobs. They have no training whatsoever. Therefore, there will be no prosperity in their earnings and employment.
5. **Low Income**: The sector of unorganized workers is small and takes up employment with minimal capital. So their income will be less. Sometimes there are fluctuations in their employment.
6. **Poverty and Indebtedness**: They are below the poverty line. As they are illiterate they are poor without knowing how to avail the facilities. As their wages are low and uncertain, they are deprived of their basic amenities. When the debt increases and they find a way to pay it off, more of them commit suicide.
7. **Gender Discrimination:** As India is a male dominated society, women are not given much priority in employment. So most of the workers in this sector are male.
8. **Caste Discrimination**: India is a secular state. Divided into upper caste and lower caste Employers of A first select workers from their own caste and then hire workers from other castes.
9. **Unorganized sector** workers have neither job security nor financial security like organized sector workers. Unorganized sector workers are often reluctant to avail any schemes due to lack of information about government facilities. Unorganized sector workers are still facing problems as those schemes do not go to the right person.

IX. SOCIAL SECURITY SCHEMES FOR UNORGANIZED WORKERS

1. **Indira Gandhi National Old Age Pension Scheme (IGNO, APS)**
The scheme was launched on August 15, 1995 as part of the National Social Assistance Programme. The scheme was renamed as Indira Gandhi National Old Age Pension Scheme on 19 November 2007. The scheme is a non-contributory pension scheme which provides a monthly pension of Rs.200/- for below poverty line age group of 60-79 years and Rs.500/- for those above 80 years of age.
2. **National Family Benefit Scheme**
It is a part of the National Social Assistance Programme. Under this scheme, the family below the poverty line is given a grant of Rs.20,000/- in case of death due to natural or accidental causes, in the age group of 18 to 60 years, including the woman who is the sole income earner of the family.
3. **Janani Suraksha Yojana**
This Yojana was launched in 2005 by Prime Minister Dr. Manmohan Singh. The scheme is sponsored by the Central Government. This scheme is implemented by all states and Union Territories of India. The scheme has been implemented with special focus on low performing states. Later it was renamed as National Maternity Benefit Scheme as it was also a part of the National Social Assistance Programme. Ante-natal and post-natal care for first two live births for below poverty line women aged 19 years and above Rs. 500/- providing financial assistance. Janani Suraksha Yojana is an intervention for pregnant women and new mothers.
4. **Health Insurance Scheme**
It provides health insurance to handloom weavers. This unit follows the National Health Insurance scheme model. This scheme is now available as Ayushman Bharat scheme. Prime Minister Narendra Modi launched this scheme. This scheme will benefit those below the poverty line. It is available to any unorganized workers and registered members of welfare boards only.
5. **New projects**
In addition to these social security measures, the Government of India implemented some new schemes and legislation to strengthen the social security of unorganized workers in India. What are they?

X. FIVE MAJOR WELFARE SCHEMES OF KARNATAKA LABOR WELFARE BOARD

The Karnataka Labor Welfare Fund was established in 1965 to finance and conduct activities. Its main objective is to promote workers and work for their prosperity. 1965 under the Karnataka Workers Welfare Act as the name suggests was established for the welfare of workers. During the year 2018-19, the Karnataka Labor Welfare Board implemented five major welfare schemes. They are as follows.

1. **Educational assistance to children of labourers.**
Scholarships are provided under this scheme for the education of children of workers. 3000/- for student/youth studying 8th to 10th standard of Fraudashishan, undergraduate education, diploma, 4000/-

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for student/youth, graduate 5000/-, post graduate 6000/- and technical, . 10,000/- for those pursuing medical education for general candidates with 50% marks and scholarship for Scheduled Caste and Scheduled Tribe students/students. About 21,127 students in Karnataka have been given assistance worth Rs.8.57 crores.

2. **Medical assistance**
   Minimum Rs. 1000/- to a maximum of Rs. 10,000/- and For medical check-up Rs. 200/- to Rs. 600/- for medical assistance
3. **Accident assistance**
   This plan covers a minimum of Rs 1000 to a maximum of Rs 3000. This scheme is envisaged when workers are subject to accidents at their work places or other places.
4. **Funeral expenses**
   5000/- as funeral expenses are paid to the family members when the workers die. 16, 27,500/- has been given to about 326 families under this scheme.
5. **Annual sports activity**
   50,000 as financial assistance under this scheme for district level annual sports activities conducted once a year by registered trade unions. 700 beneficiaries received Rs.50000/- from one union in 2018-19. porters, domestic workers, rag pickers, tailors, mechanics, washer men, barbers, goldsmiths, iron workers, potters and Steps have been taken to register and distribute smart cards under one title and one logo to 11 categories of unorganized workers including kiln workers.

XI. CONCLUSION

It is widely accepted that unorganized workers are the most vulnerable and insecure section of the society despite their immense contribution to the Indian economy. Unorganized workers have increased at an alarming rate but their basic problems are still unsolved. Government of India has taken many social security schemes to improve the condition of unorganized workers. Due to illiteracy, most of the unorganized workers are not aware of their rights and welfare schemes of the government. In some cases, even though they are aware of the government schemes, the unorganized workers do not know where to contact and how to contact them. Therefore, the National Social Security Council, a part of the government, and the NGOs (Non-Governmental Organizations) should come forward to provide information to the unorganized workers to avail the benefits of these schemes.

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CRITERION-03: Research, Innovation and Extension

3.3.1 List of research papers published per teacher in the Journals in 2021-22

(July-2021 to June-2022)

Sl No	Title of the Article	Name of Author	Publication Journal name	ISSN No	Year of Publication	Page No
01	A Check List Fish Fauna Of Narayanpur Dam, Shorapur Taluk, Yadgir District, Karnataka.	Dr. Dupam Satheesh	Glacier Journal Of Scientific Research	2349-8498	Oct-21	01 – 05
02	Information Technology Impact On Banking Industry In India	Anupama K	Mukt Shabd Journal	2347-3150	January - 2022	06 - 15
03	In-Vitro Antioxidant And Anticancer Activities Of Mnfe2o4 Nanoparticles Synthesized Using Spinach Leaves Extract	P.J. Bindu	Applied Nanomedicine	2(1), 330	Feb-2022	16 - 22
04	E-Banking And Its Impact On Rural People	Anupama K	Social Vision	2349-0519	April – June 2022	23 – 32

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3.3.1 Number of research papers published per teacher in the Journals notified on UGC CARE list during the last five years (2021-22)

Title of paper	Name of the author/s	Department of the teacher	Name of journal	Calendar Year of publication	ISSN number	Link to the recognition in UGC enlistment of the Journal /Digital Object Identifier (doi) number		
						Link to website of the Journal	Link to article / paper / abstract of the article	Is it listed in UGC Care list
A Checklist fish fauna of Naryanpur Dam, Shorapur Taluk, Yadgir District of Karnataka	Dr. Dupam Satheesh	Zoology	Glacier Journal of Scientific Research	Oct-21	ISSN-2349-8498	**https://www.glacierjournal.org**	https://www.glacierjournal.org/wpadmin/upload/papers/1633441532-CHECK%20LIST%20FISH%20FAUNA%20OF%20NARAYANPUR%20DAM%20(1).pdf	No
Information Technology Impact on Banking Industry in India	Dr.Anupama K	Commerce	Muktha Shabd	Jan.2022	ISSN-2347-3150	**https://shabdbooks.com**	https://app.box.com/s/msh78eqe1afohr1dc7isiky2gwwm1l6t	Yes
In-Vitro antioxidant and anticancer activities of MnFe2O4 nanoparticles synthesized using spinach leaves extracts	Dr. P.J.Bindu	Chemistry	Applied Nano Medicine	Feb-22	2(1),330	**https://pubs.thesciencein.org/nanomaed**	https://pubs.thesciencein.org/journal/index.php/nanomed/article/view/330	No
E-Banking and its impact on rural people	Dr.Anupama K	Commerce	Social Vision	Apr-22	ISSN-2349-0519	**http://generalif.com**	https://generalif.com/jdetails.php?jna	No

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Glacier Journal Of Scientific Research ISSN:2349-8498

A CHECK LIST FISH FAUNA OF NARAYANPUR DAM, SHORAPUR TALUK, YADGIR DISTRICT, KARNATAKA.

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-: Abstract: -

The present study deals with check list fish fauna of Narayanpur dam in shorapur taluk Yadgir district, Karnataka. The present investigation was undertaken in November-2020. The result of present investigation confirmed the occurrence of eighteen fish species belonging to six Orders. Order Cypriniformes was dominant with seven species, followed by Siluriformes with five species, and Perciformes with three species, and Channiformes, Mastacembeliformes and Osteoglossiformes each with one species.

Keywords: - Narayanpur dam, fish fauna, surpur.

Glacier Journal Of Scientific Research ISSN:2349-8498

Materials and Methods: -

Study Area

Narayanpur Dam, it is also called **Basava Sagar Dam.** It was constructed across the Krishna River. It has total storage capacity of 37.965 tmcft (1.075 km³), with 30.5 tmcft (0.85 km³) live storage. The full reservoir level is 492.25 m MSL and the minimum draw down level is 481.6 m MSL. It was a single purpose project meant only for irrigation, but downstream electrical generation and drinking water considerations enter into its management. The dam is 29 meters high and over 10 kilometres long, and has 30 gates for water release.

It was completed in 1982, it provided water to irrigate 4.21 lakh hectares in Jewargi Taluka in Kalaburgi district, Shahpur and Shorapur talukas in Yadgir district, Sindagi and Indi talukas in Bijapur district, and Lingsugur and Devadurga talukas in Raichur district.

Sampling

The present work is an attempt to study fish fauna check list at Narayanpur Dam. Fishes were collected from different selected localities during the study period with the help of local fishermen using different types of nets namely gill nets, cast nets and dragnets. Immediately photographs were taken prior to preservation since formalin decolorizes the fish colour on long preservation. Formalin solution was prepared by diluting one part of concentrated formalin or commercial formaldehyde with nine parts of water *i.e.,* 10% formalin. Fishes brought to the laboratory were fixed in this solution in separate jars according to the size of species. Smaller fishes were directly placed in the formalin solution while larger fishes were given an incision on the abdomen before they were fixed. The fishes collected and fixed were labelled giving serial numbers, exact locality from where collected; date of the collection, the common local name of fish used in this region was labelled on each jar. Identifications done were based on keys for fishes of the Indian subcontinent. Classification was carried out on lines of (Jayaram,1981) the identification of the species was done mainly on the basis of the colour pattern, specific spots or

Due to multiple uses of fisheries resources, fishing has become a major industry and a large number of these aquatic communities are under a big threat of extinction. Habitat loss and environmental degradation has seriously affected the fish fauna. Knowledge of available resources and the biological characters of species serve the base line information for further studies on resource conservation and maintenance. Further, there is a need for survey of diversity of fish fauna in different types of habitats all over the country. Industrial effluents and manmade pollutants also contribute towards the disruption in the balance on aquatic ecosystem. The work will provide future strategies for development and fish conservation. Conservation measures requires forestation in catchments and awareness on illegal fishing and killing of fishes

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In-vitro antioxidant and anticancer activities of $MnFe_2O_4$ nanoparticles synthesized using spinach leaves extract

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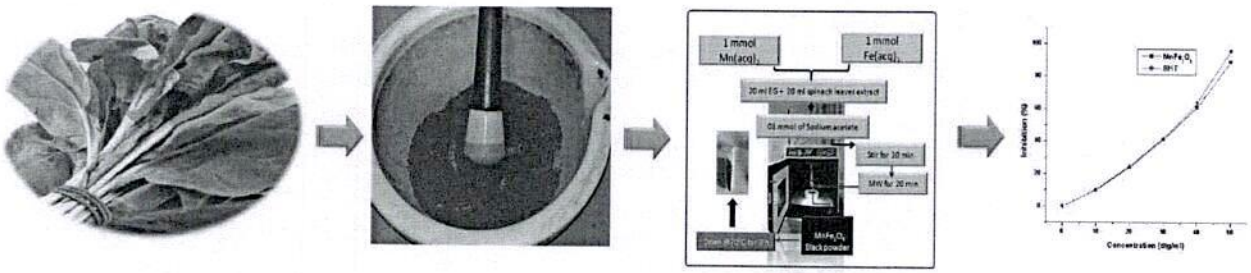
Article

ABSTRACT



Herein, $MnFe_2O_4$ nanoparticles were synthesized using microwave-assisted method in the presence of spinach leaves extract. The In-house synthesized metal Mn (II) and Fe (III) 3-acetyl-coumarin metal complexes were characterized by FTIR, 1HNMR and Mass spectra. The as-synthesized nanoparticles were characterized by FTIR, XRD, FESEM and vibrating sample magnetometer. The addition of spinach leaves extract reduces the particle size more. The antioxidant activity of functionalized $MnFe_2O_4$ was carried out. According to the results obtained, $MnFe_2O_4$ is a potential material for antioxidant material. The free radical scavenging properties of the compounds were also examined in vitro by determining the capacity to scavenge superoxide anion formation and the interaction with the stable free radical 2,2-diphenyl-1-picrylhydrazyl (DPPH). The compounds showed a significant effect in the above tests except to scavenge superoxide anion formation. The $MnFe_2O_4$ nanoparticles could be readily separated from water solution after the disinfection process by applying an external magnetic field.

Keywords: Spinach leaves extract, Microwave, 3-Acetyl-coumarin, $MnFe_2O_4$, antioxidant

INTRODUCTION

In recent years much evidence has proved the link existing between the development of human diseases and oxidative stress, oxidative stress being caused by increased free radical generation. There has been an intensive interest in the role of oxygen-free radicals, more generally known as reactive oxygen species (ROS) along with reactive nitrogen species (RNS).[1] These ROS are produced as a normal consequence of biochemical processes in the body and as a result of increased exposure to environmental and dietary xenobiotics. It is an imbalance in this oxidant versus antioxidant processes that is thought to cause subsequent cellular damage which leads to the disease processes named above.[2] The body's antioxidant systems, including enzymatic systems (superoxide dismutase, catalase) and both aqueous (glutathione-GSH and ascorbate) and non-aqueous scavengers (vitamin E) should control the oxidative processes. Drugs possessing antioxidant and free radical scavenging properties are considered for the prevention and/or treatment of such diseases which are directly related to the lack of the antioxidant capacity of the body.[2]

On the other hand, nanoparticles medicines was found as a potential compared to the traditional herbal medicines. In recent days, nanomaterials applications in antidiabetic studies has drawn attention due to their exceptional features such as very little dimensions, aptitude to pass through the cell membrane to transport medications and bio-adaptability.[3,4] The stunning advancement in nanotechnology has opened up innovative applications in various areas such as agricultural, biomedical sciences,[5] catalysis,[6] chemical industry, cosmetics, drug-gene

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delivery,[7] electronics, energy science,[8] mechanics, optics,[9] gas sensing[10] and space industry.

In this work, we considered spinach leaf extract for the synthesis of $MnFe_2O_4$ magnetic nanoprticles. Basically, spinacia oleracea, known as spinach, is a leafy green plant that belongs to the family of Amaranthaceae and is a super food as it has lots of nutrients that are beneficial to humans. It is an excellent source of iron and contains 0.81 g of iron. Few reports were available on the synthesis of ZnO NPs,[11] AgNPs,[12] FeNPs[13] and TiO_2 nanoparticles using spinach extracts.[14]

In particular, magnetic $MnFe_2O_4$ spinel ferrites was widely used in many areas, such as magnetic devices, switching devices, permanent magnets, magnetic refrigeration, lithium ion batteries, catalyst.[15] Therefore, based on the applications, an appropriate synthesis method has to be selected to achieve specific performance. Several physical and chemical methods are available for the synthesis of $MnFe_2O_4$ ferrites including thermal decomposition,[16] co-precipitation,[17,18] sol-gel,[19] microwave-hydrothermal and high-energy ball milling have been used to synthesize manganese ferrite nanoparticles. However, ferrite nanoparticles have been synthesized successfully through most of these techniques, but these conventional methods, though successful, require specially designed and expensive equipment, extra purification steps, rigorous reaction conditions and/or relatively high temperatures. The synthesis of these nanomaterials with controlled size and shape is still a major challenge and large scale synthesis of phase pure manganese ferrites nanoparticles at relatively low temperatures, using readily available, environmentally benign and cost-effective precursors is a synthetic challenge.

The spinach leaves extract can provide a desirable reaction medium and act as reducing agent in synthesis process. Green synthesis using plant extract, in particular, has attracted a great deal of research interest as they led to facile production of more stable nanoparticles.[20,21] The extracts of spinach leaves, been used as promising choices for facile green synthesis of nanoparticles in the reported literature.[11–14] This study aimed at producing $MnFe_2O_4$ via a green route, using spinach leaves extract as capping agent, and investigate their antioxidant activity. The $MnFe_2O_4$ were prepared using a microwave-assisted method in the presence of ethanolic extract of spinach leaves and the characteristics were determined using X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), energy dispersive analysis of X-rays (EDX), Fourier transform-infrared spectroscopy (FT-IR), thermogravimetric analysis (TGA), and UV-vis diffuse reflectance spectroscopy (UV-vis). Subsequently, the antioxidant activity and in-vitro cytotoxic activity of the newly synthesized $MnFe_2O_4$ nanoparticles against MCF-7 and HeLa cell lines were reported. The main objective of the present study was synthesize spinach leaves extract catalyzed $MnFe_2O_4$ nanoparticles using manganese and iron complex of 3-acetylcoumarin as precursor for the first time.

EXPERIMENTAL

Materials and equipment

All the chemicals used in the present study are of AR grade. Whenever analytical grade chemicals were not available, laboratory grade chemicals were purified and used. $FeCl_3.6H_2O$, $MnCl_2.4H_2O$ and KOH obtained from Merck chemicals and are directly used without further purification. In house prepared spinach leaves extract. 1, 1-diphenyl-2-picrylhydrazyl (DPPH), butylated hydroxytoluene (BHT), trichloroacetic acid, EDTA, were purchased from Fluka. 1H-NMR spectra were obtained using a 400 MHz on a Bruker spectrometer (chemical shifts in δ ppm), A Ultra 55, high resolution field emission scanning electron microscope (FESEM) was employed to analyze the surface morphology of the samples. The crystallinity of samples and their phase composition were examined by X-ray powder diffractometry (XRD, Rigaku, smart lab), X-ray photoelectron spectra (XPS) was recorded on Axis-ultra equipment. The samples were then examined by brightfield, high-resolution electron microscopy (HRTEM) was recorded on TECNAI GT-20 microscope operated at an accelerating voltage of 200 kV.2.2. We have synthesized 3-Acetyl-4-hydroxy-coumarin (acu) ligand[22–24] and its Fe and Mn metal complexes as reported earlier.[25] The obtained metal complexes was confirmed by IR, ^{1}H NMR, Mass and TGA spectral analysis.

Spinach leaves extract preparation.

The dried spinach leaves was obtained from a market and authenticated by a botanist. The spinach leaves were washed with distilled water to remove dusts and dried. Then, the dried spinach leaves were ground into uniform powder using a mortar and pestle. A total of 15 mg of the ground powder was weighed out and soaked in 100 ml of 96% ethanol in a conical flask and agitated on an orbital shaker at room temperature for 72h. Then, the mixture was filtered using Watman No. 1 filter paper. After that, 20 ml of the filtered extract was used in the synthesis and the rest of it was dried on a flat surface to evaporate the solvent and the resultant powder was stored at 4 ℃ for subsequent experiment.

Synthesis of $MnFe_2O_4$ nanoparticles by MW method.

Solutions of 1 mmol of Mn (II) 3-acetyl-4hydroxy-coumarin (Mn(acu)2) and 2 mmol of Fe (III) 3-acetyl-4hydroxy-coumarin (Fe (acu)3) dissolved in 20 mL of ethylene glycol and 20 ml of the spinach leaves filtered extract mixed together under constant stirring. The pH of the solution is adjusted to the desired value by 3 mmol of sodium acetate (alkaline source) with constant stirring for 20 min. The reaction mixture is irradiated into a MARS (Microwave Accelerated Reaction System, USA) microwave reactor (2.45 GHz) equipped with a water-cooled condenser and a fiber-optic temperature sensor. The solution was then irradiated for 20 min with the power set at 800 W and temperature at 250 ℃ leading to a black precipitate. After completion of reaction, the powder materials was also collected by centrifugation, washed twice with deionized water, ethanol, acetone and dried in vacuum oven at 70 ℃ for 4h.

Characterization of nanoparticles

The crystallinity and phase composition of the $MnFe_2O_4$ nanoparticles were investigated using an X-Ray Diffraction (XRD) – analysis was done with Rigaku X-ray difractometer, FT-IR studies were carried out using a Perkin Elmer Frontier FTIR spectrophotometer. Scanning electron Microscopy (SEM) and X-ray Energy dispersive Spectroscopy (EDS) analysis was done using ULTRA55 FESEM equipped with EDS, XPS was done with kratos axis ultra dld spectrometer, TGA of was carried out using Perkin Elmer STA 8000.

Antioxidant activity of $MnFe_2O_4$ nanoparticles

DPPH radical scavenging activity

The antioxidant activity of naphthyridines on DPPH radical radical scavenging activity was measured according to the literature method[26–29] The different concentrations (10, 20, 30, 40, and 50 µg/mL) of $MnFe_2O_4$ nanoparticles were prepared. A methanolic solution of DPPH (0.15%) was mixed with different concentrations of compounds. The mixture was shaken vigorously and left to stand for 15 min. Absorbance of the resulting solution was measured at 517 nm in a UV–visible spectrophotometer (UV-160A, Shimadzu co. Japan). All measurements were made in triplicates with BHA as a positive control. IC50 represents 50% of the radicals scavenged by the test sample.

Hydrogen Peroxide (H_2O_2) Scavenging Assay

The hydrogen peroxide scavenging ability of different concentrations (10, 20, 30, 40, and 50 µg/mL) of $MnFe_2O_4$ nanoparticles were investigated based on the scavenging of the hydrogen peroxide in ABTS-peroxidase system described by Muller (1995).[30] A measurement of 80 µL of each concentrations of compounds and 20µL of 10mM hydrogen peroxide was mixed with 100 µL of phosphate buffer (pH 5.0, 0.1 M) in a 96-microwell plate and the samples were incubated for 5min at 37 °C. Subsequently, 30µL of freshly prepared 1.25 mM ABTS and 30 µL of peroxidase were added and incubated for another 10 min at 37 °C. Absorbance of the resulting solution was measured at 405nm in a UV–visible spectrophotometer (UV-160A, Shimadzu co. Japan).

Evaluation of Cytotoxicity Activity of $MnFe_2O_4$ nanoparticles

Human breast carcinoma (MCF-7) and HeLa cell lines were used to evaluate the in-vitro cytotoxic properties of newly synthesized $MnFe_2O_4$ NPs as described previously by Ravikumar. Briefly, the cells were cultured on Dulbecco's Modified Eagle's Medium (DMEM) added with l-glutamine (2 mM), penicillin (100 U/mL), streptomycin (100 g/mL) and fetal bovine serum (10%). Approximately 5 x 104 cells were inoculated in each well of 96-well plates and incubated in a carbon dioxide incubator maintained at 37 °C for 48 h. The different concentrations (0, 20, 40, 80, and 160 µg/mL) of $MnFe_2O_4$ nanoparticles incubated for 24, 48 and 72 h separately to study cell viability using 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay. About 10 mL of MTT solution (5 mg/mL) was added to each well and further kept for 4 h of incubation under the same conditions and using a multi-well ELISA plate reader, absorbance was recorded at 570 nm. The absorbance was converted to percentage of cell viability by using the following formula:

% of cell viability = Value in the experimental sample/Value of optical density in control sample

RESULTS AND DISCUSSION

In the earlier work we have reported the efficient synthesis of metal β-diketonate complexes for materials synthesis.[31,32] The stability of the complexes has been influenced by the rigidity of the ligand backbone. As part of our continuing interest to synthesize metal complexes of β-diketonate type, we have synthesized coumarin metal complex with the similar ligand framework. During the metal complex formation, the 3-acetylcoumarin coordinates like 3-acetyl camphor with the metal salts. We also have made an attempt to synthesize the spinach leaves extract (figure 1) mediated microwave assisted synthesis of $MnFe_2O_4$ nanoparticles using coumarin metal complexes. Therefore, the metal complex of acetyl coumarin has been synthesized by the modified procedure of Gairola et al.[16]

From the results of FTIR, TGA and spectroscopic studies, the stoichiometry of the complexes has been deduced as M(acu)2 and M(acu)3. This coumarin entity has oxygen donor framework from hydroxyl and acetyl groups and, therefore, stabilizes comfortably the metal ions in their +2 and +3 oxidation state.

Crystalline structure

Magnetic nonmaterials exhibit unusual physical and chemical properties,[33] significantly different from those of conventional bulk materials, due to their extremely small size or large specific surface area.[19] So, their preparation and characterization have attracted increasing attention from the past decades. The ecofriendly ferrites are well known for their enormous applications in the field of magnetic and electronic materials, and currently there are more reports on their biological and biomedical applications.

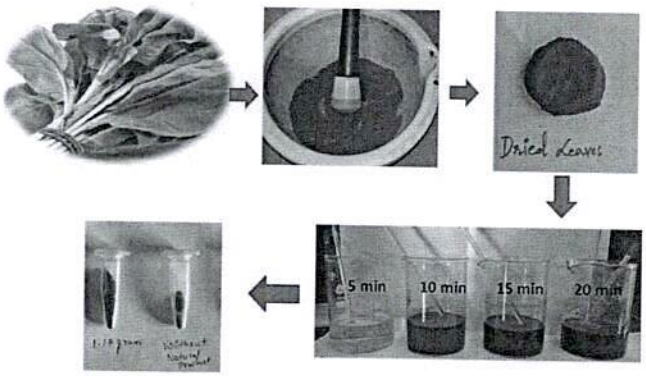

Figure 1. Preparation of Spinach leaves extract for the synthesis of $MnFe_2O_4$ nanoparticles

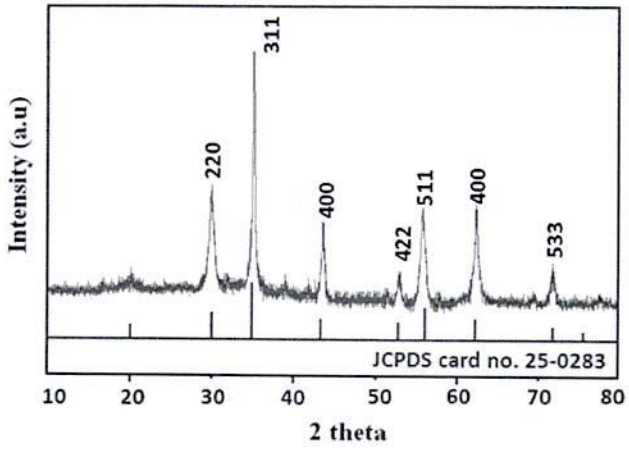

Figure 2. XRD of $MnFe_2O_4$nanoparticles

The phase of the synthesized $MnFe_2O_4$nanoparticles was identified by XRD characterization. As shown in Figure 2, the characteristic peaks at (111), (220), (311), (400), (422), (511) and (533) crystalline phases as referred to in the pattern, in accordance with JCPDS 25-0283, and no other impure phases were found. The average crystallite size of the $MnFe_2O_4$ nanoparticles is determined from the broadening of the peaks corresponding to the (311) diffraction, using Scherrer's formula. The predicted crystallite size of $MnFe_2O_4$ is about 11.0 nm.

Fourier transform infrared spectroscopy (FT -IR) studies

The formation of the $MnFe_2O_4$ nanoparticles by in the microwave method is further supported by FT-IR spectrum is as shown in Figure 3. The spinel phases are located at 612 and 446 cm-1, which are associated with the vibrations of Mn-O and Fe-O bonds, respectively. In ferrites the metal ions occupy two different interstitial sites in the lattice. One is at the tetrahedral site while the other is at the octahedral site.[34] From the FT-IR spectra, it is found that high frequency bands at 1123 cm-1 is associated to the tetrahedral site while the low frequency band at 709 cm-1 is associated to the octahedral site. The sharpness of these bands is correlated to the high degree of crystallinity of $MnFe_2O_4$ nanostructures. A broad vibration band at 3425 cm-1 are associated with the O–H stretching vibration of the adsorbed water molecules indicating higher amount of surface OH.[34]

Scanning electron microscopy (SEM) and EDX analysis

The surface morphology of the samples was observed by FESEM (Figure 4). The highly agglomerated/crystalline agglomerated nanoparticle prepared by microwave method was shown in Figure 4. The results showed that grain sizes and morphology was depended strongly on the microwave-assisted synthesis and precursor materials. An EDX pattern (Figure 5) shows that the magnetic clusters were primarily comprised of carbon, oxygen, Mn and iron. The results suggested that the precursors have fully reacted in chemical reaction to form the single phase $MnFe_2O_4$ nanoparticles and it confirms that there is no other impurity present in the samples. It is suggested that the relative atomic mass ratio of the metal ferrites are well matched along with the stoichiometry in preparation.

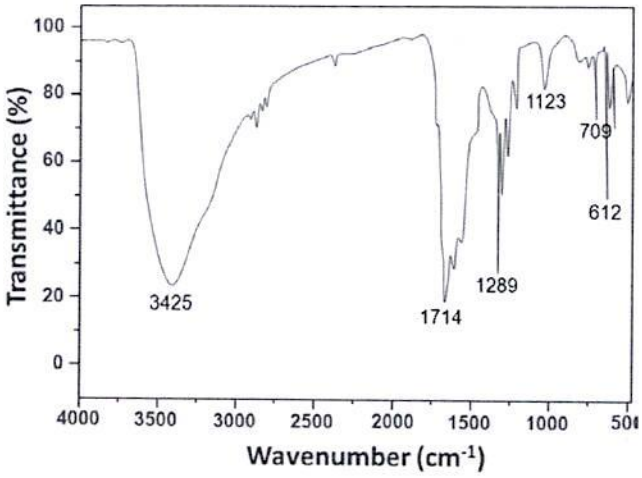

Figure 3. FTIR spectra of $MnFe_2O_4$ nanoparticles

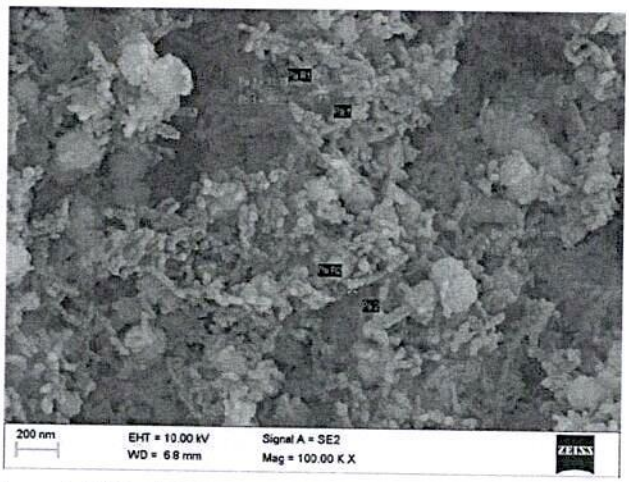

Figure 4. SEM of $MnFe_2O_4$ nanoparticles

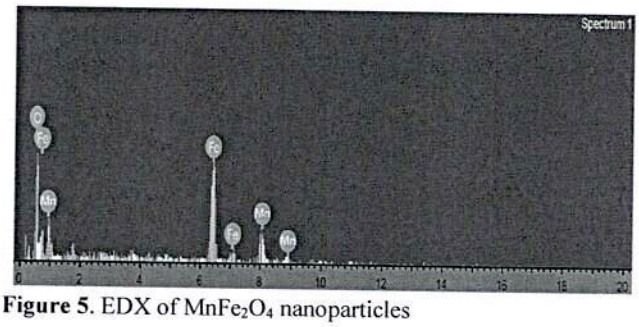

Figure 5. EDX of $MnFe_2O_4$ nanoparticles

XPS-analysis

The chemical composition of $MnFe_2O_4$ nanospheres was further investigated by XPS. The XPS survey spectrum in Figure 6a reveals that elements Mn, Fe, O, and adventitious C exist in the nanospheres. As shown in the spectrum in Figure 6a, the peak of 654.3 eV and 642.5 eV could be attributed to Mn2p1/2 and

Mn2p3/2 in the sample. Figure 6b shows the Fe 2p1/2 peaks at the binding energies of 725.6 and 711.8 eV, which is consistent with that reported for Fe2p3/2 in the sample. The peak located at 534.0 eV is attributed to the O1s region in Figure 6c.

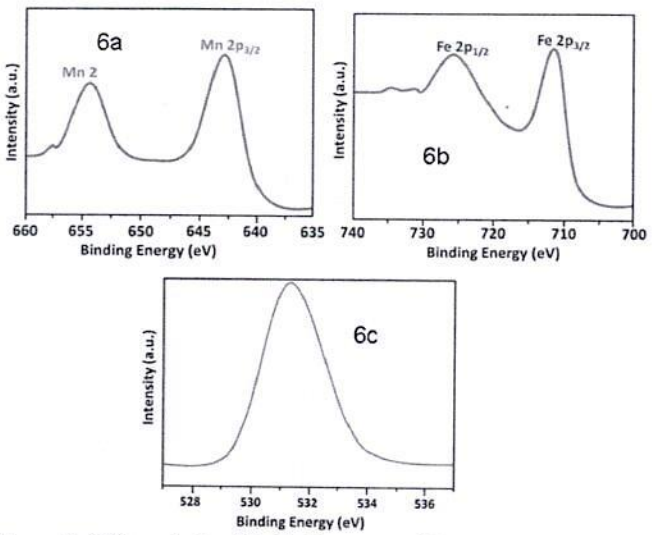

Figure 6. XPS analysis of $MnFe_2O_4$ nanoparticles

Magnetic properties.

Magnetic characterization of the as-prepared $MnFe_2O_4$ nanoparticals was carried out at room temperature using Vibration Sample Magnetometer (VSM) and the hysteresis loop of the sample is shown in Figure 7. From the figure, it is observed that the variation of magnetization as a function of applied field shows a narrow cycle and the hysteresis loop characterizes the behavior of soft magnetic materials. The saturation magnetization of manganese ferrite is 42.73 emu/g which is higher than that are reported earlier and the value nearly approached the bulk values of 50 emu/g.42-44 The lower value of the saturation magnetization of the nanoparticles is due to the combined effect of surface spin disorder, formation of spin glass structure and magneto crystalline anisotropy.

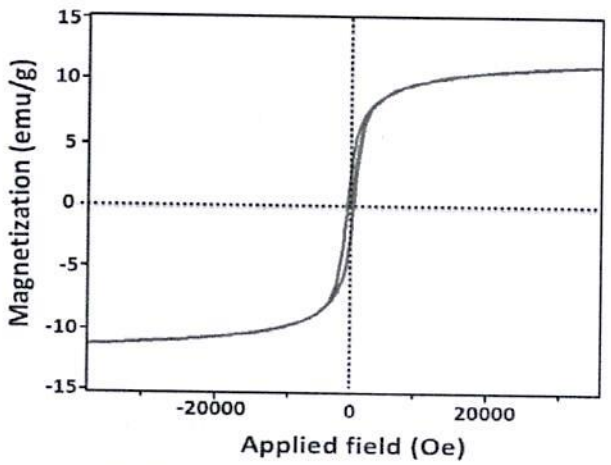

Figure 7. Hysteresis loops of in house synthesized $MnFe_2O_4$

The in vitro antioxidant effects of the $MnFe_2O_4$ nanoparticles.

DPPH radical scavenging activity

The $MnFe_2O_4$ nanoparticles exhibited a significant dose dependent inhibition of DPPH activity, with a 50% inhibition (IC50) at a concentration of 2.5 µg/ mL. The result is mentioned in figure 1. The results of the inhibitory effects of different concentrations of synthesized compounds on DPPH free radical showed that almost all the synthesized $MnFe_2O_4$ nanoparticles at 10-3M concentration had DPPH free radical scavenging activity, the scavenging extent being in the range 22–98%. It demonstrated the highest inhibitory activity compared to other antioxidants studied, reaching as high as 96.42 %, while for BHT was needed to achieve DPPH radicals' inhibition of 100 %.

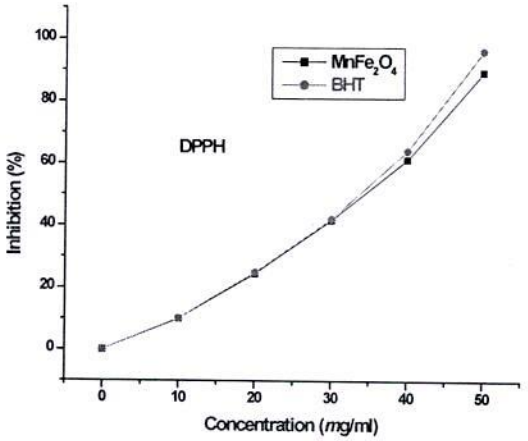

Figure 8. Scavenging effect of $MnFe_2O_4$ nanoparticles and standard BHT on 1, 1'-Diphenyl-2-picryl hydroxyl (DPPH) radical.

Hydrogen peroxide scavenging assay

To attack the substrate deoxyribose hydroxyl radicals were generated by reaction of Ferric-EDTA together with H_2O_2 and ascorbic acid. When the synthesized $MnFe_2O_4$ nanoparticles were incubated with the above reaction mixture, it could prevent the damage against sugar. The results are shown in figure 9.

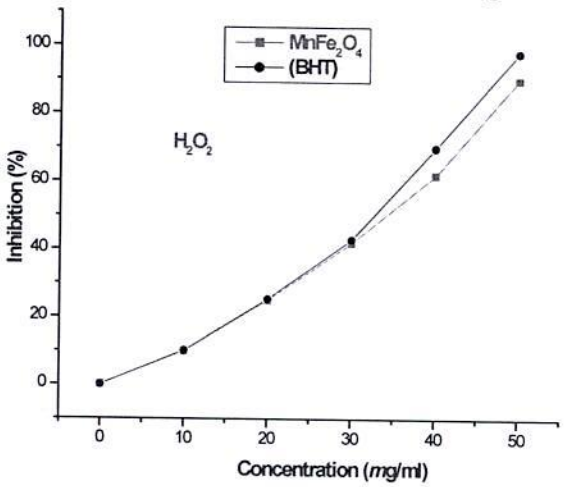

Figure 9. Scavenging effect of $MnFe_2O_4$ nanoparticles and standard BHT on Hydrogen Peroxide (H_2O_2) Scavenging Activity.

$MnFe_2O_4$ nanoparticles showed strong H_2O_2 scavenging activities (IC50 0.005 ± 0.002mg/mL) and (IC50 0.008 ± 0.002 µg / L) which were significantly ($p<0.05$) higher than those of commercial antioxidants (IC50 0.060 ± 0.04mg/mL for BHT. Almost all concentration of magnetic materials showed good activities in H_2O_2 scavenging indicating the potential of synthesized compounds.

In Vitro Cell Cytotoxicity

The anticancer activities of newly synthesized $MnFe_2O_4$ and conventional anticancer agent doxorubicin were examined on the panel of two cancer cell lines MCF−7 and HeLa cells. The potency of $MnFe_2O_4$ different concentrations of MNCs (0, 20, 40, 80 and 160 µg/mL) of $MnFe_2O_4$ nanoparticles incubated for 24, 48 and 72 h was determined using MTT (Thiazolyl Blue Tetrazolium Bromide) assay. The two different breast cancer cells are invasive and have many phenotypic/genotypic differences. As evident from the activity data presented in Figure 10, breast cancer cell line (MCF7) was the most susceptible cancer cell line to the toxic effects of the tested $MnFe_2O_4$. It was found that the nanoparticles are biocompatible as experimented in MCF-7 (Figure 10a). Conversely, HeLa treated with MNCs showed a significant decrease in cell viability (Figure 10b).

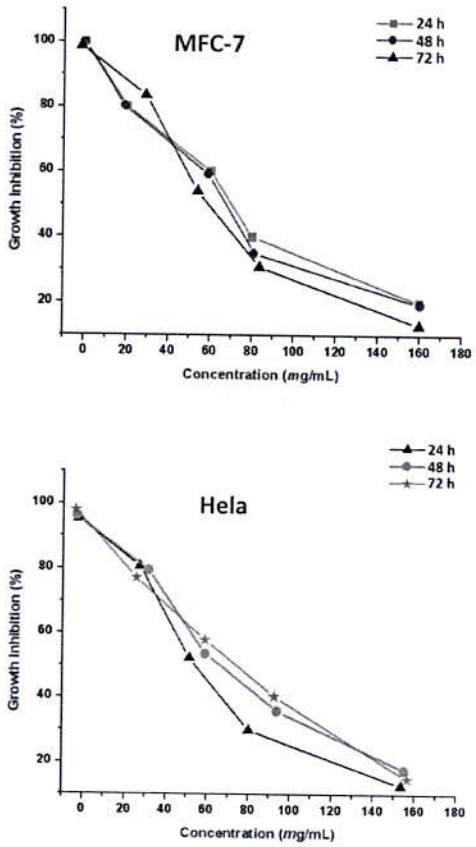

Figure 10. In Vitro anticancer activity $MnFe_2O_4$ NPs.

The cell viability of MCF-7 and HeLa significantly decreased to ~40 and 50%, respectively, when treated with MNCs at different concentration (Figure 10a). The different responses of HeLa and MCF-7 cell lines toward the cytotoxicity are possibly due to the difference in their molecular mechanisms. The cell death may be due to the reactive oxygen species (ROS) generation by $MnFe_2O_4$, which are very toxic toward the cancer cells and can be explained as follows: in acidic cancer cell pH (~4–5), $MnFe_2O_4$ may disintegrate into Mn^{2+}, Fe^{2+}, and Fe^{3+} ions. The resulting leached Mn^{2+} ions play a prime role in the generation of ROS by dissociating H_2O_2 present in the mitochondria into hydroperoxyl (HOO•) and hydroxyl (HO•) radicals through Fenton's reaction.[35,36] The possible Fenton's mechanism is explained below.

$$2O_2^- + 2H^+ \rightarrow H_2O_2 + O_2$$

$$HO_2^{\cdot} + O_2^{-\cdot} + 2H^+ \rightarrow H_2O_2 + O_2$$

$$2HO_2^{\cdot} \rightarrow H_2O_2 + O_2$$

Conclusion

Spinach leaves extract mediated microwave-assisted synthesis and biological activity of $MnFe_2O_4$ was reported. We have developed a new manganese and iron complexes of 3-acetylcoumarin precursor materials for the synthesis of metal oxide nanomaterials. The spectroscopic studies show that metal to ligand ratio is 2:1 and 3:1. The thermal behavior of the new metal precursors was characterized by TGA analysis. This bio-extract mediated microwave method is fast and template-free, cost-effective, and simple method for the preparation and remarkably shortened preparation time and avoided complicated preparation procedures. Further, we investigated the antioxidant activity of as synthesized $MnFe_2O_4$ nanoparticles. The cytotoxicity study conducted in breast cancer cells (MCF-7 and HeLa) lines revealed that the $MnFe_2O_4$ are biocompatible but possessed a significant toxic effect to breast cancer cells, probably due to generation of ROS. The offered nanoferrite crystals are recommended for versatile applications in biomedicine as they displayed broad range of magnetic properties. Thus presented and the findings would form a possible future platform for designing Spinach leaves extract based nano-structured systems with improved properties for cosmetic applications, preventing also the UV-induced ROS production.

Acknowledgments

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Conflict of Interest

Authors declared no conflict of interest.

REFERENCES AND NOTES

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E-Banking and Its Impact on Rural People

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ABSTRACT

The current circumstances progress the requirement of e-banking, had a critical influence on the usage of conventional banking and focused on the influence during the pandemic, however their preferences related to trust, safety and security, reliability, website designs and customer support, and an interesting changed. Many of the persons have taken the initiation to start using modern banking services. Now a day banks are providing various E-banking avenues to serve the customers with the help of inter connected banking networks had reached to rural areas. In recent days banking sector plays a pivotal role in the process of economic development of a country, India is not an exception to this. In India banking sector was well developed system after independence with several sorts of banking were emerged such as public sector banks, foreign banks, private sector banks, regional rural banks and co-operative banks. These banks are providing various sorts of services to the customers by the way of easy transactions of funds at the national and international level, which leads to better performance in other sectors of the country. India had witnessed several innovations in the banking sector since the introduction of globalization, such as Electronic Payment Services, Electronic Funds Transfer, Electronic Clearing Service, Automatic Teller Machine, Point of Sale Terminal, Tele Banking, Electronic Data Interchange, Real Time Gross Settlement, and Card Based System. These services provided by the banking sector create various opportunities in the other sectors of the economy.

Keywords: *E-banking, Rural People, Development*

Introduction

Various developments have taken place in Indian Banking. Among the various developments, technology has influenced the way customer interacts with banks. Electronic channels and products such as ATMs, cards,

internet banking and mobile banking are offered along with traditionary branch channel. Differences in the usage of channels exist between developed countries and developing countries. Evidence suggests that there is a shift from traditional channel to electronic channels. For example, usage of digital banking in developed countries is more than 90 per cent and diffusion of digital channels in developing countries range from 11 per cent to 25 per cent.

In India banking sector plays a predominant role in the process of economic development. The banking system in India most developed than other Asian countries due to unique geographic, social, and economic characteristics. This Banking sector is the section of the economy is associated with keeping financial assets for others, investing financial assets as authority to create more wealth, and the regulation of those activities by government agencies. From an financial credit for over 7.7 of Gross Domestic Product (GDP) over 7,500 billion in market cap, and Indian perspective, the banking sector is always been one of the most preferred entrances to employment. In recently this sector is an occupant sector in the Indian economy. In a present globalized era in the Indian banking sector has diversified its activities and introduced new products and services that include opportunities in credit cards, consumer finance, wealth management, life insurance, general insurance, investment banking, mutual funds, pensions, fund regulations, stock broking services, custodian services, private equity, etc. After the nationalization of 14 banks in the country banking sector consists of 26 public sector banks,20 banks under private banks and 43 foreign banks,61 regional rural banks (RRB's) and more than 90,000 credit cooperatives are working in India. At present Indian banking industry's worth is Rs.81 trillion. These days banking sector working by the way of using technology such as the internet, and mobile devices to provide services and carry out easy truncations through communicating with customers directly. In the above backdrop, the intended study aimed at E-Banking usage and its impact on rural customers is the need for the study.

Recent Trends in Banking

Some of the recent trends and selected E-Banking facilities are considered here and presented below

Automatic Teller Machine (ATM)- ATM is known as the Automatic Teller Machine is one sort of the most popular device in India it is permitted to the customers to withdraw their money 24 hours a day and 7 days a week. The ATM is a tool it allows the customer who has an ATM card to perform habitual banking dealings without interacting with a human teller. Under the system of Automated Teller Machines cash withdrawal, may be used for payment of utility bills, funds transfer between accounts, a deposit of cheques and cash into accounts, balance inquiry, etc.

Electronic Funds Transfer (EFT) - Another important trend in the development of banking in the country is that Electronic Funds Transfer (EFT) is a system whereby anybody those who want to make payment to another person/company etc. A person moves toward his bank and makes a cash payment in other words to provide directions/approval to transfer funds directly from his/her own account to the bank account of the receiver/beneficiary. Entire particulars i.e., the beneficiaries name, his/her bank account number, account type (savings or current account), name of the bank, town, branch name, and so on. Ought to be furnished to the bank at the point of time of requesting, for such transfers so that the sum reaches the beneficiaries' account appropriately and quicker. Reserve Bank of India is the service provider of Electronic Funds Transfers (EFT).

Tele Banking -It facilitates the customer in the banking sector to do the whole non-cash associated with banking on the telephone. Under the system of Telebanking, Automatic Voice Recorder is used for simpler queries and dealings. For multifaceted queries and transactions, manned phone terminals are used.

Electronic Data Interchange (EDI) - The Electronic Data Interchange is the electronic exchange of business documents such as purchase orders, invoices, shipping notices, receiving advice, etc. In a standard, computer processed, and universally accepted format between trading partners. Electronic Data Interchange may also be used to transmit financial information and payments in electronic form.

Mobile banking- The extension of internet banking in the county is that, Mobile banking facility. Under this system the bank is in organization with

the cellular service providers offers this service. In the Mobile Banking service, mobile phone should either be SMS or WAP enabled. Such kinds of services are available even to those customers with only credit card accounts with the bank.

Objectives

1. To know the E-banking facilities provided by banking sector in India
2. To study the utilisation of E-banking services among rural customers.

Methodology

The study mainly used primary data as well as secondary data. Secondary data was collected from different published sources. Primary data was collected by structured questionnaire survey. Systematic random sampling applied to conduct this research. Data is collected from 397 respondents for the purpose of determining the usage of E-banking among rural consumer's preference towards E Banking. All items were measured by responses on anova and Z-test was applied The analysis of primary data was carried out using Statistical Package for the Social Sciences (SPSS) 20.0 trial version for windows. Main statistical tools are Arithmetic mean, standard deviation are used to find out the accuracy of data.

Data Analysis and Interpretation

The collected data contains both the qualitative and quantitative data. Accordingly, the study uses both qualitative and quantitative techniques for the analysis of data. The data were analysed via SPSS 20.0 for Windows. Descriptive statistics were used to describe and summarize the properties of the mass of data collected from the respondents. Parametric statistics like independent sample Z test and the one way analysis of variance were used for comparison of the factors considered between different level of the demographic variables. A level of 0.05 was established a priori for determining statistical significance.

Main Objective of the study is usage of E-Banking services among rural customers. The survey was conducted among the 397 customers.

1. H_0: There is no significant difference between Educational level of the respondents and use of e-banking services.

H_1: There is a significant difference between Educational level of the respondents and use of e-banking services.

Table – 1
Educational qualification of the respondents and use of e-banking services

Educational Qualification	Digital Banking Respondents	ATM Banking Respondents	Mobile Banking Respondents	Internet Banking Respondents	UPI Banking Respondents
illiterates	21	18	16	00	00
primary	28	30	37	08	00
secondary	68	68	52	44	26
p.u.c	146	136	139	126	112
Graduation	134	145	135	104	105
total	397	397	379	282	243

Source: *field study*

Table – 1 (a)
ANOVA for the Educational level of the respondents and use of e-banking services

Source	DF	Sum of Square	Mean Square	F Statistic	P-value
Groups (between groups)	4	65193.44	16298.36	68.1883	2.285
Error (within groups)	20	4780.4	239.02		
Total	24	69973.84	2915.5767		

Results of Table 1 shows that the calculated value of F statistics was 68.1833 for the educational level of the respondents and use of e-banking services, the result is statistically significant as shown by P-value, hence the null hypothesis is rejected and therefore there is a significant difference between the educational level of the respondents and use of e-banking services. The study concludes that the respondents who have a higher education have used more e-banking services.

2. H_0 : There is no significant difference between Educational level of respondents and Kind of service used in banks to transfer money.

H_1 : There is a significant difference between Educational level of respondents and Kind of service used in banks to transfer money.

Table – 2
Educational level of respondents and Kind of service used in banks to transfer money

Educational qualification	Cheque Respondents	ATM(debit &credit card) Respondents	Mobile Banking Respondents	Internet Banking Respondents	Pay-in slip Respondents
Illiterates	00	22	00	00	46
Primary	17	41	02	00	89
Secondary	87	69	57	19	95
P.U.C	134	111	83	49	73
Graduation	159	154	237	214	60
total	**397**	**397**	**379**	**282**	**243**

Source: *field study*

Table – 2(a)
ANOVA for the Educational level of the respondents and use of banking services

Source	DF	Sum of Square	Mean Square	F Statistic	P-value
Groups (between groups)	4	70841.04	17710.26	10.4572	0.0000974
Error (within groups)	20	33872	1693.6		
Total	24	104713.04	4363.0433		

Results of Table 2 shows that the calculated value of F statistics was 10.4572for the educational level of the respondents and Nature of service used in banks to transfer money, the result is statistically significant as shown by P-value, hence the null hypothesis is rejected and therefore there is a significant difference between the educational level of the respondents and Nature of service used in banks to transfer money. The study concludes that the respondents who have a higher education have used most of the banking services.

1. H_0 : There is no significant Impact of e-banking services on the sample respondents

   H_1 : There is significant Impact of e-banking services on the Sample respondents

Table - 3
Opinion of the respondents on before and after e-banking services

Respondents opinion	Before e-banking services		After e-banking services	
	Respondents	%	Respondents	%
Excellent	18	6.38	85	**21.41**
Very good	23	8.16	96	**24.18**
Good	93	32.98	93	**23.43**
Moderately good	82	29.08	86	**21.66**
Average	51	18.09	11	**2.77**
Poor	13	4.61	17	**4.28**
Can't say	2	0.71	9	**2.27**
Total	**282**	**100**	**397**	**100**

Source: *field study*

Results of Table 3 states that the calculated value of z statistics was -2.2196, for the significant in the Opinion of the respondents on before and after e-banking services the result is statistically significant as shown by P-value, hence the null hypothesis is rejected and therefore There is significant difference in the Opinion of the respondents on before and after e-banking services.

2. H_0 : There is no significant difference in the Opinion of the respondents on before and after e-banking services

   H_1 : There is significant difference in the Opinion of the respondents on before and after e-banking services

Table – 4
Z-test is used to calculate respondents' opinion

Respondents opinion	Digital, Mobile, Internet banking respondents	%	ATM respondents	%
Very high	73	17.76	75	18.89169
High	117	28.47	97	24.43325
Moderate	149	36.25	135	34.00504
Low	45	10.95	55	13.8539
Very low	22	5.35	22	5.541562
Can't say	5	1.22	13	3.274559
total	**411**	**100**	**397**	**100**
MEAN	**68.5**		**66.16667**	
SD	**55.85607**		**46.19271**	

Source: *field study*

Results of Table 4 states that the calculated value of z statistics was **0.291871**, for the significant Impact of e-banking services on the sample respondents the result is statistically not significant as shown by P-value, hence the null hypothesis is accepted and therefore, there is no significant Impact of e-banking services on the sample respondents.

5. H_0 : There is no significant Impact of e-banking services on the sample Respondents
   H_1 : There is significant Impact of e-banking services on the sample respondents

Table – 5

Impact of e-banking services

Impact	Digital banking	ATM respondents	Mobile banking	Internet banking	UPI respondents
After the transaction Money is not credited account	**68** (17.1)	**57** (14.4)	**52** (13.7)	**50** (17.8)	**42** (17.3)
Lack of technological usage	**72** (18.2)	**63** (15.9)	**61** (16.1)	**45** (15.9)	**39** (16.0)
Card lost	-	**43** (10.8)	-	-	-
ATM machine destruction	-	**55** (13.9)	-	-	-
Lack in computer usage	**53** (13.3)	**39** (9.8)	**48** (12.7)	**41** (14.6)	**36** (14.8)
Password Forgotten	**66** (16.6)	**44** (11.1)	**59** (15.6)	**48** (17.1)	**36** (14.8)
Problem in changing the phone number	**55** (13.8)	**37** (9.3)	**83** (21.9)	**41** (17.1)	**34** (13.9)
Leakage of information	**27** (6.9)	**18** (4.5)	**31** (8.1)	**19** (6.7)	**24** (9.9)
Time taken	**56** (14.1)	**41** (10.3)	**45** (11.9)	**38** (13.4)	**32** (13.2)
total	**397 (100)**	**397 (100)**	**379 (100)**	**282 (100)**	**243 (100)**

Source: *field study*

Table -5

Anova for the calculation of Impact of e-banking services

Source	DF	Sum of Square	Mean Square	F Statistic	P-value
Groups (between groups)	4	2419.5358	604.884	3.7541	0.01296
Error (within groups)	32	5156.0316	161.126		
Total	36	7575.5674	210.4324		

Results of Table 5 states that the calculated value of f statistics was **3.754106**, for the significant Impact of e-banking services on the sample respondents the result is statistically not significant as shown by P-value, hence the null hypothesis is accepted and therefore There is no significant Impact of e-banking services on the sample respondents.

Findings

1. Usage of E-banking is dependent on demographical characteristics like Gender, Marital status, Age, Educational level, occupation, Income level.
2. Utilization of ATM cum Debit/Credit Cards of the respondents in E Banking services is moderate.
3. Utilization of Internet Banking of the respondents in E Banking services is average.
4. Utilization of Mobile Banking of the respondents in E Banking services is average.
5. Information provided by the bank, Efficiency of the bank, Supporting factors and Educating the customers by the bank are lead to customer satisfaction.

Conclusion

Banking Industry is the backbone of the financial system of a country. In modern age every customer needs a quick and customize services from banks. E-banking provides alternatives for faster delivery of banking services to a wider range of customers. E-banking refers to the use of internet as a remote delivery channel for banking services. Customers are corner stone of the success of banking activities. Many of rural banks has enhanced their services to non-banks areas because to access the e-Banking

services in every corner of India. The present context helpful to determining awareness and adoption of technology based banking services among rural customers. It also helps in determining the basic problems while using them and reasons behind not using these services.

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Criterion -03 Research Innovation and Extension

3.3.1 List of research papers published per teacher in the Journals -2020-21 (July-2020 to June-21)

Sl No	Title of paper	Name of the Author	Publication Journal Name	ISSN number	Year of publication	Page No
1	Photocatalytic degradation of solochrome balck under UV light on cobalt doped titanium dioxide photocatalysts.	Dr. A.M. Kalamma	Journal of Engineering Sciences	0377-9254	Jul-20	01-08
2	Microwave-Assisted Synthesis of Copper Nanoparticles : Influence of Copper Nanoparticles Morphology on the Antimicrobial Acivity	P J Bindu	Jounal of Materials NanoScience	2394-0867	Aug-20	09-14
3	Effective Solochrome Dye Degradation Using Synthesized Copper Doped Titanium Dioxide Nanoparticles	Dr. A.M. Kalamma	Journal of Advanced Scientific Research	0976-9595	Oct-20	15-21
4	Effect of Molarity On Structural, Morphological, Optical And The Photocatalytic Property Of (Cu1-X-Cox)-Tio2 Nanoparticles Synthesized Via Hydrothermal Method	Dr. A.M. Kalamma	Materials Today: Proceedings	2214-7853	May-21	22-29
5	Emerging Trends and Developments in Banking Sector	Anupama K	International Journal of Research	P:2348-6848 E:2348-795X	Dec-20	30-39

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3.3.1 Number of research papers published per teacher in the Journals notified on UGC CARE list during the last five years (2020-21)

Title of paper	Name of the author/s	Department of the teacher	Name of journal	Calendar Year of publication	ISSN number	Link to the recognition in UGC enlistment of the Journal /Digital Object Identifier (doi) number		
						Link to website of the Journal	Link to article / paper / abstract of the article	Is it listed in UGC Care list
Photocatalytic degradation of solochrome balck under UV light on cobalt doped titanium dioxide photocatalysts.	Dr. A.M. Kalamma	Physics	Journal of Engineering Sciences	Jul-20	0377-9254	www.jespublication.com	https://jespublication.com/upload/2020-1107121.pdf	Yes
Microwave-Assisted Synthesis of Copper Nanoparticles : Influence of Copper Nanoparticles Morphology on the Antimicrobial Acivity	P J Bindu	Chemistry	Jounal of Materials NanoScience	Aug-20	2394-0867	http://pubs.iscience.in/jmns	https://pubs.thescienceein.org/journal/index.php/jmns/article/view/223	Yes
Effective Solochrome Dye Degradation Using Synthesized Copper Doped Titanium Dioxide Nanoparticles	Dr. A.M. Kalamma	Physics	Journal of Advanced Scientific Research	Oct-20	0976-9595	http://sciensage.info	http://sciensage.info/index.php/JASR/article/download/1836/1415	No
Effect of Molarity On Structural, Morphological, Optical And The Photocatalytic Property Of (Cu1-X-Cox)-Tio2 Nanoparticles Synthesized	Dr. A.M. Kalamma	Physics	Materials Today: Proceedings	May-21	2214-7853	https://www.sciencedirect.com/journal/materials-today-proceedings	https://doi.org/10.1016/j.matpr.2021.05.458	No
Emerging Trends and Developments in Banking Sector	Anupama K	Commerce	International Journal of Research	Dec-20	P:2348-6848 E:2348-795X	http://internationaljournalofresearch.com/	https://journals.pen2print.org/index.php/ijr/article/view/20366	No

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Research Article

EFFECTIVE SOLOCHROME DYE DEGRADATION USING SYNTHESIZED COPPER DOPED TITANIUM DIOXIDE NANOPARTICLES

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ABSTRACT

A simple hydrothermal route was used for the synthesis of pristine and Cu-doped TiO_2 nanoparticles (NPs) using EDTA (di-sodium salt dehydrate) as the capping and reducing agent. In order to study the optical, functional, surface morphology, structure and elemental analysis of synthesized nanoparticles were subjected to UV-Vis spectrophotometer, FESEM, XRD and EDS. From these results UV-Vis characterization reveals that synthesized particles are having absorption maxima is around 341 and 250.23 nm and using Tauc's plot the estimated E_g values were found to be 3.07eV and 2.84 eV respectively. FESEM of particles reveal that they are having the spherical cluster with average size of about 10 nm to 20 nm. EDS spectrum confirms the presence of elements Ti and O. From the XRD pattern it confirms that they are having anatase phase, tetragonal and cubic crystal structure for TiO_2 and Cu-TiO_2 respectively . Further, the photocatalytic degradation of solochrome dye was performed under UV irradiation using these synthesized nanoparticles. Interestingly, it was observed that the relative absorption intensity continuously decreased as the UV illumination exposure time increased, significantly indicating that solochrome dye degraded effectively on the surface of bare and Cu doped TiO_2 photocatalyst.

Keywords: Copper doped titanium dioxide, Hydrothermal, Dye degradation.

1. INTRODUCTION

Organic dyes is one of the major groups of pollutants widely used in textile, plastic, medicine and many other industries, while the hazardous effects of organic dyes in waste water have been a major concern and now a major threat in the environment due to the substantial pollution problems caused by them. These industries exhausted large quantity of high content color effluents, which are generally more toxic and resistant to destruction by conventional methods. A necessary criterion in the use of these dyes is that they must be highly accumulated in water and stable in light during washing. The accumulation of these dyes in the water bodies causes eutrophication, reduces the reoxygenation capacity and makes severe damage to the aquatic organisms by hindering the infiltration of sunlight [1]. They must also be resistant to microbial attack. Therefore, they are not readily degradable and are typically not removed from water by wastewater treatment systems and conventional methods like adsorption, ultra filtration, chemical and electrochemical methods [2]. The superiority of photocatalytic degradation by nanoparticles in wastewater treatment is due to its advantages over the conventional methods, such as quick oxidation, no formation of polycyclic products and oxidation of pollutants. It is an effective and rapid technique in the removal of pollutants from wastewater [3]. In the recent years, numerous metal oxides including TiO_2 [4], ZnO [5], and other oxides have attracted growing attentions for photodegradation of organic dyes; TiO_2 is of particular interests due to its low cost and high stability. Nonetheless, TiO_2 has been gained remarkable attention as a photocatalyst in degradation of organic pollutants. Due to the properties of anti- oxidation long term stability, non-toxicity, strong redox ability, it has been widely used in the field of photocatality. TiO_2 being a semi conductor with a large band gap *i.e,* 3.2, 3.02 and 2.96 eV for anatase, rutile and brookite phases respectively. As TiO_2 particles, get irradiated by photons with energy greater than the band width of TiO_2 the valence band electrons will be transited to the

band of conduction which leave holes in the valence band. Now electron hole pairs could participate into all kinds of chemical reactions on TiO_2 surface and that ultimately degrades all the pollutants in the solution. This reaction leads to recombination of electrons and holes quickly; eventually TiO_2's photocatalytic activity greatly decreases. To obtain higher photocatalytic activity, one commonly used method is doping metal and /or non metal ions into the TiO_2's crystal lattice. Sahoo and Gupta [6-10] synthesized Ag and Fe ions doping micro crystalline TiO_2 followed by a liquid impregnation technology. They found that Ag doped with TiO_2 could be degraded up to 99% of the pollutants under the UV light. For the visible light Fe doped with TiO_2 could be degraded more than 96% and 90% for methylene blue and methyl blue respectively. Vu *et al.* [11-15] synthesizing highly active photocatalytic TiO_2 nano tubes by hydrothermal treatment in the base medium using the commercial powder of TiO_2 as Ti source. The non-metal doped with TiO_2 samples were made using urea, ammonium fluoride, thioura and ethylene glycol by post synthesis as N, S, F and C source. Degradation of Rhodamine B indicated, a non metal being doped TiO_2 samples, exhibited very high photocatalytic activity under visible light compare to that with non doped TiO_2 samples. Choi *et al* [16-19] successfully prepared TiO_2 nanoparticles doped with 21 different metal ions by sol-gel method and found that metal ions significantly influenced the photo reactivity, charge carrier recombination and interfacial electron transfer rates. Anatase phase is active for photocatalytic phenomena based on the chemical and dynamic properties of organic compounds degradation. Observing all the potential of TiO_2, here in, we have synthesized TiO_2 and Cu doped TiO_2 nano particles and analysed their photocatalytic solochrome dye degradation under the UV light.

2. MATERIAL AND METHODS

2.1. Chemicals

Titanium (IV) n butoxide (TNB) wt 99% liquid analytical grade, Copper nitrate hexahydrate [$Cu(NO_3)_2$.$6H_2O$] and EDTA (di-sodium salt dehydrate) were purchased from Alfa Aesar Chemicals, India. De-ionized water (DW) was used in the preparation of all solutions.

2.2. Synthesis of $TiO_2$and Cu doped nanoparticles

Titanium dioxide Nano particles were synthesized via hydrothermal route [20]. Here 30ml of 0.1M of E. D. T.A ($C_{10}H_{14}N_2Na_2O_8.2H_2O$) was prepared by dispersing 0.56gm in 15ml of de-ionised water (DW) with a continuous stirring with the aid of magnetic stirrer for 10 minutes, later added 15ml of DW and 5ml of 0 .1M $Cu(NO_3)_2$. $6H_2O$, then 1ml of Titanium (IV) n-butoxide was added drop wise with continuous stirring for 30 minutes. The colloidal solution was then transferred to a 50ml Teflon-lined stainless steel auto clave, the autoclave was sealed and placed in an oven heated up to 180°C for 3hours, then the autoclave was cooled down to room temperature. Under ambient conditions, the reactant mixture was centrifuged to collect the product; the product was washed continuously with DW several times to remove the organic molecules bonded to the surface of the product. The final product was dried in an oven at100 °C for one hour and the same procedure, as adopted in Cu-TiO_2 (CTO NPs) was used to synthesize TiO_2 (TO NPs) without adding dopant and the sample was then used for Photodegradation application.

2.3. Photocatalytic experiments

The photocatalytic reactor is a Pyrex-glass cell with 1.0 L capacity. A 10 W Lamp (Philips) as the light source (365 nm) was placed in a quartz lamp holder which immersed in the photo reactor cell. Before illumination, the solution was allowed to stir in dark for 60 minutes to achieve adsorption-desorption equilibrium between the dye and photocatalyst. The cell was filled with 1mg/L of dye solution and 1 x 10^{-5} M of the photocatalyst. Magnetic stirrer was used to introduce fresh air bubbles into the suspension using a pump. Dye degradation was examined by taking 4 mL of the suspension at 10 minutes irradiation time intervals. Finally, the rate of degradation was determined from the change in absorbance of Dye solution. Before the measurement, the solution was centrifuged for 10min at 5000 rpm to remove any turbidity. All kinetic data were evaluated using Microsoft Excel 2010 program.

2.4. Characterization techniques

2.4.1. UV-Vis spectroscopy

UV-Vis absorbance spectra in the wavelength range 200-800nm was measured using UV-Vis spectrophotometer (model: SPECORD 200+ Analytik-jena).

2.4.2. XRD

The crystal structure of the powder sample at a scanning rate of 0.02^0 per second in the range of 20^0 to $80^0$with the use of Cu K_α radiation of wavelength 1.54060Å were analysed by XRD (model: Rigaku pro analytical) at MIT Manipal. Peak analysis was carried out using PCPDFWIN software.

The surface morphology and nano nature of the samples at an operating voltage 5kV were examined using FESEM (model: xford-EDX system IE 250 X Max 80) At Mangalore university, Mangalore.

2.4.3. EDS

Elemental compositions were analysed using EDS (model:FEI Quanta 200 F) At Mangalore university, Mangalore.

2.4.4. Zeta potential

The zeta potential was based on the surface charge of the particles relative to the local environment of the prepared particle. This electrostatic potential of shear plane of the particle was carried out in ultrasonicated dispersion of 0.01 g/100 mL in DMSO at room temperature using the Horiba SZ-100 nanoparticle analyzer.

3. RESULTS AND DISCUSSION

3.1. Optical properties

3.1.1. UV-Vis Spectroscopy

UV-Vis Spectra were recorded for TO NPs and CTO NPs in an ethanol solvent at room temperature and are shown in Fig 1(a) and (b).

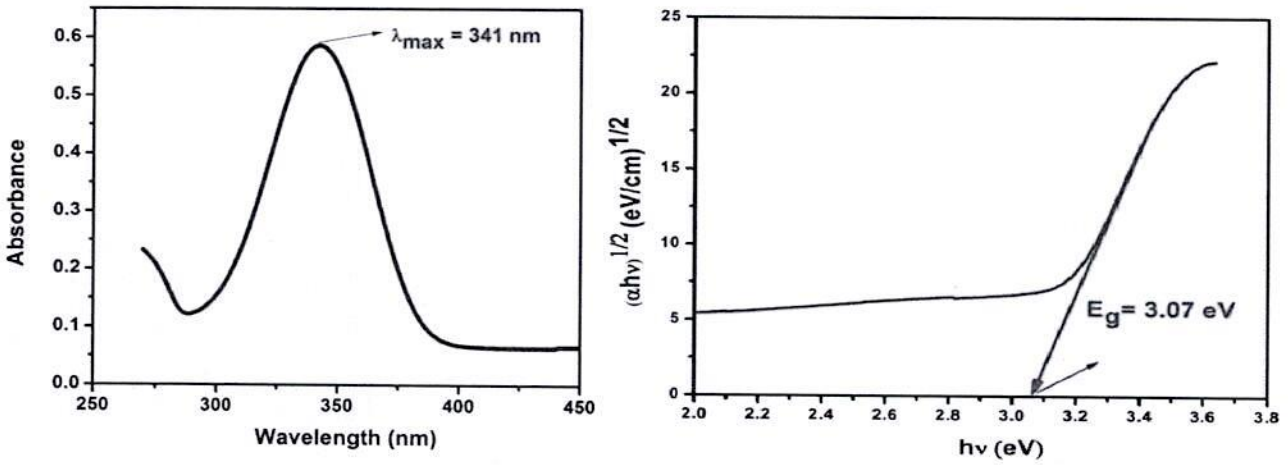

Fig. 1a: UV and Tauc's plot TiO_2

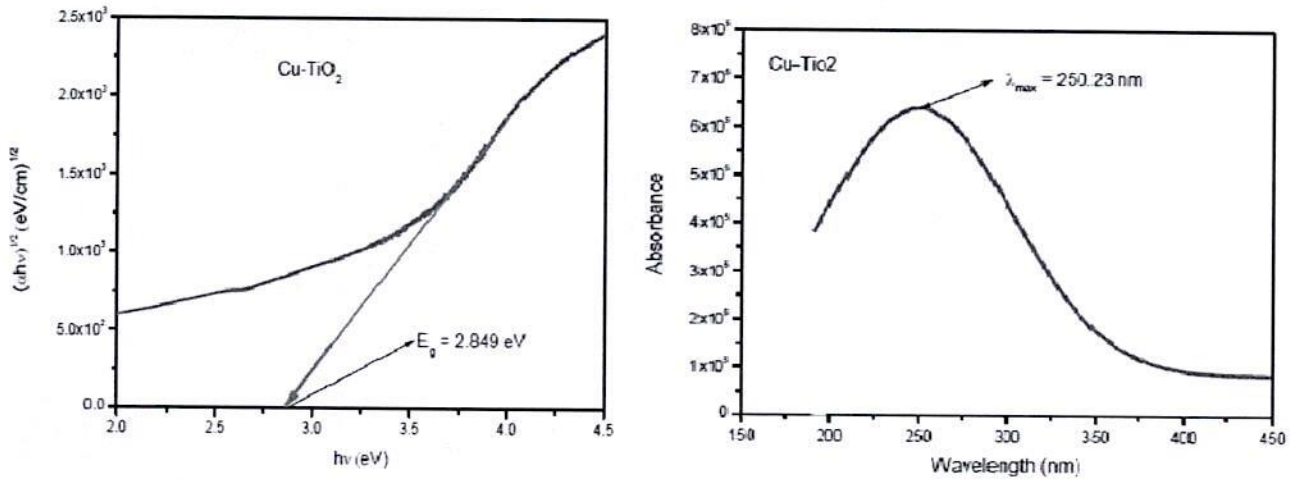

Fig. 1(b): UV and Tauc's plot Cu- TiO_2

From the Fig.1 (a) and (b), it is observed that the absorption maxima (λ_{max}) for TO NPs and CTO NPs were found to be 341 nm and 250.23 nm respectively which is a preliminary indication for the presence of TiO_2 material. The band gap of both the samples were estimated using the absorption data with the help of (K-M) transformation method [21].Band gap energy of the semiconductor was estimated using the optical absorption coefficient (α) and is expressed by equation

$$\alpha = \frac{A(h\nu - E_g)^{1/n}}{h\nu} \qquad (1)$$

Where, hν is an energy of photon, E_g is the band gap energy, A is a constant depends on the transition probability and depends on the nature of the transition for allowed direct transition n= ½, for allowed indirect transition n=2. In our cases for an indirect gap, the value of n is 2 for TO NPs and CTO NPs. Using Tauc's plot the estimated E_g values were found to be 3.07eV and 2.84 eV respectively.

3.2. Structural properties

XRD analysis was carried out to verify the presence of nano crystalline and phase formation.

Fig 3 (a and b) shows XRD patterns for TO and CTO powders respectively it is observed that the presence of strong and sharp peaks; it may indicate the formation of the well crystallized samples. From the Fig 3 (a) it is observed that the Bragg's reflection at 2Θ= 25.3429, 37.8769, 47.9727, 54.0791, 62.7467, 75.1348 and 82.6813 can be indexed to (101), (004), (200), (211), (204), (215) and (224) crystal planes respectively. The comparison of 2Θvalues in observed Fig 3(a) XRD patterns with those from the standard Joint Committee on Powder Diffraction Standards (JCPDS) data no. 89.4921 confirms the formation of the TiO_2 phases having anatase phase and tetragonal crystal structure. Fig 3(b) shows the XRD patterns for CTO powders, it is observed that the Bragg's reflection at 2Θ= 25.3803, 37.8187, 47.9622, 54.1718, 62.7795, 68.9548, 75.0959 and 82.8946 can be indexed to (311), (422), (442), (444), (731), (822), (753) and (844) crystal planes respectively. The comparison of 2Θ values in observed Fig. 3(b) XRD patterns with those from the standard Joint Committee On Powder Diffraction Standards (JCPDS) data no. 81.1611 confirms the formation of the Cu-TiO_2 having Anatase phase and Cubic crystal structure. The Scherer's equation [22] is used to estimate an average crystalline size by determining the full width at half maximum (FWHM) of the most intense reflection plane and this equation is given by

$$D \approx \frac{0.9\lambda}{\beta \cos\theta} \qquad (2)$$

Where D is an average crystalline size, λ is the wavelength of X-ray used (1.50406 x 10^{-10} m), Θ is the Bragg's angle in radian and β is the full width at half maximum of the most intense reflection in radian. In our case, the most intense peak for TO and CTO were found to be (101) and (311) plane and the estimated average crystalline size is 7.362 nm and 6.098nm respectively.

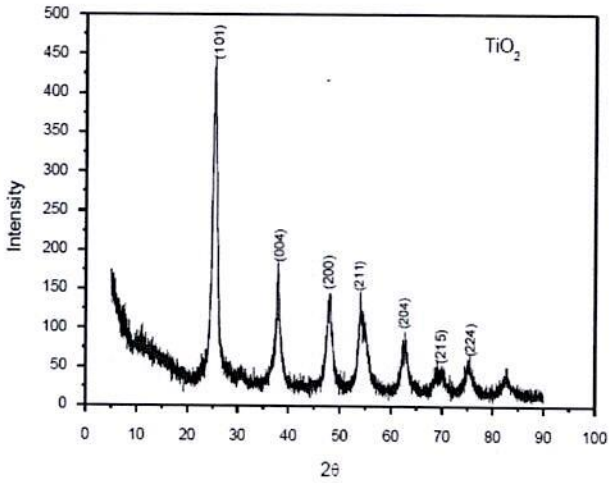

Fig. 3 (a): XRD graph for TiO_2

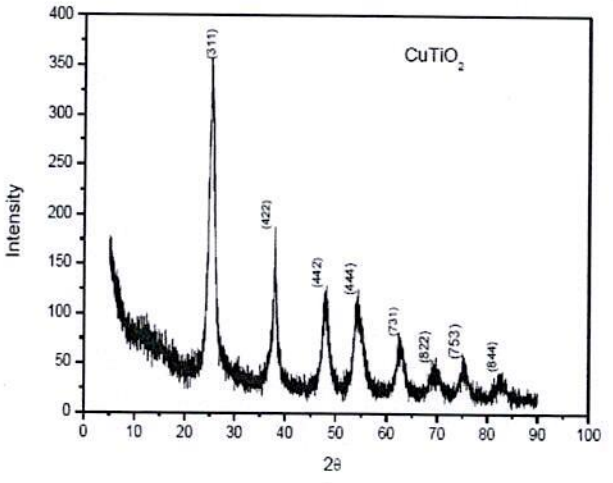

Fig. 3 (b): XRD graph for Cu-TiO_2

3.3. Morphology, Size Distribution and Elemental Analysis

FE-SEM analysis was used to examine the surface morphology and nano nature of the samples. Fig 4 (a and b) shows the particles are having the spherical cluster with average size of about 10 nm to 20 nm. EDS was examined to investigate the chemical composition in CTO NPs. Fig 4 (c and d) represents the EDS spectrum for TO NPs and CTO NPs, hence EDS spectrum confirms the presence of elements i.e. Ti and O, in addition small quantities of element C was observed since it is residue of oil contaminants. The weight percentage (%) and atomic weight percentage (%) CTO NPs are shown in Fig 4 (c and d).

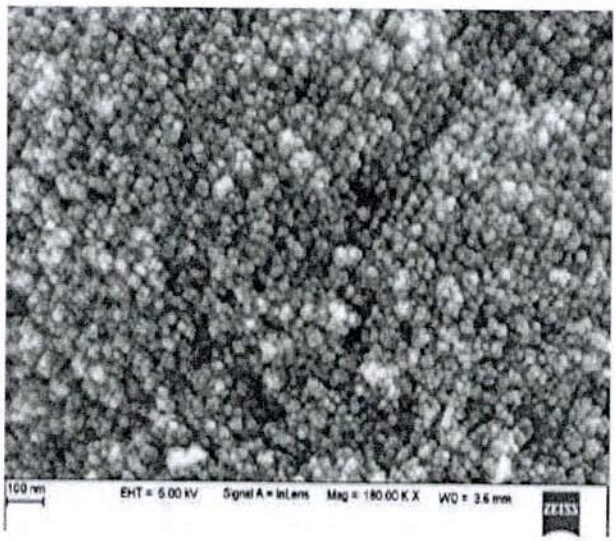

Fig. 4(a): FE- SEM image of TiO_2

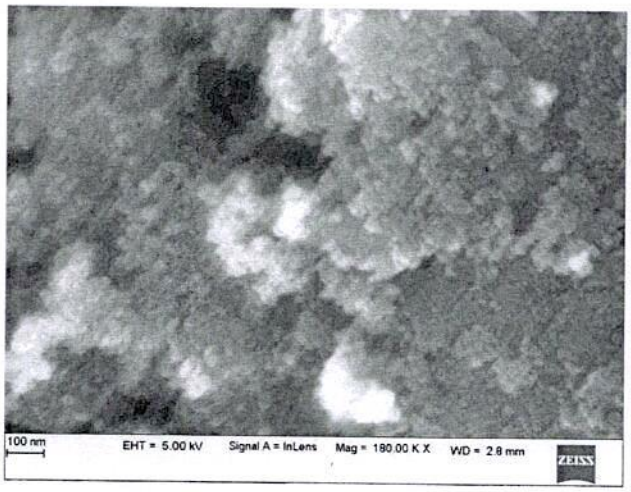

Fig. 4(b): FE- SEM image of Cu-TiO_2

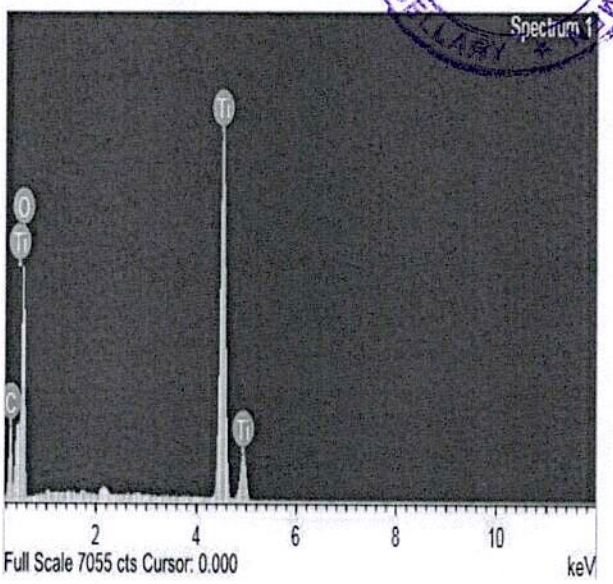

Fig. 4(c): EDS spectrum of TiO_2 NPs corresponding weight % and atomic % of element O - 61.19, 55.18 ; Ti - 57.22,17.23 and C - 22.97,27.59 respectively.

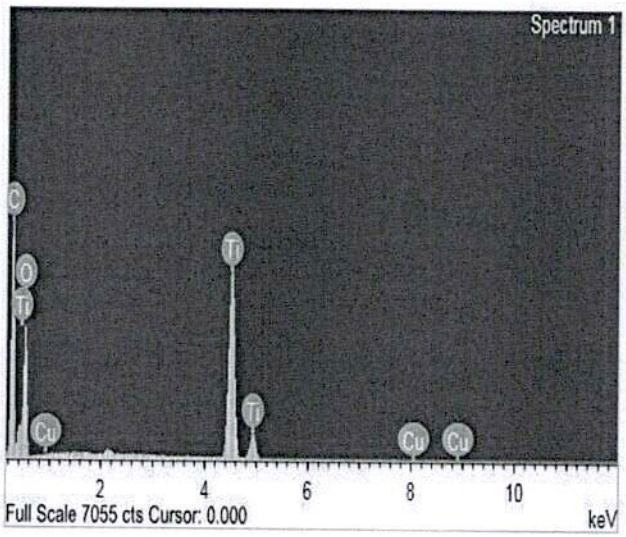

Fig. 4(d): EDS spectrum of Cu-TiO_2 NPs corresponding weight % and atomic % of elements O -36.48,55.71; Ti - 32.27,19.46 and C - - 0.06,-0.02 respectively.

3.4. Zeta Potential Study

The zeta potential with a positive value of 30 mV with electrophoretic mobility 0.000061 cm^2/Vs and with positive value of 22.9 mV with electrophoretic mobility 0.000047 cm^2/Vs suspension was obtained

for the TO and CTO NPs respectively in DMSO and the zeta potential graphs shown in the **Fig. 5**, which clearly indicates a stable dispersion without particle settlement. Furthermore, the study of prepared suspension corroborates with general criteria of zeta potential (ξ) value 30 mV with positive or negative sign for better stability.

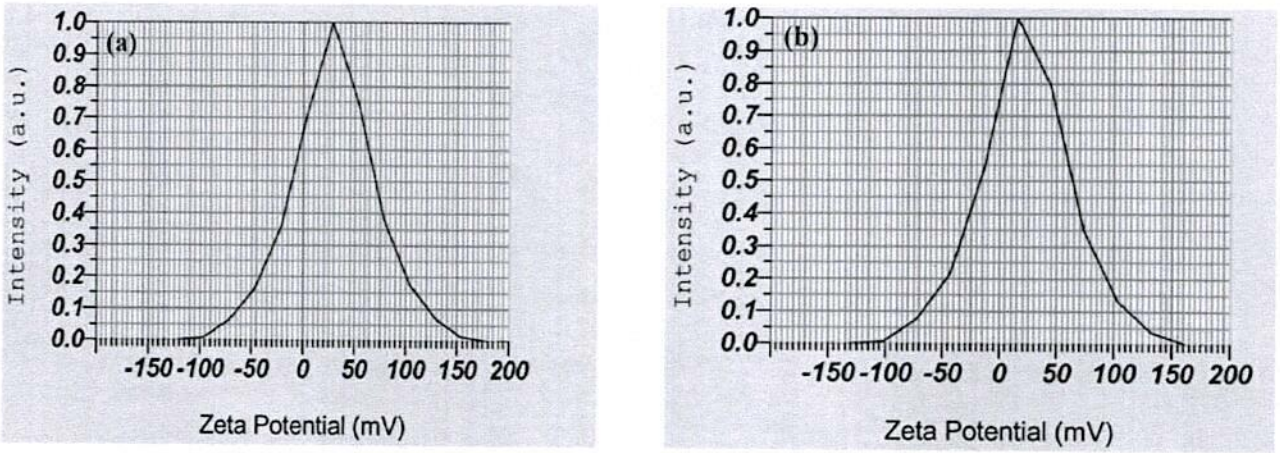

Fig. 5: Zeta potential evaluation of (a) TO NPs and (b) CTO NPs in DMSO solvent.

3.5. Photodegradartion process

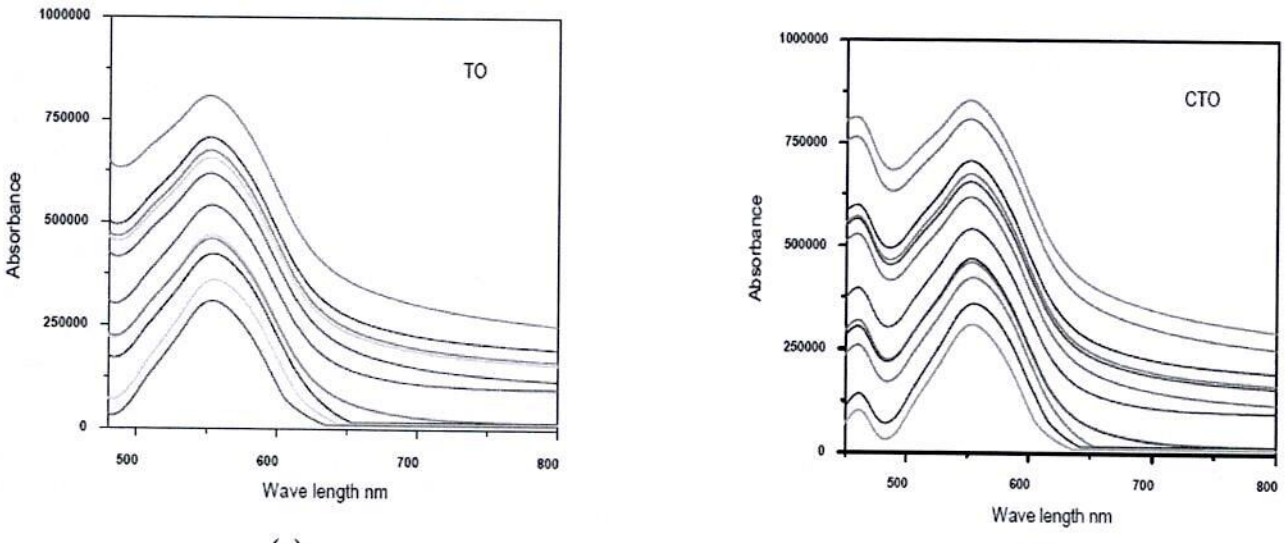

Fig. 6: Photo degradation evaluation of (a) TO NPs and (b) CTO NPs in solo chrome dye solution

3.6. Evaluation of photocatalytic activity

To evaluate the photocatalytic activity of TO NPs, the photocatalytic degradation of solochrome dye was performed under UV irradiation. The photocatalytic degradation was evaluated by measuring the absorbance at regular time intervals. Interestingly, it was observed that the relative absorption intensity continuously decreased as the UV illumination exposure time increased, significantly indicating that solochrome dye degraded effectively on the surface of TO photocatalyst [Fig. 6 (a) & (b)]. This is because, under illumination, highly oxidizing hydroxyl and oxy radicals are formed by the semiconducting metal oxides like TO, CTO etc. via generation of electron-hole pairs, which break the large organic materials into less harmful small organic materials. The obtained degradation was 63 % and 76 %

within 120 min for TO and CTO respectively [23]. It reveals that after doping with Cu, percentage of degradation was increased.

4. CONCLUSION

Eco friendly hydrothermal route was used for the synthesis of TiO_2 (TO) and Cu doped TiO_2 (CTO) nanoparticles. It was confirmed by various characterization techniques that TO and CTO are having grain size about 10 to 20 nm. Further studies showed that, Solochrome dye was degrading under UV light using TiO_2 and Cu doped TiO_2 nanoparticles. Among doped TiO_2, the maximum degradation efficiency was found to be 63 % for TO and 76% for CTO. From this it is confirmed that CTO is more efficient catalyst for degradation of dye.

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Effect of molarity on Structural, Morphological, optical and the photocatalytic property of $(Cu_{1-X}\text{-}Co_x)\text{-}TiO_2$ nanoparticles synthesized via hydrothermal method

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ABSTRACT

Copper and cobalt co-doped TiO_2 nanoparticles (NPs) [$(Cu_{1-x}\text{-}Co_x)\text{-}TiO_2$ for x = 0.1 M and 0.9 M] have been synthesized through the hydrothermal method in the current investigation. X-ray diffraction (XRD), energy dispersive X-ray spectroscopy (EDS), scanning electron microscopy (SEM) and UV–vis spectrophotometer have characterized the structural, optical, morphological, and compositional of all prepared samples. Analysis of XRD showed that all prepared nano powders were nanocrystalline and had new [$(Cu_{1-x}\text{-}Co_x)\text{-}TiO_2$], rutile and anatase phase depending on the molarity. Further studies have shown that the arrangement of tetragonal and rhombohedral crystals for TiO_2 and $(Cu_{1-x}\text{-}Co_x)\text{-}TiO_2$ for x = 0.1 M and 0.9 M respectively, with an average crystallite size of 7.362 nm for TiO_2 and 27 nm for $(Cu_{1-x}\text{-}Co_x)\text{-}TiO_2$ for x = 0.1 M and 0.9 M . The SEM analysis shows that the NPs for pure is spherical in form and doped TiO_2 have an irregular shape with an average grain size of 168 nm and 223 nm. Analysis of the EDS confirms the chemical composition of the Ti and O elements of the NPs. The difference in the indirect band gap of 3.07 eV, 2.74 eV and 3.58 eV for TiO_2 NPs, $(Cu_{0.9}\text{-}Co_{0.1})\text{-}TiO_2$ NPs and $(Cu_{0.1}\text{-}Co_{0.9})\text{-}TiO_2$ NPs is shown by Tauc's plots. Here it is noted that the maximal absorption (λ_m) showed a red shift in the UV–vis absorption spectrum due to doping. Photocatalytic activity was assessed by monitoring Eriochrome Black T (EBT) degradation under UV light. The EBT dye photocatalytic degradation results were 57.75%, 73.7% and 73 %for TiO_2 NPs, $(Cu_{0.9}\text{-}Co_{0.1})\text{-}TiO_2$ NPs and $(Cu_{0.1}\text{-}Co_{0.9})\text{-}TiO_2$ NPs for 110 min, respectively, under UV irradiation. These findings indicate that doping with copper and cobalt improves TiO_2's photodegradation quality.

Selection and peer-review under responsibility of the scientific committee of the International e-Conference on Advancements in Materials Science and Technology.

1. Introduction

Since the last decade, a huge importance has been given to the metal-oxide nanoparticles (NPs), due to their wide range of applications in the field of Technology. TiO_2 is being employed in many technological areas because of its appealing characteristics like large optical band gap and photocatalytic activity at visible light [1,2], its extended stability against the photo and chemical corrosion [3], which had continued to inspire many researchers in developing and improving its performances. Hence these characteristics of TiO_2 permit it to be used as an antireflecting coating for a solar cell [4] the sensor and capacitor materials [5,6]. Numerous studies have reported that, inclusion of different dopants in the TiO_2 nanoparticles enhances its efficiency [7]. Although, cobalt (Co^{2+}) doped TiO_2 has attracted greater attention for its application in spintronics [1–8], it has also been used for improving the photocatalytic activity on reducing its band width and shifting the absorption edge towards the visible region [9,10]. Few studies focus on the change of conducting behaviour of TiO_2 with cobalt ion (Co^{3+}) doping [11]. Existence of copper (Cu^{2+}) in the TiO_2 thin films can also be an effective way of intensifying the photocatalytic activity. Chang Wang et al. [12], have been reported that, addition of copper (Cu^{2+}) in the TiO_2 matrix avert the recombination of electron- hole and enhance the photocatalytic activity.

In addition, several studies have focused on TiO_2 co-doping with transition metals and non-metals in order to boost the photocat-

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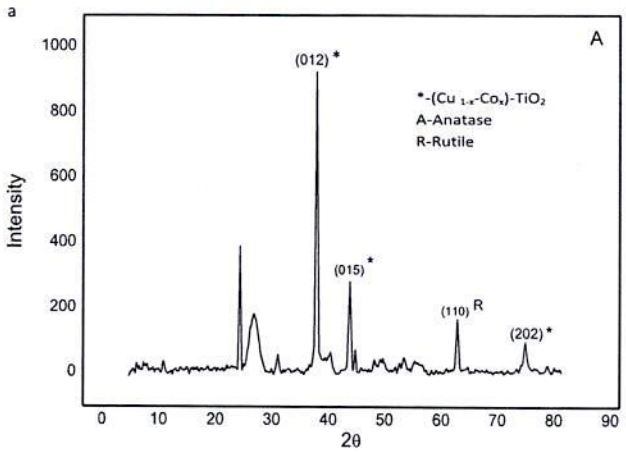

Fig. 1a. XRD.

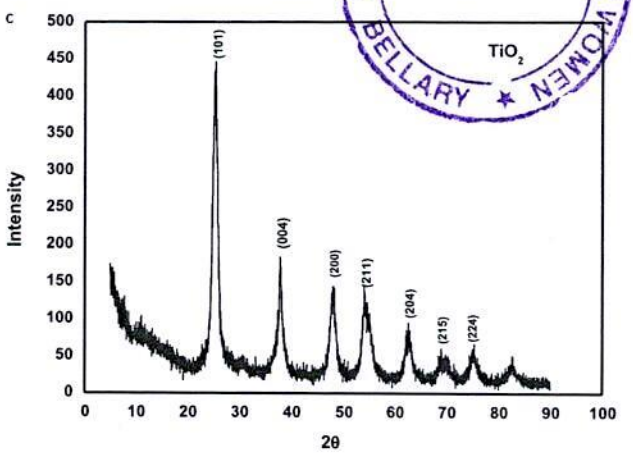

Fig. 1c. XRD pattern for T.

alytic function of TiO_2 and inhibit electron-hole pair recombination. The effect of Cu-Co co-doping on TiO_2 nanoparticles' structural and morphological properties was investigated by Toubal et al. [13]. In order to boost the absorption in the visible light region and to improve the photocatalytic activity of TiO_2, two dopants have been shown to have a more synergistic effect than a single one. The photocatalytic activity of (Cu-Co) co-doped TiO_2 for acetaldehyde destruction under visible light was reported by Reda et al. [14]. Zhang et al. [15] studied the effect of the co-doping of (N-Co) on hollow microspheres of TiO_2/SiO_2 and addressed their photocatalytic function. TiO_2 thin films co-doped with N and Co were synthesized by Xue Jun et al. [16] and explored the separation of photogenerated electron-hole pairs. An increase in the photocatalytic performance of (N-Co) co-doped TiO_2 was observed. Shi et al. [17] investigated the response of (N-Co) co-doped TiO_2 thin films to the photoelectrochemical mechanism and found an improvement in the photocatalytic reaction. Hamadanian et al. [18] discussed the degradation of methyl orange under ultraviolet (UV) and visible light irradiation of metal (Co and Cu) and non-metal (C,N,S) doped TiO_2 photocatalysis, observed an improvement in TiO_2 photocatalytic activity attributed to delay of recombination of electron-hole in TiO_2 due to Cu-Co doping. $CoTiO_3$-TiO_2 composite films are used in a range of technical functions and are used as photocatalysts [19] and gas sensors [20,21].

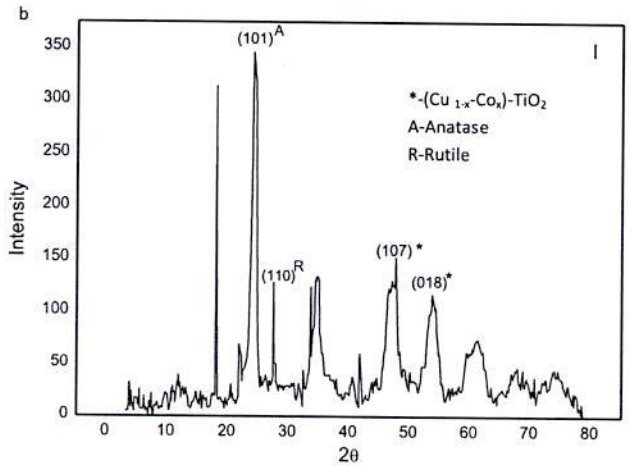

Fig. 1b. XRD pattern for T_B.

Photocatalytic degradation of EBT using the TiO_2 catalyst has been reported by Sushil et al. [22].

The main objective of this work is to investigate the effect of both copper and cobalt dopant molarity on the structural, morphological, optical and photocatalytic properties of TiO_2 NPs synthesized via hydrothermal technique. In this study we synthesized $(Cu_{(1-x)}\text{-}Co_x)$–TiO_2 NPs where x = 0.1 M and 0.9 M and characterized all the samples by employing XRD, SEM, UV–vis and EDS. Further we have studied the photocatalytic destruction of Eriochrome Black T (EBT) using the synthesized photocalysts.

2. Materials and methods

2.1. Chemicals

Titanium (IV) n-butoxide (TNB, $C_{16}H_{36}O_4Ti$) [99 wt% liquid analytical grade] was purchased from Alfa Aesar chemicals, India, EDTA (di-sodium salt dehydrate), copper nitrate hexahydrate and cobalt nitrate hexahydrate were purchased from Sigma-Aldrich chemical company. Eriochrome Black T (EBT, M.W. = 461.381g-mol^{-1}) dye was supplied by Thermo Fisher Scientific India Pvt. Ltd. In preparing all the solutions, de-ionized water (DW) was used.

2.2. Synthesis of $(Cu_{(1-x)}\text{-}Co_x)$-TiO_2 NPs

$(Cu_{0.9}\text{-}Co_{0.1})$-$TiO_2$ [T_A] NPs have been synthesized using a method mentioned in the previous article [23]. Herein 0.1 M EDTA was prepared by dissolving 0.56gm in 15 ml of de-ionised water (DW) with a continuous stirring with the aid of magnetic stirrer, 10 min later 15 ml of DW then 2.5 ml of 0.9 M Copper nitrate hexahydrate and 2.5 ml of 0.1 M cobalt nitrate hexahadrate were added along with 2 ml of Titanium (IV) n butoxide drop wise with continuous stirring for 30 min. The colloidal solution was then poured into a 50 ml Teflon-lined stainless steel autoclave, the autoclave was sealed and placed in an oven and heated up to 180 °C for 3 h, then the autoclave was cooled down to room temperature. The reactant mixture was centrifuged to collect the product under ambient conditions; the product was washed continuously with DW several times to remove the organic molecules bonded to the product's surface. The final product was dried for one hour in an oven at 100° C and the same procedure, as adopted in $(Cu_{0.9}\text{-}Co_{0.1})$-$TiO_2$ was used to synthesize $(Cu_{0.1}\text{-}Co_{0.9})$-$TiO_2$ (T_B) and pure TiO_2 (T_C) NPs.

Table 1
Cell parameters, unit cell volume and crystallite size.

Sample	* Lattice Parameter in Å			* Unit cell volume	* Interplanar spacing d	^Crystallite Size
	a	b	c	$10^{-30}m^3$	Å	nm
T_A	3.033	3.033	17.183	136.89	2.471	29.12
T_B	2.033	3.033	17.183	136.89	2.469	24.58
T_C	3.777	3.777	9.501	135.54	3.511	7.36

* XRD data.
^Scherrer formula.

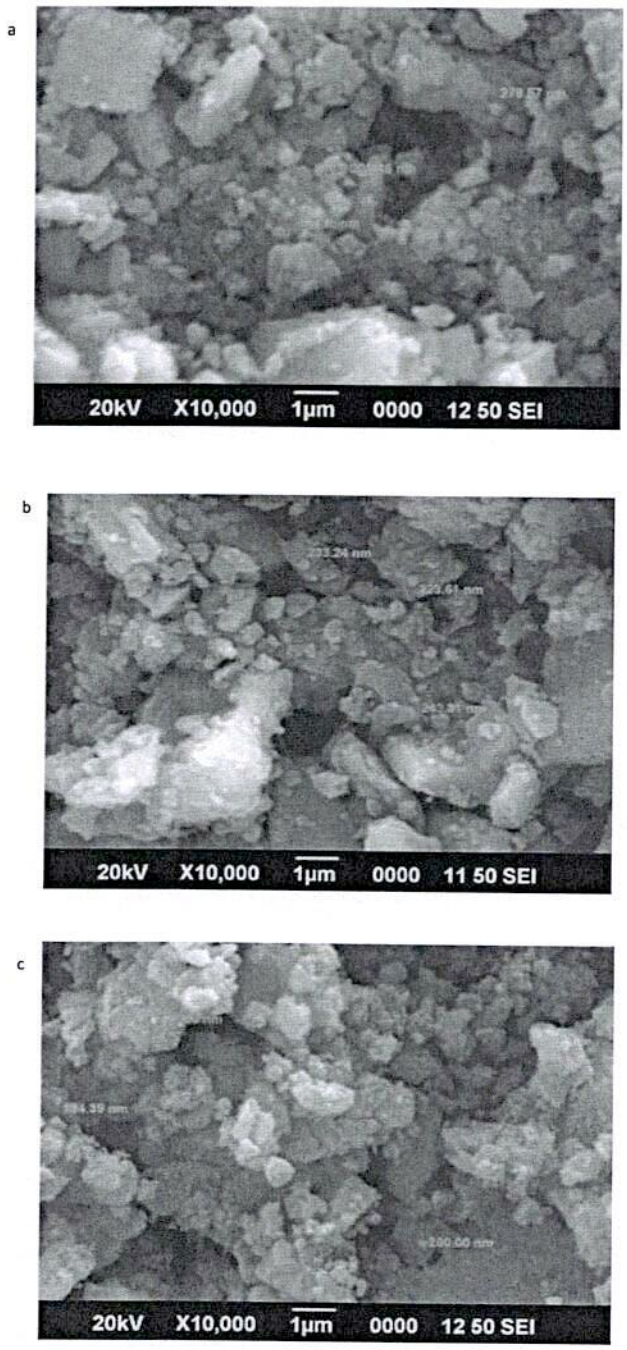

Fig. 2. SEM image of (a) T_A; (b) T_B; (c) T_C.

2.3. Characterization techniques

For the crystal structure and crystallite size estimation, X-ray powder diffractometer (XRD, Model-Bruker AXS D8 Advance) study was performed. UV–vis spectrophotometer (model: SPECORD200 + Analytikjena) was used to measure the absorption spectra in the wavelength range 200–800 nm. For surface morphology and size distribution, scanning electron microscopy (SEM, model-JEOL6390LA) analysis was examined. Elemental compositions were analysed using EDS (model: OXFORD XMX N).). UV–vis absorption spectra were analyzed by a UV–vis spectrophotometer (model: SPECORD200 + Analytikjena) for EBT degradation.

2.4. Photocatalytic activity assessment of catalysts

The photocatalytic activity of undoped and doped TiO_2 nanoparticles was assessed by the decomposition of Eriochrome Black T (EBT) aqueous solution under UV light irradiation. Pyrex-glass cell with a capacity of 1.0L was used in the photocatalytic reactor. Photo reactor has a quartz lamp holder with a 10 W lamp (Philips) as a 365 nm light source. In order to achieve an adsorption–desorption balance between photocatalyst and dye, the solution was stirred in the dark for 60 min before illumination. The cell has been filled with 1 mg/L of dye solution and 1×10^{-5} M of photocatalyst. The magnetic stirrer was used with a pump to create fresh air bubbles in the suspension. The solution was centrifuged for 10 min at 5000 rpm prior to the measurement to remove any turbidity. Dye degradation was studied by taking 4 ml of suspension at 10 min of irradiation time intervals. Finally, the rate of degradation was determined by the change in the absorbance of the Dye solution. The data collected was analyzed using the Microsoft Excel 2010 software.

3. Results and discussion

3.1. Structural properties of $(Cu_{1-x} - Co_x)$-TiO_2 nanoparticles (for x = 0.1 M and 0.9 M)

XRD analysis confirmed the existence of nano crystalline and phase formation. XRD patterns for T_A, T_B and T_C powders respectively are shown in Fig. 1(a), 1(b) and 1(c). The appearance of sharp and intense peaks suggests the formation of samples that have been well crystallized. It is observed from the Fig. 1(a) that the Bragg's reflection at 2θ = 36.331, 43.173, 61.266 and 73.381 can be indexed to (0 1 2), (0 1 5),(1 1 0) and (2 0 2) crystal planes respectively. XRD pattern of $(Cu_{0.9}$-$Co_{0.1})$-TiO_2 exhibits the formation of a new phase blended with a rutile phase and rhombohedral crystal structure is verified by the comparison of 2 θ values with those from standard JCPDS data no. 41–0904. The XRD pattern of $(Cu_{0.1}$-$Co_{0.9})$-TiO_2 powder is shown in Fig. 1(b),the crystal planes (1 0 1), (1 1 0), (0 1 7) and (0 1 8) corresponds to Bragg's reflection at 2 θ = 25.176, 27.6, 50.3 and 54.2 respectively. XRD pattern of $(Cu_{0.1}$-$Co_{0.9})$-TiO_2 exhibits with combination of a new phase , rutile and anatase phase and rhombohedral crystal structure is verified

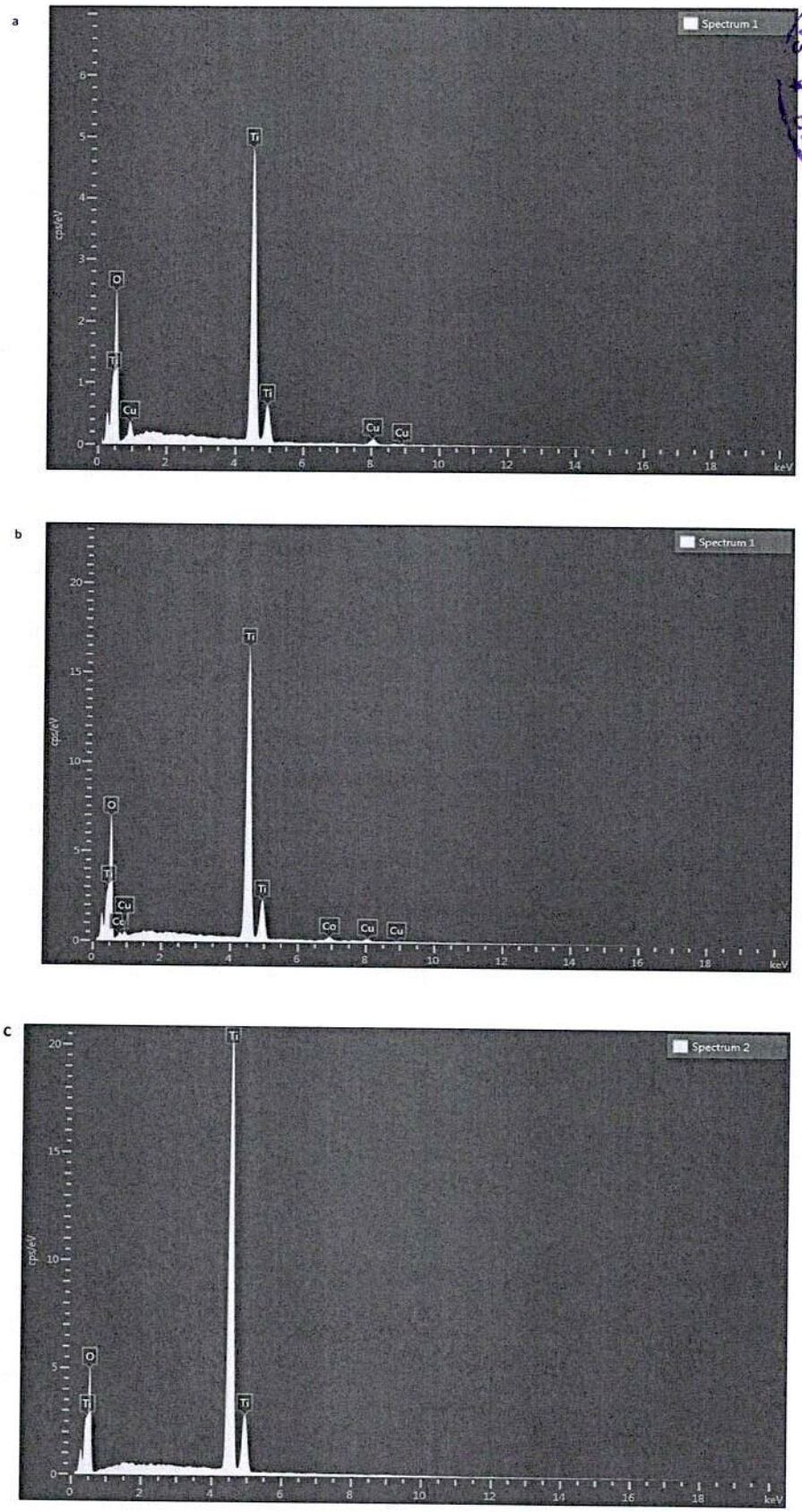

Fig. 3. EDS spectrum of (a) T_A; (b) T_B; (c) T_C.

Table 2
Weight percentage (%) and atomic percentage (%) of (a) T_A; (b) T_B; (c) T_C.

	(a) T_A		(b) T_B		(c) T_C	
Element	Atmoi %c	Wt%	Atmoi %c	Wt%	Atmoi %c	Wt%
O	46.76	72.85	51.48	76.29	43.37	69.63
Ti	48.85	25.41	45.7	22.62	56.63	30.37
Co	0.63	0.27	1.42	0.57	---	---
Cu	3.75	1.47	1.4	0.52	---	---
Total	100	100	100	100	100	100

by the comparison of 2 θ values with those from standard JCPDS data no. 41–0904. Fig. 1(c) shows the XRD pattern of TiO_2 NPs, and Bragg's reflection can be indexed to (1 0 1), (0 0 4), (2 0 0), (2 1 1), (2 0 4), (2 1 5) and (2 2 4) crystal planes at 2 θ = 25.3429, 37.8769, 47.9727, 54.0791, 62.7467, 75.1348 and 82.6813 respectively. The formation of anatase phase and tetragonal crystal structure of TiO_2 is confirmed by the comparison of 2 θ values found in Fig. 1(c) XRD patterns with those from data no. 89-4921 of the standard Joint Committee on Powder Diffraction Standards (JCPDS). By determining the full width at half maximum (FWHM) of the most intense reflection plane, the Scherrer equation is used to estimate an average crystallite size and this equation is given by,

$$D = \frac{0.9\lambda}{\beta cos\theta} \quad (1)$$

where D is an average crystalline size, λ is the wavelength of X-ray used (1.50406 Å), Θ is the Bragg's angle in radian and β is the full width at half maximum of the most intense reflection in radian. In our case, the most intense peak for T_A, T_B and T_C were found to be (1 0 1), (0 1 2), (1 0 1) plane and the average crystallite size is 29.12 nm, 24.58 nm and 7.362 nm respectively. It was observed that there is a slight increase in unit cell volume due to doping with Cu and Co but the change of molarity does not alter the unit cell volume and were presented in Table 1.

3.2. Morphology, size distribution and elemental analysis of (Cu_{1-x} – Co_x)-TiO_2 nanoparticles (for x = 0.1 M and 0.9 M)

SEM studies analyzed the surface morphology and nano-type of the samples, indicating that the particles have irregular shapes with a mean size of 223 nm to 234 nm for doped and 168 nm for bare TiO_2 NPs, as shown in Fig. 2 (a, b and c). EDS was studied to investigate the chemical composition of T_A, T_B and T_C NPs. The Fig. 3(a, b and c) reflect the EDS spectrum for T_A, T_B and T_C NPs; the presence of the elements, i.e. Ti, Cu, Co and O, as well as small quantities of element C, have been detected as traces of oil pollutants have been verified by the EDS spectrum review. Table 2 (a, b and c) indicates the weight percentage (%) and atomic weight percentage (%) of T_A, T_B and T_C NPs respectively.

3.3. Optical properties of (Cu_{1-x} – Co_x)-TiO_2 nanoparticles (for x = 0.1 M and 0.9 M)

3.3.1. UV–Vis spectroscopy

UV–vis spectroscopy has studied the light absorption properties of T_A, T_B and T_C NPs, the findings of which are shown in Fig. 4. (a, b and c).Preliminary indication for the presence of TiO_2 content is shown by the absorption maxima (λ_{max}) for T_A, T_B and T_C NPs are i.e. 411 nm, 409 nm and 341 nm respectively as seen in Fig. 4(a, b and c) and reported in Table 3. The (K-M) method of transformation [24] was used to analyze the sample band gap using the recorded absorption data.

The semiconductor band gap energy was calculated using the optical absorption coefficient (α) and is expressed by an equation (2). Where hv is a photon energy, E_g the band gap energy, A is a constant depends on the nature of transition; n = 1⁄2 for permitted direct transition, n = 2 for permitted indirect transition. In our case, the value of n is 2 for the indirect band width. For T_A, T_B and T_C NPs, the approximate Eg values from Tauc's plot shown in Fig. 5 (a, b and c) are 2.74 eV, 3.58 eV and 3.07 eV respectively and are tabulated in Table 3.

3.4. Evaluation of photocatalytic activity

To find out the photo catalytic activity of bare and doped TiO_2 NPs, photo catalytic degradation of EBT dye was performed under UV illumination. The photo catalytic degradation was determined by estimating the absorbance at the regular time interval. Interestingly, as the UV brightening exposure time increased, the relative absorption intensity constantly decreased, it was significantly shown that EBT dye degraded effectively on the surface of the TiO_2 photo catalyst [Fig. 6(a, b and c)]. Highly oxidizing hydroxyl and oxy radicals are formed by the semiconducting metal oxides like T_A, T_B etc. through generation of electron–hole pairs, which break down the large organic materials into less harmful small organic materials, under illumination. For T_A, T_B and T_C NPs, the degradation achieved was73.7%, 73% and 57.75% within 110 min respectively and is illustrated in Fig. 7. The experiment was conducted with a specific EBT dye concentration. The degradation of pure TiO_2 NPs was compared to (Cu_{1-x}-Co_x)-TiO_2 NPs (for x = 0.1 M and 0.9 M) for an exposure time of 110 min and the percentage of degradation was measured using the formula:

It is well known that the Langmuir-Hinshelwood model governs photocatalytic oxidation of organic contaminants in aqueous suspension.

$$-\frac{dC}{dt} = \frac{krKaC}{1 + kaC} \quad (2)$$

Where (-dC/dt) is the rate of degradation of EBT, C is its concentration in solution, t is reaction time, k_r is a reaction rate constant, and K_a is the reactant's adsorption coefficient K_aC is negligible when C is very small. Equation (1) can thus be used to define a first-order kinetics. Applying initial conditions of the photocatalytic procedure to equation (1), when t = 0, C = C_0, it can be described as follows:

$$\left(\frac{C_0}{C_t}\right) = k_{app}t \quad (3)$$

Where k_{app} is the apparent rate constant, which is used as the basic kinetic parameter for the various photocatalysts since it allows one to assess photocatalytic activity regardless of the previous adsorption time in the dark or the concentration of EBT remaining in the solution [25]. Fig. 8 shows the variance of ln (C_0/Ct) as a function of irradiation time for T_A, T_B, and T_C.

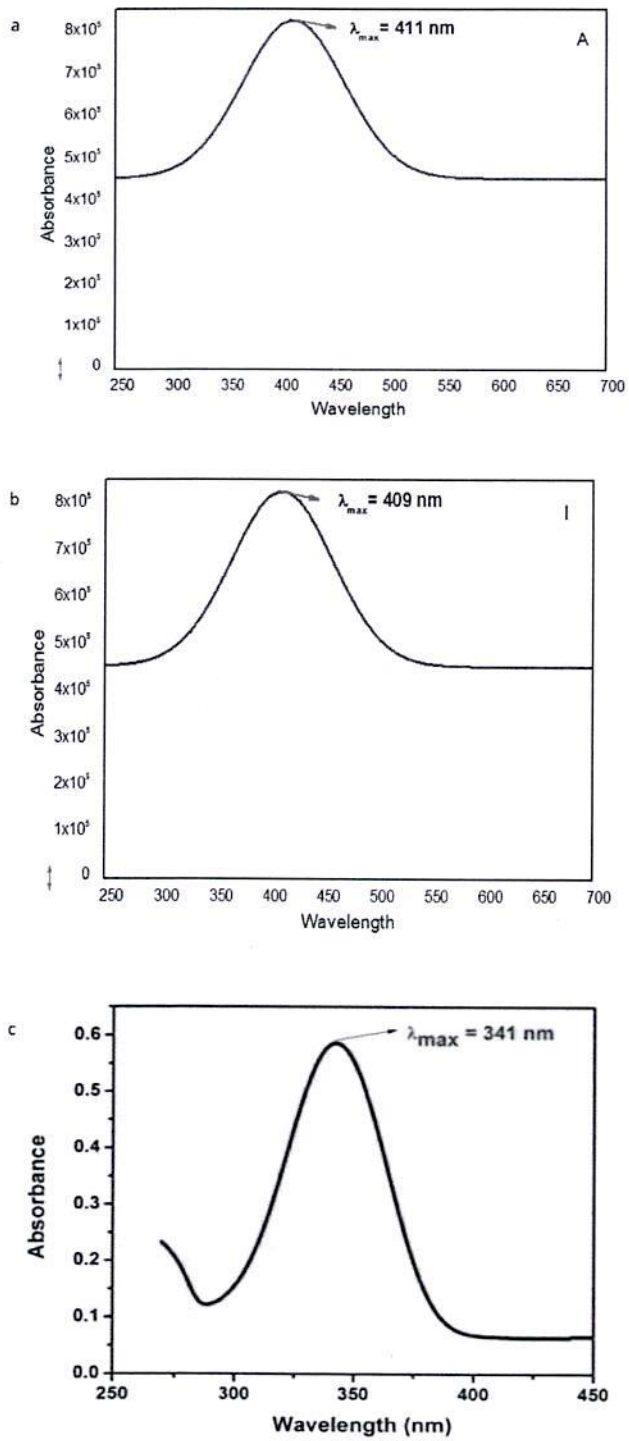

Fig. 4. UV absorbance spectra of (a) T_A; (b) T_B; (c) T_C.

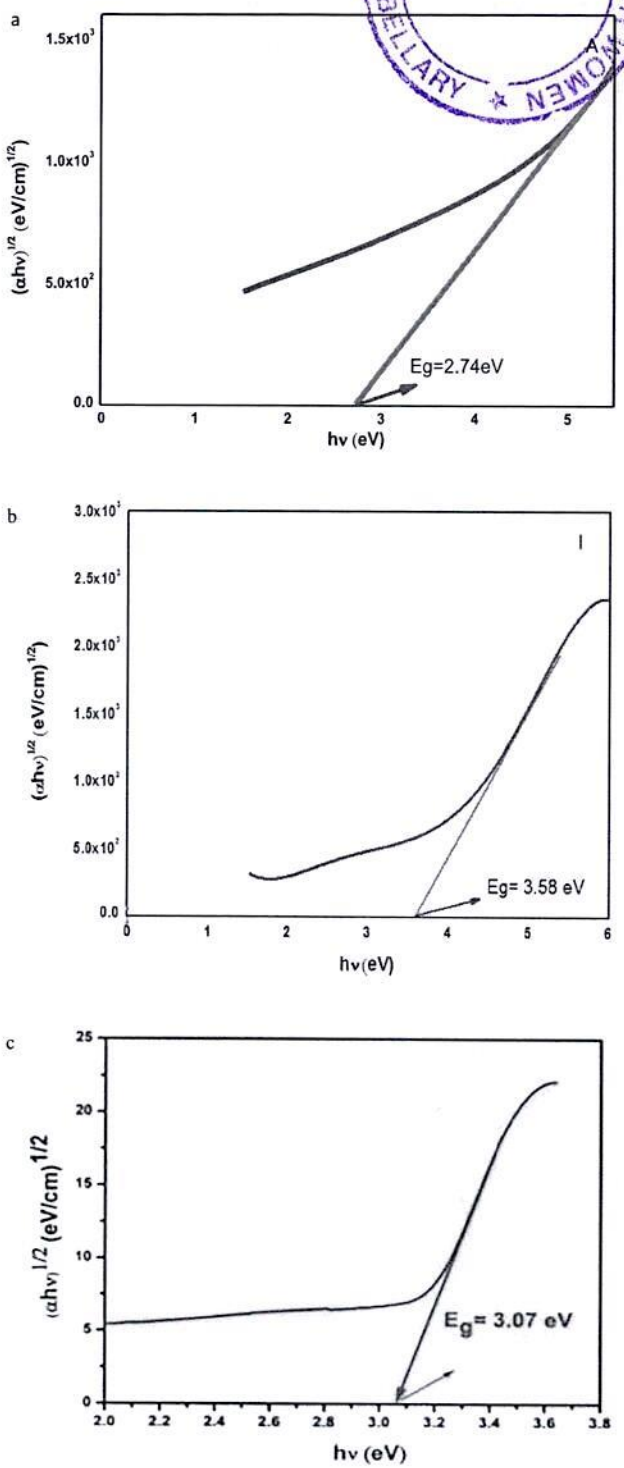

Fig. 5. Tauc's plot of (a) T_A; (b) T_B; (c) T_C.

Table 3
UV absorption maxima and band gap.

Sample	Absorption maxima (λ_m) nm	Band gap (E_g) eV
T_A	411	2.74
T_B	409	3.58
T_C	341	3.07

4. Conclusion

In this study, TiO_2 nanoparticles were synthesized and modified by doping with copper-cobalt of different molarity through hydrothermal synthesis technique, then were confirmed with various characterization techniques such as XRD, SEM, EDX, and UV–Vis Spectroscopy. The structural studies confirm that, the variation of molarity affects the crystal phase and the crystal structure of the

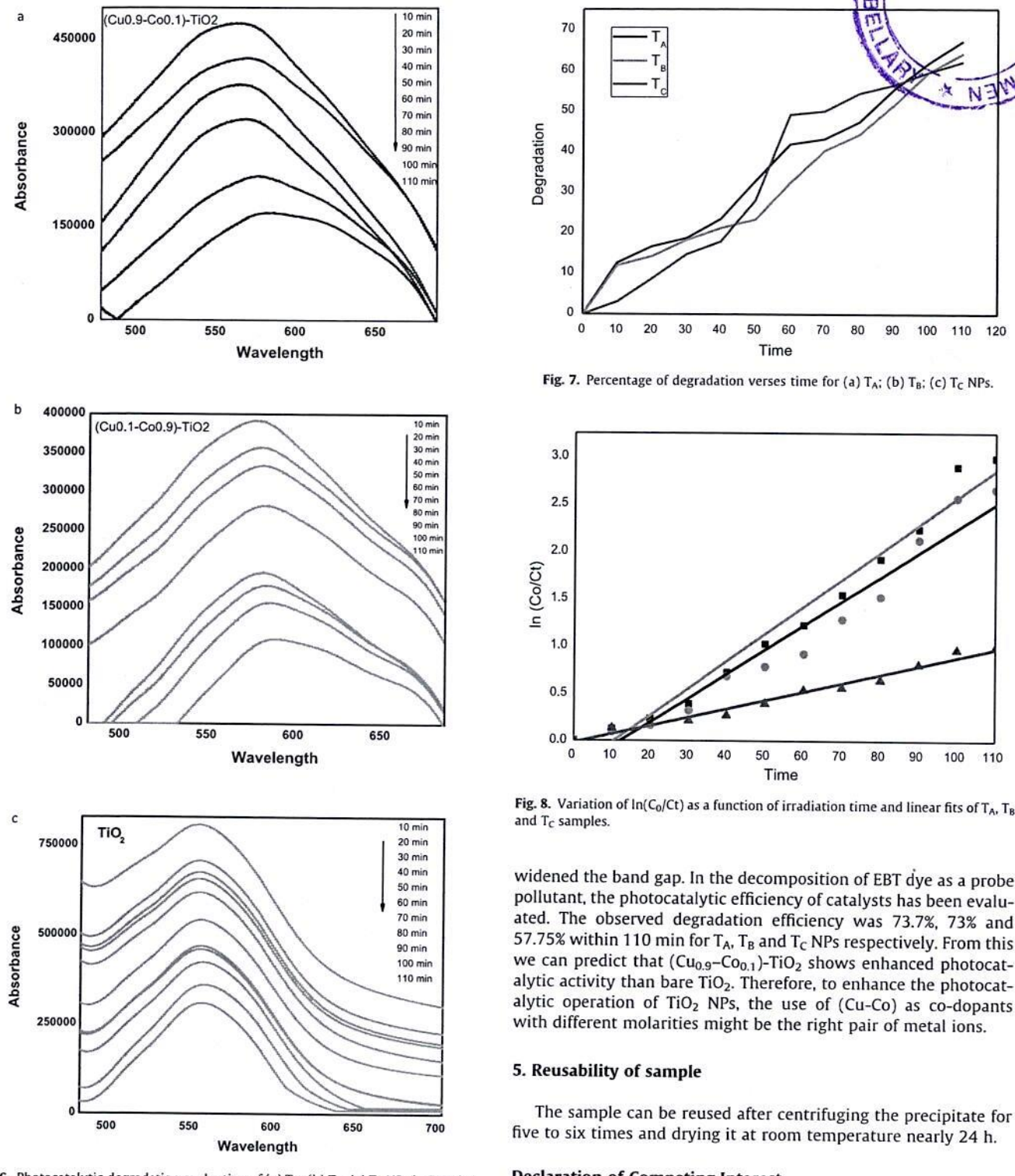

Fig. 6. Photocatalytic degradation evaluation of (a) T_A; (b) T_B; (c) T_C NPs in EBT dye solution.

NPs, because the synthesized samples show new [$(Cu_{1-x}$-$Co_x)$-TiO_2], rutile and anatase phase. The morphological studies revealed the slight increase in grain size due to doping. The UV–vis absorption spectra analysis showed the red shift for T_A and T_B. The optical band gap was decreased for x = 0.1 M and increased for x = 0.9 M, by this we conclude that increase of cobalt concentration had

Fig. 7. Percentage of degradation verses time for (a) T_A; (b) T_B; (c) T_C NPs.

Fig. 8. Variation of $\ln(C_0/Ct)$ as a function of irradiation time and linear fits of T_A, T_B and T_C samples.

widened the band gap. In the decomposition of EBT dye as a probe pollutant, the photocatalytic efficiency of catalysts has been evaluated. The observed degradation efficiency was 73.7%, 73% and 57.75% within 110 min for T_A, T_B and T_C NPs respectively. From this we can predict that $(Cu_{0.9}$–$Co_{0.1})$-TiO_2 shows enhanced photocatalytic activity than bare TiO_2. Therefore, to enhance the photocatalytic operation of TiO_2 NPs, the use of (Cu-Co) as co-dopants with different molarities might be the right pair of metal ions.

5. Reusability of sample

The sample can be reused after centrifuging the precipitate for five to six times and drying it at room temperature nearly 24 h.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Emerging Trends and Developments in Banking Sector

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Abstract:

Indian Banking sector is the largest player, plays a dominant role in building the economy of an individual as well as a nation. The growth of banking sector depends upon the services provided by them to the customers in various aspects. The growing trend of banking services is found significant after the new economic reforms in India. Banking in Indian economy which reflects as a supporter during the period of boom and recession. A strong banking and finance sector are necessary for a country to emerge as a developed one. Today, Indian banking system has a fairly developed with different classes of banks – public sector banks, foreign banks, private sector banks – both old and new generation, regional rural banks and co-operative banks with the Reserve Bank of India as the fountain Head of the system. Today banking is known as innovative banking. Information technology has given rise to new innovations in the product designing and their delivery in the banking and finance industries. Customer services and customer satisfaction are their prime work. Recently, banks are focusingto shift their activities from mass banking to class banking with the introduction of value added and customized products.With the advent of electronic banking, electronic funds transfer and other similar products, funds transfer within time frames which would have appeared impossible a few years ago has made it reality. With networking and internet connection new challenges are arising related to security privacy and confidentiality to transactions. Finally, the banking sector will need to master a new business model by building management and customer services with a variety of products and controlled cost to stay in the long run and services.

INTRODUCTION

Today, we are having a fairly qualified banking system with different classes of banks – public sector banks, foreign banks, private sector banks, regional rural banks and co-operative banks. The Reserve Bank of India (RBI) is at the paramount of all the banks. The RBI's most important goal is to maintain monetary stability (moderate and stable inflation) in

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India. Reducing inflation has been one of the most important goals for some time. Growth and diversification in banking sector as transcended limits all over the world. In 1991, the Government opened the doors for foreign banks to start their operations in India and provide their wide range of facilities, thereby providing a strong competition to the domestic banks, and helping the customers in availing the best of the services. The Reserve Bank in its bid to move towards the best international banking practices will further sharpen the prudential norms and strengthen its supervisor mechanism. There has been considerable innovation and diversification in the business of major commercial banks.

The core of banking does not merely recline in the acceptance of deposits & granting of loans to the needy persons butthis was a traditional function of banking. Nowadays it is not limited to only deposit and lending but enhanced to more sophisticated services. Current banking system constitutes a new innovative system with new technological system. Information technology in banking sector made the use of revolutionary information and communication technologies together with computers to enable banks to provide better services to its customer in a secure, credible and affordable manner. commercial banks besides providing customer services play a significant role in the economic development of a country. Commercial banks assist in removing the problem like acute shortage of capital, depressed industrial development, bad means of transport and communication. Bankers helps in performing their day to day activities and also in other remote services e.g. foreign exchange.The developing countries depends a lot on their banking system for their economic development. The banking sector in India is different from other countries due to country's unique geographic, social and other economic characteristics. Our banking sector has concerned about every people of our population i.e.of urban, rural and other backward areas. India has followed the path of growth led export rather than exports led growth of other Asian economies, with focus on self-reliance through import substitution and these features are showed in the diversity of our banking sector.

Indian banking industry has also been undergoing a metamorphic change. Today the banking industry is stronger and capable of withstanding the pressures of competition. While internationally accepted prudential norms have been adopted, with higher disclosures and

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transparency, Indian banking industry is gradually moving towards adopting the best practices in accounting, corporate governance and risk management. Interest rates have been deregulated, while the rigour of directed lending is being progressively reduced.

The Indian Banking Sector

The history of banking can be divided into three main phases:

Phase I (1786-1969): Initial phase of banking in India when small banks were setup

Phase II (1969-1991): Nationalising the banks, regularization and growth

Phase III (1991 onwards): liberalization and its aftermath with the change

In phase III banking sector has come out with a greater reach, maturity in supply and with banks having clean, strong, transparent, true and fair balance sheet and with the technological advancements.

During the last 51 years since 1969, tremendous changes have taken place in the banking industry. The banks have shed their traditional functions and have been innovating, improving and coming out with new types of the services to cater to the emerging needs of their customers. Massive branch expansion in the rural and underdeveloped areas, mobilization of savings and diversification of credit facilities to the either to neglected areas like small scale industrial sector, agricultural and other preferred areas like export sector etc. have resulted in the widening and deepening of the financial infrastructure and transferred the fundamental character of class banking into mass banking.

There has been considerable innovation and diversification in the business of major commercial banks. Some of them have engaged in the areas of consumer credit, credit cards, merchant banking, leasing, mutual funds etc. A few banks have already set up subsidiaries for merchant banking, leasing and mutual funds and many more are in the process of doing so. Some banks have commenced factoring business.

Objectives of the study:

- To study the growth in Indian banking sector in the emerging liberalized economy.
- To examine the recent trends in banking sector.
- To analyse the recent changes initiated in the banking sector.
- To figure out the technological developments in Indian Banking Field.

Transformation of Indian Banking

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Indian banking has undergone a total transformation over the last decade. Moving seamlessly from a manual, scale-constrained environment to a technological leading position, it has been a miracle. Such a transformation takes place in such a short span of time with such a low cost.

Entry of technology in Indian banking industry can be traced back during the 1990s, the banking sector witnessed various committee recommendations. One of the major objectives of Indian banking sector reforms was to encourage operational self-sufficiency, flexibility and competition in the system and to increase the banking standards in India to the international best practises. With the ease of licensing norms, new private and foreign banks emerged-equipped with latest technology.

Information Technology (IT) in Banking

Today has become an important tool for an efficient banking system, and Indian banks have put in place a fairly strong infrastructure to leverage its benefits. Digitization is not an option for banking industry rather it is evitable because every industry is being digitized and banking sector is no exception for that. Now India as well as Indians is ready to become cashless in this era of Digitization. Banking services steadily moved forward with digitizationto offer customer services at their fingertips and laptop screens. The 'Digital India' campaign Started by prime minister Narendra Modi has the potential to transform the Indian banking industry.While highlighting the progress of 'Digital India', more than 12,000 rural post office branches have been linked into payment banking. Apart from giving licences to new payment banks, many other policies and regulations are expected to be in place in the upcoming years which can bring a paradigm shift in the Indian banking sector. The Digital India vision aims to transform our country into a digital economy with participation from citizens and businesses. Over 190 million accounts have been opened under the financial inclusion scheme, with around 38 per cent of these being zero-balance accounts. It aims at achieving themaximum value, maximum empowerment to people and maximize technological penetration among the masses. India, being as a nation which continues to be driven by cash, is also moving towards a cashless economy with financial inclusion policy and 'Digital India' campaign by the government, with the aim of controlling the flow of black money.

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Today's customers are more sophisticated and tech savvy, and to cater to their specific needs, each customer needs a unique experiencefrom banking. They want the companies to understand their unstated needs as well as their likes. So, it should come as no surprise that these customers are expecting similar kind of response and service from banking institutions too. From researching new services, opening an account, checking balance, conducting transactions, loans, credits, wealth management, customer support, delivering an Omni-channel experience has become a key to success in this competitive market place.

The RBI has assigned priority to the up gradation of technological infrastructure in financial system. Technology has opened new products and services, new market and efficient delivery channels for banking industry. IT also provides the framework for banking industry to meet challenges in the present competitive environment. IT enables to cut the cost of global fund transfer.

Some of the recent IT devices described as below

a. **Electronic Payment and Settlement System** – The most common media of receipts and payment through banks are negotiable instruments like cheques. These instruments could be used in place of cash. The inter-bank cheques could be realized through clearing house systems. Initially there was a manual system of clearing but the growing volume of banking transaction emerged into the necessity of automating the clearing process.

b. **Use of MICR Technology** – MICR overcomes the limitation of clearing the cheques within banking hours and thus enables the customer to get the credit quickly. These are machine – readable codes added at the bottom of every cheque leaf which helped in bank and branch-wise sorting of cheques for smooth delivery to the respective banks on whom they are drawn. This no doubt helped in speeding up the clearing process, but physical delivery of cheques continued even under this partial automation.

c. **CTS (Cheque Truncation System)** – Truncation means stopping the flow of the physical cheques issued by a drawer to the drawee branch. The physical instrument is truncated at some point on route to the drawee branch and an electronic image of the cheque is sent to the drawee branch along with the relevant information like the MICR fields, date of presentation, presenting banks etc. This would eliminate the

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need to move the physical instruments across branches, except in exceptional circumstances, resulting in an effective reduction in the time required for payment of cheques, the associated cost of transit and delays in processing etc., thus speeding up the process of collection or realization of cheques.

d. **Electronic Clearing Services (ECS)** – The ECS was the first version of "Electronic Payments" in India. It is a mode of electronic funds transfer from one bank account to another bank account using the mechanism of clearing house. It is very useful in case of bulk transfers from one account to many accounts or vice-versa. The beneficiary has to maintain an account with the one of the bank at ECS Centre.
There are two types of ECS (Electronic Clearing Service)

ECS – Credit:ECS Credit clearing operates on the principle of 'single debit multiple credits' and is used for transactions like payment of salary, dividend, pension, interest etc.

ECS – Debit:– ECS Debit clearing service operates on the principle of 'single credit multiple debits' and is used by utility service providers for collection of electricity bills, telephone bills and other charges and also by banks for collections of principle and interest repayments.

e. **Electronic Fund Transfer (EFT)** – EFT was a nationwide retail electronic funds transfer mechanism between the networked branches of banks. NEFT provided for integration with the Structured Financial Messaging Solution (SFMS) of the Indian Financial Network (INFINET). The NEFT uses SFMS for EFT message creation and transmission from the branch to the bank's gateway and to the NEFT Centre, thereby considerably enhancing the security in the transfer of funds.

f. **Real Time Gross Settlement (RTGS)** – RTGS system is a funds transfer mechanism where transfer of money takes place from one bank to another on a 'real time' and on 'gross basis'. This is the fastest possible money transfer system through the banking channel. Settlement in 'real time' means payment transaction is not subjected to any waiting period. The transactions are settled as soon as they are processed. "Gross settlement" means the transaction is settled on one to one basis without bunching with any other transaction.

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g. **Core Banking Solutions (CBS)** – Computerization of bank branches had started with installation of simple computers to automate the functioning of branches, especially at high traffic branches. Core Banking Solutions is the networking of the branches of a bank, so as to enable the customers to operate their accounts from any bank branch, regardless of which branch he opened the account with. The networking of branches under CBS enables centralized data management and aids in the implementation of internet and mobile banking. Besides, CBS helps in bringing the complete operations of banks under a single technological platform.

h. **Development of Distribution Channels** – The major and upcoming channels of distribution in the banking industry, besides branches are ATMs, internet banking, mobile and telephone banking and card base delivery systems.

i. **Automated Teller Machine (ATM)** – ATMs are perhaps most revolutionary aspect of virtual banking. The facility to use ATM is provided through plastic cards with magnetic strip containing information about the customer as well as the bank. In today's world ATM are the most useful tool to ensure the concept of "Any Time Banking" and "Any Where Banking".

j. **Phone Banking** – Customers can now dial up the banks designed telephone number and he by dialling his ID number will be able to get connectivity to bank's designated computer. By using Automatic voice recorder (AVR) for simple queries and transactions and manned phone terminals for complicated queries and transactions, the customer can actually do entire non-cash relating banking on telephone: Anywhere, Anytime.

k. **Tele Banking** – It is another innovation, which provided the facility of 24hour banking to the customer. Tele-banking is based on the voice processing facility available on bank computers. The caller usually a customer calls the bank anytime and can enquire balance in his account or other transaction history.

l. **Internet Banking** – Internet banking enables a customer to do banking transactions through the bank's website on the internet. It is system of accessing accounts and general information on bank products and services through a computer while sitting in its office or home. This is also called virtual banking.

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m. **Mobile Banking** – Mobile banking facility is an extension of internet banking. Mobile banking is a service provided by a bank or other financial institution that allows its customers to conduct financial transactions remotely using a mobile device. Unlike the related internet banking it uses software, usually called an App, provided by the financial institution for the purpose. Mobile banking is usually available on a 24hour basis. Some financial institutions have restrictions on which accounts may be accessed through mobile banking, as well as a limit on the amount that can be transacted. Transactions through mobile banking may include obtaining account balances and lists of latest transactions, electronic bill payments, and fund transfers between a customer's or another's accounts.

n. **Digital Banks** - Banking is not just refining its predominant business models, but redefining it. Digital banks are on the rise. They are an alternative to branch-based banks offering the same services remotely over the internet with minimal paperwork. Their USP is that customers never have to visit the branch because there isn't any, making such financial services digital-only. The regulatory climate for digital banks may be affected by geography and the level of digital transformation within the economy. Also, it may inhibit the extent of offered services, limiting core banking products (such as saving/checking account) to retail banks.

o. Unified Payment Interface (UPI) -UPI is a trend that emerged in the last couple of years and it is revolutionizing the way we pay and receive money. Transactions can be done within seconds using this interface. Goggle Pay and BHIM (Government of India) are two major interfaces among numerous other services that enable easy payment even if you are out of physical cash.

p. Blockchain - Block chain is a robust technology that is still in the development phase. Security is a major factor as far as digital services are concerned. Despite technical advances, fraud practices are still a challenge in the digital domain. Blockchain is the answer to these challenges. Like the way in which it operates, there is no scope for any malpractices in it. The technology works on computer science, data structures and cryptography.

q. Artificial Intelligence (AI) Robots-Many private and nationalized banks have started to make use of chatbots or Artificial Intelligence (AI) robots for assistance in

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customer support. The practice is still in its initial stage but will definitely evolve and make the entrance to the general public in the near future. Chatbots are one of the emerging trends that are estimated to grow.

Table-01
Payment system indicator (volume in lakhs)

Services	2015-16	2016-17	2017-18	2018-19	2019-2020
RTGS	983	1079	1244	1366	1507
APBS	7175	9491	12980	15032	16802
IMPS	2028	5067	10098	17529	25792
UPI	-	180	9152	53915	125186
NEFT	12529	16221	19464	23189	27445
BHIM(Aadhar based)	-	-	20	68	91
Credit cards	7857	10871	14052	17626	21773
Debit cards	11736	23993	33434	44143	51239
Total digital payments	59361	96912	145901	234340	343456

Source: RBI statistical reports 2019-2020

Table-01 states the number of customers used in various banking services from 2015-16 to 2019-20. The table also indicates very clearly that number of customers who are accessing to the modern banking services are increasing over the years.

Methodology

This paper is based on secondary data. Data is collected from various lectures, reports, seminars, important publications of various banks, statistical tables relating to banks, newspapers, journals and annual reports. Collected data has _been classified according to the requirements. In depth study and analysis of the classified data has been done and interpretation of findings are made thereof.The data required for the study was primarily obtained from performance Highlights of Bankspublication of the Indian BanksAssociation. The data was also retrieved from publications of different institutions like

- Annual reports on trends and progress of banking in India
- Reports on the basic statistical return
- Highlights of public sector banks in India for the relevant period

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Methodology adopted for the purpose of this includes systematic study of nature, objects and magnitude of the problem and efficiency of the measures adopted to solve the problem.

Conclusion

In the days to come, banks are expected to play a very useful role in the economic development and the emerging market will provide business opportunities to harness. Through the innovation and IT system used in banking field, banks are able to better risk management system, adoption of internationally accepted accounted practices and increased disclosure and transparency. These reforms which has taken place in different phases further strengthen the system of banking in India. It will become more and more knowledge supported capital will emerge as the finest assets of the banking system. Ultimately banking is people and not just figures. To conclude it all, the banking sector in India is progressing with the increased growth in customer base, due to the newly improved and innovative facilities offered by banks.by the government support and revaluation of existing business, strategies can set the stage for Indian banks to become wider and stronger, thereby setting the stage for expansion into a global consumer base. The economic growth of the country is an indicator for the growth of the banking sector.

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1969-2019 50 Years Golden Jubilee

CRITERION-03: Research, Innovation and Extension

3.3.1 List of research papers published per teacher in the Journals in 2019-20

(June-2019 to July-2020)

Sl No	Title of the Article	Name of Author	Publication Journal name	ISSN No	Year of Publication	Page No
01	Synthesis, DNA photo cleavage, molecular docking and anticancer studies of 2-methyl-1,2,3,4-tetrahydroquinolines	P. J. Bindu	Chemical biology letters	2347-9825	14-June-2019	01 - 06
02	Synthesis and Characterization of Cu And Co Doped Tio2 Nanoparticles via Hydrothermal Route	A M Kalamma	Journal of Interdisciplinary Cycle Research	0022-1945	June/2020	07 - 19
03	Low-temperature microwave-assisted synthesis and antifungal activity of CoFe2O4 nanoparticles	P. J. Bindu	Journal of Materials Nano Science	2394-0867	24-Sept-2019	20 - 25
04	Synthesis of nano crystalline ZnO: Reusability and its morphological effect on catalytic activity, yield and time of the reaction	P. J. Bindu	Research Journal of Chemistry and Environment	09720626	December 2020	26 - 29

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Research Development Council,
Smt. Allum Sumangalamma Memorial College for Women, Ballari.

IQAC
CO-ORDINATOR
Smt. Allum Sumangalamma Memorial College For Women, BELLARY.

PRINCIPAL
Smt. Allum Sumangalamma Memorial College For Women, BELLARY.

3.3.1 Number of research papers published per teacher in the Journals notified on UGC CARE list during the last five years (2019-20)

Title of paper	Name of the author/s	Department of the teacher	Name of journal	Calendar Year of publication	ISSN number	Link to the recognition in UGC enlistment of the Journal /Digital Object Identifier (doi) number		
						Link to website of the Journal	Link to article / paper / abstract of the article	Is it listed in UGC Care list
Synthesis, DNA Photoclea, Molecular Mocking & Anti-Cancer Studies of 2-Methyl - 1, 2, 3, 4 - tetrahydroquinolines	Dr. P.J. Bindu	Chemsitry	Chemical Biology Letters	2019	2347-9825	http://thesciencein.org/journal/index.php/jmns/article/view/82	https://www.google.com/search?sca esv=597807857&q=Synthesis,+DNA+Photoclea,+Molecular+Docking+and+Anticancer+Studies+of+2-Methyl+-+1,+2,+3,+4+-&spell=1&sa=X&ved=2ahUKEwip2qC1gdiDAxUj4jgGHb3pC8EQkeECKAB6BAgIEAI	No
Low Temperature Micro wave assisted Synthesis & Anti Fungal activity of CoFe204 Nano Particles	Dr. P.J. Bindu	Chemsitry	J.Mat. Nano Science	2019	2347-9825	http://pubs.iscience.in/journal/index.php/cbl/article/view/858	http://pubs.thescienceincein.org/journal/index.php/jmns/article/view/233	No
Synthesis & Characterization of Cu & Co Doped Tio2 Nano Particles via Hydrothermal route	A M Kalamma	Physics	Journal of Interdisciplinary Cycle Research	2020	0022-1945	http://www.jicrjournal.com/gallery/55-jicr-june-2808-2.pdf	https://jicrjournal.com/?s=Synthesis+%26+Characterization+of+Cu+%26+Co+Doped+Tio2+Nano+Particles+	Yes
Synthesis of nano crystalline ZnO: Reusability and its morphological effect on catalytic activity, yield and time of the reaction	Dr. P.J. Bindu	Chemistry	Research Journal of Chemistry & Environment	Dec-20	9720626	http://eprints.iisc.ac.in/id/eprint/67622	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85098129531&partnerID=40&md5=8268a1004fa7778909	No

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Integrated Science

Chem. Biol. Lett. 2019, 6(1), 8-13 Article

Chemical Biology
LETTERS

Synthesis, DNA photocleavage, molecular docking and anticancer studies of 2-methyl-1,2,3,4-tetrahydroquinolines

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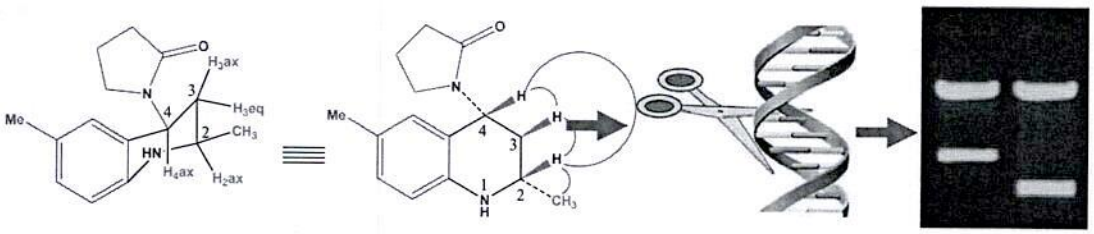
Submitted on: 12-Dec-2018, Accepted and Published on: 14-June-2019

ABSTRACT



2-Methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones (**3a–g**) were synthesized by one pot multicomponent aza Diels-alder reaction between *N*-arylimines with two molecules of *N*-vinyl-2-pyrrolidinone in presence of Sm(III)nitrate as catalyst in acetonitrile solvent at room temperature stirring. The photocleavage studies with 2-methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones (**3a–g**) revealed that almost all derivatives exhibited effective photocleavage of pUC−19 DNA at 365 nm, The The anticancer activities of newly synthesized compounds (3a–g) were more potent than doxorubicin on MCF−7 cells. The docking of PBR receptor (1EQ1) protein with newly synthesized THQ's (**3a-g**) exhibited well established bonds with one or more amino acids in the receptor active pocket.

Keywords: Sm(III)nitrate, 2-methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones, pUC−19 DNA Photocleavage, Anticancer acivity

INTRODUCTION

DNA cleavage by synthetic nucleases is of current interests for their potential utility in the photodynamic therapy (PDT) of cancer.[1-4] During the past decades, PDT has emerged as a new modality of cancer cure due to its non-invasive nature and for its selectivity in which the photo-irradiated cancer cells are selectively damaged leaving the unexposed normal cells intact.[1-4] The mode of action of the synthetic organic PDT agents is to generate cytotoxic singlet oxygen ($^1O_2$) upon photoactivation cause cellular photodamage during the PDT process. Some of the metal-based PDT agents largely depend on their high quantum yield of singlet oxygen generation which is often difficult to achieve thus making them unsuitable for phototherapeutic applications and also some of them showed side effects.[1-4] These problems could be circumvented using synthetic organic based PDT agents which could be suitably designed to cause cellular photodamage in addition to the generation of singlet oxygen species.

Functionalized tetrahydroquinolines are attractive small organic molecules that can be applied as pharmaceuticals and agrochemicals, as well as useful synthetic blocks in the preparation of several alkaloids.[5-7] For these reasons, the tetrahydroquinoline scaffold is considered to be privileged, and the development of new efficient and convenient synthetic approaches to these heterocyclic molecules remains an active research area. The tetrahydroquinolines and its products are widely featured in commercial drugs and other useful materials.

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 ISSN: 2347–9825
http://pubs.sciencein.in/cbl

Table 1 Synthesis of 2-methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones (**3a–g**).

Entry	R	Time (hrs)	Yield (%)[a]	M.P(°C)
3a	*p*-H	2	92	71–74
3b	*p*-CH_3	2	88	93–97
3c	*p*-F	2	95	138–142
3d	*p*-Cl	2	92	151–154
3e	*p*-Br	2	75	158–162
3f	*p*-OCH_3	2	90	91–94
3g	*p*-NO_2	2	85	141-143

[a]*Yields of isolated products*

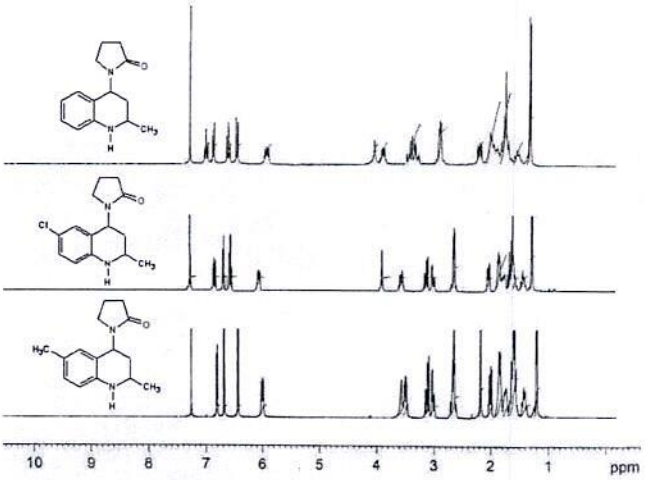

Figure 2. The condensed ^1H NMR spectra of 2-methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones (**3a–g**)

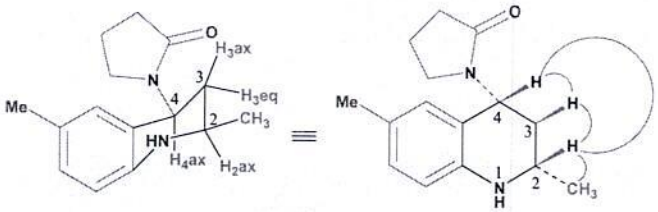

Figure 3. Correlations of the *cis* 2,6-Dimethyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones (**3b**).

The mechanism of the formation of 2-methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones (**3a–g**) is shown in Scheme 2.

In our previous results, we have discussed the *cis* configuration of the final compounds, which was confirmed by COSY and NOESY spectral studies.[22,23] The Figure 3 shows the all reciprocal interactions were observed among H–4, H–3a and H–2 are in accord with the *cis* configuration.

DNA PHOTOCLEAVAGE STUDIES

DNA cleavage by synthetic nucleases is of great interest in biology and bioorganic chemistry. During the past decades, many DNA cleavage reagents have been developed as potential antitumor agents. Especially, designing of the compound based on their ability to cleave DNA under photo-irradiation is of great importance not only from the biological point of view but also in terms of photodynamic therapeutic approach to develop potent antitumor agents. The photo-irradiation technique has a very high potential to strike at specific targeted sites. Photocleavage efficiency of the drug is basically related to the tendency of relaxation of the super coiled (SC) DNA into open circular (OC) DNA or more specifically degradation of both the SC and OC form of DNA.[25–27, 30–32]

The photo-irradiation of 2-methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones (**3a–g**) at 365 nm in different concentration was studied. A solution of 2-methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones (**3a–g**) at 40 μM, and 80 μM in the presence of pUC–19 DNA was irradiated for 2h, in 1:9 DMSO: Trisbuffer (20 μM, pH–7.2) at 365 nm. The DNA cleavage ability was determined quantitatively by the effectiveness in converting super coiled plasmid DNA (Form I) to nicked circular (Form II) and linear (Form III). As electrophoresis experiment proceeds, the control DNA (lane-1) will not show any apparent cleavage (Figure 4). The studies shows that the substituted 2-methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones (**3a–g**) was found to induced photoextrusion under conditions required for DNA cleavage which produced intermediates capable of hydrogen abstraction

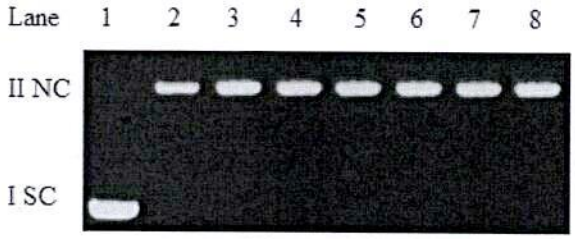

Figure 4. Photo cleavage of DNA by 2-methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones 3a-h was irradiated with UV light at 365 nm. Supercoiled DNA runs at position I (SC) and nicked DNA at position II (NC). Lane; 1: control DNA (with out compound), Lane; 2: 40μM (**3a**), Lane; 3: 40μM (**3b**), Lane; 4: 40μM (**3c**), Lane; 5: 40μM (**3d**), Lane; 6: 40μM (**3e**), Lane; 7: 40μM (**3f**), Lane; 8: 40μM (**3g**).

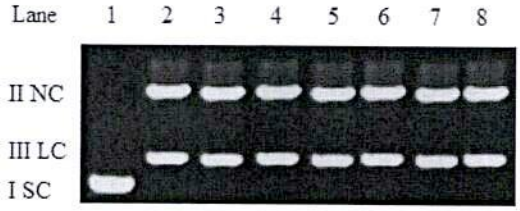

Figure 5. Light-induced cleavage of DNA by 2-methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones 3a-g of 80 μM were irradiated with UV light at 365 nm. Supercoiled DNA runs at position I (SC), linear DNA at position III (LC) and nicked DNA at position II (NC). Lane; 1: control DNA (with out compound), Lane; 2: 80μM (**3a**), Lane; 3: 80μM (**3b**), Lane; 4: 80μM (**3c**), Lane; 5: 80μM (**3d**), Lane; 6: 80μM (**3e**), Lane; 7: 80μM (**3f**), Lane; 8: 80μM (**3g**).

415 forms hydrogen bond with amino group of THQ in ligand **3f** with a hydrogen bond distance of 2.193Å (Figure 7). Similarly halogen derivatives show two hydrogen bonds with the protein molecules as shown in Figure 7 respectively. The nitro substitution of THQ (**3g**) was shown four hydrogen bonds with the protein molecule (Figure 7). However, in this research, molecular docking analysis suggested that THQ (**3g**) has the more specificity towards the Pheripheral benzodiazepine receptor than THQ (**3f**). Regarding the obtained results, THQ could serve as an appropriate starting point for designing new chemical entities as potent anti cancer drug.

Conclusion

In conclusion a mild, rapid and highly regioselective one pot synthetic protocol has been developed to achieve THQ's. The structures of all compounds were established on the basis of physicochemical data. The photo-induced DNA cleavage activity and anticancer activity of seven THQ's are presented. The THQ with the photoactive quinoline moiety display efficient UV–light-induced DNA cleavage activity at low drug concentration via mechanistic pathways that involve formation of both singlet oxygen and stereochemistry. DNA photocleavage study showed that the compound **3f** and **3g** having *p*-methoxy and *p*-nitro substitution on phenyl ring, respectively resulted in the complete DNA degradation even at 80 μM concentration. However, the THQ (**3a–g**) display good cytotoxic effect in HeLa cells giving IC_{50} values in the micromolar range and a concentration-dependent photocytotoxicity is observed for the compound. Due to presence of nitrogen atom in the all THQ's, the photocleaved phenyl radical finds more stability to further damage DNA. Therefore, it is concluded that the THQ may act as lead compounds for the development of potent anticancer agents in future.

Experimental

General procedure for the synthesis of 2-methyl-1,2,3,4-tetrahydroquinolin-4-yl)pyrrolidin-2-ones

To a stirred solution of aniline (4 mmol) and *N*-vinyl-2-pyrrolidinone (10 mmol) in acetonitrile (15 mL) was added Sm(III) nitrate (10 mole %) and stirring was continued for the appropriate time as mentioned in Table 1. After completion of the reaction, as indicated by TLC, the reaction mixture was quenched with saturated aqueous $NaHCO_3$ solution and extracted with dichloromethane (3x25 mL). The combined organic layer was dried over anhydrous Na_2SO_4 and evaporated. The crude product was purified by silica gel column chromatography eluting with petroleum ether: ethyl acetate (7:3) mixture. The resulting products were characterized by ^1H NMR, ^{13}C NMR, MS and IR spectra, and comparison with the literature data (ESI).

Acknowledgments

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Supporting Information

The spectral data of the synthesized compounds is provided as supplementary file and can be downloaded from journal site.

Conflict of Interest

The authors do not have any *conflicts of interest* to declare for the work reported in this article.

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Low-temperature microwave-assisted synthesis and antifungal activity of $CoFe_2O_4$ nanoparticles

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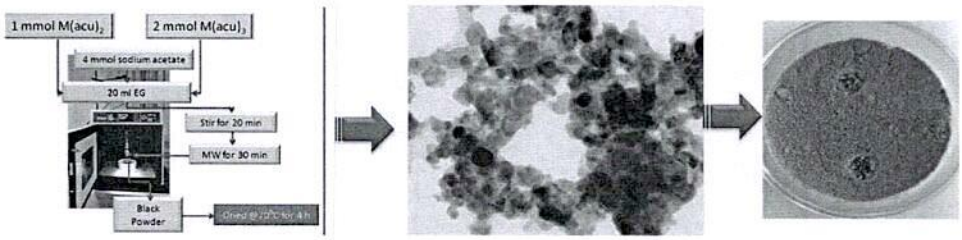
ABSTRACT



Nanoparticle ferrite with chemical formula $CoFe_2O_4$ was prepared from the Co (II) and Fe (III) 3-acetyl-4-hydroxy-coumarin metal complexes by solution based one-pot microwave assisted technique. Single phase structure of $CoFe_2O_4$ ferrites nanoparticles was confirmed using FTIR, XRD, SEM, and EDX analysis. Transmission Electron Microscope (TEM) showed that the particle size of the samples in the range of (15 nm). The hysteresis studies showed ferromagnetic behaviour at room temperature. The antifungal activity of $CoFe_2O_4$ nanoparticle was investigated against *A.flavus* and *A. niger* by employing disc diffusion method. According to the results obtained, $CoFe_2O_4$ is a potential material for antifungal diseases. The $CoFe_2O_4$ nanoparticles could be readily separated from water solution after the disinfection process by applying an external magnetic field.

Keywords: Microwave-irradiation, Nanocrystalline $CoFe_2O_4$, Coumarin metal complexes, Antifungal activity

INTRODUCTION

In recent years, the spinel ferrites belonging to AB_2O_4 structure having A-site (metal) and B-site (iron) have drawn huge attention due to their fascinating properties to meet the requirements in various applications.[1,2] The cobalt ferrites have been found to be the most versatile ferrites systems from the perspective of their technological application because of its high electrical resistivity, high permeability, compositional stability and for high frequency applications.[1,2] The outstanding combination of these properties makes them attractive for potential applications in diverse field. The research and application of magnetic materials[3] have been developed considerably in the few past decades.[4,5] In order to discover new types of ferrites and develop their properties, scientific communities have also paid their significant attention.

Nanotechnologies have a great potential for various biomedical applications, including cancer diagnostics[6] and treatment.[7,8] Some specific characteristics are required for nanoparticles in biomedicine like, biocompatibility, heating ability,[9,10] morphology,[11] size. lipophilicity,[12] distribution, a ferrimagnetic/superparamagnetic behavior, hemocompatiblity, dispersibility in water and suspensions stability. Magnetite nanoparticles, with an inverse spinel structure, are the most studied ferrites for biomedical applications.[5]

$CoFe_2O_4$ (spinel-type ferrites), have many potential biomedical applications.[13] This is due to its high magnetic and thermal stability and high anisotropy field. These $CoFe_2O_4$ ferrites have potential applications in high-density magnetic recording,

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microwave devices, magnetic fluids catalytic materials, gas-sensing materials.[14,15] Recently, cobalt ferrite ($CoFe_2O_4$) has attracted considerable research interest for visible-light-driven-photocatalyst due to its narrow band gap.[16]

In recent decades, much attention has been paid on their shape and size of the nanoparticles synthesis.[17,18–20] Therefore, the synthesis of small size and uniformly dispersed $CoFe_2O_4$ has been the target of materials chemists. In recent years, cobalt ferrite nanoparticles prepared using various methods, such as sol–gel technique, thermolysis, hydrothermal method, coprecipitation, microemulsions, solvothermal, have been extensively studied.[17] However, ferrite nanoparticles have been synthesized successfully through most of these methods, but these techniques involves, selection of metal precursors, high reaction temperatures, long reaction times, toxic reagents used, and the by-products produced that have the potential to harm the environment. Among all these techniques, microwave[21,22] route seems to be the most convenient for the synthesis of cobalt nanoparticles.[23,24] This convenience come from its homogeneity, simplicity, cost effectiveness, less time consuming, better control over morphology, crystallite size.[25]

In particular, the synthesis of $CoFe_2O_4$ was reported by traditional methods by using commercial metal acetates and metal halides. Even though, there have been a lot of effort in the synthesis of the $CoFe_2O_4$ nanostructures by using the precursors as described above, very little attention was undertaken for the design of a new precursor for the synthesis of $CoFe_2O_4$ nonomaterials.[26] Also, the use of 3-acetylcoumarin as precursors for the preparation of metal oxide nanomaterials, such as $CoFe_2O_4$ using microwave-assisted synthesis has not yet been investigated. Hence we made an attempt to synthesize $CoFe_2O_4$ nanoparticles using cobalt and iron complex of 3-acetylcoumarin as precursor for the first time. The thermal decomposition behavior of metal precursors was examined. The structure, size, morphology, magnetic properties of as-prepared powder material were examined. The antimicrobial performance[27] of as-synthesized $CoFe_2O_4$ nanoparticles is discussed, where the excellent selective antimicrobial performance is confirmed.

EXPERIMENTAL

Synthesis and Characterization of metal precursor material.

All the chemicals used in the present study are of AR grade. Whenever analytical grade chemicals were not available, laboratory grade chemicals were purified and used. All the chemicals and reagents were purchased from SDFCl chemicals and Sigma-Aldrich. We have employed β-diketonates complexes type Co(II) and Fe(III) 3-acetyl-4-hydroxy-coumarin metal complexes as precursor materials. The Co(II) and Fe(III) metal complexes were synthesized and purified in-house. The FTIR, ^{1}H-NMR, Mass, TGA and UV-analysis of in house synthesized metal complexes was performed. The metal–oxygen bond present in β-diketonates complexes makes them appropriate precursors for the synthesis of metal/metal oxide nanoparticles.

Synthesis of $CoFe_2O_4$ nanoparticles.

Solutions of 1 mmol of Cobalt (II) acetyl coumarin ($Co(acu)_2$) and 2 mmol of Fe (III) acetyl coumarin ($Fe(acu)_3$) dissolved in 30 mL of ethylene glycol and mixed together under constant stirring. The pH of the solution is adjusted to the desired value by 4 mmol of sodium acetate (alkaline source) with constant stirring for 20 min. The reaction mixture is irradiated into a MARS (Microwave Accelerated Reaction System, USA) microwave reactor (2.45 GHz) equipped with a water-cooled condenser and a fiber-optic temperature sensor. The solution was then irradiated for 30 min with the power set at 800 W and temperature at 250 °C, leading to a black precipitate. After completion of reaction, the powder materials was also collected by centrifugation, washed twice with deionized water, ethanol, acetone and dried in vacuum oven at 70 °C for 4h (Figure 1).

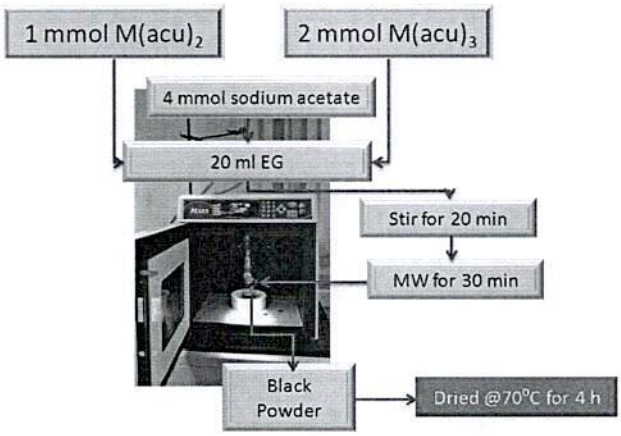


Figure 1. Flow chart for the synthesis of $CoFe_2O_4$ nanoparticles. Where M = $Co(acu)_2$ and $Fe(acu)_3$ metal complexes.

Characterization of nanoparticles

The crystallinity and phase composition of the $CoFe_2O_4$ nanoparticles were investigated using an X-Ray Diffraction (XRD) - analysis was done with Rigaku X-ray difractometer, FT-IR studies were carried out using a Perkin Elmer Frontier FTIR spectrophotometer. The particle size and composition of CoFe2O4 nanoparticles were confirmed by using ULTRA55 FESEM equipped with EDS. The XPS analysis of $CoFe_2O_4$ nanoparticles was recorded by using kratos axis ultra dld spectrometer. The TGA of $CoFe_2O_4$ was recorded using Perkin Elmer STA 8000.

Antimicrobial assay

The antifungal activity of the as-prepared $CoFe_2O_4$ nanoparticles was assessed against *A. flavus* and *A. niger* through agar disk diffusion method. The pure fungal strains were maintained on nutrient agar and potato dextrose agar (PDA) respectively. The dried powder of $CoFe_2O_4$ was taken at the concentration of 50 µg/ml for the antimicrobial tests. Inoculum from the spore suspension cultures of the different fungal strains were spread onto the solidified agar plates. Distilled water poured disk was used as a negative control and Amphotericin B as a positive control. Plates were incubated at 37°C for 48 h. The diameter of zone of inhibition was measured for each compound in milimeter after 48 h.

RESULTS AND DISCUSSION

In the earlier work we have reported the efficient synthesis of metal β-diketonate complexes for materials synthesis.[28] The stability of the complexes has been influenced by the rigidity of the ligand backbone. As part of our continuing interest to synthesize metal complexes of β-diketonate type,[29] we have synthesized coumarin metal complexes with the similar ligand framework. As part of our continuing interest to synthesize metal complexes of β-diketonate type, we have reported 3-acetyl-4-hydroxy-coumarin metal complexes with the similar ligand framework. We described here a convenient approach to the preparation of $CoFe_2O_4$ nanoparticles using 3-acetyl-4-hydroxy-coumarin metal complexes by microwave method.[30]

From the results of FTIR, TGA and spectroscopic studies, the stoichiometry of the complexes has been deduced as $M(acu)_2$ and $M(acu)_3$. This coumarin entity has oxygen donor framework from hydroxyl and acetyl groups and, therefore, stabilizes comfortably the metal ions in their +2 and +3 oxidation state.

Magnetic $CoFe_2O_4$ nanoparticles were prepared via a rapid, facile and green microwave irradiation pathway with Co and Fe coumarin metal complexes as precursor materials, sodium acetate as an alkaline source and ethylene glycol (EG) as a reducing agent and microwave-absorbing solvent. As we know, microwaves are selectively absorbed by polar molecules, which are superheated through dipole rotation and ionic conduction, resulting in rapid heating and low thermal gradients. Briefly, EG has a high dielectric constant and therefore an excellent absorbing capacity towards microwaves, and has been frequently used as a microwave absorbent in microwave synthesis. Interestingly, compared with the previous results from our group, microwave irradiation dramatically accelerated the cluster formation process and the reaction occurred at a temperature of 250 °C within only 20 min, in striking contrast to the traditional methods.

The phase of the synthesized $CoFe_2O_4$ nanoparticles was identified by XRD characterization is as shown in Figure 2. All of the peaks of the patterns of the calcined samples can be readily indexed to cubic $CoFe_2O_4$ with spinel structure (JCPDS file No. 22–1086), where the diffraction peaks can be indexed to the reflection of (220), (311), (400), (422), (511), and (440) planes of the spinel $CoFe_2O_4$, respectively. No impurity phase is found in the XRD patterns, indicating high purity of the products. The average crystallite size of the as-prepared cobalt ferrite nanomaterial was calculated from the width of the prominent (311) reflection using the Scherrer's equation. The size of the $CoFe_2O_4$ crystal is about 18 nm.

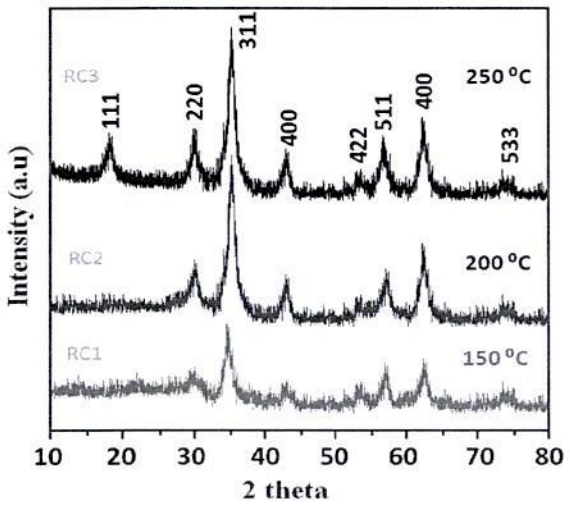


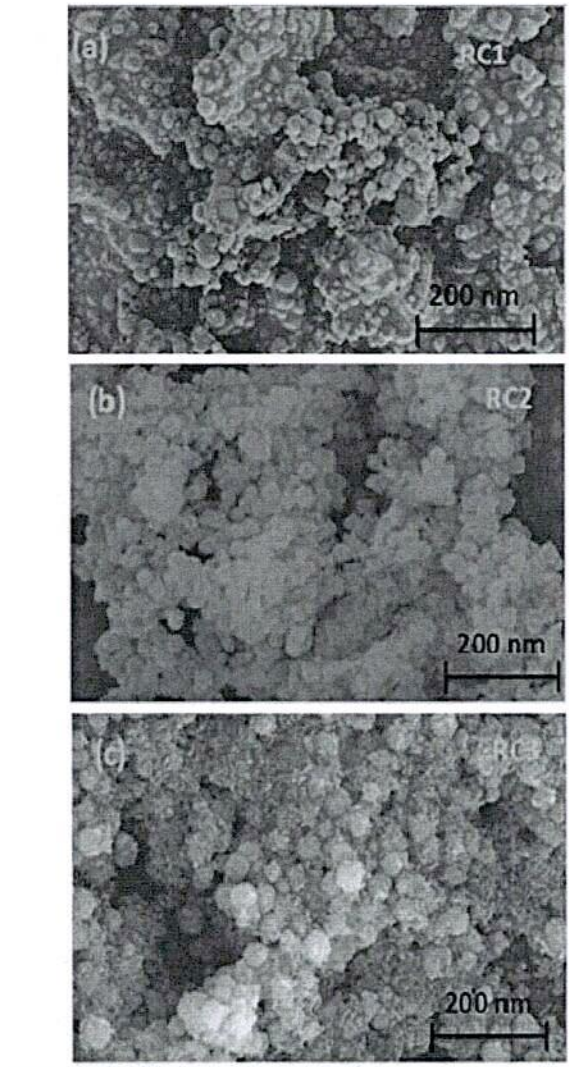
Figure 2. XRD of as-prepared $CoFe_2O_4$ nanoparticles at different temperatures by microwave assisted method.

We have also studied the effect of microwave temperature and power on the synthesis of nanocrystalline cobalt ferrites. Figure 2 shows the XRD patterns of the cobalt ferrites synthesis at 150 °C (RC1), 200 °C (RC2) and 250 °C (RC3) with constant microwave power (800 W) and irradiation time (20 min) respectively.

The morphological studies of the obtained $CoFe_2O_4$ nanoparticles were investigated by the FE-SEM analysis. The highly agglomerated nanoparticle prepared by microwave method was shown in Figure 3. The results showed that grain sizes and morphology depended strongly on the microwave-assisted synthesis. The SEM of precursor material is as shown in figure 3(a), 3(b) and 3(c), respectively. High-resolution transmission electron microscopy (HRTEM) at an accelerating voltage of 200 kV was employed to know the morphology and size of prepared $CoFe_2O_4$ nanoparticles (Figure 3d). The particle diameters are in the range of 15 nm, which may be due to the preparation method and the presence of magnetic interactions among the particles.

Figure 3 (e) shows the EDX analysis of $CoFe_2O_4$ nanoparticles carried out at room temperature for the elemental confirmation and purity of the sample. The EDX spectrum confirms both the homogeneity and gradient of the elements Fe, Co, O present in the sample. The results suggested that the precursors have fully reacted in the microwave-irradiation to form the single phase $CoFe_2O_4$ nanoparticles and it confirms that there is no other impurity present in the samples. Further we investigated the chemical composition and oxidation state of the as-prepared $CoFe_2O_4$ nanoparticles (RC3) was by XPS analysis. The O1s peaks and regions were easily visible, and originated from the prepared $CoFe_2O_4$ oxides and surrounding environment. The XPS spectra of the primary Fe2p and Co2p core levels of Sample 3 (RC-3) of the prepared $CoFe_2O_4$ oxide nanoparticles are shown in figure S14 (see supplementary file). The Fe2p spectra in Fig. exhibited two peaks at 710.9 and 724 eV could be attributed to the $Fe2p_{3/2}$ and $Fe2p_{1/2}$ oxidized states of Fe^{3+} inside $Co^{2+}Fe^{3+}{}_2O_4$ oxide. The peak at 780.6 eV is from $Co2p_{3/2}$, and the peak at 796.8 eV is caused by $Co2p_{1/2}$. Further quantitative EDX analysis finds that the atomic ratio between Co and Fe is about 1:2, which is compatible with the data of XRD.

In addition the magnetic data of the as-prepared $CoFe_2O_4$ nanoparticles (RC3) was recorded at 30 K and is as shown in Fig. 4. The sample exhibits a ferromagnetic behavior at room temperature. The magnetic properties of the magnetic materials are dependent on the sample shape, crystallinity, magnetization direction, etc. The observed value of saturation magnetization (M_s), coercivity (H_c) and remanent magnetization (M_r) was



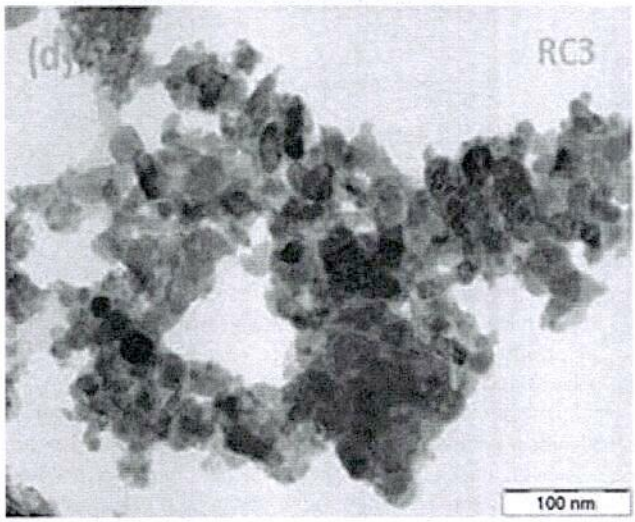


Figure 3. SEM of as-prepared $CoFe_2O_4$ by microwave method (a) RC1 at 150 °C, (b) RC2 at 200 °C (c) RC3 at 250 °C (d) TEM of RC3

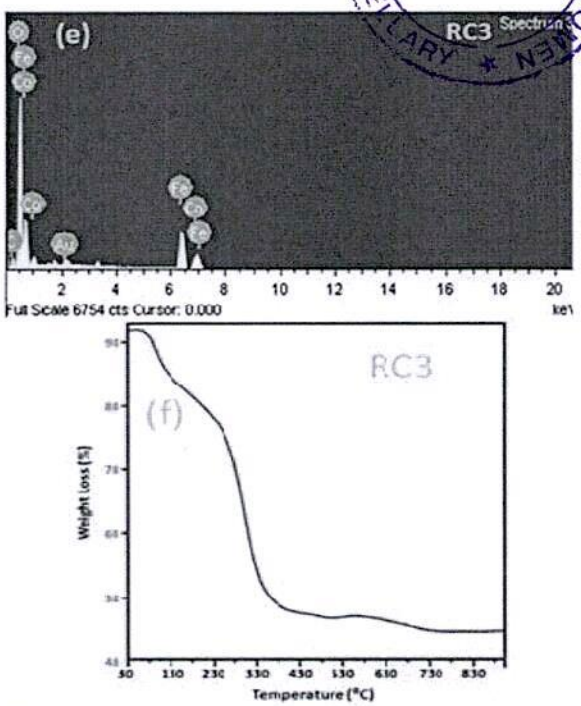


Figure 3. (e) EDX of RC3, (f) TGA of RC3

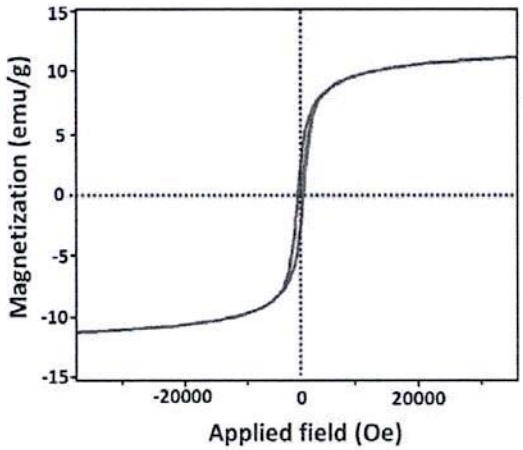


Figure 4. M-H curve of as-prepared $CoFe_2O_4$ measured at 30 K (RC3).

12 emu/g and 6.3 Oe respectively. Consequently, the smaller the grain size, the better the magnetic property. When the grain size is beyond the single-domain size, the coupling effect of ferromagnetic exchange between the grains cannot significantly reduce the magnetocrystalline anisotropy of local regions within the grains. In this case, the domains in the material have distinctly non-uniform states of magnetization. Since the spin magnetic moments in the grain boundary regions are randomly distributed, it is difficult to magnetize these regions. Moreover, the randomly distributed magnetic moments can be counteracted each other to some degree.

Further, the in vitro antifungal activity of the $CoFe_2O_4$ nanoparticles was evaluated by disk diffusion method and is as shown in figure 5a). The $CoFe_2O_4$ nanoparticles RC2 and RC3 displayed antifungal activity toward the tested pathogenic strains of *A. flavus* (19 mm), (23 mm) and *A. niger* (17 mm), (20 nm) respectively. On the other hand, the negative control (distilled water) did not exhibit any zone of inhibition. The positive control showed antifungal activity against both the fungi. In this article, bactericidal activities of $CoFe_2O_4$ nanoparticles against the above mentioned bacteria were evaluated by determining the presence of inhibition zones (Figure 5b).[31]

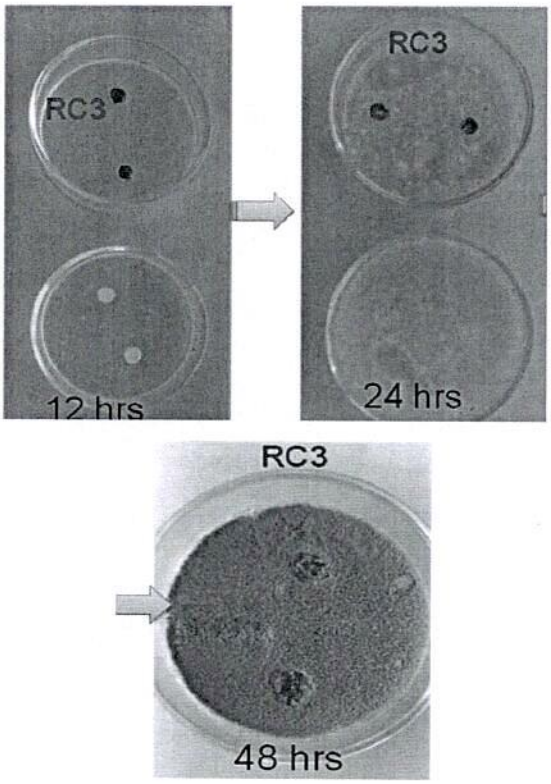


Figure 5a. Antifungal activity of RC3 at different time interval.

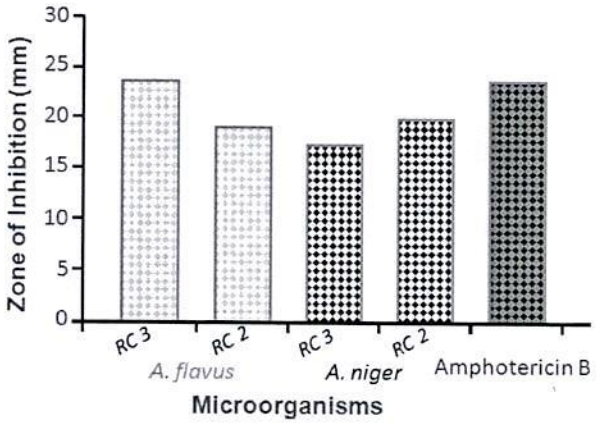


Figure 5b. Zone of inhibition of antifungal activity $CoFe_2O_4$ NPs.

CONCLUSION

In conclusion, we have developed a new cobalt and iron complex of 3-acetylcoumarin precursor materials for the synthesis of metal oxide nanomaterials by microwave method. The spectroscopic studies show that metal to ligand ratio is 2:1 and 3:1. The thermal behavior of the new metal precusors was characterized by TGA analysis. Further, we have developed a simple and rapid one-step microwave-assisted method for the synthesis of $CoFe_2O_4$ nanoparticles with the diameter approximately 15 nm. The results assure that the preparation method served as a facile tune for obtaining the desired morphology and microstructure of the ferrite nanocrystals. Finally, we investigated the antifungal activity of as synthesized $CoFe_2O_4$ nanoparticles. The offered nanoferrite crystals are recommended for versatile applications in biomedicine as they displayed good antimicrobial activity. Thus, coumarin metal complexes were found to be one of the potential metal precursor materials for the synthesis of metal oxide nanostructures.

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The authors thank DeitY, Govt. of India, for a research grant and the Department of Organic Chemistry, Indian Institute of Science, Bangalore for providing the NMR and mass spectra of metal complexes and CeNSE for materials characterization.

SUPPLEMENTARY INFORMATION

The synthesis and characterization of Coumarin molecules used as metal complexation have been provided as supplementary file. Details of nanoparticle sytnesis and analysis data (XPS, TGA) is included in supplementary file. The file can be downloaded from article page on journal site free of charge.

CONFLICT OF INTEREST DECLARATION

The authors declare no conflict of interest.

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Synthesis of nano crystalline ZnO: Reusability and its morphological effect on catalytic activity, yield and time of the reaction

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Abstract

A green, efficient methodolgy was developed for the synthesis of ZnO nanoparticles in aqueous ethanol media in the presence of microwave irradiation. The in-house synthesized ZnO was used for the synthesis of 1,4-dihydropyridines. The target molecules were obtained in good to excellent yield applying the current method. After completion of the reaction ZnO catalyst was separated and characterized by powder XRD and SEM analysis. The result indicates that no such change was observed in powder XRD but there is a remarkable change in the ZnO morphology. Further we repeated the similar experiment to know the catalytic behavior and its frequently changes in the ZnO nanoparticles.

These results show that the reused crystalline ZnO catalyst morphology was changed and its particle size also increases. These factors influence on the catalytic activity, time and yield of the reaction product.

Keywords: Microwave-irradiation, ZnO, Morphology, 1,4-Dihydropyridines.

Introduction

Morphology is the study of form comprising shape, size and structure and is important for materials research in general. For nanostructured materials, popularly known as nanomaterials, morphology has special significance in this case and dictates physical and chemical properties.[1,2] Unlike bulk materials, properties of nanomaterials are strongly correlated to shape. This shape is attained during growth through a self-assembling process dictated by the interplay of size and molecular interactions.[2,3]

On the other hand, Zinc oxide nanomaterials are useful in a range of commercial applications and products including catalysts, superconductors and lithium–ion electrodes.[4-6] For the synthesis of nanoparticles with uniform size distribution, it will be the best if all nuclei form at the same time with the same size. In this case, all the nuclei are likely to have the same or similar size, since they are formed under the same conditions. In addition, all the nuclei will have the same subsequent growth.

Consequently, monosized nanoparticles can be obtained. So, it is obvious that it is highly desirable to have nucleation occur in a very short period of time. To assess the impacts of microwave and different chemical entities, catalytic activities of ZnO nanoparticles have been undertaken for 1,4-DHP synthesis.

In recent years, ZnO nanoparticles have emerged as an efficient and powerful catalyst in modern synthetic organic chemistry, allowing the facile creation of several new bonds in a one-pot reaction.[7,8] Therefore, in the last decade, research in academia and industry has increasingly emphasized the use of ZnO nanoparticles in new organic transformation. Zinc oxide nanoparticles are inexpensive, effective, safe, recyclable and require only mild reaction conditions to produce high yields of products in duration shorter than possible with traditional catalysts.[7,8] In particular, crystalline nano-ZnO oxide exhibits better catalytic activity compared to their bulk sized counterparts.

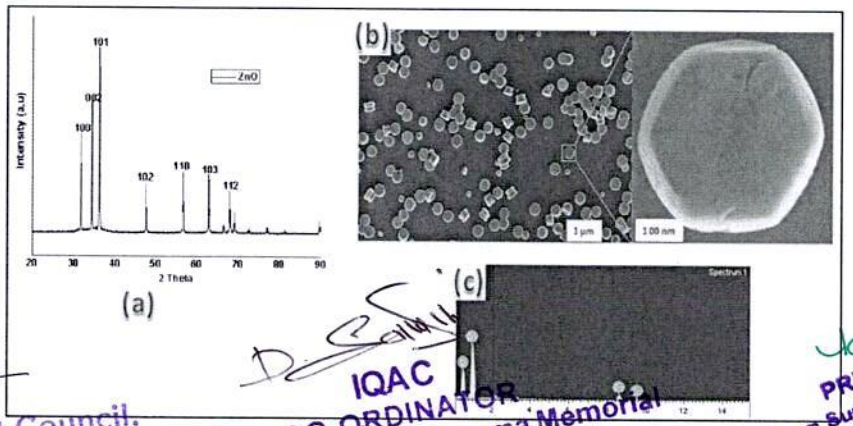


Figure 1: (a) Powder XRD of obtained ZnO nano particles by microwave method; (b) SEM images of ZnO-NPs;

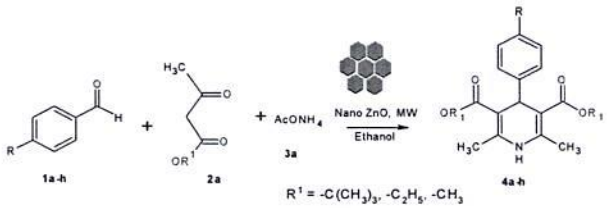
(c) EDX analysis spectrum of obtained ZnO nano particles by microwave method

Material and Methods

A microwave irradiation-assisted process very often minimizes the formation of byproducts and requires much less time than thermal methods. The main benefits of performing reactions under controlled conditions in sealed vessels are the significant rate enhancements and the higher product yields that can frequently be achieved.[9] Therefore, in continuation of our studies on microwave synthesis of nano-materials,[9] we have synthesized monodispersed hexagonal ZnO NPs. These NPs have excellent colloidal properties. The size of the NPs obtained by MW methods was varied from 100 nm to 500 nm (Fig. 1). The prepared crystalline ZnO-NPs were characterized using IR, powder XRD, SEM, EDX (ESI‡).

From the green chemistry point of view, efficient recovery and reuse of the catalyst are highly desirable, thus the recovery and reusability of ZnO-NPs were investigated. Therefore, the recovery and reusability of ZnO-NPs were investigated in the reaction of Cl-benzaldehyde under optimized microwave method. The catalyst was recovered by solvent extraction of the product using ethyl acetate and was isolated by centrifugation.

The obtained ZnO-NPOs powder was washed thoroughly with ethyl acetate, deionized water and ethanol to remove the organic impurities. It was then dried at 80 ^{0}C for 2 h and used for the next catalytic cycle. The recovered catalyst was directly used in Hantzsch synthesis of 1.4-DHPs and it was observed that the reaction yield decreased by decreasing the catalytic activity in each repeated cycle (Fig. 2, Table 2).



Scheme 1: Synthesis of 1,4-dihydropyridine

Table 1
Synthesis of 1,4-dihydropyridines.

Entry[a]	R	R^1	Time (min)	Yield(%)[b]
4a	C_6H_5	*t*-Bu	30	90
4b	4-MeO-C_6H_5	*t*-Bu	30	96
4c	4-Cl-C_6H_5	*t*-Bu	30	95
4d	4-F-C_6H_5	*t*-Bu	30	95
4e	C_6H_5	Et	30	94
4f	4-MeO-C_6H_5	Et	30	93
4g	4-OH-C_6H_5	Et	30	90
4h	4-F-C_6H_5	Et	30	95
4i	2-Pyridyl	Et	30	92
4j	2-Furyl	Et	30	92

[a]All the products were characterized by, ^{1}H NMR and ^{13}C NMR studies and compare with the literature mps.
[b]Yields of isolated products

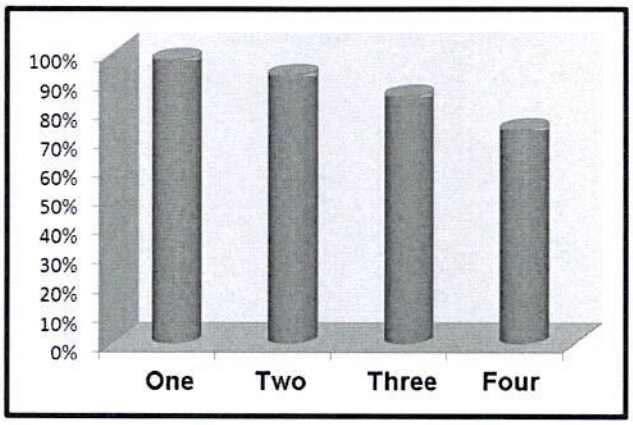


Figure 2: Reusability of nano ZnO catalyst in the enamination of ethylacetoacetate with 3-nitrobenzaldehyde

Result and Discussion

As mentioned above, the ZnO catalyzed organic reactions and in particular, the muticomponent synthesis of 1.4-DHPs was reported in the literature. But, there is no significant report on recovered ZnO-Nps morphology (structure) and its catalytic behavior during the process. We carried out the detailed investigation of synthesised ZnO-Nps to explore the catalytic activity. The regenerated (recycled) ZnO-Nps from the first cycle were characterized by powder XRD as shown in fig. 2 (R1) and it was found that there are no impurities in the obtained powder pattern of ZnO-Nps.

Further, through SEM analysis it was found that the hexagonal structure I (~80-100nm size) was slowly converted into structure II (Fig. 3a) without having any impurities. The EDX (Fig. 4, R1) analysis also confirmed that the recovered powder was pure ZnO. Similarly, we characterize the regenerated ZnO-Nps (from second cycle) by XRD, SEM and EDX analysis, the structure II was converted into structure III.

Further, from the third cycle, structure III was converted into structure IV. The FESEM of the R2 (structure II) (Fig. 3b) shows distorted hexagons of sizes ~80-100 nm whereas samples R3 (structure III) (Fig. 3c) shows a half circle structure with sizes of ~100-150 nm and the sample R4 (structure IV) (Fig. 3d) show flakes nanoparticles with sizes of ~300-400 nm. The reused new ZnO nanoparticle structure formation in each microwave process is shown in figure 5.

Table 2
Synthesis of 1,4-dihydropyridines using recycled ZnO

Entry	R	R^1	Time (min)	Yield(%)	No of Recycled
4c	4-Cl-C_6H_5	*t*-Bu	30	95	01
4c	4-Cl-C_6H_5	*t*-Bu	30	90	02
4c	4-Cl-C_6H_5	*t*-Bu	35	80	03
4c	4-Cl-C_6H_5	*t*-Bu	40	70	04

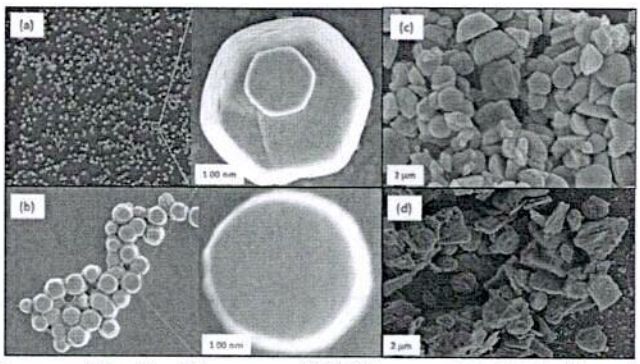


Figure 3: FESEM (low and high magnification) images of ZnO nanostructures by microwave method, (a) first cycle, (b) second cycle, (c) third cycle, (d) forth cycle

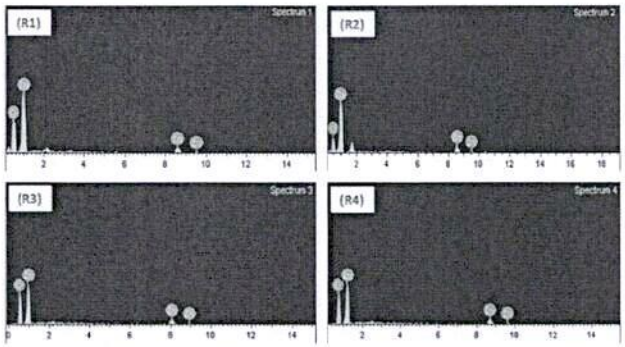


Figure 4: EDX analysis of recycled ZnO nanoparticles by microwave method

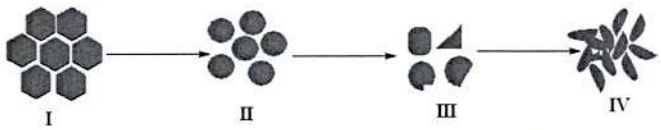


Figure 5: The change in the morphology of reused ZnO-Nps in each microwave process

Conclusion

In conclusion, after careful evaluation of the above results, the over-all morphology of reused (regenerated) ZnO-NPs was changed in each run of the experiment, so that ZnO-Nps crystal morphology was directly influenced by microwave irradiation and chemicals entities that were used for the synthesis of 1.4-DHP. It was also observed that the recycled ZnO-NPs decrease the catalytic activity during the synthesis of 1.4-DHP. All the products prepared from these routes were characterized by IR, ^{1}H NMR and ^{13}C NMR.

Acknowledgement

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CRITERION-03: Research, Innovation and Extension

3.3.1 List of research papers published per teacher in the Journals in 2018-19

(June-2018 to July-2019)

Sl No	Title of the Article	Name of Author	Publication Journal name	ISSN No	Year of Publication	Page No
01	Azolla Filiculoides Lam As A Phytotool For Remediation Of Heavy Metals From Sewage	Bheemanagouda N. Patil	International Journal Of Pharmaceutical, Chemical And Biological Sciences	2249-9504	2018	01 - 06
02	Limonia Acidissima L. Leaf Mediated Synthesis Of Silver And Zinc Oxide Nanoparticles And Their Antibacterial Activities	Bheemanagouda N. Patil	Microbial Pathogenesis	115 (2018) 227–232 0882-4010	2018	07 - 12

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3.3.1 Number of research papers published per teacher in the Journals notified on UGC CARE list during the last five years (2018-19)

Title of paper	Name of the author/s	Department of the teacher	Name of journal	Calendar Year of publication	ISSN number	Link to the recognition in UGC enlistment of the Journal /Digital Object Identifier (doi) number		
						Link to website of the Journal	Link to article / paper / abstract of the article	Is it listed in UGC Care list
Azolla Filiculoides Lam As A Phytotool For Remediation Of Heavy Metals From Sewage	Bheemanagouda N Patil	Department of the Botany	International Journal of Pharmaceutical Chemical and Biological Sciences	2018	2249-9504	www.ijpcbs.com	https://www.academia.edu/download/62319277/IJPCBS20200309-80404-1b788rj.pdf	No
Limonia Acidissima L. Leaf Mediated Synthesis Of Silver And Zinc Oxide Nanoparticles And Their Antibacterial Activities	Bheemanagouda N Patil	Department of the Botany	Microbial Pathogenesis	2018	0882-4010	www.elsevier.com/locate/micpath	https://doi.org/10.1016/j.micpath.2017.12.035	Yes

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Research Article

AZOLLA FILICULOIDES LAM AS A PHYTOTOOL FOR REMEDIATION OF HEAVY METALS FROM SEWAGE

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ABSTRACT

Heavy metals are significant environmental pollutants, and their toxicity is a problem of increasing significance of ecological, evolutionary, nutritional and environmental reasons. Water pollution is a global problem. The heavy metals are omnipresent in our environment, and higher concentration of heavy metals poses a serious threat to the aquatic ecosystem. The remediation of aquatic environment by aquatic plants i.e. phytoremedition is an emerging area of research. In the present investigation laboratory experiments were conducted to study the accumulation profile of heavy metals in *Azolla filiculoides* Lam., exposed to 25%, 50%, 75% and 100% concentration of sewage, at the interval of 4 days for 12 days. The results revealed that the accumulation of heavy metals in test plant varies with sewage concentration and duration of exposure and directly proportional to its concentration and duration of exposure. It is evident from the present investigation that the *Azolla filiculoides* Lam., can be used as phytotool for remediation of heavy metals from sewage.

Keywords: *Azolla filiculoides*, Phytoremediation, sewage, Heavy metals and Accumulation.

INTRODUCTION

The term "Heavy Metal (HM)" refers to any metallic element that has a relatively high atomic density greater than 4g /cm^3 or 5 times more than water [1] and is toxic or poisonous even at lower concentration [2]. However, chemical properties of HMs are the most influencing factors compared to their density. It also changes the physicochemical characteristic of water bodies [3]. These include Lead (Pb), Cadmium (Cd), Nickel (Ni), Cobalt (Co), Zinc (Zn), Chromium (Cr), Iron (Fe) Arsenic (As) and Silver (Ag). The aquatic plants play an important role in balancing the water bodies by accumulating large quantity of heavy metals [4,5]. Several submerged, emergent and free-floating aquatic macrophytes are known to accumulate heavy metal [6,7]. Researchers have proved the capabilities of many aquatic plants and algae for reclamation of wastewater [8,9]. Bioaccumulation of HMs was also well demonstrated by using aquatic macrophytes such as *Echhornia, Lemna, Spirodella, Nasturtitum, Ipomea; Pistia stratiotes* and algae for renovation of different types of domestic sewage, dairy and animal waste waters [10-12]. These macrophytes are important components of the aquatic ecosystem not only as a sources food for aquatic invertebrates, but also act as an efficient accumulator of heavy metals [13,14]. Similarly, *Ceratophyllum demersum* L. is a free floating aquatic perennial macrophytes growing slow flow running water, rich nutrients water bodies, which is important source of food for aquatic invertebrates, fish and herbivorous aquatic birds [15].

Azolla filiculoides a free floating aquatic macrophyte belonging to pteridophytes has been intensively studied during the last few years due to its potential use as green manure in rice fields of Asia and Africa and as a feed supplement for aquatic and terrestrial animals [16]. In fact, a symbiotic association between *Azolla filiculoides* and a heterocyst's blue-green algae *Anabena azollae* has been used as bio-

fertilizer because of its nitrogen-fixing capacity [17,18]. On the other hand, it has a negative effect on aquatic ecosystem due to its capability of colonizing rapidly to form a dense mat over water surfaces. The present study was conducted to evaluate the capability of *Azolla filiculoides* to absorb and accumulate the heavy metals from different concentrations of sewage.

MATERIALS AND METHODS

Collection of sewage samples and experimental plant

The sewage samples were collected from the Hubblli main sewage channel near Bidnal, brought to the laboratory in plastic cans and stored under dark condition until their use. Experimental plant *Azolla filiculoides* Lam. were sampled from the pond at Shivagiri, Dharwad, Karnataka, India. The samples were brought to the laboratory in small polythene bags and maintained under laboratory conditions. The young and healthy *Azolla filiculoides* plants were selected and acclimatized for two weeks in plastic tubs of (10 liters capacity) containing Hoagland's solution.

Experimental Design

The 50 g of plant material was sampled from the original stock maintained under laboratory conditions and introduced into separate plastic tubes containing 25, 50, 75 and 100% of sewage. The control plants were maintained in tap water. All experiments were carried out in triplicate under well aerated conditions.

Analysis of heavy-metal accumulation

The plants were harvested at 4, 8 and 12 days of exposure to sewage, thoroughly washed with distilled water and dried at 80^0 C in an oven for 24 hours to achieve constant weight. The dried plant material was blended to obtain powder and used for mixed acid digestion [19]. One gram powder was taken in a digestion tube containing 2 ml of 60% perchloric acid, 5ml of conc. HNO_3 and 0.1 ml of Conc. H_2SO_4. After gentle swirling, it was digested slowly on moderate heat with a gradual increase in temperature. The mixture was digested till the appearance of white fumes. The digested samples were cooled and diluted with double distilled water and filtered through Whatman Filter Paper No.42 into 100 ml volumetric flask and volume made to mark by adding distilled water. The estimation of heavy-metal content in both treated and control plants were carried out using Atomic Absorption Spectrophotometer (GBC 932 Plus, Australia) with Air Acetylene Oxidizing flame and Metal hallio cathode lamps.

Statistical analysis

The statistical analysis was done using IBM (SPSS windows software) version 20 followed by one way ANOVA and Tukey test.

RESULTS AND DISCUSSION

The accumulation of heavy metals by experimental plant from the sewage is directly proportional to the increasing concentration of sewage and duration of exposure. The rate of accumulation of heavy metals increased with the duration of the experiment. The accumulation of the iron (Fe) was a maximum at all concentrations of sewage followed by the manganese (Mn) and occurs in the following order Fe > Mn >Pb >Cr >Ni >Cu > Cd. The accumulation potentional of experimental plant was more in the concentrated medium showing the amelioration potentional of heavy metals. Like all living organisms, plants are also sensitive to both the deficiency and excess availability of some heavy-metal ions occurring as potentional micronutrients in the aquatic ecosystem. At higher concentration's ions such as Fe, Mn, Pb, Cr, Ni, Cu and Cds are poisonous to the metabolic activities. Among various water pollutants, heavy metals are of major concern because of their persistent, bio-accumulative and biomagnification nature [20-23]. *Azolla* plants are known to absorb and store the considerable amount of metals [24,18]. The free-floating aquatic plants viz., *Salvinia molesta, Pistia strateotes, Echhornia, Spirodella; Boccopa monira* have been evaluated for their performance to remove heavy metals from different concentrations of sewage [25,26]. The toxic effect of sewage on plant depends upon the type of the metal accumulated, its concentration and stability.

The results revealed that the accumulation of chromium, nickel, cadmium, lead, copper, iron and manganese was found to be accumulated in the following order 54.43 to 80.21 mg/g, 22.57 to 40.73mg/g, 16.17 to 89.20mg/g, 15.50 to.93mg/g, 408 to 942mg/g and 89.20 to 382.10mg/g 10mg/g respectively (Table 1 and fig 1; A-G). Chromium stress is one of the important factors that affect photosynthesis in terms of CO_2 fixation, Electron transport, photophosphorylation and enzyme activities [27]. Nickel (Ni) is a transition metal found in natural soil in trace concentrations except in serpentic soil. However, Ni concentration is increasing in certain areas by human activities. *Pistia stratoites* (water lettuce) is an aquatic plant that grows rapidly with an extensive root system which enables the heavy-metal removal and exhibited different patterns of lead removal

from the media and accumulated in high concentrations, mainly in the root system [28]. Lead contaminates water by the corrosion of household plumbing system and erosion of natural deposits (US EPA 2005). Presence of higher concentration of heavy metals in plants signifies the biomagnifications Uysal and Taner [29] examined the ability of the *L. minor* to remove soluble lead under different pH values (4.5-8.0) and temperature (15-35°C) exposed to different Pb concentrations 0.1-10.0 mg/L for 7 days. Gallardo et al., [30] found that after one week of exposure lead accumulation by hydrilla which showed maximum uptake (98%) of Pb.

The Results of Benarya [31] revealed that metal content was higher in the whole plant than in the extracted fractions indicating the contribution of both apoplast and symplast to the proportional accumulation of lead in the *Azolla* Leaf. Analysis of accumulation of heavy metals in plants has practical value in outlining ore deposits of variety of metals and phytoremediation studies. It is evident from the present investigation that *Azolla filiculoides* found to be an excellent tool for phytoremidation heavy metals from aquatic environment.

Table 1: Influence of different concentrations of sewage treatment on accumulation of heavy metals by *Azolla filiculoides*

Days	Concentration (Percentage)	Chromium (µg/g tissue)	Nickel (µg/g tissue)	Cadmium (µg/g tissue)	Lead (µg/g tissue)	Copper (µg/g tissue)	Iron (µg/g tissue)	Manganese (µg/g tissue)
4th day	Control	33.70±0.20	22.57±0.21	2.27±0.12	16.17±0.15	15.50±0.26	408.30±1.28	89.20±0.10
	25	54.43±0.21	24.60±0.10	2.40±0.20	35.77±0.15	16.37±0.29	384.97±0.47	94.40±0.20
	50	62.27±0.31	27.43±0.15	3.37±0.25	44.10±0.78	16.43±0.25	557.20±1.11	106.30±2.07
	75	63.33±0.42	29.11±0.15	3.40±0.20	48.50±0.36	17.30±0.10	800.17±0.67	286.40±0.70
	100	64.50±0.26	30.67±0.25	3.53±0.15	80.37±0.06	18.43±0.25	912.00±2.00	331.00±1.00
8th day	Control	40.30±0.20	25.43±0.15	2.50±0.10	18.30±0.10	17.50±0.10	414.33±1.03	91.20±0.20
	25	58.17±0.29	26.40±0.20	2.63±0.12	16.70±0.28	18.23±0.06	395.47±0.75	97.30±0.10
	50	68.33±1.00	28.47±1.12	3.17±0.06	45.37±0.15	19.30±0.10	566.23±2.74	112.97±0.12
	75	71.23±0.40	33.53±0.83	3.57±0.15	49.03±0.32	19.63±0.23	810.60±0.70	311.13±0.95
	100	77.23±0.49	39.13±0.67	3.90±0.10	87.20±0.10	21.33±0.12	922.00±1.00	362.03±1.05
12th day	Control	40.50±0.10	28.53±0.15	2.80±0.10	19.30±0.10	18.57±0.25	424.27±0.35	93.17±0.15
	25	67.97±0.47	36.93±0.42	2.73±0.06	42.67±0.21	19.20±0.20	404.67±0.21	99.17±0.15
	50	72.50±0.10	37.50±0.26	3.80±0.10	48.60±0.10	21.73±0.15	577.20±0.92	125.67±0.25
	75	77.50±0.26	39.37±0.15	4.20±0.10	51.80±0.46	23.77±0.32	831.30±0.61	293.23±0.95
	100	80.21±0.26	40.73±0.15	4.83±0.06	89.20±0.10	24.93±0.25	942.77±0.49	382.10±0.20

Each value represents three replicates mean values ± standard error with significant $p<0.05$ level.

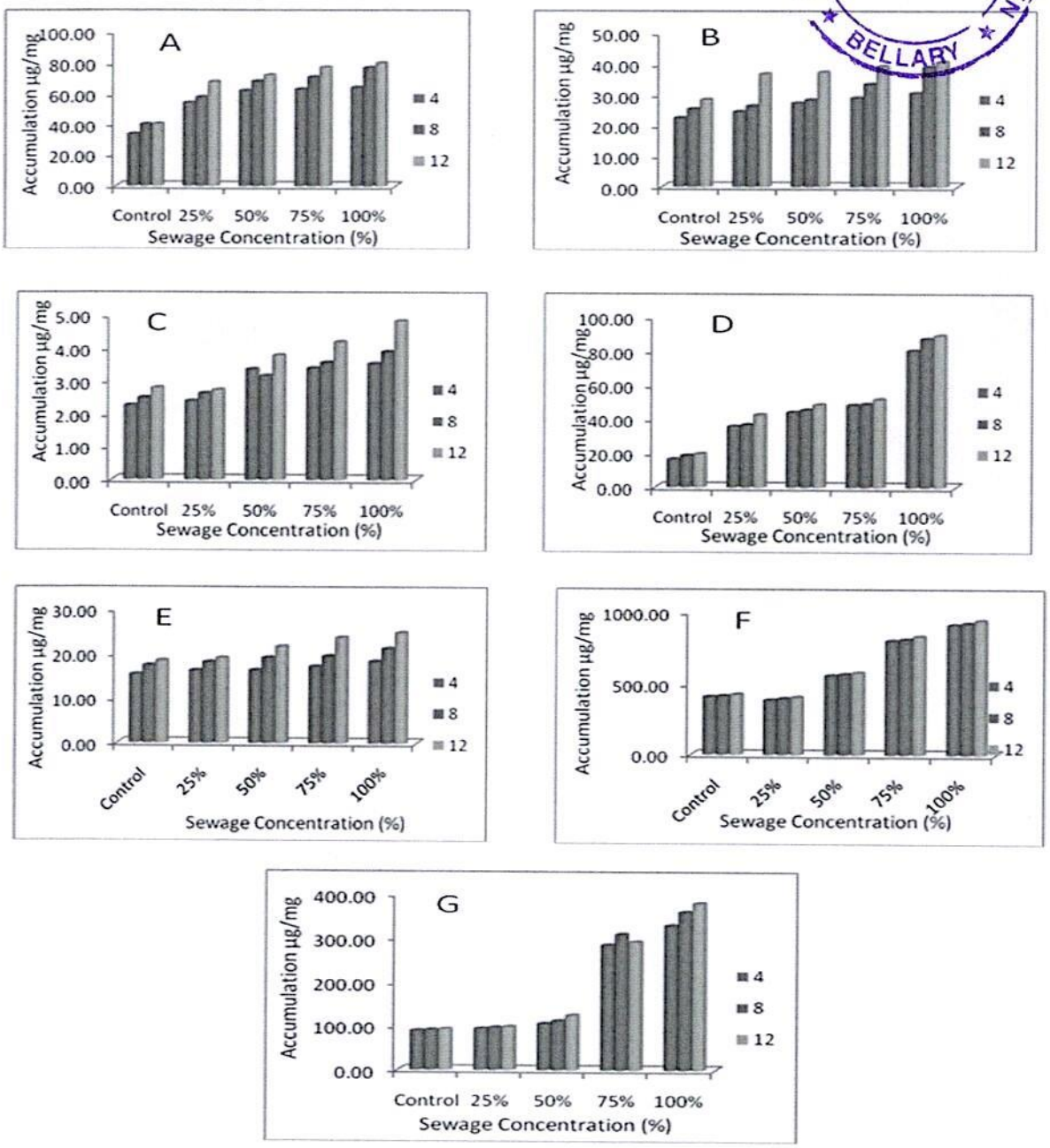

Fig. 1: Accumulation of Heavy metals in *Azolla filiculoides.*
1. Chromium, B) Nickel, C) Cadmium, D) Lead, E) Copper, F) Iron and G) Manganese

7. CONCLUSION

Azolla filicoloides Lam. demonstrated the good accumulation profile of heavy metals at all concentrations of sewage throughout the experiment. The rate of heavy metal accumulation increased with increasing concentration of heavy metals being directly proportional to sewage concentration and duration of exposure. The experiment revealed that the *Azolla filiculoides* accumulates a maximum amount of Fe. Followed by Mn, Pb, Cr, Ni, Cr and Cd. Accumulation potentional was more in higher concentration showing amelioration potential of heavy metals. From the present investigation, it is evident that the aquatic macrophyte *Azolla filiculoides* Lam., can be used as an effective phyto tool for remediation of sewage and domestic waste water.

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3.3.1 Number of research papers published per teacher in the Journals notified on UGC CARE list during the last five years (2022-23)

Title of paper	Name of the author/s	Department of the teacher	Name of journal	Calendar Year of publication	ISSN number	Link to the recognition in UGC		
						Link to website of the Journal	Link to article / paper / abstract of the	Is it listed in UGC Care list
Problems Faced by Readymade Garments Workers in Ballari District , Karnataka	Gangadhara K	Commerce	International Journal of Research and Analytical Review (IJRAR)	Apr-23	E-2348-1269, P-2349-5138	http://www.ijrar.org	https://ijrar.org/download.php?file=IJRAR23B1710.pdf	Yes

Director,
Research Development Council,
Smt. Allum Sumangalamma Memorial
College for Women, Ballari.

IQAC, Co-ordinator
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Problems Faced By Readymade Garments Workers In Ballari District, Karnataka.

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Abstract: Workers in the readymade garment industry are mostly employed as helpers and laborers in home industries. It is impossible to estimate the number of workers in this business because they primarily operate in unorganized or unregistered sectors. Although there are workers in several sectors in Ballari district, for the purpose of the study, so researcher has considered only the workers of the readymade garment industry have been selected for the research study. Thus, it may be claimed that those employed in the ready-made clothing sector have relocated to urban regions in search of work, where they are subjected to economic and social exploitation through the use of more labor and lower pay. It can be said that the workers of the readymade garment industry are subjected to economic and social exploitation. The workers in this industry have a low monthly income and are below the poverty line, whose standard of living is low. Although the workers are partners in the economic development of the industry, they are not getting adequate reward for their work. Even if the workers work in different units of the same enterprise, the wages are not the same. One entity differs from another entity. In order to overcome the inequality of workers, it is necessary for the labor unions and the government to provide adequate employment protection and social security to the domestic workers. There is no doubt that India will become a developed country only then. As their work is more monotonous or repetitive work, they inevitably work to support their families. The working environment in which they are doing is so lacking in basic facilities and due to the use of many chemicals they are prone to many occupational diseases or problems. Searching of readymade garment industry workers in different units of Ballari district. To know their problems, a study is undertaken to suggest suitable measures to overcome the problems, create awareness about the Government schemes and help in getting them.

Key Words: RMG Workers, Wage Discrimination, Social and Economic Problems, Risk factors.

I. Introduction:

Our country is a developing country where employment is an important source of subsistence economy. Its contribution to the country's economy is also seen to be significant. There are many types of unorganized sector out of which readymade garment industry is one in which many men and women are employed. Although there are more workers in the unorganized sector than in the organized sector, they are not unorganized as per the name and do not come under the legal framework. So they are deprived of many facilities. They are facing many discriminations like gender discrimination, caste discrimination, wage discrimination, job discrimination etc. in workplaces. Equal pay for equal work is limited to what is mentioned in labor laws. This study has gained importance in examining the social and economic conditions of the three sectors of workers namely daily wage basis, contract basis and permanent basis workers as mentioned above as well as the conditions at their workplaces.

Karnataka State is at the forefront of development in the industrial sector and in 2019-20 the share of this sector in the income of the state reached 21.3 percent. But it fell to 19.8 percent in 2020-21 due to Covid-19. Textile industry is the main industry as cotton production is very high in the state. In many parts of the state handloom, power loom and ready-made garments sector are developing at a high rate in the state. There are cotton mills in Bangalore, Davangere, Gadag, Hubli, Gokak, Ballari, Nanjangud, Belgaum, Bagalkote, Raichur, Ilakallu, Gudegudda. Karnataka is the readymade garment manufacturing capital of the country with readymade garments production worth $1.56 billion. Readymade garments are being exported from Karnataka state to America, Italy, Germany, England, Hong Kong, Canada, Australia and Western Europe.

One such mean of research for readymade garments Ballari's ready-made garments, jeans, has a history of hundreds of years. This has been achieved through the hard work of thousands of families. As cotton, the raw material required for jeans, is grown more in Ballari district, jeans manufacturing is at a very high level here. Ballari Jeans has put its stamp on the international map. Today, Ballari is known as Jeans Nadu even before it was called as Borderland.

There are more than 1000 jeans manufacturing units in Ballari. There are two units in the manufacturing of jeans namely spare parts unit and assemble unit. In the accessories section, cutting the cloth separately according to the size, i.e. the leg part of a pant, the packet part and so on. Ready-made garments are made by adding all the accessories in the assembled units. There are 800 units that make these accessories and 200 assembly units. Recently, after 5 decades of production of most jeans clothes, not only in our state, but also in foreign states and foreign countries, the state government and the central government hope to make many industrial units in Kuditini to make jeans fair in Ballari. Ballari is the jeans hub but there is no doubt that Ballari is on the rise. There are many workers in these units.

Utilization of goods and services is essential in production. Economists divide the factors of production into four categories namely land, labor, capital and entrepreneurship. "The laborers who are employed in different types of industries are called 'Industrial Laborers'. But cottage industries are not considered industrial workers in India. Only those working in organized large and medium industries are included in this group. All workers covered by the Industrial Factories Act are treated as organized workers, while workers in cottage industry and contract work are treated as unorganized workers".

1. Review of Literature:

Research always starts with a question and a problem. Its basic objective is to find an answer to a question through the application of the scientific method. Literature, research papers, articles, books related to the study can help the current research study perfectly and meaningfully.

"Health Hazard and Occupational Safety Challenges for Unorganized Sector Works in India" written by **Mohammad Shams Muktar and Dr. Preeti R. Gatmre (2021)** states that it is common for workers in the unorganized sector to fall prey to many health problems. The government instituted many health policies and programs in urban and rural areas of India which include government hospital, community health centers, sub-centers and primary health centers. They are National Health Mission, National Mental Health Programme, Asha, Ayushman Bharat, National Rural Health Mission and National Urban Health Mission, all launched by the Union Ministry of Health and Family Welfare. found in their study that it is the combination of all organized activities that ensure the welfare and well-being of all employees working in the unorganized sector.

The article **"Working and Living Conditions of Workers in Unorganized Sector-A Review of Literature"** by **PrasanaKumar Shetty and Surbhikapoor (2014)** provides information about the living conditions of workers in the unorganized sector. He undertook an in-depth study of the working and living conditions of the workers in the unorganized sector. Unorganized sector is popularly known as the insecure sector, where most of the people feel that there is no regular source of income and work throughout the year. The article echoes the general plight of poor relations between employers and employees, discrimination at work, sexual harassment, poor health/medical care and denial, terminal benefits, torture and poor working conditions. Workers in almost all sectors of the sector suggest that more research is needed in this area to suggest practical solutions to existing problems and on issues such as social security and the positive impact of unions and labor laws on workers.

Nitika Diwakar and Tafpikku Ahmed (2014) have done a study on **"Problems and Challenges Faced by the Unorganized Sectors: An Indian Perspective".** Unorganized sector workers are defined as working in small scale industries. The unorganized sector has less capital and fewer workers at home or less. It is often not consistent. Out of the total population of India, there are only 46.5 crore workers, out of which only 2.8 crore are in the organized sector and 43.7 crore are in the unorganized sector, according to the report of National Sample Survey Institute 2009-10. They do not have any specific framework. The workers are mostly

illiterate and without any knowledge of the laws they are forced to work long hours and low wages given by the employers.

Lilipet S, Jain T and Joseph B (2017); In their study **"Health Problems Among Garment Factory Workers – A Narrative Literature Review"** the objective of this study was to identify the pattern and prevalence of major health problems among garment factory workers. Working for long periods of time without rest, absence of personal protective equipment and inadequate provision of ergonomic facilities at the workplace lead to major health related problems among workers. Workers of repetitive nature are prone to physical, mental and nutritional health problems. Respiratory problems, cardiovascular diseases, gastrointestinal diseases, gynecological diseases, nervous disorders, mental disorders and nutritional deficiencies are common health risks. Sidda therefore opined that it is necessary to organize specific programs aimed at preventing muscular and skeletal disorders for garment workers.

2. Objectives of the Study

1. To know the problems faced by the workers of readymade garment industry.
2. To know the social security programs undertaken by the governments for the welfare of workers.

3. Results and Discussion:

Industrial workers in general and garment workers in particular are facing several occupational problems. While some are exposed to work that requires intense concentration, such as cutting, sewing, and finishing, which can result in headaches and blurred vision, others are exposed to more physically demanding tasks and experience muscle aches from prolonged sitting or standing. They primarily have health issues including shoulder discomfort, hip pain, etc. as a result of using their hands for extended periods of time while performing repetitive activities. The information available indicates that women are more likely than men to experience depression or mental health issues as a result of juggling work and housework. As it is very important for the study to know the problems of the workers, the information provided by the workers, the information provided by the workers in the study is described in Table 1 below.

Table: 01

Description of occupational problems of workers in readymade garment industry in Bellary district

Health Problems	Daily wage workers		Contract workers		Permanent workers		Total		Total (%)
	Male	Female	Male	Female	Male	Female	Male	Female	
Allergy	16 (25.00)	19 (13.67)	16 (19.57)	13 (23.21)	11 (17.74)	0 (0.00)	43 (20.77)	32 (15.69)	75 (0.18)
Eye Pain	6 (9.38)	27 (19.67)	14 (17.28)	15 (26.79)	9 (14.52)	2 (22.22)	29 (14.01)	44 (21.57)	73 (0.17)
Body Pain	21 (32.81)	31 (22.30)	22 (27.16)	17 (30.36)	19 (30.65)	3 (33.33)	62 (29.95)	51 (25.00)	113 (0.27)
Difficulty in Breathing	15 (23.44)	19 (13.67)	9 (11.11)	9 (16.07)	12 (19.35)	2 (22.22)	36 (17.39)	30 (14.71)	66 (0.16)
Tiredness	3 (4.69)	16 (11.51)	11 (13.58)	2 (3.57)	7 (11.29)	2 (22.22)	21 (10.14)	20 (9.80)	41 (0.09)

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Cough	0 (0.00)	9 (6.47)	6 (7.41)	0 (0.00)	2 (3.23)	0 (0.00)	8 (3.86)	9 (4.41)	17 (0.04)
Other	0 (0.00)	7 (5.04)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	7 (3.43)	7 (0.03)
None of the above	3 (4.69)	11 (7.91)	3 (3.70)	0 (0.00)	2 (3.23)	0 (0.00)	8 (3.86)	11 (5.39)	19 (0.04)
Total	**64 (100)**	**139 (100)**	**81 (100)**	**56 (100)**	**62 (100)**	**9 (100)**	**20 7 (100)**	**204 (100)**	**411 (100)**

Table 1 reveals that the health problems faced by the 411 workers selected for the study at the place of work or by nature of work. Looking at the figures in the table, a total of 411 male and female workers in the entire sector have health problems. Allergy 0.18%, Eye pain 0.17%, Migraine 0.27%, Breathing problem 0.16%, Fatigue 0.09%, Cough 0.04%, Other 0.03%, None 0.04%. . There are no respondents other than the number of daily wage earners who are facing other problems. Women are no exception. Generally speaking, readymade garment workers are more likely to work sitting and standing on the same side, so they have more eyestrain and eye strain in hemming and stitching. A large number of people who face problems like allergies are those who dye their clothes and use chemicals. Its information is depicted in diagram 1.

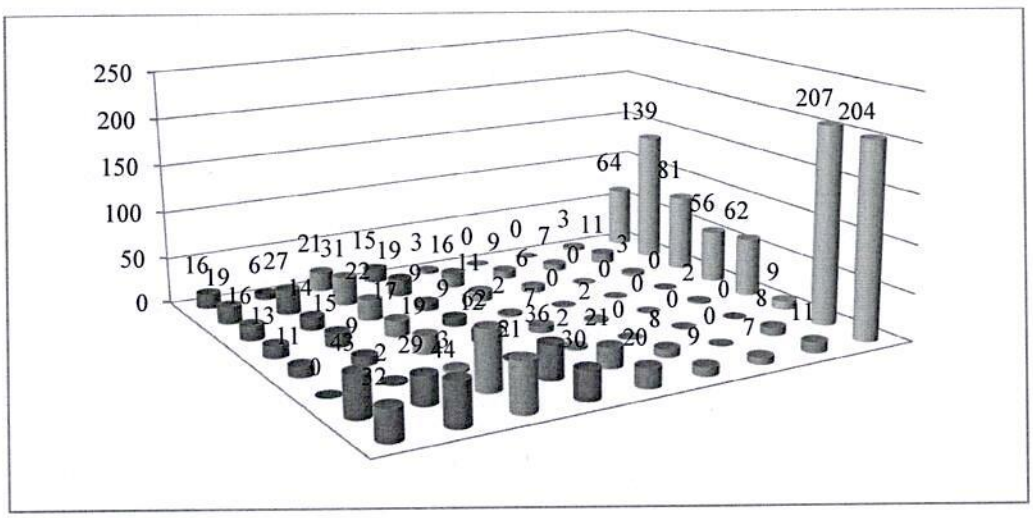

Figure 1: Description of occupational problems of workers in RMG

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4. Problems of Workers in Readymade Garment Industry in Ballari

1. Overtime duty: - Bellary has a high demand for readymade garments such as jeans garments. Apart from our country, these are also exported to foreign countries. So this industry is always profitable. As there is a huge demand especially during the festive season, the employers give overtime work to the workers as they produce more for their profit.
2. Lack of transport system: - Majority of people in Bellary is living in villages. They have to travel far away from their place of residence as there is a ready-made garment unit in the urban area. Employers do not provide transport arrangements for any type of workers. Go through government buses or autos.
3. Wage Discrimination: - Wage discrimination is an unsolved problem across India. Garment workers are no exception. As there are many types of jobs, low pay for low work, high pay for high work or high pay for skilled work. For example, low skilled jobs like threading, buttoning, labelling etc. One of them has not come but another can do that job. But some skilful things like cutting cloth etc. can be done only by experienced people. Because their work is indispensable, they are paid more. Similarly, women worked equally as men and were paid less. It is decided that the male is a wage earner and the female is a wage earner.
4. Delay in payment of wages: - Livelihood of workers depends on readymade work. Their wages or wages are low and the cost of daily necessities is high, making it difficult for them to make ends meet. When entrepreneurs delay in paying wages, they resort to debt. Very high interest has to be paid.
5. Job insecurity: - Although the readymade garment industry seems to be always in demand, sometimes there is no work. Because there is always a change in the styles of clothes. People always want new style of clothes. This made the garments less expensive when they were made in the old style without more advanced machines. Only when all of them are sold do the entrepreneurs start making new clothes. As a result, workers have to face insecurity without job stability.
6. Scolding with unspoken words: - Ready-made garment workers do not have any respect as they do menial work. If you don't do the right work or come to work a little late, they scold you with unspoken words regardless of whether you are male or female. As the laborers are in the habit of swearing all the time, they have assimilated excuses regardless of whether they are deaf or work is inevitable.
7. Lack of toilet facilities for women: - Readymade garments units are in many nooks and crannies or in small spaces so they do not have toilet facilities. If they are men, they go outside somewhere. But women are not able to go out and are blocking those going home. Due to this many health problems are faced.
8. Dermatological problem due to excessive use of chemicals: - In readymade clothes especially jeans clothes which have many colors A chemical material is used. Moreover, there are many stages in the manufacture of ready-made garments and some stages require the use of chemicals. Workers working in this stage may suffer from various types of allergies or skin diseases.
9. Physical and Mental stress: - Readymade garment manufacturers not only make the workers work longer hours to get more profit, they have to work more in less time without any kind of freedom, but if they do not work properly, the workers are subjected to a lot of physical and mental stress.
10. Absence of proper medical facility: - Although the garment workers suffer from many allergies, they are not provided with medical facilities by the workers. Due to the high cost in private hospitals, one cannot afford them and has to go to the government hospital. Many people are succumbing to diseases without proper medical facilities.
11. Children are not provided with higher or better educational facilities: - The workers of the readymade garment industry are unable to provide education in better or better schools as they struggle to meet their daily or essential supplies due to their low wages. Their children are not able to pursue higher studies and half of their children drop out of school and join other small jobs.
12. Without any kind of insurance facility: - Many government facilities like insurance facility, health facility, provident fund and ESI. are deprived of It is an unorganized unit and due to lack of stability in their work and non-fixed monthly payments.
13. Not getting the membership of labor union: - Although there are many labor unions, not knowing its existence or presence is a major reason for not getting membership of the labor union. Deprived of the benefits of a trade union.

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5. Conclusion:

In some cases, unorganized workers know about government schemes but do not know where to contact and whom to contact. Therefore, the National Social Security Council, a part of the government, and the NGOs (Non-Governmental Organizations) should come forward to provide information to the unorganized workers to avail the benefits of these schemes.

Although the contribution of the readymade garment industry in the Indian economy is immense, the workers working in this industry face many problems such as wage problems, health problems, etc. As this sector is mostly cottage industry and unorganized sector, there is no legal framework for the workers in this sector. There is no regular relationship between the employer and the employed as the workers in the readymade garment industry mostly work under contract workers. As the workers in this sector are highly illiterate, they are subjected to many forms of exploitation, but without knowing the labor laws that fight against them, they inevitably work for a living.

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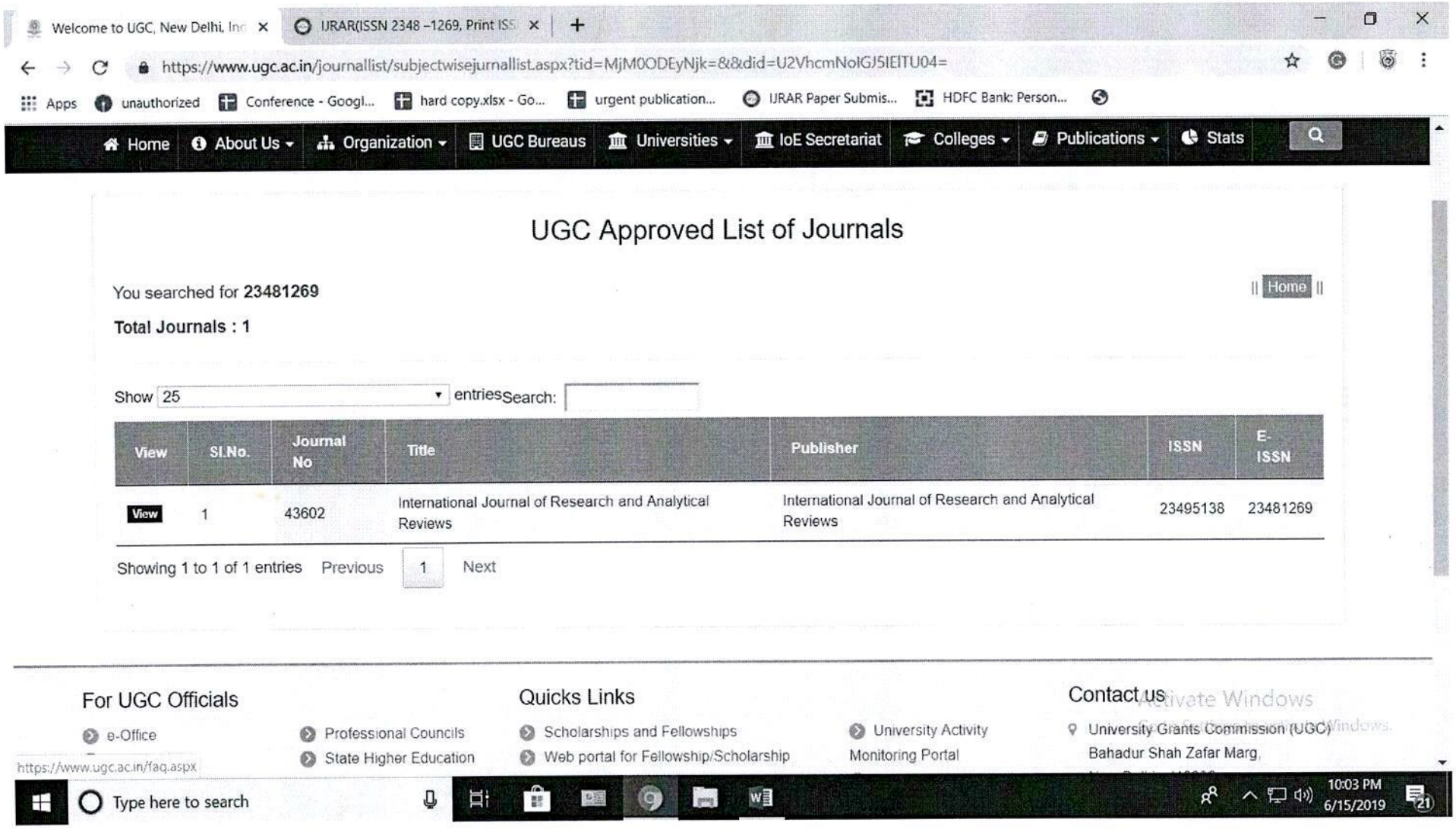
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3.3.1 Number of research papers published per teacher in the Journals notified on UGC CARE list during the last five years (2021-22)

Title of paper	Name of the author/s	Department of the teacher	Name of journal	Calendar Year of publication	ISSN number	Link to the recognition in UGC		
						Link to website of the Journal	Link to article / paper / abstract of the article	Is it listed in UGC Care list
Information Technology Impact on Banking Industry in India	Dr.Anupama K	Commerce	Muktha Shabd	Jan.2022	ISSN-2347-3150	**https://shabdbooks.com**	https://app.box.com/s/msh78eqe1afohr1dc7isiky2gwwm1l6t	Yes

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INFORMATION TECHNOLOGY IMPACT ON BANKING INDUSTRY IN INDIA

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Abstract

The Banking industry in India is rapidly progressing with increased customer base and due to newly improved and innovative facilities offered by technology. As the coin has two faces likewise technology also has its two sides on Indian banking Sector-the positive and the negative side. The risks are high, though it can be minimized and Technology will be the backbone of Indian Banking Industry in upcoming time. Banking atmosphere has to turn into highly competitive currently. IT states to the gaining, dealing out, storing and broadcasting of all forms of material using computer knowledge and telecommunication systems. These technologies are used for the input, storing, dealing out, and communication of information. The basic essential of Information Technology (IT) in the banking sector are meeting internal requirements, effective in data handling, extending customer services, creative support for new product development, end-user development of the nontechnical staff. Emerging trends of information technology in the banking sector are Outsourcing, Combination, Distinguishing Edge, IT as Income Centre, Flourishing in Down Market. Tests faced by Indian banking scenario in India are Meet customer prospects on service and capability offered by the bank, Customer retaining, Dealing the spread and sustain the functioning profit, Recollecting the present market share in the industry and the enlightening the same, Accomplishment from another group of actors in the banking industry.

Key words: Banking Industry, Emerging Trends and Information Technology

Introduction

Banking industry is a backbone of Indian financial system and it is afflicted by many challenging forces. One such force is revolution of information technology. In today's era, technology support is very important for the successful functioning of the banking sector. Without IT and communication we cannot think about the success of banking industry, it has enlarged the role of banking sector in Indian economy. For creating an efficient banking system, which can respond adequately to the needs of growing economy, technology has a key role to play. In past 10 years, banks in India have invested heavily in the technology such as Tele banking, mobile banking, net banking, ATMs, credit cards, debit cards, electronic payment systems and data warehousing and data mining solutions, to bring improvements in quality of customer services and the fast processing of banking operation. Heavy investments in IT have been made by the banks in the expectation of improvement in their performance. But important in the performance depends upon, differences in the deployment, use and effectiveness of IT.

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Information technology in banking sector refers to the use of sophisticated information and communication technologies together with computer science to enable banks to offer better services to its customers in a secure, reliable and affordable manner and sustain competitive advantage over other banks. The significance of technology is greatly felt in the financial sector in view of the competitive advantage for banks resulting in the efficient customer service.

Information Technology revolution is of entirely changing the way financial business is done and has considerably widened the range of products and increased the expected demands of the customers. Financial sector reforms and banking sector reforms are the part and parcel of economic reforms, which strengthen the economic reforms. IT Act of 2000 gave new dimension to the Indian financial sector. IT has created transformation in banking sector: banking structure, business process, work culture and human resource development. It affected the productivity, profitability and efficiency of the banks to a large extent. Strengthening the financial sector and improving the functioning of financial market have been the core objective of the financial sector reforms. It was in June 1999 that an IT revolution actually appeared in the Indian financial institutions specially banking sector when the world of IT seemed too wide open with introduction of Indian Financial Net. This Indian Financial Net included a wide area satellite based network, which used Very Small Aperture Terminals Technology. The Reserve Bank of India jointly set it up with the Institute for Development and Research in Banking Technology. The Indian Financial Network initially comprised only the public sector banks but was later on opened up for participation by other categories of members including foreign banks as well. It was the payment system, which was the first segment of banking system, benefited a lot from the introduction of the new technology.

Transformation of Indian Banking

Indian banking has undergone a total transformation over the last decade. Moving seamlessly from a manual, scale-constrained environment to a technological leading position, it has been a miracle. Such a transformation takes place in such a short span of time with such a low cost.

Entry of technology in Indian banking industry can be traced back during the 1990s, the banking sector witnessed various liberalization measure. One of the major objectives of Indian banking sector reforms was to encourage operational self-sufficiency, flexibility and competition in the system and to increase the banking standards in India to the international best practices. With the ease of licensing norms, new private and foreign banks emerged-equipped with latest technology. Deregulation has opened up new opportunities to banks to increase revenues by diversifying into investment banking, insurance, credit cards, mortgage financing, depository services etc. The role of banking is redefined from a mere intermediary to service provider of various financial services under one roof acting like a financial supermarket.

Evolution of Information Technology in Banking

- MICR based cheque processing

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- Arrival of card based payments
- Electronic Clearing Services
- RTGS/NEFT
- Cheque Truncation System (CTS) or Image-based Clearing System (ICS)
- Core Banking Solutions (CBS)
- Automated Teller Machine (ATMs)
- Phone and Tele Banking
- Internet and Mobile Banking

Recent IT Trends of Indian banks

The banking industry is going through a period of rapid change to meet competition, challenges of technology and the demand of end user. Clearly technology is a key differentiator in the performance of banks. Banks need to look at innovation not just for product but for process also.

Today, technology is not only changing the environment but also the relationship with customers. Technology has not broken barriers but has also brought about superior products and channels. This has brought customer relationship into greater focus. It is also viewed as an instrument of cost reduction and effective communication with people and institutions associated with the banking business. The RBI has assigned priority to the up gradation of technological infrastructure in financial system. Technology has opened new products and services, new market and efficient delivery channels for banking industry. IT also provides the framework for banking industry to meet challenges in the present competitive environment. IT enables to cut the cost of global fund transfer.

The Banking industry has been taking advantage of the following technology Products

Electronic Payment and Settlement System – The most common media of receipts and payment through banks are negotiable instruments like cheques. These instruments could be used in place of cash. The inter bank cheques could be realized through clearing house systems. Initially there was a manual system of clearing but the growing volume of banking transaction emerged into the necessity of automating the clearing process.

Use of MICR Technology – MICR overcomes the limitation of clearing the cheques within banking hours and thus enables the customer to get the credit quickly. These are machine – readable codes added at the bottom of every cheque leaf which helped in bank and branch-wise sorting of cheques for smooth delivery to the respective banks on whom they are drawn. This no doubt helped in speeding up the clearing process, but physical delivery of cheques continued even under this partial automation.

CTS (Cheque Truncation System) – Truncation means stopping the flow of the physical cheques issued by a drawer to the drawee branch. The physical instrument is truncated at some point on route to the drawee branch and an electronic image of the cheque is sent to the

drawee branch along with the relevant information like the MICR fields, date of presentation, presenting banks etc. This would eliminate the need to move the physical instruments across branches, except in exceptional circumstances, resulting in an effective reduction in the time required for payment of cheques, the associated cost of transit and delays in processing etc., thus speeding up the process of collection or realization of cheques.

Electronic Clearing Services (ECS) – The ECS was the first version of "Electronic Payments" in India. It is a mode of electronic funds transfer from one bank account to another bank account using the mechanism of clearing house. It is very useful in case of bulk transfers from one account to many accounts or vice-versa. The beneficiary has to maintain an account with the one of the bank at ECS Centre.

There are two types of ECS (Electronic Clearing Service)

ECS – Credit – ECS Credit clearing operates on the principle of 'single debit multiple credits' and is used for transactions like payment of salary, dividend, pension, interest etc.

ECS – Debit – ECS Debit clearing service operates on the principle of 'single credit multiple debits' and is used by utility service providers for collection of electricity bills, telephone bills and other charges and also by banks for collections of principle and interest repayments.

Electronic Fund Transfer (EFT) – EFT was a nationwide retail electronic funds transfer mechanism between the networked branches of banks. NEFT provided for integration with the Structured Financial Messaging Solution (SFMS) of the Indian Financial Network (INFINET). The NEFT uses SFMS for EFT message creation and transmission from the branch to the bank's gateway and to the NEFT Centre, thereby considerably enhancing the security in the transfer of funds.

Real Time Gross Settlement (RTGS) – RTGS system is a funds transfer mechanism where transfer of money takes place from one bank to another on a 'real time' and on 'gross basis'. This is the fastest possible money transfer system through the banking channel. Settlement in 'real time' means payment transaction is not subjected to any waiting period. The transactions are settled as soon as they are processed. "Gross settlement" means the transaction is settled on one to one basis without bunching with any other transaction.

Core Banking Solutions (CBS) – Computerization of bank branches had started with installation of simple computers to automate the functioning of branches, especially at high traffic branches. Core Banking Solutions is the networking of the branches of a bank, so as to enable the customers to operate their accounts from any bank branch, regardless of which branch he opened the account with. The networking of branches under CBS enables centralized data management and aids in the implementation of internet and mobile banking. Besides, CBS helps in bringing the complete operations of banks under a single technological platform.

Development of Distribution Channels – The major and upcoming channels of distribution in the banking industry, besides branches are ATMs, internet banking, mobile and telephone banking and card based delivery systems.

Automated Teller Machine (ATM) – ATMs are perhaps most revolutionary aspect of virtual banking. The facility to use ATM is provided through plastic cards with magnetic strip containing information about the customer as well as the bank. In today's world ATM are the most useful tool to ensure the concept of "Any Time Banking" and "Any Where Banking".

Phone Banking – Customers can now dial up the banks designed telephone number and he by dialing his ID number will be able to get connectivity to bank's designated computer. By using Automatic voice recorder (AVR) for simple queries and transactions and manned phone terminals for complicated queries and transactions, the customer can actually do entire non-cash relating banking on telephone: Anywhere, Anytime.

Tele Banking – It is another innovation, which provided the facility of 24 hour banking to the customer. Tele-banking is based on the voice processing facility available on bank computers. The caller usually a customer calls the bank anytime and can enquire balance in his account or other transaction history.

Internet Banking – Internet banking enables a customer to do banking transactions through the bank's website on the internet. It is system of accessing accounts and general information on bank products and services through a computer while sitting in its office or home. This is also called virtual banking.

Mobile Banking – Mobile banking facility is an extension of internet banking. Mobile banking is a service provided by a bank or other financial institution that allows its customers to conduct financial transactions remotely using a mobile device. Unlike the related internet banking it uses software, usually called an App, provided by the financial institution for the purpose. Mobile banking is usually available on a 24 hour basis. Some financial institutions have restrictions on which accounts may be accessed through mobile banking, as well as a limit on the amount that can be transacted. Transactions through mobile banking may include obtaining account balances and lists of latest transactions, electronic bill payments, and fund transfers between a customer's or another's accounts.

Emerging Trends of Information Technology in Banking Sector

1). Outsourcing: Banking business process outsourcing or banking BPO is a highly specialized sourcing strategy used by banks and lending institutions to support the business acquisition and account servicing activities associated with customer lending lifecycle.

2). Integration: integration is a phenomenon in which financial markets in neighbouring, regional and/or global economies are closely linked together. ... Because of financial market imperfections, financial integration in neighbouring, regional and/or global economies is therefore imperfect.

3). Distinctive Edge: banking entity, owned by a state or nationally chartered BANK, with an international business scope. Edge Act banks are authorized to operate interstate branches,

accept DEPOSITS from offshore sources, invest in foreign securities and projects, and grant foreign LOANS.

4). Prospering in Down Market: to commercial products, services, etc, that are cheap, have little prestige. The market condition in which the values of safeties are falling and extensive gloom causes the undesirable sentiment to be self-sustaining .

5). Leading to Downsizing: Downsizing is the eternal decrease of a company's labor power through the removal of unproductive workers or divisions. Downsizing is a mutual administrative exercise, usually connected with economic downturns and fading businesses.

6). Getting Competitive Intelligence: Competitive intelligence is the performance of gathering and examining actionable info about participants and the marketplace to form a business strategy. It is effective when a business has a comprehensive plentiful representation of the marketplace so that it may anticipate and respond to tests and problems before they arise.

Positive impact of technology on banking sector

- The biggest revolution came in banks is Digitization.
- Banking process is faster than before and more reliable. Maintenance and retrieval of documents and records have become much faster and easier.
- Computerized banking also improves the core banking system. With CBS (core banking system) all branches have access to common centralized data and are interconnected.
- With the innovation of MICR cheque processing system, the processing of cheques becomes more faster and efficient h than before.
- USSD (Unstructured supplementary service data) was launched by Government, so people with no internet-connectivity too can access their bank accounts without visiting the branch.
- With increasing internet reach, Internet Banking was developed and now offered by almost every bank. Through this, every transaction details and inquiries can be performed online without visiting the bank.
- It offered more transparency in transactions.
- The scope of frauds in banks is being minimized through the use of passwords, double authentication in online banking.
- Technology also leads to competition among the banks which eventually provides better services to people.
- With introduction of mobile banking, one can access their bank from anywhere-anytime. Everything is one quick tap away.
- To facilitates better services, Banks have introduced Automated Banking Services Solution like Cash Deposit Machine, Cheque Deposit Machine, Passbook Printing Machine through these service have become easier.

Digital Payments

In line with earlier years, large value credit transfers through RTGS dominated the overall digital payments landscape in the year 2020-21, accounting for 80.8 per cent of the total value of digital transactions. In terms of volume

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Digital Payments

Item	2018-19		2019-20		2020-21	
	Volume (in lakh)	**Value (in crore)**	**Volume (in lakh)**	**Value (in crore)**	**Volume (in lakhs)**	**Value (in crore)**
Payment system						
Credit transfers						
1.Large Value Credit Transfers - RTGS	1366	135688187	1507	131156475	1592	105599849
2.Credit Transfers	118481	26090471	206506	28562857	317852	33522150
AePS (Fund Transfers)	11	501	10	469	11	623
ECS Cr	54	13235	18	5145	-	-
IMPS	17529	1590257	25792	2337541	32783	2941500
NACH Cr	8834	729673	11290	1043212	16450	1232714
NEFT	23189	22793608	27445	22945580	30928	25130910
UPI	53915	876971	125186	2131730	223307	4103658
3.Debit transfers						
BHIM Aadhaar Pay	68	815	91	1303	161	2580
ECS Dr	9	1260	1	39	-	-
NACH Dr	4830	522461	7340	718166	9630	868906
4.Card Payments						
Credit Cards	17626	603413	21773	730894	17641	630414
Debit cards	44143	593475	50611	703920	40146	661385
5.Prepaid Payment Instruments	46072	213323	53318	215558	49392	197695
Total Digital Payments (1+2+3+4+5)	232601	163713425	341239	162089411	437064	141483892

Source: Report on Trend and Progress of Banking in India 2020-21

However, credit transfers via multiple channels such as the Unified Payments Interface (UPI), National Electronic Funds Transfer (NEFT) and Immediate Payment Service (IMPS) were the leaders. In case of card payments, the value of debit card transactions registered a growth of 35.6 per cent as against 21.1 per cent for credit cards

Negative impact of technology on banking sector :

- The biggest negative impact of technology is loss of Jobs as automation has replaced number of jobs in banking sector.
- Through technology comes the threat of Cyber Attack, a loophole in the system, millions of data can be lost in the blink of an eye.
- These technologies consumes less time, it also sometimes makes people careless- which causes loss of personal details as happened last year in 2016,many debit cards details of big banks were compromised.

Conclusion:

Information Technology offers enormous potential and various opportunities to the Indian Banking sector. It provides cost-effective, rapid and systematic provision of services to the customer. The efficient use of technology has facilitated accurate and timely management of the increased transaction volumes of banks which comes with larger customer base. Indian banking industry is greatly benefiting from IT revolution all over the world.

The Indian banks lag far behind the international banks in providing online banking. In fact, this is not possible without creating sufficient infrastructure or presence of sufficient number of users. Technology is going to hold the keys to future of banking. So banks should try to find out the trigger of change. Indian Banks need to focus on swift and continued infusion of technology

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3.3.1 Number of research papers published per teacher in the Journals notified on UGC CARE list during the last five years (2020-21)

Title of paper	Name of the author/s	Department of the teacher	Name of journal	Calendar Year of publication	ISSN number	Link to the recognition in UGC		
						Link to website of the Journal	Link to article / paper / abstract of the article	Is it listed in UGC Care list
Photocatalytic degradation of solochrome balck under UV light on cobalt doped titanium dioxide photocatalysts.	r. A.M. Kalamn	Physics	Journal of Engineering Sciences	Jul-20	0377-9254	www.jespublication.com	https://jespublication.com/upload/2020-1107121.pdf	Yes
Microwave-Assisted Synthesis of Copper Nanoparticles : Influence of Copper Nanoparticles Morphology on the Antimicrobial Acivity	P J Bindu	Chemistry	Jounal of Materials NanoScience	Aug-20	2394-0867	http://pubs.iscience.in/jmns	https://pubs.thesciencein.org/journal/index.php/jmns/article/view/223	Yes

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PHOTOCATALYTIC DEGRADATION OF SOLOCHROME BLACK UNDER UV LIGHT ON COBALT DOPED TITANIUM DIOXIDE PHOTOCATALYSTS

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Abstract - In the present investigation well-crystalline cobalt doped TiO_2 nanoparticles (NPs) were prepared by hydrothermal process. The structural, morphological, optical and compositional properties of as prepared samples have been characterized by X-ray diffraction (XRD),field emission scanning electron microscopy (FESEM), UV-Vis spectrophotometry and energy dispersive X-ray spectroscopy (EDS) .XRD analysis reveals that the prepared samples were nanocrystalline and had anatase phase. The average size of crystallites using Scherrer's formula was found to be 7.07nm and 5.73nm for TiO_2 and Co-TiO_2 NPs respectively. FESEM analysis shows the NPs were spherical shape with an average size of about 10nm to 20nm.EDS analysis confirms the chemical compositions of the NPs having Ti and O elements. UV-Vis measurement shows increase in optical band gap due to cobalt doping. The photocatalytic activity was evaluated by monitoring the degradation of Solochrome Black [Eriochrome Black T (EBT)] under UV-light illumination. The photocatalytic degradation results for Solochrome dye were 61.4 % and 78.3 % for TiO_2 NPs and Co-TiO_2 NPs respectively under UV irradiation for 110 minutes. Thus increase in photocatalytic degradation when doped with Co.

Keywords- Hydrothermal synthesis, Photocatalytic degradation, TiO_2 NPs, Co-TiO_2 NPs.

INTRODUCTION

Natural colors is one of the significant gatherings of poisons broadly utilized in material, plastic, medication and numerous different businesses, while the unsafe impacts of natural colors in waste water have been a significant concern and now a significant danger in the earth because of the considerable contamination issues brought about by them. These businesses depleted enormous amount of high substance shading effluents, which are commonly increasingly harmful and impervious to devastation by traditional techniques. An essential basis in the utilization of these colors is that they should be profoundly collected in water and stable in light during washing. The gathering of these colors in the water bodies causes eutrophication, decreases the reoxygenation limit and makes serious harm to the aquatic living beings by impeding the invasion of daylight [1]. They must also be resistant to microbial attack. Therefore, they are not readily degradable and are typically not removed from water by wastewater treatment systems and conventional methods like adsorption, ultra filtration, chemical and electrochemical methods [2]. The predominance of photocatalytic degradation by nanoparticles in wastewater treatment is because of its favourable circumstances over the regular techniques, for example, snappy oxidation, no development of polycyclic items and oxidation of toxins. It is a compelling and quick strategy in the expulsion of contaminations from waste water [3]. In the recent years, numerous metal oxides including TiO_2 [4], ZnO [5], and other oxides have attracted growing attentions for photodegradation of organic dyes; TiO_2 is of specific interests because of its ease and high strength. In any case, TiO_2 has been increased momentous consideration as a photocatalyst in corruption of natural poisons. Because of the properties of hostile to oxidation long haul strength, non-harmfulness, solid redox capacity, it has been broadly utilized in the field of photocatality. TiO_2 being a semiconductor with a huge band gap i.e, 3.2, 3.02 and 2.96eV for anatase, rutile and brookite phases individually. As TiO_2 particles, get lighted by photons with vitality more noteworthy than the band width of TiO_2, the valence band electrons will be travelled to the band of conduction which leave gaps in the valence band.

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Presently electron gap sets could take an interest into a wide range of substance responses on TiO_2 surface and that at last debases all the toxins in the arrangement. This response prompts recombination of electrons and openings rapidly; in the long run TiO_2's photocatalytic movement incredibly diminishes. To acquire higher photocatalytic action, one usually utilized technique is doping metal and/or non metal particles into the TiO_2's crystal lattice. In photocatalysts, vitality of the episode pillar ought to be equivalent to this boundary that can energize the electron and move to conduction band. By considering the band gap of anatase stage, it is considered as a photocatalyst under UV illumination. As per the examinations, daylight on Earth's surface is around 52 to 55% infrared (over 700 nm), 42 to 43% visible (400 to 700 nm), and 3 to 5% bright (under 400 nm) [6]. Along these lines, planning of photocatalysts with energizing vitality in obvious range or changing the necessary vitality for energizing the electrons can be valuable for utilizing the daylight so as to cleansing of water. While vitality change and capacity is the large test in the modernized world, over these issue is significant for the improvement of synergist and electrochemical innovation [7-10]. Doping is one of the most common methods to change the required energy for exciting of electrons in photocatalysts [11]. Doping can decrease or increase this energy; this change depends on type of photocatalyst and dopants [12]. Vu et al [13-17] incorporating exceptionally dynamic photocatalytic TiO_2 nano tubes by aqueous treatment in the base medium utilizing the commercial powder of TiO_2 as Ti source. In this work, Co was used as dopants in TiO_2 nanostructures and the products were characterized and analysed their photocatalytic solochrome dye degradation under UV light.

2. MATERIALS AND METHODS

2.1 CHEMICALS

Titanium (IV) n butoxide (TNB) wt 99% liquid analytical grade, Cobalt nitrate hexahydrate [Co $(NO_3)_2.6H_2O$] and EDTA (di-sodium salt dehydrate) were purchased from Alfa Aesar Chemicals, India. De-ionized water (DW) was used in the preparation of all solutions.

2.2 SYNTHESIS OF TIO_2 AND CO DOPED TIO_2 NANOPARTICLES

TiO_2 NPs were synthesized using hydrothermal method [18]. 30ml of 0.1M of E.D.T.A ($C_{10}H_{14}N_2Na_2O_8.2H_2O$) was prepared by dispersing 0.56gm of E.D.T.A in 15ml of de-ionised water (DW) with a continuous stirring with the aid of magnetic stirrer for 10 minutes later adding 15ml of DW and 1ml of Titanium (IV) n butoxide was added drop wise with continuous stirring for 30 minutes. The colloidal solution was then transferred to a 50ml Teflon-lined stainless steel auto clave, the autoclave was sealed and placed in an oven at 180^0C for 3hours, then the autoclave was allowed to cool down to room temperature. Under ambient conditions, the reactant mixture was centrifuged to collect the product; the product was washed continuously with DW several times to remove the organic molecules bonded to the surface of the product. The final product was dried in an oven at100^0C for one hour. Same procedure is adopted for Cobalt doped TiO_2 nanoparticles by adding 5ml of 0 .1M [Co $(NO_3)_2.6H_2O$] to the solution, then the prepared sample is used for photodegradation application.

PHOTOCATALYTIC EXPERIMENTS

The photo catalytic reactor is a Pyrex-glass cell with 1.0 L capacity. A 10 W Lamp (Philips) as the UV light source (365 nm) was set in a quartz light holder which immersed in the photo reactor cell. Prior to passing light, the solution was allowed stirred in dark for 60 minutes to accomplish adsorption–desorption balance between the color and photo catalyst. The cell was loaded up with 1mg/L of color arrangement and 1 x 10^{-5} M of the photo catalyst. Magnetic stirrer was used to introduce fresh air bubbles into the suspension using a pump. Dye degradation was inspected by taking 4 mL of the suspension at 10 minutes light time spans. Finally, the rate of degradation was determined from the change in absorbance of Dye solution. Prior to the estimation, the resultant solution was centrifuged for 10min at 5000 rpm to remove any turbidity. Kinetic data were evaluated using Microsoft Excel 2010 program.

2.3 CHARACTERIZATION TECHNIQUES:

2.3.1 UV-VIS SPECTROSCOPY

UV-Vis absorbance spectra in the wavelength range 200-800nm was measured using UV-Vis spectrophotometer (model: SPECORD 200+ Analytikjena)

2.3.2 XRD

The crystal structure of the powder sample at a scanning rate of 0.02^0 per second in the scattering angle range of 20^0 to 80^0 with the use of Cu K_α radiation of wavelength $1.54060A^0$ were analysed by XRD (model: Rigaku pro analytical) Peak analysis was carried out using PCPDFWIN software.

2.3.4 The surface morphology and nano size nature of the samples at an operating voltage 5kV were examined using FE-SEM (model: Xford-EDX system IE 250 X Max 80).

2.3.5 EDS Elemental compositions were analysed using EDS (model: FEI Quanta 200 F).

2.3.6 ZETA POTENTIAL

The zeta potential was based on the surface charge of the particles relative to the local environment of the prepared particle. This electrostatic potential of shear plane of the particle was carried out in ultrasonicated dispersion of 0.01 g/100 mL in DMSO in room temperature using the Horiba SZ-100 nanoparticle analyzer.

3. RESULTS AND DISCUSSIONS

3.1 OPTICAL PROPERTIES:

3.1.1 UV-VIS SPECTROSCOPY;

UV-Vis Spectra were recorded for TiO_2 NPs and Co-TiO_2 NPs in ethanol solvent at room temperature and graphs are shown in Fig 1(a). From the curves it is seen that the absorption maxima (λmax) for TiO_2 NPs and Co-TiO_2 NPs were seen at 341 nm and 370.8 nm separately which is a preliminary indication for the presence of TiO_2 material. The band gap of both the samples were estimated utilizing the absorption information with the assistance of (K–M) transformation method [19].Band gap energy of the semiconductor was estimated using the optical absorption coefficient (α) and is expressed by equation

$$\alpha = \frac{A(h\nu - E_g)^{1/n}}{h\nu} \qquad (1)$$

Where, hν is energy of photon, E_g is the band gap energy, A is a constant depends on the transition probability and depends on the nature of the transition for allowed direct transition (n= ½), for allowed indirect transition (n=2). In the present cases for an indirect gap, the value of n is 2 for TiO_2 NPs and Co-TiO_2 NPs. Using Tauc's plot the estimated E_g values were found to be 3.07eV and 3.95 eV respectively.

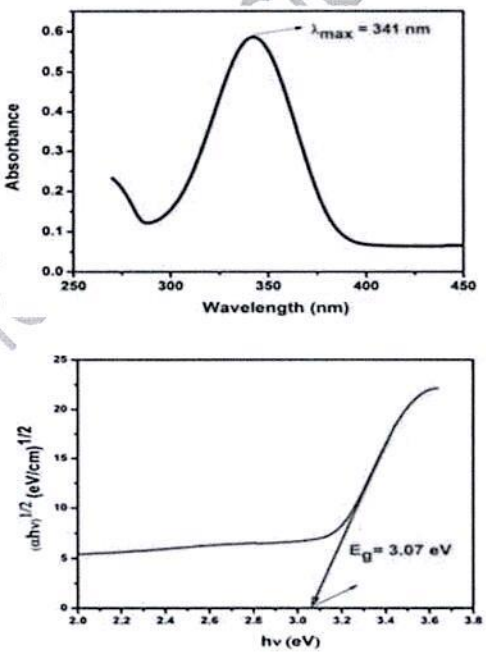
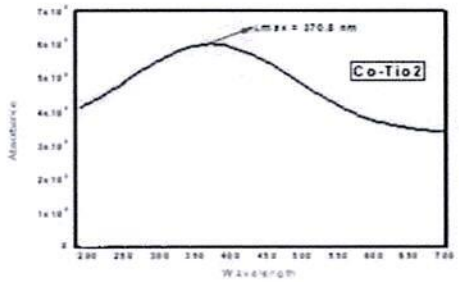


Fig (1) a: UV and Tauc's plot for TiO



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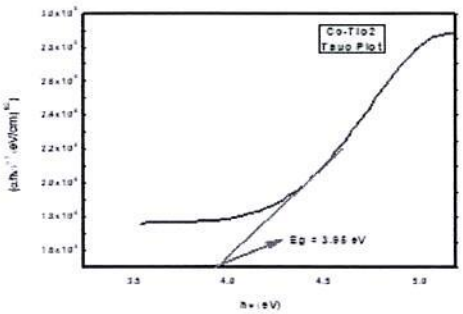

Fig 1(b): UV and Tauc's plot for Co -TiO_2

3.2 STRUCTURAL PROPERTIES:

XRD analysis was carried out to verify the presence of nano crystalline and phase formation. Fig 3 (a and b) shows XRD patterns for TiO_2 and Co-TiO_2 powders respectively it is observed that the presence of strong and sharp peaks; it reveals the formation of the well crystallized samples. From the Fig 3 (a) it is observed that the Bragg's reflection at 2Θ = 25.3429, 37.8769, 47.9727, 54.0791, 62.7467, 75.1348 and 82.6813 can be indexed to (101), (004), (200), (211), (204), (215) and (224) crystal planes respectively. The comparison of 2Θ values in observed Fig 3(a) XRD patterns with those from the standard Joint Committee on Powder Diffraction Standards (JCPDS) data no. 89.4921 confirms the formation of the TiO_2 having anatase phase and tetragonal crystal structure. Fig 3(b) shows the XRD patterns for Co-TiO_2 powders, it is observed that the Bragg's reflection at 2Θ=25.3669, 37.7705, 48.0267, 54.1788, 62.749, 75.1144 and 82.8806 can be indexed to (220), (311), (002), (060), (402), (650) and (660) crystal planes respectively. The comparison of 2Θ values in observed Fig 3(b) XRD patterns with those from the standard Joint Committee On Powder Diffraction Standards (JCPDS) data no. 35.0793 confirms the formation of the Co-TiO_2 having anatase phase and orthorhombic crystal structure. The Scherer's equation [20] is used to estimate an average crystalline size by determining the full width at half maximum (FWHM) of the most intense reflection plane and this equation is given by

$$D \approx \frac{0.9\lambda}{\beta \cos\theta} \qquad (2)$$

Where D is an average crystalline size, λ is the wavelength of X-ray used (1.50406 x 10^{-10} m), Θ is the Bragg's angle in radian and β is the full width at half maximum of the most intense reflection in radian. In our case, the most intense peak for TiO_2 and Co-TiO_2 were found to be (101) and (006) plane and the estimated average crystalline size is 7.07nm and 5.73nm respectively

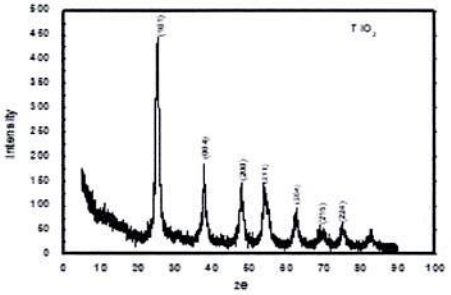

Fig 3 (a) XRD graph for TiO_2

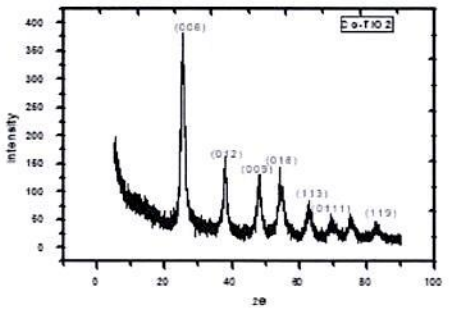

Fig 3 (b) XRD graph for Co-TiO_2

3.3 MORPHOLOGY, SIZE DISTRIBUTION AND ELEMENTAL ANALYSIS

FE-SEM analysis was used to examine the surface morphology and nano size nature of the samples. Fig 4 (a) and Fig 4 (b) shows the particles are having the spherical cluster with average size of about 10 nm to 20 nm. EDS was examined to investigate the chemical composition in $CoTiO_2$ NPs Fig 4 (c) and Fig 4 (d) represents the EDS spectrum for TiO_2 NPs and Co-TiO_2 NPs, hence EDS spectrum confirms the presence of elements i.e. Ti and O, in addition small quantities of element C was observed since it is residue of oil contaminants. The weight percentage (%) and atomic weight percentage (%) Co-TiO_2 NPs are shown inset of Fig 4 (c) and Fig 4 (d)

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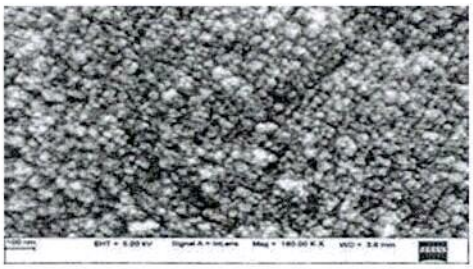
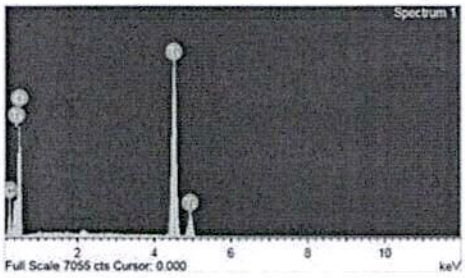


Fig 4(a) FE- SEM image of TiO_2



Element	Weight %	Atom %
O k	61.19	55.18
Ti k	57.22	17.23
C k	22.97	27.59

Fig 4(c) EDS spectrum of TiO_2 NPs inset corresponding weight % and atomic % of element

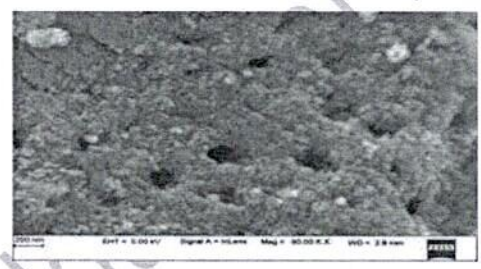
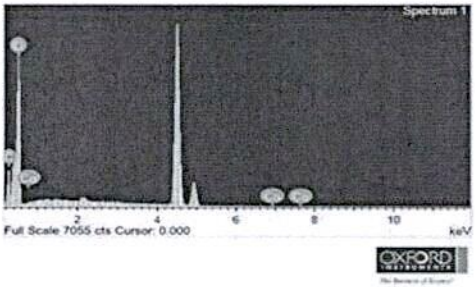


Fig 4(b) FE- SEM image of Co-TiO_2

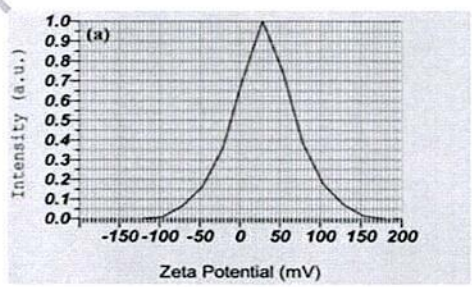


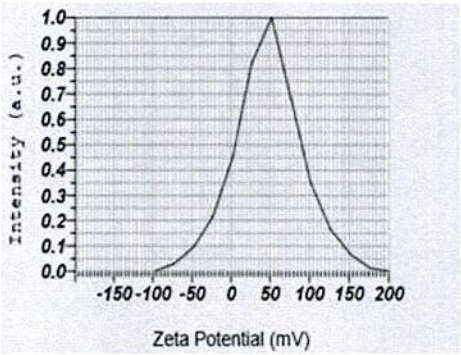
Element	Weight %	Atom %
O	33.77	66.56
Co	0.29	0.16
C	12.68	33.28

Fig 4(d) EDS spectrum of Co-TiO_2 NPs inset corresponding weight % and atomic % of elements

ZETA POTENTIAL STUDY

The zeta potential with a positive value of 30 mV with electrophoretic mobility 0.000061 cm^2/Vs and with positive value of 47.6 mV with electrophoretic mobility 0.000097 cm^2/Vs suspension was obtained for the $TiO_2$and Co-TiO_2 NPs respectively in DMSO and the zeta potential graphs shown in the Fig (5), which clearly shows a stable dispersion without particle settlement. Furthermore, the study of prepared suspension corroborates with general criteria of zeta potential (ζ) value 30 mV with positive or negative sign for better stability.





(b)

Fig. 5: Zeta potential evaluation of
(a) TiO_2NPs and (b) Co-TiO_2 NPs in DMSO solvent.

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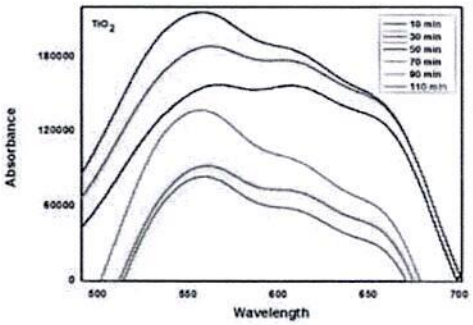
PHOTODEGRADATION PROCESS:

(a)



(b)

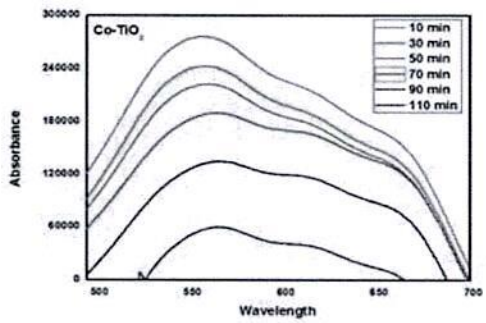


Fig. 6: Photo degradation evaluation of (a) TiO_2 NPs and (b) Co-TiO_2 NPs in solochrome dye solution.

EVALUATION OF PHOTO CATALYTIC ACTIVITY

To assess the photo catalytic activity of TiO_2 NPs, the photo catalytic degradation of solochrome color was performed under UV illumination. The photo catalytic degradation was assessed by estimating the absorbance at customary time stretches. Strikingly, it was seen that the relative absorption intensity constantly diminished as the UV brightening presentation time expanded, altogether demonstrating that solochrome dye degradation viably on the outside of TiO_2 photo catalyst [Fig. 6(a) and Fig 6(b)]. This is on the grounds that, under light, profoundly oxidizing hydroxyl and oxy radicals are shaped by the semiconducting metal oxides like TiO_2, Co-TiO_2 etc. via generation of electron–hole pairs, which break the large organic materials into less harmful small organic materials. The obtained degradation was 61.4 %, 78.3 % within 110 min for TiO_2 and Co-TiO_2 [21].It reveals that after doping with Co percentage of degradation was increased. The Solochrome degradation percentage was calculated as:

$$\text{Degradation rate } (\%) = \frac{A_0 - A}{A_0} \times 10 \quad (3)$$

In order to compare the photo catalytic efficiency of prepared TiO_2 NPs with commercially available photo catalyst such as, TiO_2 & Co-TiO_2 experiments have been done at a fixed solochrome dye concentration for 110 min.

CONCLUSION

Eco friendly hydrothermal route was used for the synthesis of TiO_2 and Co doped TiO_2 nanoparticles and was confirmed by various characterization techniques. The TiO_2 and Co-TiO_2 are having particle size about 10 to 20 nm. Further studied Solochrome dye was degraded under UV light using TiO_2 and Co doped TiO_2 nanoparticles. Among doped TiO_2, the maximum degradation efficiency was found to be 61.4 % for TiO_2 and 78.3 % for Co-TiO_2. From this we can conclude that Co-TiO_2 Shows enhanced photocatalytic activity than bare TiO2.

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J. Mat. NanoSci. 2020, 7(2), 62-67 Article

Integrated Science

Journal of Materials NanoScience

Microwave-assisted synthesis of copper nanoparticles: influence of copper nanoparticles morphology on the antimicrobial activity

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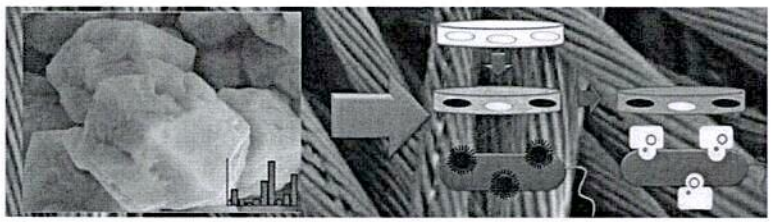
ABSTRACT



Among the several transition metals known to mankind, the synthesis of Cu has remained a major challenge owing to their instinctive oxidative power under ambient conditions. Microwave assisted synthesis of copper nanoparticles (CuNPs) using different types of copper-β-diketonates complexes and glycine as reducing agent. The morphology, size, and structural properties of obtained nanoparticles were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), and UV-visible spectroscopy (UV-VIS) techniques. The results of FE-SEM exhibited that the CuNPs of various shapes and size, depended upon the type of copper-β-diketonates complexes used. Furthermore, all the CuNPs exhibited good antimicrobial activity against both, Gram-positive and Gram-negative bacteria. The result shows that, the cubic CuNPs derived from $Cu(acac)_2$ demonstrated a better antibacterial activity against both bacterial strains.

Keywords: Cu nanoparticles, Microwave-irradiation, Antifungal activity

INTRODUCTION

Metal nanoparticles have been received much attention due to their unique optical, electrical, biomedical and catalytic properties.[1] The size, shape and surface morphology of the particles were crucial in tuning these properties of nanosized metal particles. There are many synthesis methods have been developed to prepare metal nanoparticles including, chemical, physical and biological methods.[2] Among these, microwave-assisted synthesis of metal nanoparticles is the simplest and environment friendly method.[3-5]

On the other hand, copper nanoparticles are the most preferred target for microwave-assisted methods due to their diverse applications like, catalysis, electronics, optics, medicine, photonics, and antimicrobial agent.[6] Several synthesis techniques for CuNPs with controlled size and shape have been reported, including vacuum vapor deposition, radiation, microemulsion, laser ablation, super critical techniques and sonochemical.7 One of the main limitations of these approaches, is the use of toxic chemicals and harmful by-products produced during the process. As a consequence, microwave-assisted synthesis have been used by researchers for the synthesis of various metallic nanoparticles. Microwave-assisted synthesis is appealing because it can dramatically reduce reaction time, improve product yield, and enhance material properties when compared to conventional synthesis routes.[7,8] Among the different metallic nanoparticles, CuNPs exhibit good antibacterial activity.[9,10] Very recently, the mechanism of antibacterial activity of CuNPs was reported and

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the CuNPs are known to be very effective against bacteria.[11] CuNPs are preferred to silver nanoparticles because of lower cost of copper than silver, easier mixing with polymers, and relatively more physic-chemical stability.[9,10]

In this work, we reported a facile microwave-assisted method for the synthesis of CuNPs by using different copper metal beta diketonates and reducing agent. The synthesized CuNPs were characterized by UV–visible spectrophotometer, energy dispersive X-ray spectra (EDS), field emission scanning electron microscopy (FE-SEM), Fourier transform infrared spectroscopy (FTIR), X-ray diffraction crystallography (XRD), and the antimicrobial activity of CuNPs was evaluated.

EXPERIMENTAL

Materials and equipment

All the chemicals used in the present study are of AR grade. Whenever analytical grade chemicals were not available, laboratory grade chemicals were purified and used. We have employed metal β-diketonates as precursor materails,[12,13] which possess low moisture sensitivity and are thus less susceptible to hydrolysis, rendering them superior to metal alkoxides and halides often used in metal/metal oxide synthesis. The metal–oxygen bond present in β-diketonates complexes makes them appropriate precursors for the synthesis of metal/metal oxide nanoparticles. The metal complexes, Cu (II) β-diketonates like, $Cu(acac)_2$, $Cu(maa)_2$, $Cu(eaa)_2$ and $Cu(tbob)_2$, were synthesized and purified in-house.[14-16] ^{1}H- NMR spectra were obtained using a 400 MHz on a Bruker spectrometer (chemical shifts in δ ppm). Mass spectra were recorded using a micro spray Q-TOF MS ES Mass spectrometer.

Synthesis of Cu(β-diketonates)$_2$ Complexes.

To a solution of 6 g copper(II) chloride dihydrate ($CuCl_2.2H_2O$) in 4 mL of distilled water in a 500-mL beaker, add dropwise over a period of 30 minutes a solution of 7.5 mL of β-diketonates in 10 mL of methanol, while maintaining constant stirring. Add to the resulting mixture 10 g of sodium acetate in 30 mL of distilled water over a period of 20 minutes. Heat the reaction mixture with constant stirring for about 30 min on water. After completion of reaction was cooled to room temperature and the obtained precipitate was collected by filtration and cold distilled water and vacuum dry for 30 minutes before drying in an oven at 110^{0}C. Cu(II)-acetyl acetonate ($Cu(acac)_2$), Cu(II)-methylacetoacetate ($Cu(maa)_2$), Cu(II)-ethyl acetoacetate ($Cu(eaa)_2$), Cu(II)-ter-butyl-acetyl acetonate ($Cu(tbob)_2$), respectively. The formation of Cu(β-diketonates)$_2$ complexes were confirmed by powder XRD technique. The FTIR, ^{1}H- NMR and mass spectra of in house synthesized copper metal complexes are shown in ESI (Scheme 1, S1-S9†).

Synthesis of copper nanoparticles

Copper nanoparticles (CuNPs) were synthesized by reduction of four different Cu(β-diketonates)$_2$ complexes using glycine and potassium hydroxide as reducing agents. In a typical synthesis process, the mixture of $Cu(acac)_2$ (10 mmol) was dissolved in 15 ml of EG (Ethylene Glycol) and 15 mmol of glycine was added with constant stirring. Finally 15 mmol of KOH in 5 ml of EG was added when the solution completely turned blue after 10 minutes of stirring. The resulting mixture was irradiated in a microwave for about 10 minute till a dark red colour appeared. The reaction mixture was cooled and centrifuged for about 10 min at 7000 rpm yield copper nanoparticle. The isolated product was then washed with absolute ethanol and dried under vacuum at 80 °C for 4 h to obtain powdered CuNPs. The Experiment was repeated with $Cu(maa)_2$, $Cu(eaa)_2$ and $Cu(tbob)_2$ respectively, and in every case the end product was CuNPs only.

Characterization of Copper nanoparticles

The crystallinity and phase composition of the copper nanoparticles were investigated using an X-Ray Diffraction (XRD) – analysis was done with Rigaku X-ray difractometer, FT-IR studies were carried out using a Thermofisher Scientific FTIR spectrophotometer (Nicolet 6700 FT-IR). Scanning electron Microscopy (SEM) and X-ray Energy dispersive Spectroscopy (EDS) analysis was done using ULTRA55 FESEM equipped with EDS.

Antimicrobial assay

The antibacterial activities of the synthesized silver nanoparticles were assessed against both gram positive (*S. aureus*) and gram negative pathogen (*P. aeruginosa*) through agar disk diffusion method.[17,18] The pure bacterial and fungal strains were maintained on nutrient agar and potato dextrose agar (PDA), respectively. The dried powder of CuNPs was taken at the concentration of 50 µg/ml for the antibacterial tests. The wells were made in agar plates and 50 µL of CuNPs were added into the wells and subsequently incubated at 37 °C for 24 h. Zone of inhibitions were determined by measuring the diameter of the bacterial growth inhibition around the wells. All assays were carried out in triplicates and results are presented as mean±standard deviation (SD).

RESULTS AND DISCUSSION

Synthesis and characterization

Metal-β-diketonate fragments have attracted widespread attention because of their potential applications as a high quality advanced materials for the synthesis of metal/metal oxide nano materials.[19] Generally, the β-diketone ligands are considered as potential ligands due to their enclosing ability in metal complexes synthesis. Recently, we have reported the synthesis of metal-β-diketonate fragments for the synthesis of different metal/metal oxide nanoparticles.[20,21] We have developed four copper metal-β-diketonate complexes (Scheme 1, ESI†) for the synthesis of copper nanomateraials by MW method. The main stretching modes in the infrared spectra of the complex resulting from β-diketones are υC=O, υM-O, υC-O (ESI, Figure S1†). The coupled vibrations of Cu-O stretching modes appeared below 700-742cm^{-1} in the complex and the 457-489 cm^{-1} band have been assigned as pure υ(Cu-O) vibrations.[22,23] In the H^1- NMR spectrum of Cu (β-ketonate)$_2$ shows, the peak at δ = 4.86-5.47 corresponds to the -CH- proton in between the two carbonyl groups in the acetyl acetone of Cu(β-ketonate) and peak at δ = 1.2-2.22 corresponds to the CH_3-C=O protons (ESI, Figure S2†). The mass spectra (ESI,

Figure S3†) and powder XRD data also (ESI, Figure S4†) supported the formation of Cu(β-diketonates)$_2$.

For the past few years, our research has been focused to develop novel synthetic protocols for the synthesis of metal/metal oxide nanopaerticles maintaining some of the sustainable principles. In this process, we attempted the reaction of Cu(β-diketonates)$_2$ for the synthesis copper nanoparticles by microwave-assisted method in EG. The obtained powder materials was confirmed by the powder XRD spectra (Figure 2).

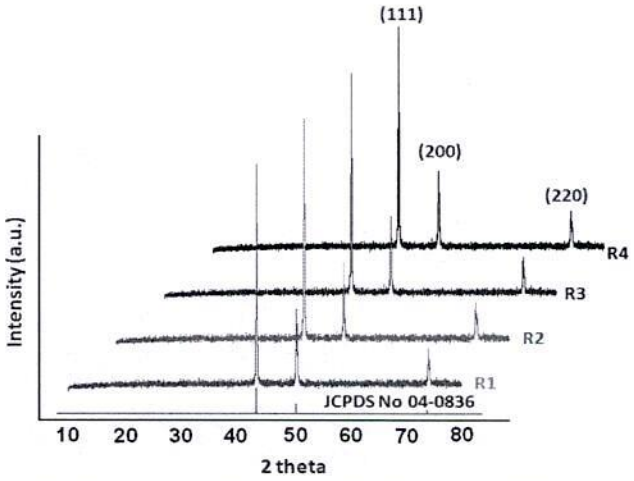

Figure 1: Powder XRD of CuNPs by microwave method.

The powder XRD confirms the formation of pure single crystalline CuNPs is shown in Figure 1. In Figure 1, the $2\theta = 43.4$, 50.5, and 74.0^0, attributed to the (111), (200), and (220) crystal planes, respectively, belonging to pure copper with face-centered cubic symmetry (FCC) [24,25] and corresponding to the diffraction pattern of metallic copper (JCPDS number 04-0836) [26], as shown at the bottom of this figure.

Microwave technology has been demonstrated to speed up reactions, often achieving good purity and product yield. We decided to investigate the selectivity of the reaction between Cu(acac)$_2$ and glycine and explore the effect of microwave irradiation for the formation of copper nanopartciles. The formation of copper nanopartciles by MW method was studied by powder XRD technique (Figure 1). The each sample was collected 2 min interval of the reaction and centrifuge the samples and characterized by XRD and it clearly shows that, the lower angle peaks (belongs to the organic moieties) was disappeserd with increasing the microwave irradiation time. The peak (111) was appeared at 3 min and peak (200), (220) were apeared at 12 min of microwave irradiation.The pure phase of copper nanoparticle was achieved at 18 min of microwave irradiation.

We have also discussed the effect of different reducing agents for the synthesis of copper naopartilces by microwave method (Table 1). Among the different reducing agents, glycine was produced copper nanoparticles quickly in 18 minutes in good yields compare others.

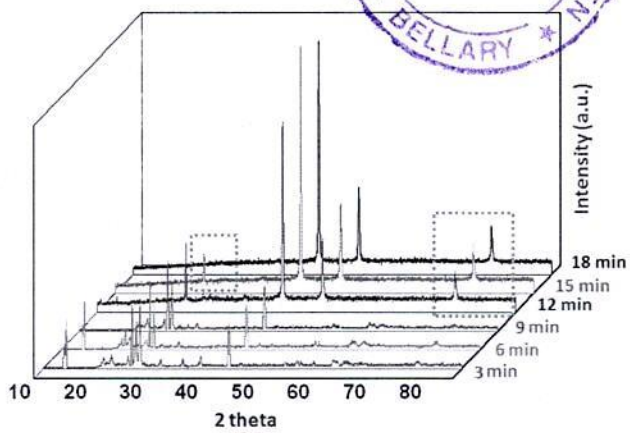

Figure 2: Powder XRD of the CuNPs by microwave method at different time intervals.

Table 1. Effect of reducing agents for the synthesis of CuNPs by MW method.

Complex	Reducing agent	Time (min)	Solvent
Cu(acac)$_2$	Glycine (15 mmol)	18	EG
Cu(acac)$_2$	Hydrazine Hydrate (15 mmol)	35	EG
Cu(acac)$_2$	CTAB (15 mmol)	45	EG
Cu(acac)$_2$	$NaBH_4$ (15 mmol)	45	EG

Table 2. Effect of solvents for the synthesis of CuNPs by MW method.

SOLVENT	TIME (MIN)	REDUCING AGENT
Ethanol	40	Glycine (15 mmol)
Propane 1,3 diol	30	Glycine (15 mmol)
Decanol	30	Glycine (15 mmol)
Ethylene Glycol	18	Glycine (15 mmol)

Microwave-assisted reactions is based on the efficiency of the interaction of molecules in a reaction mixture (substrates, catalyst and solvents) with electromagnetic waves generated by a "*microwave dielectric effect*". The reaction medium with a high value of (*tan δ*) at the standard operating frequency (2.45 GHz) of microwave system is required for the good absorption i.e. high heating rate. We different solvents for the synthesis of copper nanoparticles are high-lighted in Table 2.

The powder XRD of the copper nanoparticles in different solvents under microwave irradiation method was shown in Figure 2. The results indicates that, EG has been used because of high boiling point, high dielectric loss constant, because of chelating properties (auto surfactant). There is no extra satellite peaks were absorbed in EG solvent assisted synthesis of copper nanoparticles. The morphology of the copper nanopaticles synthesis form different solvents by microwave method is as shown in Fig 4.

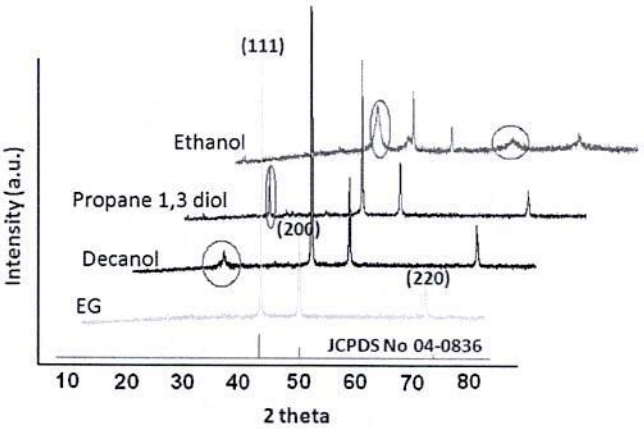

Figure 3: Powder XRD of the CuNPs synthesis by different solvent at microwave method.

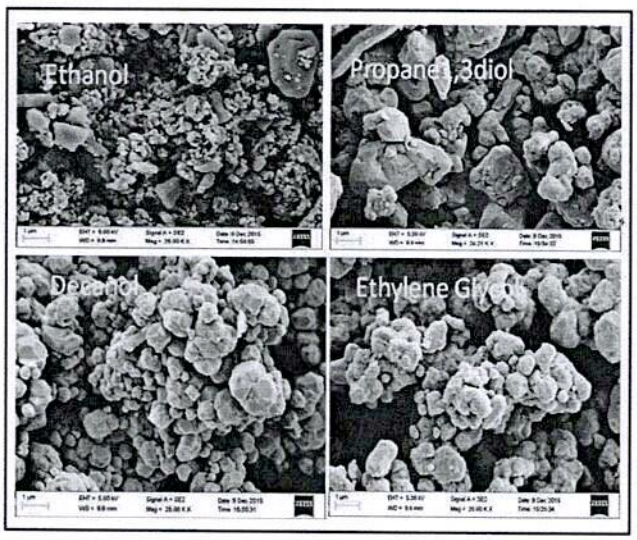

Figure 4: SEM images of the CuNPs synthesis by different solvent at microwave method.

The typical SEM (Figure 5) of CuNPs shows large number of single crystals were formed at 40 min of MW irradiation in EG solvent. Uniform and crystalline CuNPs was obtained because MW provided suitable condition for nucleation and crystal growth (Figure 5). The chemical purity and stoichiometry of the obtained CuNPs were obtained by EDX spectrum (Figure 6).

We studied the effect of different metal β-diketones complexes for the preparation of CuNPs, the presence of β-diketones during the microwave reaction affected the morphology and size of the nanoparticles. From the SEM images and Image J (ESI, Figure S8†) the CuNPs from $Cu(acac)_2$ had an average size of 79.5 nm, and the CuNPs were spherical and uniform as shown in Figure 5(a) (ESI S9†). On the other hand, the CuNPs from $Cu(maa)_2$ had an average size of 36.4 nm with uniform distribution of size and shape as shown in Figure 5(b). The Cu-NPs from $Cu(eaa)_2$ and $Cu(tbob)_2$ had an average size of 85.7 nm and 37.9 nm respectively Figure 5(c,d). The drastic change in the size and

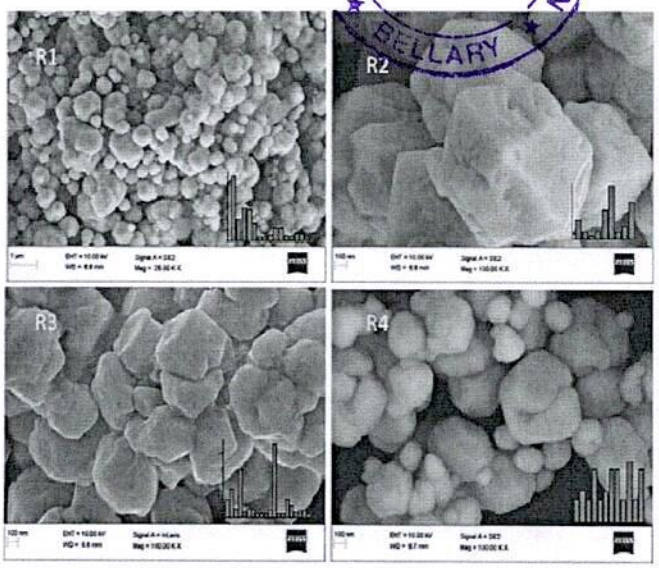

Figure 5. SEM image of single crystalline Cu-NPs: R1= $Cu(acac)_2$, R2= $Cu(maa)_2$, R3 = $Cu(eaa)_2$ and R4 = $Cu(tbob)_2$ respectively.

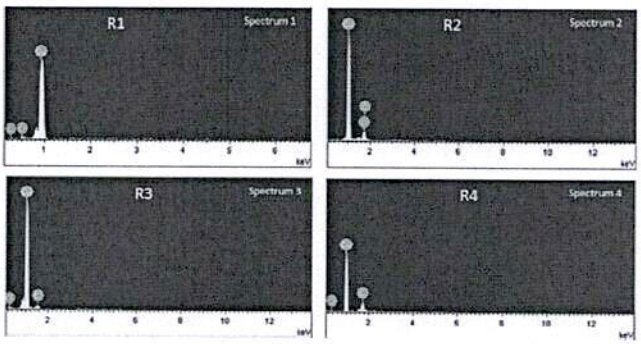

Figure 6. EDX spectrum of R1, R2, R3 and R4 CuNPs respectively.

morphology was thought to be because the presence of glycine enhances the growth of crystalline CuNPs as the temperature is increases. These results clearly showed that the CuNPs were produced from $Cu(maa)_2$, was more crystalline and uniform size distribution compare to other metal complexes.

The formation of copper nanoparticles was also confirmed by FTIR analysis.

X-ray photoelectron spectroscopy (XPS) was employed for copper nanoparticle (R2) resulted from $Cu(maa)_2$. Figure 7 shows the core shell XPS spectra of Cu 2p recorded from powder and supported copper nanostructures. The two strong peaks observed at 932.65 eV and 952.56 eV are in agreement with the binding energies of Cu 2p3/2 and Cu 2p1/2, respectively.[27,28] All the obtained nanoparticles will have different structural morphology with different sizes.

Nanoparticles applications in medicine depend on the size and the composition of the nanoparticles. The ability to target diverse bacterial structures was the important property of nanoparticles. Copper naoparticles have a great bactericidal effect and it possess

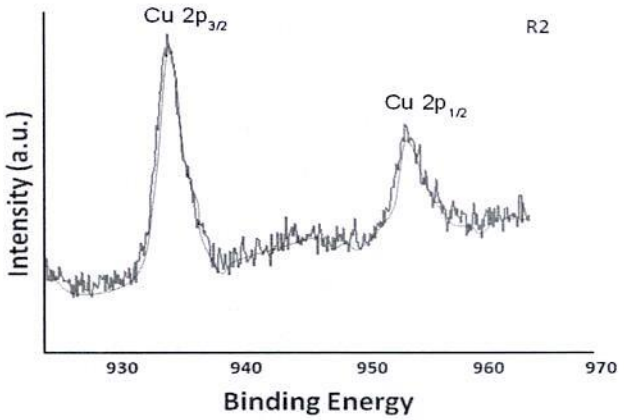

Figure 7. XPS spectra of R2 copper nanoparticles.

Impact of morphology on Antimicrobial activity

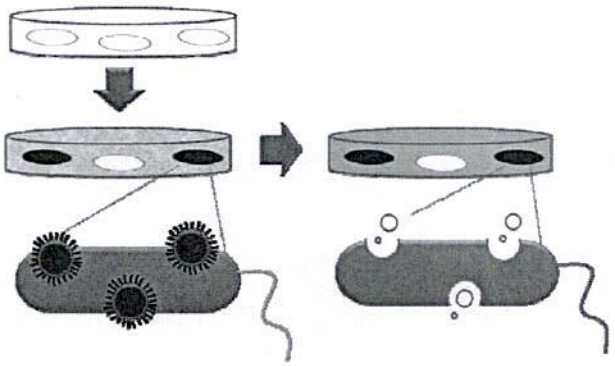

Figure 8 Pictorial demonstration showing the anti-bacterial action of CuNPs respectively.

well-developed surface chemistry, chemical stability and appropriate smaller size which make them easier to interact with the microorganisms. The mechanism of action is as shown in Figure 8. The antibacterial activity of copper naoparticles against gram positive (*S. aureus*) and gram negative pathogen (*P. aeruginosa*) is as shown in Figure 8. Figure 9 shows the enlarged microscopic images of antimicrobial activity. The growth inhibition zones obtained from the antibacterial study of the synthesized copper nanoparticles was shown in Figure 10. The results display that the copper nanoparticles, prepared from all the four copper metal complexes, showed a good antibacterial activity against gram-negative than gram-positive bacteria. The largest inhibition zone was obtained for the Gram-negative bacteria (*P. aeruginosa*) compare to *Staphylococcus aureus*.

The obtained results shows that, the antibacterial activity was dependent on the size of the nanoparticles–the highest activity was observed for CuNPs synthesized from the $Cu(acac)_2$ by microwave-assisted method. In our case, we believe that the CuNPs from microwave-assisted method had the crystalline, smaller size and the largest surface/volume ratio. Small CuNPs are able to be penetrated inside the bacteria and caused further damage, lose their activity and finally cell death. At last, the CuNPs release copper ions, which will have an additional contribution to the antibacterial activity of the CuNPs. This characteristic enhances biological and chemical activity of the nanoparticles with high antibacterial efficacy.

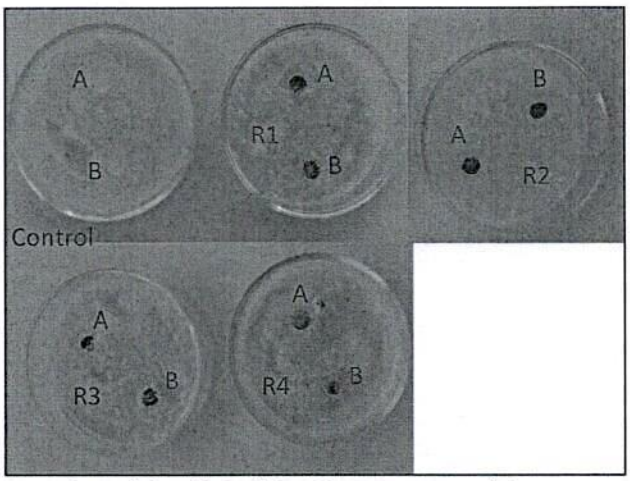

Figure 8. Antimicrobial activity of copper nanoparticles.

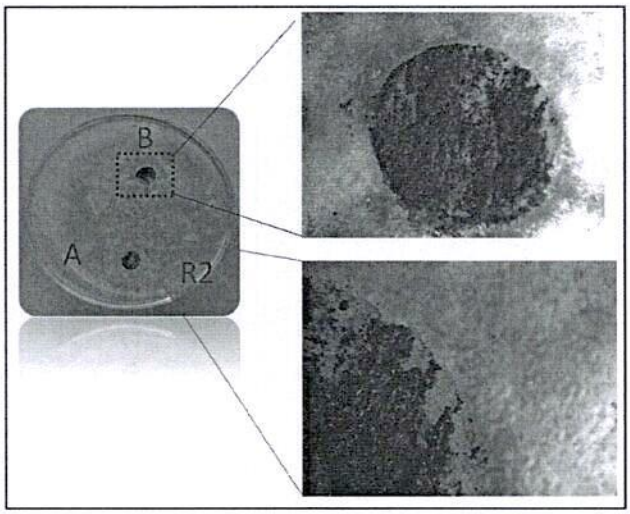

Figure 9. Microscopic images of the antimicrobial activity of copper nanoparticles.

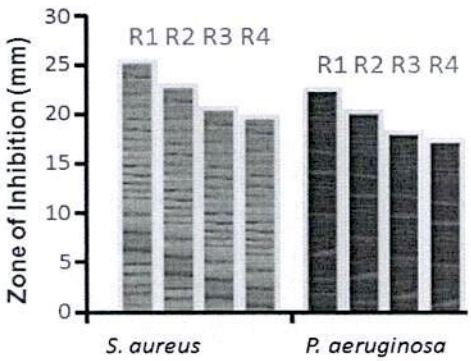

Figure 10. Zone of inhibition of antimicrobial activity CuNPs.

CONCLUSION

Copper nanoparticles were synthesized from different copper metal β-diketones by microwave-assisted method. The crystalline metallic copper nanoparticles were confirmed from XRD results. The morphology of these copper nanoparticles was found to be spherical through SEM micrographs. The SEM analyses revealed that the size of the CuNPs synthesized from different copper metal β-diketones by microwave-assisted method varied in the order: $Cu(acac)_2$<$Cu(eaa)_2$<$Cu(tbob)_2$<$Cu(maa)_2$. Antimicrobial study displayed that the CuNPs synthesized from the $Cu(maa)_2$ showed the highest activity, which can be attributed to the single crystalline and smallest size of the CuNPs. Results obtained from our present work would be helpful in the development of new morphology oriented copper nanoparticles and their potential applications in biological, pharmaceutical and physiological fields in future.

ACKNOWLEDGMENTS

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Synthesis & Characterization of Cu & Co Doped Tio2 Nano Particles via Hydrothermal route	A M Kalamma	Physics	Journal of Interdisciplinary Cycle Research	2020	0022-1945	http://www.jicrjournal.com/gallery/55-jicr-june-2808-2.pdf	https://jicrjournal.com/?s=Synthesis+%26+Characterization+of+Cu+%26+Co+Doped+Tio2+Nano+Particles+	Yes

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Synthesis and Characterization of Cu And Co Doped Tio_2 Nanoparticles via Hydrothermal Route

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ABSTRACT

In the present investigation copper and cobalt co-doped TiO_2 nanoparticles (NPs) have been synthesized via hydrothermal method. The structural, optical, morphological and compositional properties of all the prepared samples have been characterized by X-ray diffraction (XRD), energy dispersive X-ray spectroscopy (EDS), field emission scanning electron microscope (FESEM) and UV-Vis spectrophotometry.XRD analysis have revealed that all prepared nano powders were nanocrystalline and had TiO_2 rutile structure. The FESEM analysis shows the NPs were of spherical shape with an average size of 10 nm to 20 nm. EDS analysis confirms the chemical composition of the NPs having Ti and O elements. UV-Vis measurement shows variation in indirect band gap of 3.07eV, 2.84eV, 3.95eV and 4.01eV for TiO_2 NPs, Cu-TiO_2 NPs, Co-TiO_2 NPs and (Cu-Co)TiO_2 NPs respectively. Zeta potential measurements show a stable dispersion without particle settlement in DMSO solvent.

KEY WORDS

Hydrothermal, Tio2, Cu doped Tio2 NPs, Co doped Tio2 NPs, (Cu-Co) doped Tio2 NPs.

I.INTRODUCTION

Commercial production of titanium dioxide or titania (TiO_2) was started in 1923. It is derived from a variety of ores. The bulk material of TiO_2 mainly exists in three phases: Rutile, Anatase and Brookite. Most of the TiO_2 exists in rutile and anatase phases because both have tetragonal structures. As rutile is a high temperature stable phase and has an optical energy bandgap of 3.0 eV (451nm), whereas anatase is formed at a lower temperature with an optical energy bandgap of 3.2eV(380nm) and refractive index [1]. Among these polymorphs, rutile and anatase are studied widely, whereas brookite is studied rarely due to its complicated structure and difficulty in sample preparation [2]. These three phases can be represented as constituted by arrangements of the same building block Ti-O_6 octahedron in which Ti atom is surrounded by six oxygen atoms situated at the corners of distorted octahedron. Even though the similarities in building blocks of Ti-O_6 octahedral for these polymorphs, the electronic structure are significantly different[3]. Photocatalysis using TiO_2 as a catalyst has been widely reported as a most promising technology for the removal of various organic and inorganic pollutants from contaminated water and air because of its stability, low cost, and non-toxicity [4].

Nanosized transition metal oxides including doped and undoped TiO_2 are the areas of sustained scientific concern due to their potential applications in sensing, catalyses, opto-electronic devices, biomedical field, cosmetics and magnetism [5-7]. CuO has a narrow band gap (1.2eV) and is a p-type semiconductor with photochemical and photoconductive properties and has found applications in gas sensing [8,9], in catalysis [10-13], as antimicrobial agent[14-18], in batteries [19], magnetic devices [20-22], super capacitors [23] and field emission [24]. TiO_2 is an n-type semiconductor with wide band gap ranging from 3.2eV to 3.6eV. It has numerous applications such as medical devices coating, cosmetics and gas sensors [25-27]. The presence of cobalt ions in TiO_2 structure causes a significant absorption shift towards the visible region compared to the pure TiO_2 powder [28,29] A significant advantage of TiO_2 is the formation of a heterojunction on reaction with another material [30,31]. In these applications an important parameter is the specific surface area, which is strongly related to the morphology. The properties of nanoscale materials are significantly different from those of the bulk material of same chemical composition. The physical and chemical properties of doped and undoped TiO_2 depend on their microstructure such as morphology, the size and the orientation

of the constituent grains. To improve and extend the functions of these inorganic nano materials, one or more components are often combined to form nanocomposites for various applications in photocatalysis, electronics and gas sensors [32, 33].

The exclusive properties of composite nano materials originate from their ability to combine the most desirable physiochemical properties of their constituents. Synthesis of high quality nano crystals of desired size is essential for investigating and utilizing their size dependent properties. Several approaches such as chemical precipitation [15], sol-gel method [16, 34, 35], hydrothermal method [11,36], microwave assisted method [37], sonochemical synthesis [38], and solvothermal synthesis [39] have been reported for the synthesis of uniform sized metal oxide nanocomposites with varied morphologies.

Inspite of all the progress made, the synthesis of Cu doped TiO_2, Co doped TiO_2 and Cu-Co doped TiO_2 nanoparticles of controlled size and shape still a challenge. Size and shape needs to be tailored by an appropriate choice of the synthesis methods and conditions. Fine-tuning of the morphology is of key importance, since the electronic structure, the surface energy, bonding and the chemical reactivity of nanomaterials are all directly related to surface morphology [40]. The purity and stoichiometry depends on the synthesis route. In this paper we report on the synthesis ofTiO_2, Cu doped TiO_2, Co doped TiO_2, Cu-Co doped TiO_2 nanoparticles by hydrothermal process via a precursor solution of titanium(IV) n butoxide and copper nitrate hexahydrate, cobalt nitrate hexahydrate as dopants. The influence of amount of dopant on; crystal structure, composition, surface morphology and optical properties of Cu and Co co-doped TiO_2 nanoparticles were characterized by means of XRD,FESEM,EDS and UV-Vis spectrometer respectively.

II. MATERIALS AND METHOD

2.1 Chemicals: Titanium (IV) n butoxide (TNB) wt 99% liquid analytical grade, Copper nitrate hexahydrate [$Cu(NO_3)_2.6H_2O$], [$Co(NO_3)_2.6H_2O$] and EDTA (di-sodium salt dehydrate) were procured from Alfa Aesar Chemicals, India. De-ionized water (DW) was used in the preparation of all solutions.

2.2 Synthesis of Cu-TiO_2, Co-TiO2 and TiO_2 Nanoparticles

Copper doped Titanium dioxide Nano particles were synthesized via hydrothermal route.30ml of 0.1M E. D. T.A($C_{10}H_{14}N_2Na_2O_8.2H_2O$)was prepared by dispersing 0.56gm in 15ml of de-ionised water (DW) with continuous stirring with the aid of magnetic stirrer for 10 minutes by adding 15ml of DW. Then 5ml of 0 .1M Cu $(NO_3)_2.6H_2O$ and 1ml of Titanium(IV) n butoxide were added drop wise with continuous stirring for 30 minutes. The colloidal solution was then transferred to a 50ml Teflon-lined stainless steel auto clave, the autoclave was sealed and placed in an oven heated up to 180^0C for 3hours, then the autoclave was cooled down to room temperature. Under ambient conditions, the reactant mixture was centrifuged to collect the product; the product was washed continuously with DW several times to remove the organic molecules bonded to the surface of the product. The final product was dried in an oven at100^0C for one hour and the same procedure, as adopted in Cu-TiO_2 was used to synthesize Co-TiO_2, CuCo-TiO_2 and TiO_2.

2.3 Characterization techniques

2.3.1UV-vis spectroscopy: UV-Vis absorbance spectra in the wavelength range 200-800nm were measured using UV-Vis spectrophotometer (model: SPECORD 200+ Analytikjena) at SECAB college, Vijayapur.

2.3.2 XRD: The crystal structure of the powder sample at a scanning rate of 0.02^0 per second in the range of 20^0 to $80^0$with the use of Cu K_α radiation of wavelength 1.54060A^0 were analysed by XRD (model: Rigaku pro analytical) at MIT Manipal. Peak analysis was carried out using PCPDFWIN software.

2.3.3 FESEM: The surface morphology and nanonature of the samples at an operating voltage 5kV were examined using FESEM (model: xford -EDX system IE 250 X Max 80) At Mangalore university, Mangalore.

2.3.4 EDS: Elemental compositions were analysed using EDS (model: FEI Quanta 200 F) at Mangalore university, Mangalore.

2.3.5 Zeta potential: The zeta potential was based on the surface charge of the particles relative to the local environment of the prepared particle. This electrostatic potential of shear plane of the particle was carried out in ultrasonicated dispersion of 0.01 g/100 mL in DMSO in room temperature using the Horiba SZ-100 nanoparticles analyzer.

III. RESULTS AND DISCUSSIONS

3.1 Optical properties:

3.1.1 UV-Vis Spectroscopy;

UV-Vis Spectra were recorded for TiO_2 NPs, Cu-TiO_2NPs,Co-TiO_2NPs and (Cu-Co)TiO_2 NPs in an ethanol solvent at room temperature and are shown in Fig 1(a, b, c and d). From the Fig1(a) it is observed that the absorption maxima (λ_{max}) for TiO_2 NPs , Cu-TiO_2NPs ,Co-TiO_2 NPs and(Cu-Co)TiO_2NPs were found to be 341 nm ,250.23 nm,370.8nm and 259.37nm respectively which is a preliminary indication for the presence of TiO_2 material. The band gap of all the samples were estimated using the absorption data with the help of (K–M) transformation method [7].Band gap energy of the semiconductor was estimated using the optical absorption coefficient (α) and is expressed by equation (1)

$$\alpha = \frac{A(h\nu - E_g)^{1/n}}{h\nu} \quad \text{..... (1)}$$

Where,

hν is an energy of photon, E_g is the band gap energy, A is a constant depends on the transition probability and depends on the nature of the transition for allowed direct transition (n= ½), for allowed indirect transition (n=2).In our cases for an indirect gap, the value of n is 2 for TiO_2 NPs, Cu-TiO_2NPs,Co-TiO_2NPs and (Cu-Co)TiO_2 NPs. Using Tauc's plot the estimated E_g values were found to be 3.07eV, 2.84 eV ,3.95ev and 4.01eV respectively.

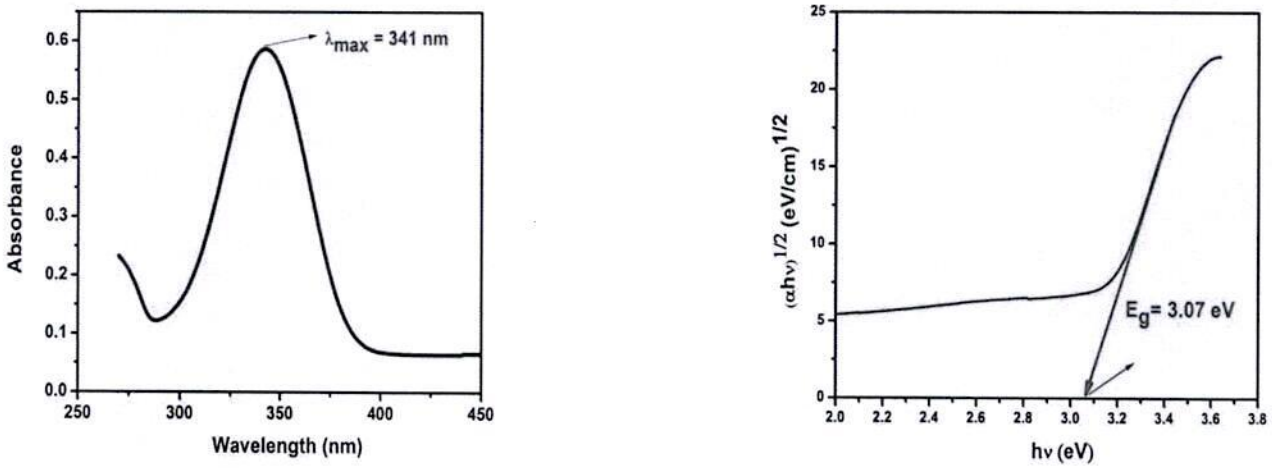


Fig 1 (a): UV and Tauc's plot TiO_2

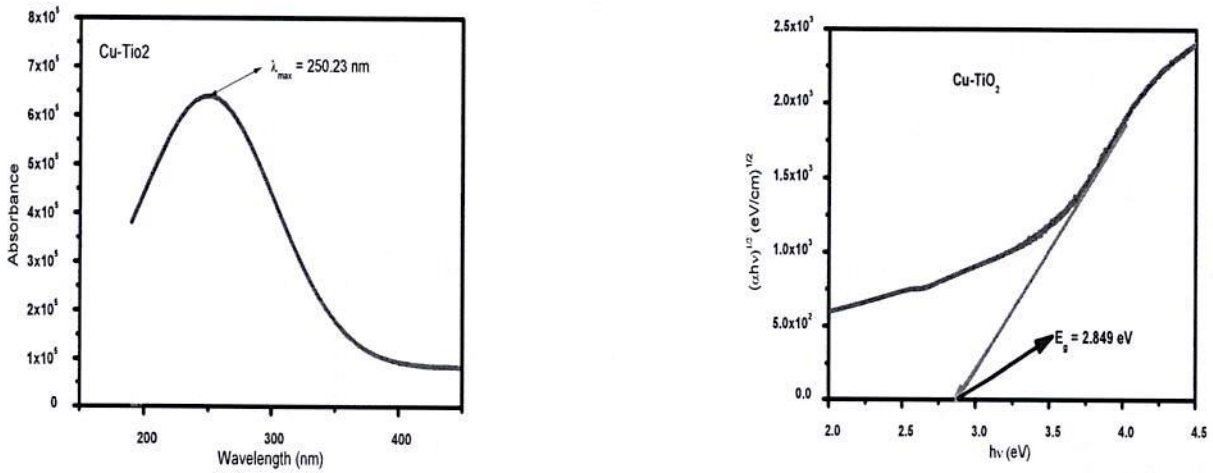
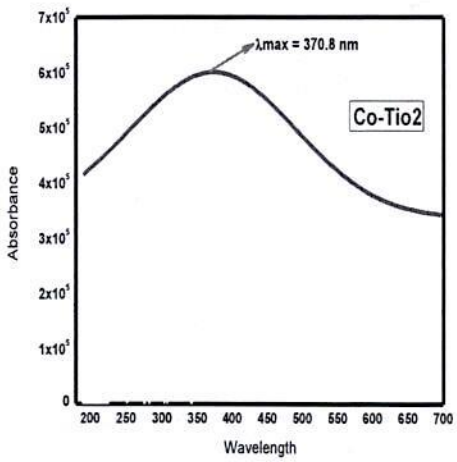


Fig 1(b): UV and Tauc's plot Cu-TiO_2



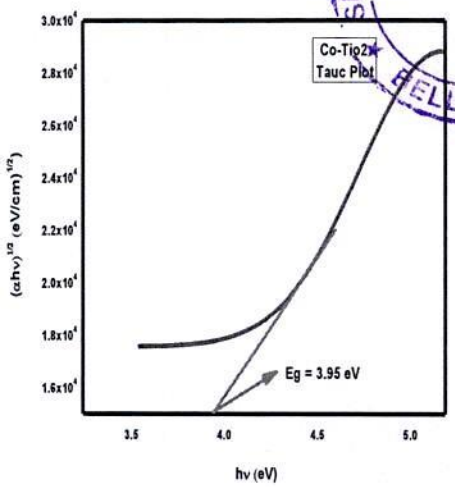
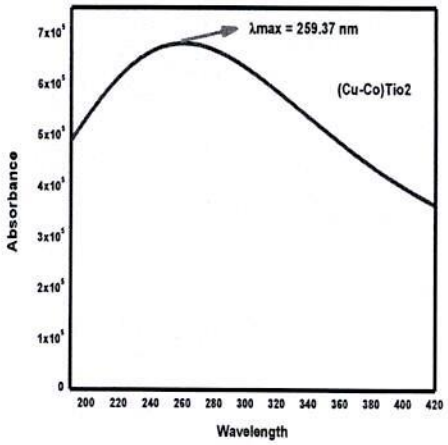


Fig 1(c): UV and Tauc's plot Co-TiO_2



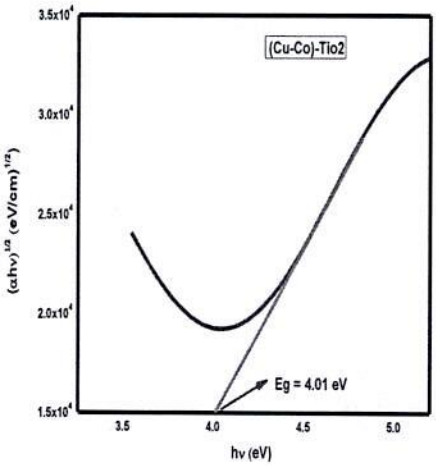


Fig 1(d): UV and Tauc's plot (Cu-Co)-TiO_2

3.2 Structural properties

XRD analysis was carried out to verify the presence of nano crystalline and phase formation. Fig 3 (a, b, c and d) shows XRD patterns for TiO_2, Cu-TiO_2,Co-TiO_2 and (Cu-Co)TiO_2 powders respectively. It is observed that, the presence of strong and sharp peaks may indicate the formation of the well crystallized samples. From the Fig 3 (a) it is observed that the Bragg's reflection at 2Θ=25.3429,37.8769,47.9727,54.0791,62.7467,75.1348 and 82.6813 can be indexed to (101),(004),(200),(211),(204),(215) and (224) crystal planes respectively. The comparison of 2Θvalues in observed Fig 3(a)XRD pattern with those from the standard Joint Committee on Powder Diffraction Standards(JCPDS) data no. 89.4921 confirms the formation of the TiO_2 having rutile phase and tetragonal crystal structure. Fig 3(b) shows the XRD patterns for Cu-TiO_2 powders, it is observed that the Bragg's reflection at 2Θ=25.3803, 37.8187,47.9622,54.1718,62.7795,68.9548,75.0959 and 82.8946can be indexed to (311),(422),(442),(444),(731),(822),(753) and (844) crystal planes respectively. The comparison of 2Θvalues in observed Fig 3(b)XRD pattern with those from the standard JCPDS data no. 81.1611 confirms the formation of the Cu-TiO_2 having Rutile phase and tetragonal crystal structure. Fig3(c) shows the XRD pattern of Co-TiO_2 powders, it is observed that, the Bragg's reflection at2Θ=25.3669,37.7705,48.0267,54.1788,62.749,75.1144 and 82.8806 can be indexed to (220),(311),(002),(060),(402),(650) and (660) crystal planes respectively. The comparison of 2Θ values in observed fig3(c) XRD pattern with those from the standard JCPDS data no. 35.0793 confirms the formation of theCo-TiO_2 having Rutile phase and orthorhombic crystal structure.Fig3(d) shows the XRD pattern of (Cu-Co)TiO_2 powders, it is observed that, the Bragg's

reflection at 2Θ=25.4254,37.8603,48.0919,54.1802,62.7517,68.6983,75.1736 and 82.8828 can be indexed to (006),(012),(009),(018),(113),(011),(024) and(119) crystal planes respectively. The comparison of 2Θ values in observed fig3(d) XRD pattern with those from the standard JCPDS data no. 41.0904 confirms the formation of theCo-TiO_2 having Rutile phase and rhombohedral crystal structure. The Scherer's equation [2] is used to estimate an average crystalline size by determining the full width at half maximum (FWHM) of the most intense reflection plane and this equation is given by

$$D \approx \frac{0.9\lambda}{\beta \cos \theta} \qquad (2)$$

Where D is an average crystalline size, λ is the wavelength of X-ray used (1.50406 x 10^{-10} m), Θ is the Bragg's angle in radian and β is the full width at half maximum of the most intense reflection in radian. In our case, the most intense peak forTiO_2, Cu-TiO_2,Co-TiO_2 and (Cu-Co)TiO_2were found to be (101) ,(311),(006) and (220) plane and the estimated average crystalline size is 7.07nm , 8.66nm,5.73nm and 5.78nm respectively.

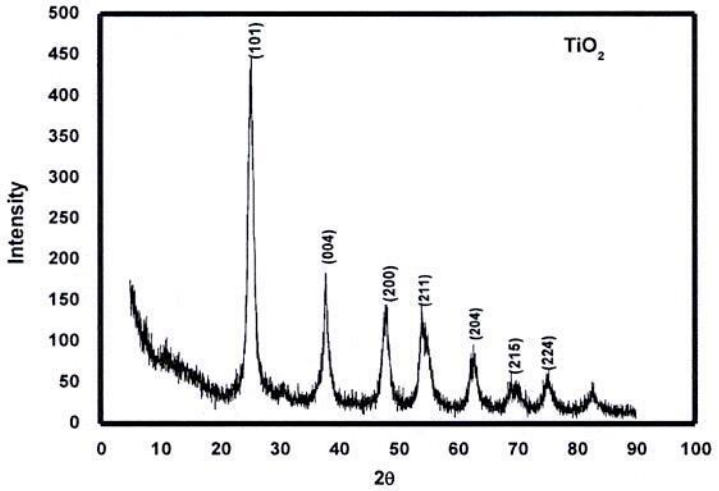


Fig.3(a)XRD pattern for TiO_2

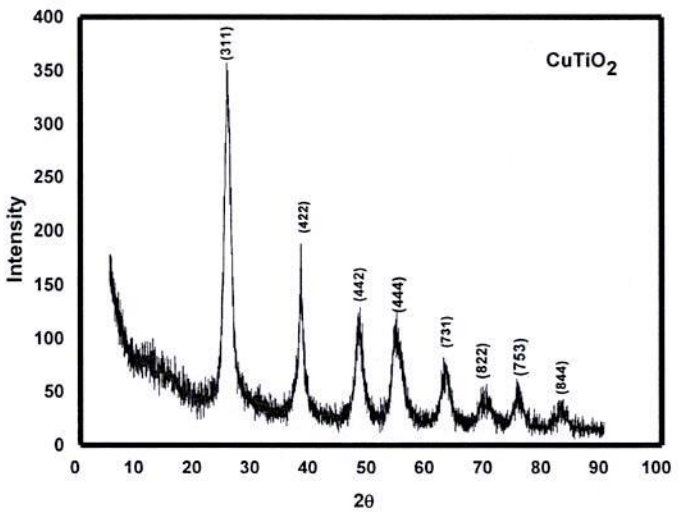


Fig.3(b) XRD pattern for CU-TiO_2

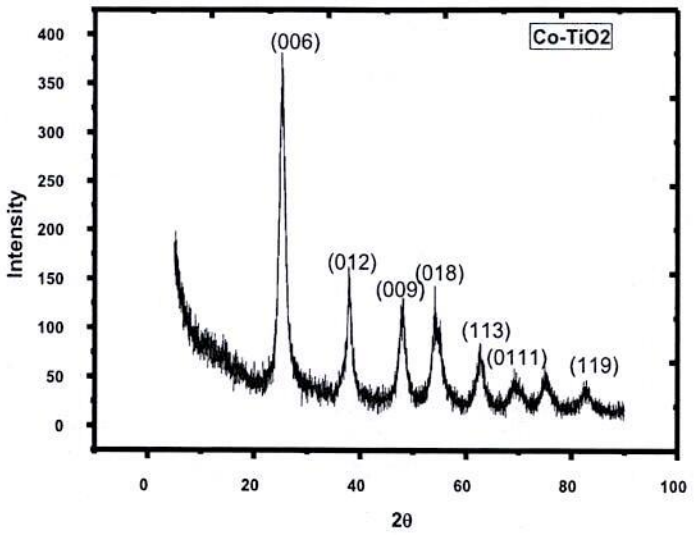


Fig 3 (c) XRD pattern for Co-TiO_2

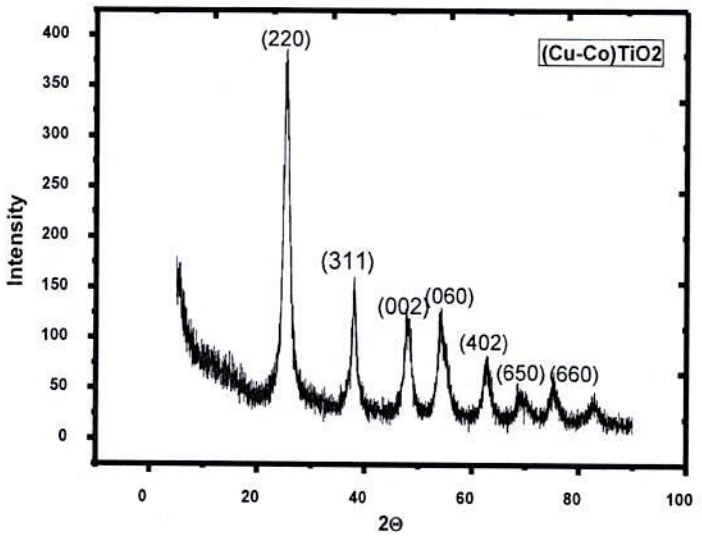


Fig.3 (d) XRD pattern for (Cu-Co)TiO_2

3.2 Morphology, Size Distribution and Elemental Analysis

FE-SEM analysis was used to examine the surface morphology and nano nature of the samples. Fig 4(a, b, c and d) shows the particles are having the spherical cluster with average size of about 10 nm to 20 nm. EDS was examined to investigate the chemical composition in copper and cobalt doped TiO_2 NPs. Fig 4(e, f, g and h) represents the EDS spectrum for TiO_2, Cu-TiO_2, Co-TiO_2 and (Cu-Co)TiO_2 NPs, hence EDS spectrum confirms the presence of elements i.e. Ti and O, in addition small quantities of element C was observed since it is residue of oil contaminants. The weight percentage (%) and atomic weight percentage (%) of NPs are shown inset of Fig 4 (e, f, g and h).

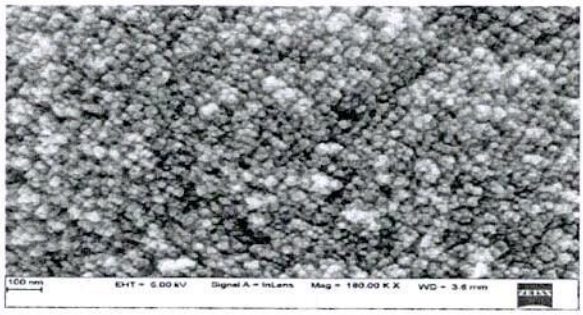


Fig 4(a) FE- SEM image of TiO_2

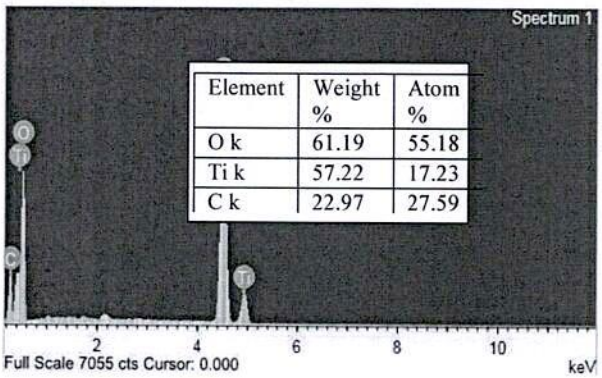


Fig 4(e) EDS spectrum of TiO_2 NPs inset corresponding weight % and atomic % of element

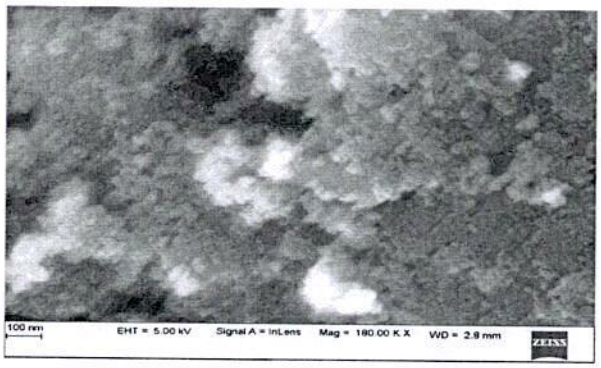


Fig 4(b) FE- SEM image of Cu-TiO_2

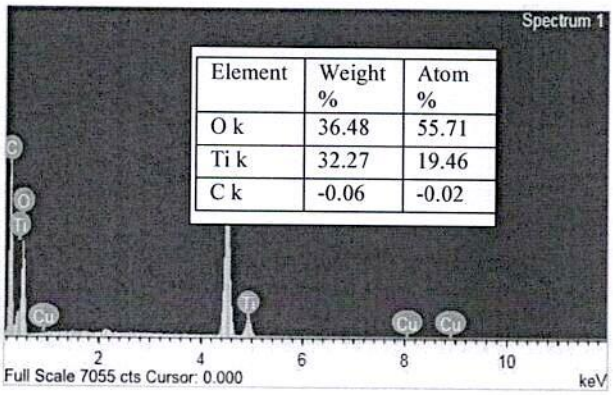


Fig 4(f) EDS spectrum of Cu-TiO_2 NPs inset corresponding weight % and atomic % of elements

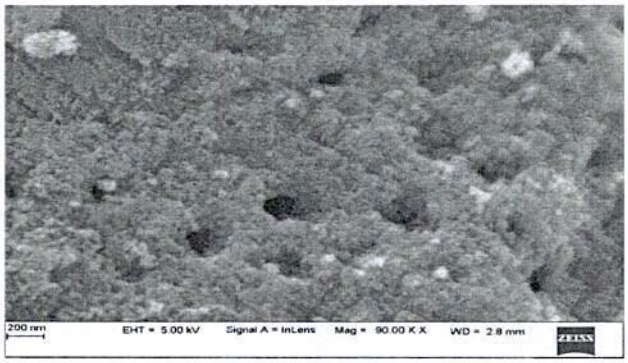
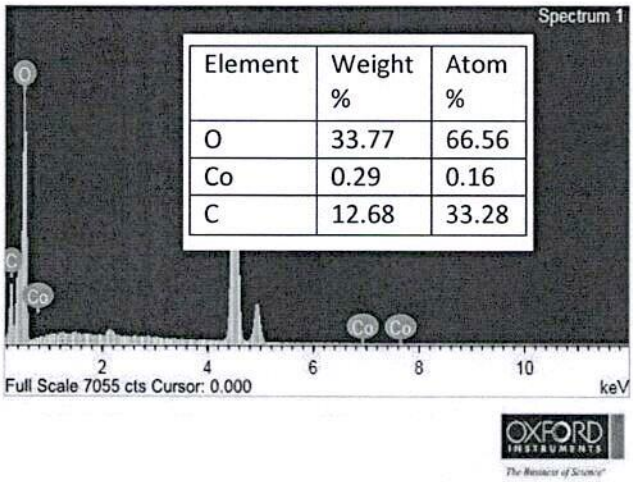


Fig 4(c) FE- SEM image of Co-TiO_2



Element	Weight %	Atom %
O	33.77	66.56
Co	0.29	0.16
C	12.68	33.28

Fig 4(g) EDS spectrum of Co-TiO_2NPs inset corresponding weight % and atomic % of elements.

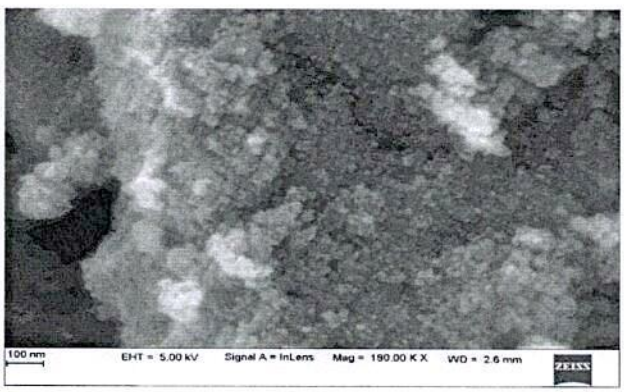


Fig 4(d) FE- SEM image of (Cu-Co)TiO_2

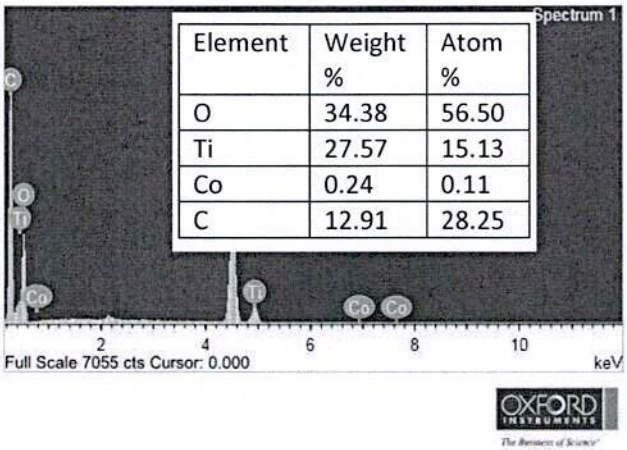


Fig 4(h) EDS spectrum of (Cu-Co) TiO_2 NPs inset corresponding weight % and atomic % of elements

Zeta Potential Study

Zeta potential and electrophoretic mobility of pure, copper and cobalt doped TiO_2suspension in DMSO are given in table (1).The studies reveals that, doping with copper gives positive value of zeta potential of 30.0mV and cobalt doping gives the positive value of zeta potential of 47.6mV, but doping with both copper and cobalt shows reduced values of zeta potential and electrophoretic mobility. The zeta potential graphs shown in the Fig.6 (a, b, c and d), which clearly indicates a stable dispersion without particle settlement. Furthermore, the study of prepared suspension corroborates with general criteria of zeta potential (ξ) value 30 mV with positive or negative sign for better stability.

Sample	Zeta potential	Electrophoretic mobility
TiO_2	27.2mV	0.000055 cm^2/Vs
Cu- TiO_2	30.0mV	0.000061 cm^2/Vs
Co-TiO_2,	47.6mV	0.000097 cm^2/Vs
Co-Cu TiO_2	22.9mV	0.000047 cm^2/Vs

Table.1 Zeta potential and electrophoretic mobility of pure, copper and cobalt doped TiO_2

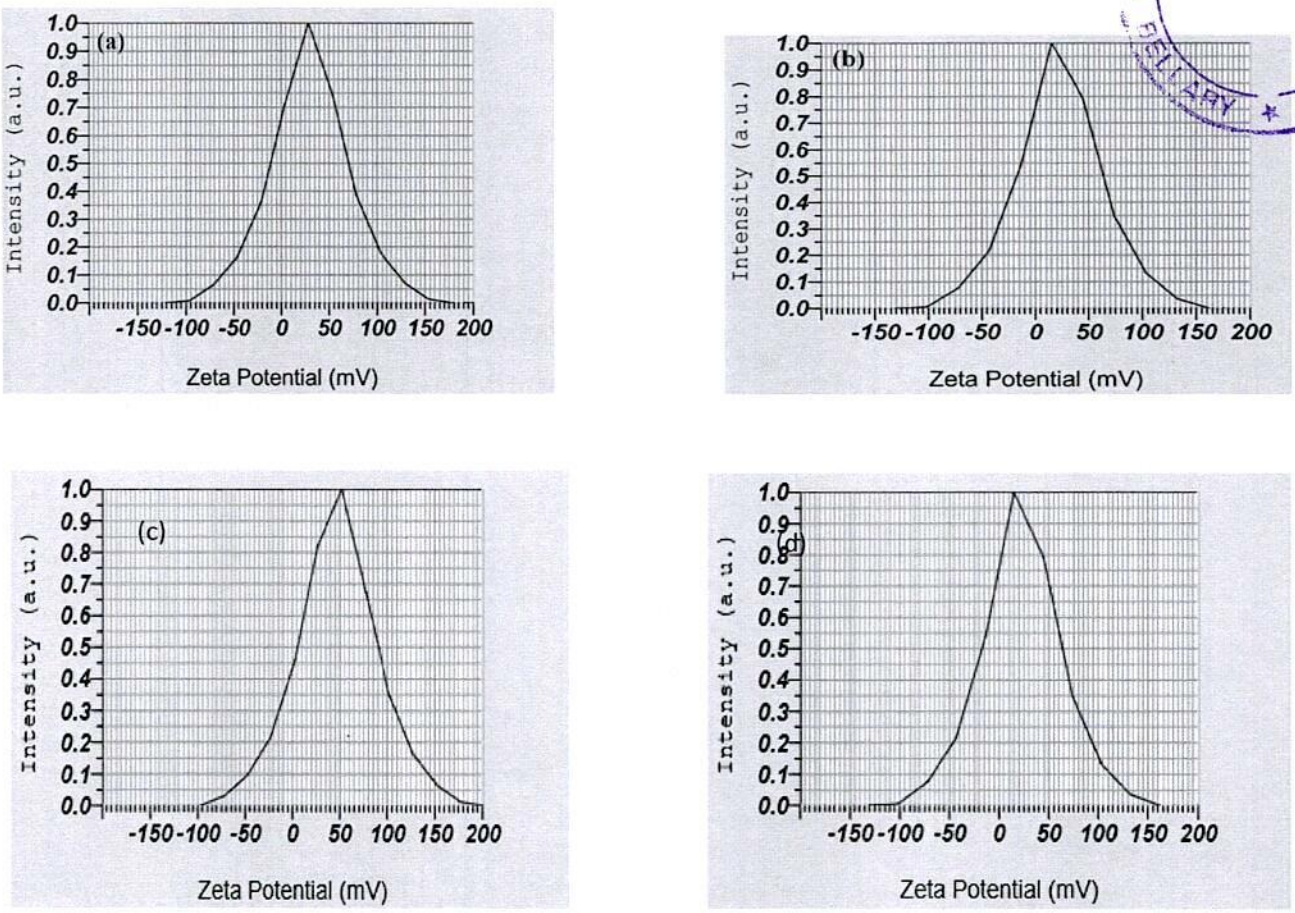


Fig. 6 : Zeta potential evaluation of (a) TiO_2 NPs and (b) Cu-TiO_2 NPs (c) Co –TiO_2 NPs and (d) (Cu-Co)TiO_2 NPs in DMSO solvent.

IV .CONCLUSION

In summary, we have synthesized copper and cobalt co-doped TiO_2 NPs via hydrothermal route. These NPS were characterized using XRD, EDS, FESEM and UV-Vis spectrophotometer. The XRD data obtained for all synthesized NPs holds in good agreement with the standard JCPDS data and they are having rutile phase with tetragonal structure for TiO_2NPs and Cu-TiO_2 NPs, orthorhombic for CO-TiO_2 NPs and rhombohedral structure for (Cu-Co) TiO_2NPs. EDS analysis confirms the presence of Ti and O compositions. FESEM images confirms the average particle size of about 10nm to20nm.UV-vis spectroscopy confirms the presence of TiO_2 material and from the Tauc's plot it is inferred that, the indirect band gap of TiO_2 NPs, Cu-TiO_2NPs,Co-TiO_2NPs and (Cu-Co)TiO_2 NPs were 3.07eV, 2.84 eV ,3.95eV and 4.01eV respectively, the results of Tauc's plot shows increase of band gap due to cobalt doping, Zeta potential measurements reveals that ,Cu-TiO_2 and Co-TiO_2 shows stable dispersion without particle settlement since zeta potential values are positive 30mV and 47.6mV respectively. Furthermore, we may be concluded that these synthesized TiO_2 NPs can be used for photocatalytic degradation of dyes.

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Limonia acidissima L. leaf mediated synthesis of silver and zinc oxide nanoparticles and their antibacterial activities

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ABSTRACT

Green chemistry is a novel method for the synthesis of silver and zinc oxide nanoparticles. The present investigation focused on synthesis of biogenic silver and zinc oxide nanoparticles. They were assayed for their antibacterial activities against test bacterial species. The results revealed that the silver nanoparticles showed the maximum zone of inhibition 15.16, 15.5 and 13.33 mm at 400 μg/mL to *S. aureus*, *S. typhi* and *P. aeruginosa* respectively, when compared to the *Erythromycin*. While zinc oxide nanoparticles showed less activity in comparison to silver nanoparticles owing to the agglomeration of nanoparticles. It is evident from our investigation that silver nanoparticles could be used as an antimicrobial due to their intrinsic properties in biomedical application and food packing industries.

1. Introduction

Nanotechnology is an emerging area of research for manipulation of dimension of materials less than 1 nm with varying sizes and shapes. Different methods are in vogue for synthesis of nanoparticles. Chemical and physical synthesis of nanoparticles involve hazardous chemicals and high energy consumption which affects the environmental quality [1,2]. Biological methods are nontoxic, environmental friendly and involve the use of micro-organisms [3], algae [4], plant extracts [5–7], agro-wastes [8–20], enzymes [21–26], arthropods [27] and pigments for the synthesis of nanoparticles [28–33]. Silver, zinc oxide, gold and copper nanoparticles were used for antimicrobial activity [3]. The antimicrobial activity of silver known since time immemorial [34,35]. Silver has been used as a disinfectant to prevent the human infection in the medical field because of its natural antimicrobial activity towards many pathogens such as bacteria, viruses and fungi [36]. It is notable that silver ions and silver based chemicals are profoundly lethal to microorganisms [14,32,37] and is not lethal to human beings [13]. Nanoparticles are used in industrial sectors viz., food safety, medicine and other fields.

Zinc oxide nanoparticles were used in the biological applications as biosensors in medical diagnostics [38] and to combat mycobaterial growth [6]. Nanoparticles enhance the immobilization and activity of catalysts in the pharmaceutical industry [39,40], gas sensors [41], antifungal activity [42,43] electronic nanodevices, and UV filters [44] due to the novel properties exhibited by the material. Biological method allows reduction, capping, and manipulation of size and shape. The biofabrication of zinc nanoparticles synthesized by *Justicia adhathoda* [45] and *Aloe barbadenis*, *Limonia acidissima* and *Cochlospermum religiosum* leaf extract were used to synthesize of zinc oxide nanoparticles [6,46,47]. The *Pongamia pinnata* coated zinc oxide nanoparticles are used for antimicrobial and anticancer activity [48]. Bacterial composite zinc oxide nanoparticles were used for the wound healing properties [49]. Zinc oxide is a non-toxic, inexpensive, and non-hygroscopic polar inorganic crystalline material. The emerging multidrug resistance gram negative bacteria of *P. aeruginosa* causing respiration tract and vaginal infection may be controlled by nanoparticles.

In India, rural folk used the decoction of *L. acidissima* leaves for the treatment of blocking, heaving, cardiotonic and diuretic [50]. The leaves are known to have hepatoprotective activity [51]. Leaves, bark and product of this plant have been utilized as a customary medication for their antimicrobial activity [52,53], astringent, mitigation [54] and insulin secretagogue exercises [55]. Essential oil extracted from the leaves has shown antimicrobial activity [56]. The present investigation was undertaken to assay the comparative antimicrobial activities of various concentrations of silver and zinc oxide nanoparticles.

2. Materials and method

2.1. AgNPs and ZnONPs

The silver and zinc oxide nanoparticles synthesized by leaf extract of *L. acidissima* showed a characteristic surface plasmon resonance (SPR) at 452 nm and 374 nm respectively. The biogenic silver and zinc oxide

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nanoparticles were spherical in shape with size ranging from 21 to 42 nm and 12–53 nm respectively [5,6]. The stock solution of AgNPs and ZnONPs was prepared by dispersing 1 mg of silver and zinc oxide nanopowder in 1 mL 2% DMSO (Dimethyl sulphoxide) respectively. The resulting suspension was sonicated (Ultrasonic bath Fisherbrand unheated, 230 V, 50 Hz) for 30 min, followed by 10 min vertex. Stock solutions were kept at 4 °C in the dark to prevent the photo oxidation. The various exposure concentrations were prepared from this stock solution.

2.2. Antibacterial activity

The antibacterial activity of biosynthesized silver and zinc oxide nanoparticles was tested against Gram positive (*Staphylococcus aureus* MTCC 3160, *Bacillus cereus* MTCC 8733, *Enterococcus faecalis* ATCC 35550), Gram negative (*Escherichia coli* MTCC 433, *Salmonella typhi* MTCC 3216 and *Pseudomonas aeruginosa* ATCC 25619) bacteria were procured from the Council of Scientific and Industrial Research-Institute of Microbial Technology (CSIR-IMTECH), Chandigarh, India. About 100 µL of test bacteria (inoculums obtained as 18-h culture, i.e. 10^6 CFU/mL growth in Mueller-Hinton broth) were used to seed uniformly onto the surface of the freshly prepared plates of Mueller–Hinton Agar (Hi-media Mumbai) using a sterile glass spreader. The Hi-media sterile disc 6 mm diameter was impregnated with silver and zinc oxide nanoparticles in different concentrations (100, 200 and 400 µg/mL). Antibiotic *Erythromycin* (15mcg/disc) for bacteria was used as a standard control (empty sterile disc), 1 mM $AgNO_3$, $ZnNO_3$ and 2% DMSO were used as control. These discs were gently pressed in Muller Hinton agar plates and were inverted and incubated for 24 h, for measurement of zones of inhibition (in millimeters including disc) using the Hi-media antimicrobial zone scale. Each screening, treatment was conducted in triplicates and mean and standard errors were calculated using IBM SPSS Statistics 20 software. The Tukey's post hock test was used to assess the statistical significance (P value ≤ .05).

3. Results and discussion

The silver nanoparticles exhibited effective zone of inhibition against *B. cereus* (16.10 ± 0.20) followed by *S. typhi* (15.50 ± 0.28), *S. aureus* (15.16 ± 1.66), *P. aeruginosa* (13.33 ± 1.66), *E. coli* (9.83 ± 0.16) and *E. faecalis* (9.33 ± 0.33) at 400 µg/mL (Fig. 2, Table 1). In silver nanoparticles the F value 3259.984, 5.33, 13.625 of *B. cereus*, *S. aureus* and *P. aeruginosa* respectively, with (2, 6) degree of freedom shows a significant P value which show factors level means are statistically significant. Where as in case of *E. faecalis*, *E.coli* and *S. typhi* F value is 0.583, 2.400 and 4.876 respectively with (2, 6) degree of freedom shows the P value is greater than the critical value which reveals the factors level means are statistically insignificant (Table 1).

The *B. cereus* (13.50 ± 0.28) showed the highest zone of inhibition when treated with the zinc oxide nanoparticles followed by *S. typhi* (8.33 ± 0.28), *E. faecalis* (7.66 ± 1.66), *P. aeruginosa* (7.50 ± 0.50), *S. aureus* (7.33 ± 0.57) and *E.coli* (7.00 ± 0.00) at 400 µg/mL (Fig. 2, Table 2). In zinc oxide nanoparticles, the F value of *B. cereus*, *S. aureus*, *E.coli*, *S. typhi* and *P. aeruginosa* is 178.00, 248.714, 31.00, 86.00 and 354.00 respectively, with (2, 6) degree of freedom shows a significant P value which shows factors level means are statistically significant. Further, in case of *E. faecalis* of 4.750 with (2, 6) degree of freedom; here P value is greater than the critical value which reveals that the factor level means are statistically insignificant. The silver nanoparticles show the greater zone of inhibition in *S. aureus*, *S. typhi* and *P. aeruginosa* when to compared to the standard *Erythromycin* (Figs. 1 and 2; Tables 1 and 3).

The synthesis of silver and zinc oxide nanoparticles by addition of a leaf extract to silver nitrate and zinc nitrate solution indicated by a change in color of the reaction mixture to deep brown color. Zinc oxide nanoparticles show the yellowish color due to the surface plasmon resonance The same results have been reported by several investigators [13,14,57]. Formation of nanoparticles further confirmed by their characteristic absorption spectra of silver and zinc oxide nanoparticles at 452 and 374 nm. The observed maximum absorbance peak fall within the range previously reported [58,59]. The microscopic analysis using HR-TEM results showed that the silver and zinc oxide nanoparticles were spherical in shape with size ranging from 21 to 42 nm and 12–53 nm respectively.

The leaf mediated synthesis of silver nanoparticles shows prominent absorption peaks at 1612 cm^{-1} attributed to stretch mode of the amide linkage [14]. The intense peak at 1268 cm^{-1} indicates stretching vibration of C-O group [60]. The absorption spectrum at 2849 and 2918 cm^{-1} were corresponding to antisymmetric and symmetric vibrations of hydrocarbons [5]. The zinc oxide nanoparticles show intense absorption band at 3412 cm^{-1} indicates due to the presence of the phenol molecules, and the spectra 1610 cm^{-1} show carboxylic group. The spectrum at 1056 cm^{-1} was attributed to the Si–O–Si proteins. The presence of alcohol, phenol, carboxylic acids and alkaloids are responsible for reducing and reduction, capping and stabilization of silver and zinc oxide nanoparticles [6,61,62].

Silver and zinc oxide nanoparticles exhibit inhibitory activity against test species of bacteria. The current study reveals for the first time the comparative assay of antimicrobial activity of bioinspired silver and zinc oxide nanoparticles synthesized by *L. acidissima* leaf extract. The biogenic silver and zinc oxide nanoparticles exhibited effective antibacterial activity against human pathogens. The different concentration of silver nanoparticles 100–400 µg/mL effectively inhibited the growth of species viz., *S. aureus*, *E. faecalis*, *E. coli*, *S. typhi P. aeruginosa*. Several other investigations reported the similar antimicrobial activities of biogenic silver nanoparticles [7,13,14,22,23,43,63–66]. The size and concentration of nanoparticles are two important factors which combat the growth of microbes. The concentration of nanoparticles was restricted at 400 µg/mL, otherwise the higher doses might be harmful to the host of pathogens [67]. Similar results were observed in the synthesis of nanoparticles by *Theobroma cacao* mediated synthesis of silver nanoparticles [13,14]. The

Table 1
Antimicrobial activity of silver nanoparticles by *L. acidissima* leaf extract.

Strains	Concentrations (µg/mL)			F and P^* values
	100 µg/mL	200 µg/mL	400 µg/mL	
B. cereus	–	14.16 ± 0.16	16.10 ± 0.20	$F_{2,6} = 3259.984$ $P = .000$
S. aureus	15.83 ± 1.66	15.16 ± 1.66	15.16 ± 1.66	$F_{2,6} = 5.33$ $P = .047$
E. faecalis	08.83 ± 0.16	9.166 ± 0.76	09.33 ± 0.33	$F_{2,6} = 0.583$ $P = .587$
E. coli	10.16 ± 1.66	10.50 ± 0.28	09.83 ± 0.16	$F_{2,6} = 2.400$ $P = .710$
S. typhi	15.16 ± 1.66	14.33 ± 0.33	15.50 ± 0.28	$F_{2,6} = 4.876$ $P = .055$
P. aeruginosa	11.33 ± 0.33	12.50 ± 0.28	13.33 ± 1.66	$F_{2,6} = 13.625$ $P = .006$

*The mean difference is significant at $p < .05$ level.

Table 2
Antimicrobial activity of zinc oxide nanoparticles by *L. acidissima* leaf extract.

Strains	Concentrations (μg/mL)			F and P values
	100 μg/mL	200 μg/mL	400 μg/mL	
B. cereus	7.83 ± 0.16	9.83 ± 0.16	13.50 ± 0.28	$F_{2,6} = 178.00$ $P = .000$
S. aureus	–	6.50 ± 0.50	7.33 ± 0.57	$F_{2,6} = 248.714$ $P = .000$
E. faecalis	6.50 ± 0.28	7.00 ± 0.00	7.33 ± 0.28	$F_{2,6} = 4.750$ $P = .58$
E. coli	6.00 ± 0.00	6.16 ± 0.28	7.00 ± 0.00	$F_{2,6} = 31.000$ $P = .001$
S. typhi	6.00 ± 0.00	6.33 ± 0.28	8.33 ± 0.28	$F_{2,6} = 86.000$ $P = .000$
P. aeruginosa	–	6.23 ± 0.14	7.33 ± 0.57	$F_{2,6} = 354.00$ $P = .000$

*The mean difference is significant at $p < .05$ level.

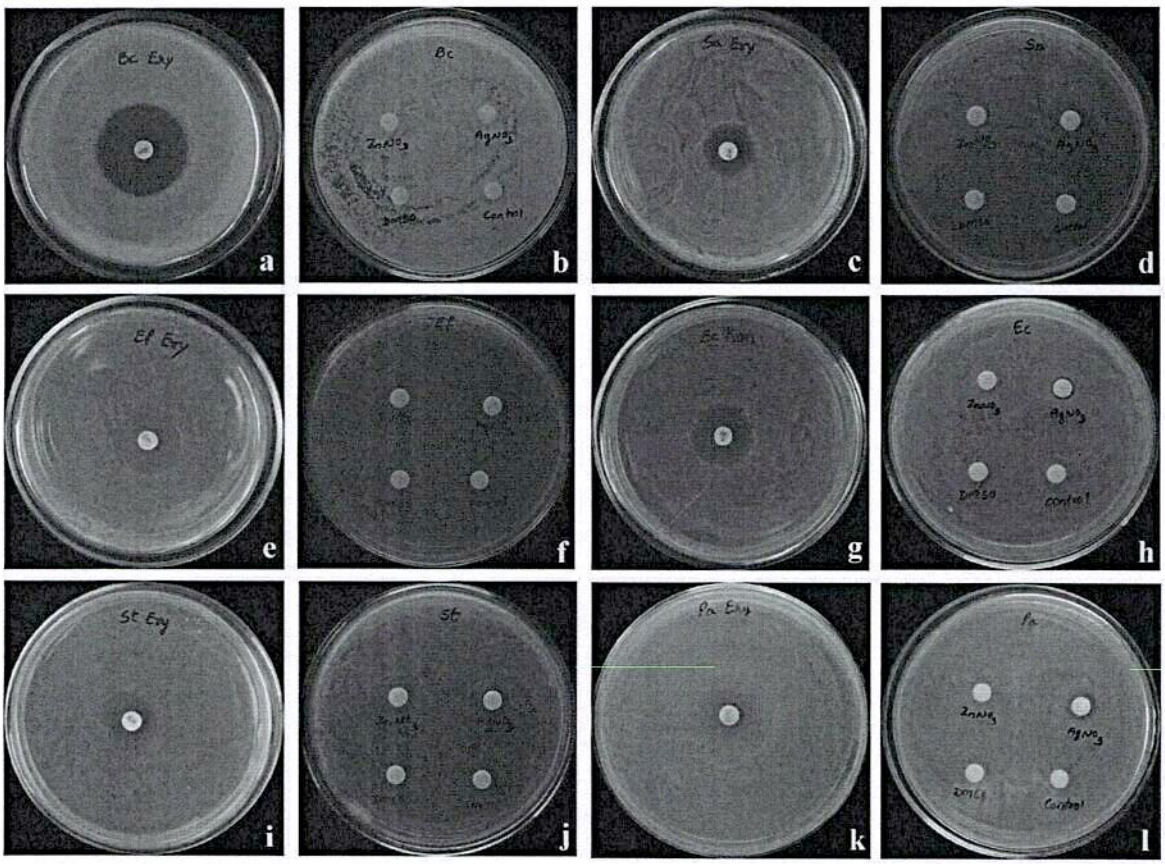

Fig. 1. Antimicrobial activity of *Erythromycin* (a, c, e, g, i, k) and Control, $AgNO_3$, $ZnNO_3$, 2% DMSO (b, d, f, h, j, l) *B. cereus* (a, b), *S. aureus* (c, d), *E. faecalis* (e, f), *E. coli* (g, h), *S. typhi* (i, j) and *P. aeruginosa* (k, l).

silver and zinc oxide nanoparticles were tested for their activity against different microbes, silver nanoparticles showed remarkable zone of inhibition against *B. cereus*, but in case of *S. aureus* 200 and 400 μg/mL of concentration showed the same zone of inhibition and found to be dose response relationship is not significant. Similar result was observed with the silver nanoparticles synthesized by *Cola nitida* pod extract; they found that in *P. aeruginosa* 150 μg/mL shows the less zone of inhibition when compared to the 120 μg/mL [13].

The nanoparticles attach to the surface [68,69] and damages the structure of the cell membrane and reduce the activity of some membranous enzymes [70,71]. The physical vandalism such as disruption of phospholipid bilayer and protein on cell membrane by silver and zinc oxide nanoparticles causing a leakage of intracellular content of cell membrane to kill bacteria by pricking into the bacterial cell membrane. The nanoparticles induce an increase in permeability of bacterial cell membrane by antimicrobial peptides, which facilitate the better penetration of nanoparticles. The probable toxicity mechanism of silver and zinc oxide nanoparticles against the bacteria is shown in Fig. 3. Moreover, nanoparticles are also known to induce oxidative stress in bacteria. These properties will eventually lead to the killing of bacteria [38–40]. The entry of silver and zinc oxide nanoparticles into the bacteria seemed to utilize multiple pathways including clathrin intervened endocytosis [41], caveolae meditated endocytosis and to a lesser degree macropinocytosis [42], also play a vital role for internalization of the resulting receptor ligand complexes leading to receptor mediated endocytosis [44].

Alternatively, nanoparticles may interact with the membrane via hydrophobic and electrostatic interaction and taken into the cell through pinocytosis. The small sized nanoparticles (silver nanoparticles 21–42 nm and zinc oxide nanoparticles 12–53 nm) induce more cell

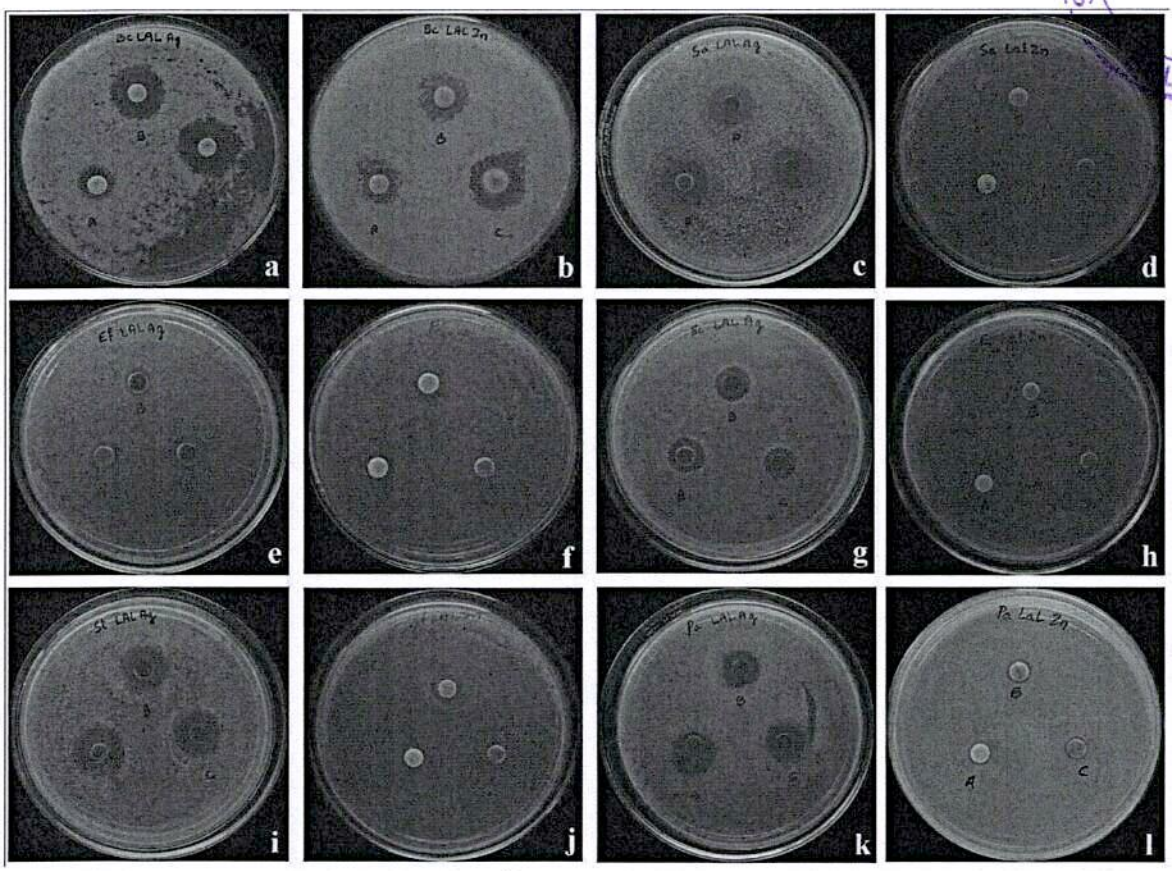

Fig. 2. Antimicrobial activity of silver nanoparticles (a, c, e, g, i, k) and zinc oxide nanoparticles (b, d, f, h, j, l) *B. cereus* (a, b), *S. aureus* (c, d), *E. faecalis* (e, f) *E. coli* (g, h), *S. typhi* (i, j) and *P. aeruginosa* (k, l).

Table 3
Antimicrobial activity of *Erythromycin*.

Strains	*Erythromycin* (Mean ± SE)
B. cereus	27.50 ± 0.28
S. aureus	14.83 ± 0.16
E. faecalis	19.66 ± 0.16
E. coli	16.50 ± 0.00
S. typhi	14.83 ± 0.16
P. aeruginosa	09.50 ± 0.28
F and *P** values	$F_{5,12}$ = 879.044 *P* = .000

*The mean difference is significant at p < .05 level.

permeability by creating intracellular loss and thereby leading to cell death [2]. In this study, the size of zinc oxide nanoparticles is lesser than silver nanoparticles but antibacterial activity shows the less effectuality when compared to the silver nanoparticles owing to agglomeration which shows the lesser zone of inhibition which confirms the findings of shekar and others [45].

The nanoparticles bind to DNA or with bacterial ribosome and affect polypeptide synthesis leading to inhibition of bacterial growth. Further nanoparticles initiate lipid peroxidation reaction, subsequently causing DNA damage, glutathione depletion, disruption of membrane morphology and electron transport chain, leading to cell death [46]. The DNA strand breaks induced by silver and zinc oxide nanoparticles. They may respond with sulfur or phosphorus containing delicate bases [4], for example R–S–R, PR_3 and R–SH RS– and it advances the loss of capacity of DNA replication [72] and finally to combat the bacterial development.

4. Conclusion

The present investigation focuses on synthesis of silver and zinc oxide nanoparticles through simple biological method using *L. acidissima* leaf extract which provided reducing and stabilizing agents for the biosynthesis of nanoparticles. The comparative assay of different concentrations of silver and zinc oxide nanoparticles on antibacterial activity silver revealed that the silver nanoparticles showed more effective zone of inhibition when compared to the zinc oxide nanoparticles, due to their ability of penetration into the cell leading to death of bacterium.

Conflicts of interest

The authors have no conflicts of interest.

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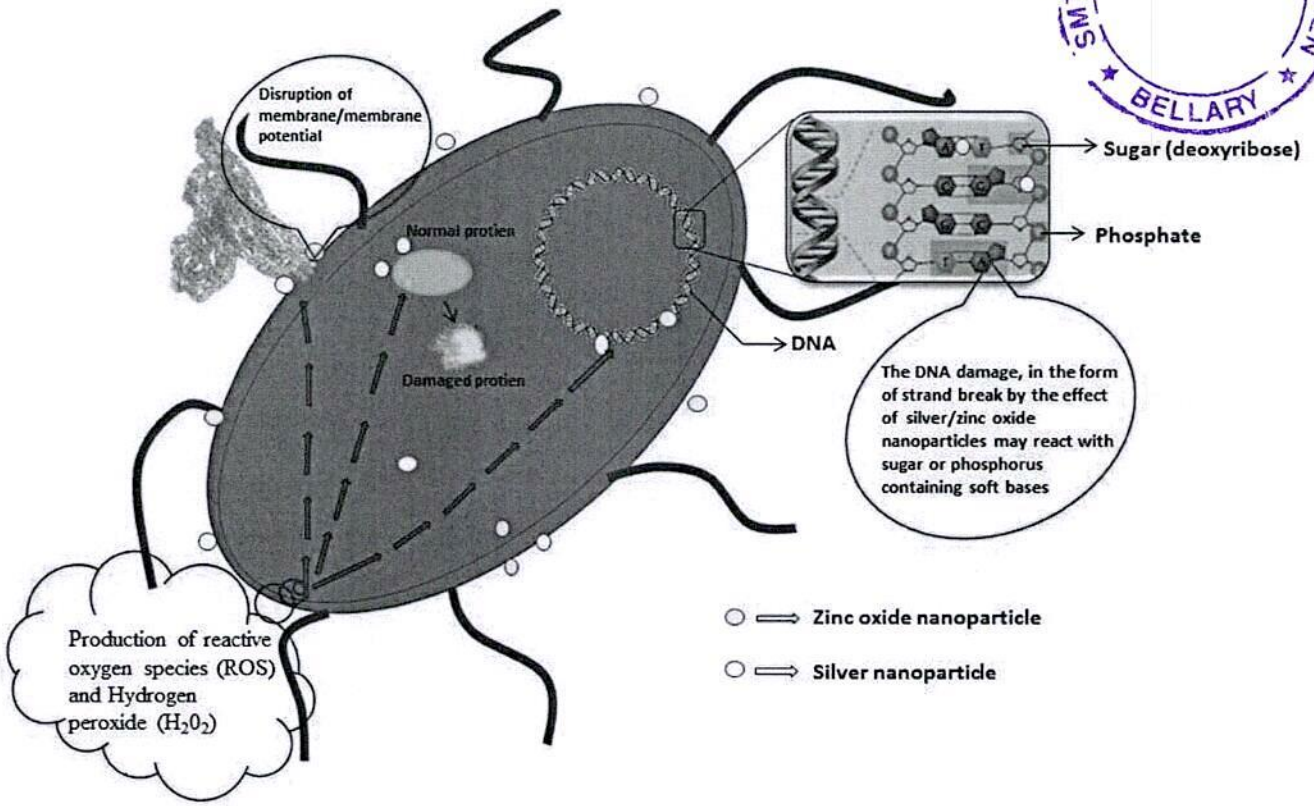

Fig. 3. Schematic diagram showing the possible toxicity mechanism of silver and zinc oxide nanoparticles against the bacteria.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.micpath.2017.12.035.

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