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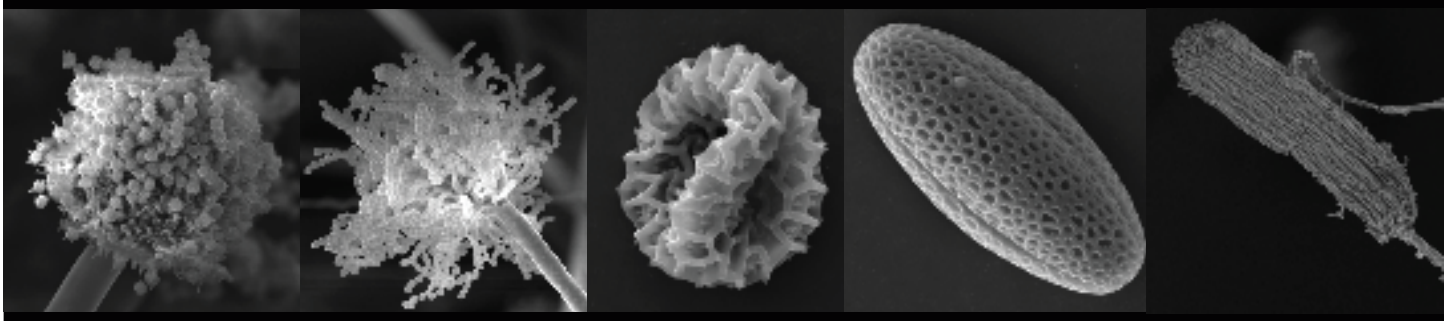

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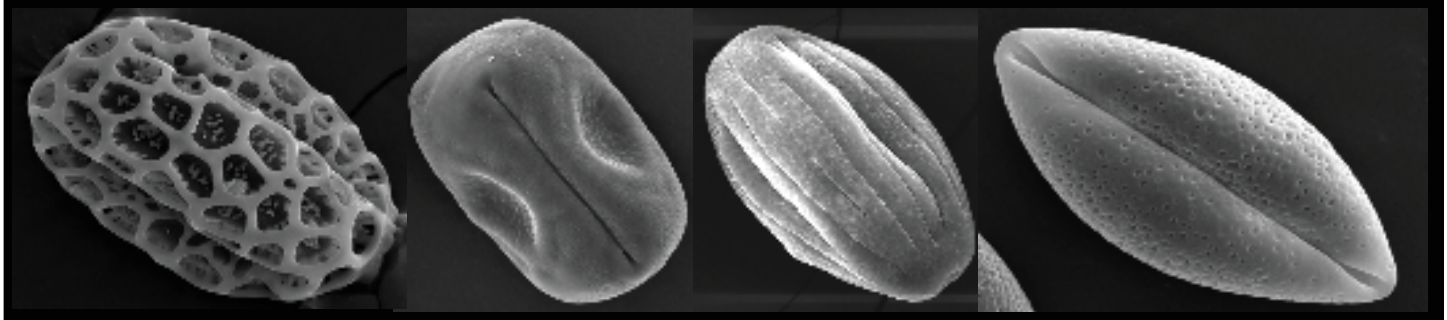

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Contents

DOCUMENTATION OF FLORA REPORTED WITH TOXIC EFFECTS IN THE NAVI MUMBAI REGION OF MAHARASHTRA

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An extensive botanical field survey was conducted in the Navi Mumbai region of Maharashtra during the years 2020-2021. A list of the plants reported to have poisonous effect, growing in Navi Mumbai has been prepared for the first time. The present investigation will contribute to the identification of toxic plants in the study area. This sort of study will be useful to generate awareness, especially for protection of the kids and the cattle from these harmful and toxic plants. A total of 16 toxic or poisonous plant species belonging to 12 families were recorded. Several plants of poisonous nature were identified that cause a variety of diseases in humans and animals. Poisonous substances can be found in a variety of plant parts including the bark, stem, leaves, fruits, latex, and tubers. Pollen grains of many such plants are reported to be airborne as well as allergenic.

Key Words: Toxic plants, poisonous effect, Navi Mumbai, Maharashtra

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INTRODUCTION

Plants have been used by the indigenous people for food, clothing, and shelter from the prehistoric period of ancient civilization. Plant kingdom is also one of the principal sources of various types of traditional medicine. Ancient people extracted numerous chemical compounds in primitive ways and used them to treat a variety of ailments. Herbal medications derived from various sections of plants are frequently used in modern medicine to treat a variety of diseases. The pharmaceutical industry is dependent on various chemical ingredients derived from plants. Some of these plants have also been observed to be harmful to man and his domestic animals in specific circumstances. Poisonous plants are defined as plants that, when consumed or brought into contact with a living thing in any way, produce harmful effects or even death, either immediately or through the cumulative action of the toxic property due to the presence of known or unknown chemical substances in them and not through mechanical action[1].

A poison is any substance that, when ingested, causes harm in a non-thermal or mechanical manner, causing death or serious health consequences. While it is common to think of toxic chemicals as being eaten whole, this is not always the case. Some compounds are not poisons at all, but break down into distinct substances during digestion, one or more of which could be poisonous[2].

Plants with glucosides, acids, or alkaloids are utilised to make treatments. When consumed in excess, they might have negative consequences. If used in excess, the latex, white or coloured sap found in the Apocynaceae, Asclepiadaceae, Sapotaceae, Euphorbiaceae, and Papaveraceae families is poisonous. Plants of the Araceae family contain calcium carbonate or oxalate crystals, which induce significant mouth and throat irritation, as well as enlargement of the throat and intestinal walls. This might result in suffocation or death. When certain plants containing orthophosphoric acids come into touch with the skin or mucous membrane, they induce severe irritation and eruption.

Several toxic plants, such as *Nerium* (oleander), *Digitalis*

purpurea (Foxglove), *Cestrum diurnum* (Jasmine berries), common decorative plants, *Calatropis* and *Datura*, commonly recognized weed species, can be found in our surroundings. These plants have the potential to be harmful to cattle and people[3].

These potentially poisonous plants include physiologically active chemicals that cause systemic and local toxicity in cardiac, nervous, muscular, and vascular tissues. These poisonous compounds have been found in intact plant parts such as seeds (*Abrus precatorius* and *Datura stramonium*), roots (*Aconitum napellus*), and leaves (*Calotropis gigantea*), among others. The degree of plant toxicity is affected by plant shapes and their growing conditions[4].

Young kids tend to be particularly sensitive to deadly plants ingested by accident. Deaths from poisonous plant intake are documented in pieces of information, but a consistent pattern of such occurrences, particularly in India, is hard to come by. Poisonous plants are the third most common sources of toxin in the world. Plant toxicoses exist everywhere, but the rich flora of India places the location high on the list of possible exposure to deadly plants. Accidental plant ingestion resulting in acute poisoning is more common in pre-school children and is believed to be more prevalent in countries where plant-based traditional remedies are widely utilised.

The main concern in phytomedicine and other situations where potentially toxic plants are consumed is phytotoxicity. Plants, in addition to their medicinal properties, produce harmful by-products such as tannins, glycosides, toxa-albumin, and alkaloids, among others, which can have antagonistic toxic effects in humans[5].

Toxic plants are the third most common type of toxin in the world[6]. A study revealed the medicinal use of toxic plants such as *Abrus precatorius* seed paste (for joint pain relief); *Argemone mexicana* seed oil mixed with *Ricinus communis* oil (for treating skin irritation and wounds)[6-8]. Poisonous plants are those that cause a harsh problem or even death when a small number of their leaves, seeds, stem, fruits, and roots are injected, ingested, inhaled, and direct contact[9].

According to the literature, there are approximately 700 plant species with poisonous effect[10] in India. Plant poisoning in children is different from plant poisoning in adults, as children are naturally curious and chew on anything that is easily accessible, including attractive berries or fruit. Plants can differ in terms of toxicity, and many sources categorize plants as extremely, moderately, or minimally toxic. As a result, some cases are not generally fatal due to the low toxicity of plants, or else only vomiting occurs, whereas other cases become serious when not managed by owners and veterinary specialists[11].

Angiosperm plants can be toxic to humans, livestock, insects, and fish under certain conditions[12]. Plant poisoning is not common in India, but it is reported regularly. Toxic plant species such as *Datura, Calotropis, Croton, Thevetia, Abrus,* and *Ricinus* are common in India. According to previous research, plant poisoning is often lethal to humans, but death can occur if the LD50 is too low. It typically occurs when there is insufficient knowledge of potentially toxic plants[13].

This observation will contribute to the identification of toxic plants in the area. Several authors[14-17] reported on various Indian plants and their toxicological consequences as deadly doses. Some hazardous Indian plants are described by Viswanathan *et al*.[18]. In Haryana, Siwach and Gupta[19] worked on poisonous plants and Singh *et al*.[20] recorded some poisonous plants from the Chandigarh zone from the state of Punjab. Treatments for different poisonous plants are also reported in different literature sources[17, 21].

In the present study, it was predicted that, several hazardous plants are grown in the vegetation in the study area of Navi Mumbai. The residents of this area do not have the expertise to determine which plants were harmful. Hence, the goal of this article is to show people how to recognize these plants, so that they can prevent the unavoidable hazards of simply touching or eating them. For this, a scientific list of the plants reported to have poisonous effect (whole plant or any specific part), growing in Navi Mumbai has been prepared for the first time on the basis of vegetation survey.

MATERIALS AND METHODS

Location of the study

Navi Mumbai is a planned city in Mumbai, Maharashtra, India, on the west coast of the state. It began as a new urban township for Mumbai in 1972 and has since grown to become the world's largest planned metropolis. The elevation of Navi Mumbai is 29 meters above sea

level with tropical climate. The average annual temperature in Navi Mumbai is 26.6°C and average annual rainfall is 1,920 mm.

Identification of plants

Specimens were identified using local floras and supporting material for ethnomedical purposes as published in various literature[22,23]. Specimens were dried and prepared as herbarium specimens as supporting documentation and stored permanently at the Herbarium of the Department of Botany, V. P. M.'S, B. N. Bandodkar College of Science, Thane Maharashtra.

Vegetation Survey

During 2020-2021, a total of ten survey visits to seven nodes in the Navi Mumbai area were conducted. The data was crosschecked with suitable and specialized applications of plants and plant components.

RESULTS AND DISCUSSION

Several poisonous plant species were found growing along roadsides and near homes. Exposure-related effects varied from skin rashes to death. Common suggestions about reducing toxic effects after intake included consuming milk or warm water. Some claim that boiling plant components reduces the toxicity. Many of the deadly plants were also employed in traditional medicine.

Toxic plants are the plants when touched or ingested in a sufficient quantity, can be harmful or fatal to human beings and other animals. When used in small amounts and in correct proportions, products from these plants can be utilized as drugs and toxins. The beauty of these plants hides the toxicity within them. The toxicity may differ from plant to plant and it depends on several factors, especially on the different chemicals that characterize it. Moreover, it depends on the part of the plant ingested with respect to its concentration and stage of growth.

The principal purpose of the present study is to identify the plants with toxic effects in the Navi Mumbai region, and to generate awareness, especially for protection of the kids and the cattle from these harmful and toxic plants. The protection against the poisonous plants includes avoiding the touching, smelling, or ingesting the harmful parts of these toxic plants.

Some of the studied plants, such as Oleander, *Calatropis, Gloriosa, Ricinus*, etc., were shown to be extremely harmful to human.

The easiest way to reduce unintentional toxicity from hazardous plants is to raise knowledge about them. In the event of an unintentional intake, the leftover plant should be removed from the mouth and washed with water. The plant must be preserved for identification so that the best treatment may be given. It is critical to avoid producing vomiting since it might cause glottic obstruction and suffocation.

In the present study, the Navi Mumbai region was found to be rich in toxic flora with a significant effect on human and animal health. It has16 toxic (poisonous) plant species belonging to 12 families. Botanical names and local names for plant species as well as toxic parts were recorded, identified, and discussed in this study.

1. *Abrus precatorius* L., Common Name: Bead Vine; Family: Leguminosae, (Fabaceae).

   Harmful effects: Toxin Abrin is found in the seeds' hard, water-resistant outer covering. Unless the seed is chewed and digested, or the seed coat is otherwise damaged, the poison is not released (for example, when the seeds are pierced and threaded on a string as in a necklace). Toxalbumin, a plant lectin related to ricin, inhibits cellular protein synthesis and is potentially hazardous. Seeds that have been ingested usually pass through the gastrointestinal tract unharmed, releasing no poison and producing no toxicity. The toxin is absorbed by intestinal cells if the seeds are chewed, crushed, or digested (i.e., if passage through the gastrointestinal tract is delayed), producing mild to severe gastrointestinal toxicity. Symptoms include nausea, vomiting, stomach cramping, diarrhea, and dehydration, depending on the quantity of toxin exposure. The degree to which the seeds are ground or chewed before intake may influence the level of poisoning. Even with tiny exposures, parenteral delivery (such as by injection or inhalation) or even significant ingestion might result in life-threatening systemic results, including multisystem organ failure[24-26].

2. *Caladium bicolor* (Aiton)Vent, common name: Heart of Jesus; Family: Araceae.

   Harmful effects: It produces acute mouth burning, vomiting, and other gastrointestinal irritations when consumed. Its sap causes temporary blindness when

it comes into touch with the eyes. Calcium oxalate crystals are the substance that causes inflammation[27].

3. *Calotropis gigantea* L., common name: Giant Milkweed, Family: Asclepiadaceae.

   Harmful effects: Chemical constituents found in the leaves and stalk include voruscharin, calotoxin, calotropin, uscharidin, trypsin, calactin, uzarigenin, syriogenin, and proper side isolated from latex, benzoyllineolone and benzoylisolineolone isolated from root bark, and cyanidin-3-rhamnoglucoside isolated from flowers. Many toxic components are created by latex, trypsin, calotoxin, and calotropin, which appear to be collectively responsible for plant toxicity. The latex of the plant causes blindness and skin and mucous membrane irritation. Latex can be fatal at doses of 4-5 ml. The milky liquid is a poisonous material[28].

4. *Caryota urens* L. Common Name: Fishtail Palm; Family: Palmae (Arecaceae)

   Harmful effects: The pulp of the fruit is toxic unverified proteinaceous toxin and raphides of water-insoluble calcium oxalate. Ingestion causes a painful burning sensation in the lips and oral cavity. There is an inflammatory response, which is commonly accompanied by oedema and blistering. Hoarseness, dysphonia, and dysphagia are possible side effects[29].

5. *Cassia fistula* L. Common name: Golden shower; Family: Leguminosae (Fabaceae)

   Harmful effects: The sticky fruit pulp is hazardous. The leaves and bark are not as poisonous. Anthraquinone cathartic toxin Emodin glycoside (senna) causes nausea, vomiting, abdominal discomfort, diarrhoea, and dehydration can all result after ingestion. Emodin can also induce mild urine discoloration (yellowish-brown urine in acid urine, red or violet urine in basic urine)[30].

6. *Catharanthus roseus* (L.) G. Don. Common name: Periwinkle; Family: Apocynaceae.

   Harmful effects: The most serious adverse effect is diarrhea, which is caused by an imbalance in the secretory function of the gastrointestinal tract. The principal alkaloids detected in the leaves are theirocritine (vincristine) and vincaleucoblastine[31].

7. *Dieffenbachia seguine* (Jacq.) Schott, Common Name: Dumbcane; Family: Araceae

   Harmful effects: The entire plant is toxic containing unverified proteinaceous toxins and raphides of water-insoluble calcium oxalate. Chewing on the leaf creates severe discomfort right away[32].

8. *Ficus elastica* Roxb. ex Hornem. Common name: Rubber tree; Family: Moraceae.

   Harmful effects: Ingesting latex can cause a range of stomach problems, and large dosages can be fatal[33].

9. *Gloriosa superba* L. Common name: Climbing Lily; Family: Liliaceae

   Harmful effects: The entire plant, especially the tubers, is poisonous. Colchicine is a medication that is used to treat (*Colchicum autumnale* is a commercial source plant of this drug.) It may induce oropharyngeal pain at first, followed by severe gastrointestinal symptoms after a few hours. Abdominal pain and severe, frequent, and chronic diarrhoea may occur, resulting in severe fluid depletion and accompanying complications. Colchicine may cause peripheral neuropathy, bone marrow suppression, and cardiovascular collapse because of its use[34,35].

10. *Heliotropium indicum* L. Common name: Scorpion's Tail; Family: Boraginaceae

    Harmful effects: The plant as a whole is poisonous. Alkaloids of pyrrolizidine Acute hepatitis can result from significant short-term exposure, whereas chronic exposure to lesser doses can result in hepatic venous-occlusive disease (Budd–Chiari syndrome) and, in some cases, pulmonary hypertension[36].

11. *Jatropha curcas* L. Common name: Physic Nut; Family: Euphorbiaceae

    Harmful effects: Poisonous seeds are present. Jatrophin (curcin) is a toxalbumin (lectin) found in plants that are linked to ricin. Unlike poisoning from other plants containing poisonous lectins, symptoms (nausea, vomiting, and diarrhoea) frequently appear quickly. The loss of fluid and electrolytes, as well as the reduction of intestinal function, are likely to cause other symptoms. Ingestion of a single seed might result in severe poisoning[37].

12. *Lantana camara* L. Common name: Lantana; Family: Verbenaceae

    Harmful effects: Poisonous pentacyclic triterpenes Lantadene A, B, and C cause prolonged cholestasis in grazing animals. Immature berries are poisonous. The consumption of mature fruit has been linked to intoxication. Wolfson and Solomons[38] claimed that the leaves are hazardous to cattle.

13. *Melia azedarach* L. Common name: Persian Lilac; Family: Meliaceae

    Harmful effects: Toxin-melatonin, *Melia azedarach's* blooms, and berries are poisonous to humans. It produces severe colic, nausea, and vomiting. It produces nervousness and limb trembling in animals. By both oral and parenteral methods, the increased concentration of the extracts depresses the respiratory center significantly. This may be due to the direct effect on the respiratory centers. It was noted that death occurs owing to the stoppage of respiration in doses where mortality was seen[39].

14. *Parthenium hysterophorus* L. Common name: Carrot/Congress grass, Family: Asteraceae

    Harmful effects: Contact with the plant causes dermatitis and respiratory difficulties in people, as well as dermatitis in cattle and domesticated animals. The main cause is parthenin, a highly dangerous toxin. Bitter milk disease is caused when cattle feed becomes polluted with Parthenium leaves[40].

15. *Ricinus communis* L. Common name: Castor-Oil Plant; Family: Euphorbiaceae

    Harmful effects: Ricine and ricinin (more poisonous) are water-soluble glycoproteins present in the seed. The seed coat, leaves, and stem all contain ricin. The seed's oil is not nearly as deadly as the seed itself. The seed contains glycerides and ricinolic acid. When you ingest the seed, you will get a burning feeling in your throat and tongue, followed by exhaustion, thirst, dizziness, and a faster heartbeat. In the end, it leads to unconsciousness. The oil cake cannot be used as animal feed because it contains more ricin than usual. Death occurs swiftly if the oil is administered directly into the bloodstream. Allergies may be triggered by the seed extract[41].

16. *Thevetia nerifolia* L. Common name: Yellow Oleander, Family: Apocynaceae.

    Harmful effects: The fruit is the most poisonous part. Its chewing dries up the tongue and throat, causing muscle strain and dilatation of the eyes. The heartbeat rises and falls, and the blood supply is cut off, ending in death. Poisonous glucosides thevetin and theveresin, as well as cardiotoxic crystal particles phytosterolin, ahoein, and cocilphin, are present in the seeds[16]. Among the poisonous plant parts seed is the most poisonous part followed by fruits and root.

The findings of the recent study corroborates with the reports of the previous researchers like Prashant and Shiddamallayya[42] from Hassan district, Karnataka, Rajbhoj and Kagne from Poladpur, Maharashtra[40], Banerjee and Sinhababu[43] from West Bengal and Vishwanathan and Joshi[18] from Mumbai, Maharashtra.

Pollen grains of many of the studied plants such as *Cassia fistula, Catharanthus roseus, Lantana camara, Melia azedarach, Parthenium hysterophorus, Ricinus communis* are reported to be airborne and causing respiratory allergy and asthma (Adak *et al.*)[44].

CONCLUSION

In the present study, it was observed that, several plants are growing in the study area are reportedly poisonous to cause a variety of problems in man and animals. These plants are generally ignored by the public. Poisonous substances can be found in a variety of plant parts, including the bark, stem, leaves, fruits, latex, and tubers. The degree of the disease caused by these plants is mostly determined by the dose consumed by the affected organisms or the level of skin contact. Poisoning by plants is considered a public health issue. Educating and raising awareness among the public about these deadly plants and their parts will be a significant long-term issue. The local database of hazardous plants undoubtedly aids in public awareness and serves as a doorway for study in the fields of botany, pharmaceuticals, and other related fields.

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Highly efficient magnetically separable Zn-Ag@L-arginine Fe_3O_4 catalyst for synthesis of 2-aryl-substituted benzimidazoles and multicomponent synthesis of pyrimidines

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Magnetic Nanocatalyst

ABSTRACT

A general and efficient one pot protocol has been developed for the synthesis of benzimidazoles and pyrimidines using Zn and Ag@L-arginine Fe_3O_4 as a heterogeneous catalyst. The prepared catalyst provided good yields of the corresponding products within a short reaction time. Catalyst was characterized by using XRD, TEM, FEG-SEM, EDS, XPS, Raman, CHNS and FT-IR. The present method provided high yields of the products with wide substrates scope. The catalyst could be reused five cycles without a significant loss of catalytic activity.

Introduction

During the last few decades, magnetically separable materials area emerged as notable tool for organic transformations due to their properties like easy separation, recyclability, and nonleaching nature of the catalyst in the reaction medium. These materials are used in a variety of fields, including administration of drugs, magnetic high-density information storage, magnetic resonance imaging, and cancer treatment [1]. Their magnetic features, prevent material loss and increases cost-effectiveness, making them appealing industrial-scale alternatives [2]. Magnetite, a type of magnetic material, is extensively studied for the creation of more environmentally benign reaction protocols, and the field is still productive for research [3].

Magnetic nanoparticle-based materials are being extensively explored as a green chemistry tool in organic synthesis, since they are easy to prepare, cost-effective, and environmentally friendly [4]. Heterocyclic compounds, which are made up of carbon, nitrogen, and oxygen, are used in a wide range of potent drugs. The 2-aryl-substituted benzimidazoles and pyrimidines are found in pharmacologically active compounds and natural products [5,6]. These compounds are extensively used as antiviral, antimicrobial, antibiotic, antifungal, anticonvulsant, antiulcer, analgesic, antihypertensive agents, [7] also light-emitting devices [8]. Benzimidazole derivatives act as effective fungicides [9] and also exhibit distinct pharmaceutical properties such as Telmisartan as AT_1 receptor antagonists and Rabeprazole used in the treatment of gastric ulcers [10,11]. Oxibendazole, Albendazole,and Mebendazole to treat parasitosis, bis benzimidazole derivatives bind with DNA topoisomerase, also cytotoxic against breast adenocarcinoma [12,13]. Tetrahydropyrimidine derivatives exhibit powerful and selective activities on a wide range of membrane receptors [14] and substituted derivatives of tetrahydropyrimidine are valuable building blocks for the synthesis of heterocycles that possess high activities towards cell-permeable antitumor scaffold, Monastrol, and antihypertensive agent (R)[15–17].

As a result, the development of novel synthetic methods for these heterocyclic molecules is crucial. In the last few decades, several elegant strategies for the synthesis of benzimidazoles derivatives have been well established by reacting 1,2 phenylenediamine with aldehyde/ carboxylic acids by using various catalysts such as Fe_3O_4@SiO_2@$(CH_2)_3N^+Me_3I^-_3$,[18] clay supported titanium catalyst,[19] lanthanum chloride,[20] NaY zeolite, [21] ceric ammonium nitrate/polyethylene glycol,[22] $CoFe_2O_4$, [23] DDQ [24]. However, in most of the earlier reports including ferrite and metals supported on ferrite catalysts, have drawbacks like longer reaction times, and high reaction temperatures

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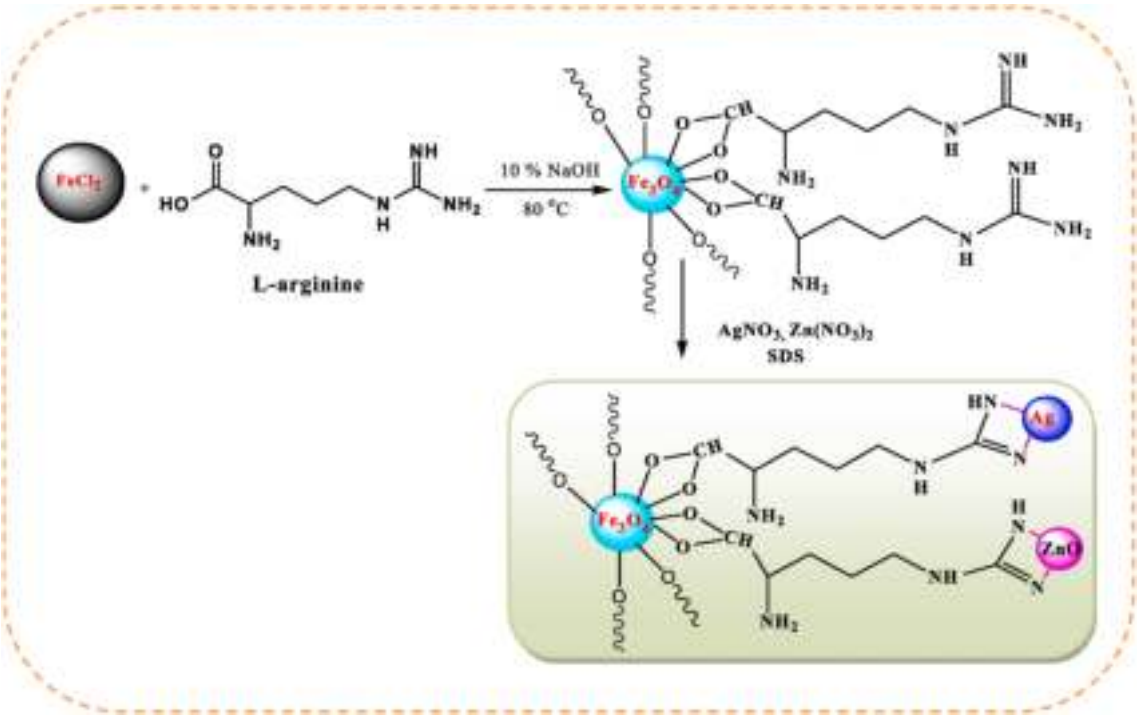


Scheme 1. Preparation of Zn-Ag @L-arginine Fe_3O_4 Catalyst.

with costly and tedious catalyst preparation procedures. Similarly, the synthesis of pyrimidine is generally carried out using aldehyde, urea, and β-ketoester in presence of acid catalysts such as $ZrOCl_2{\cdot}8H_2O$, [25] carrageenan moss/Fe_3O_4, [26] Fe_3O_4@C@OSO_3H, [27] ionic-liquid like $TiCl_3$OTf-[bmim]Cl, [28] Iron (III) Tosylate, [29] Cp_2TiCl_2 [30] and many more associated with some drawbacks of higher reaction temperatures, high catalyst loadings, and non-green protocols.

The heterogeneous catalysis finds numerous applications in the preparation of important oxygen and nitrogen containing heterocycles. Their use in biologically active pharmaceuticals, agrochemicals, and functional materials is increasingly becoming more and more important [31–37]. In continuation of our efforts for the development of environmentally benign and efficient routes for various organic functional group transformations [38–43]. In the present study, L-arginine serves as a bridge between ferrite Fe_3O_4 and ZnO-Ag nanoparticles in a Zn-Ag@L-arginine Fe_3O_4 catalyst. In the present catalytic system, ZnO plays an important role as a Lewis acid catalyst [44] and Ag metal [45,46] for the activation of carbonyls and also plays a vital role in the transition states of reaction mechanisms like dehydration, oxidation, and cyclization. ZnO and silver metal enhance the catalytic activity of the material.

To the best of our knowledge, the synthesis of 2-aryl-substituted benzimidazoles and pyrimidines using a recyclable and magnetically separable heterogeneous catalyst Zn-Ag @L-arginine Fe_3O_4 was not previously documented in the literature.

Experimental

Chemicals

All chemicals and reagents were procured with the maximum purity obtainable from S.D. Fine Chemicals and utilized without further purification.

Characterization

Powder X-ray diffraction (XRD) was performed on a PANalytical, X' Pert Pro diffractometer using Cu/Kα radiation with a wavelength of 1.54184 Å in the range of 2θ range of 25–90°. Scanning electron microscopic (SEM) images and EDS were collected on a JEOL JSM-7600F FEG-SEM microscope. Transmission electron microscopy (TEM) was performed with a PHILIPS CM 200 instrument (Operating voltages: 20-200kv). FT-IR spectra of samples were investigated on a 3000 Hyperion Microscope with Vertex 80 FTIR System (Bruker, Germany). X-ray photoelectron spectroscopy of the catalyst was recorded on a Thermo Fischer Scientific ESCALAB Xi + instrument and Raman spectra were studied with Raman-Horiba Japan Xplora Plus. Elemental analysis was investigated using Thermo Scientific, FlashSmart Elemental Analyzer. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker Avance III, 400 MHz, NMR instrument in DMSO-d_6 with TMS as the standard.

Catalyst preparation:

The catalyst Zn-Ag@L-arginine Fe_3O_4 (Scheme 1), was prepared according to a previously reported procedure with some modifications [47]. In a typical experiment, 100 mL of an aqueous 20 mM $FeCl_2$ solution was stirred with 100 mL aqueous solution of 20 mM L-arginine solution under a nitrogen atmosphere at 10 °C, with the constant addition of 10 % NaOH solution to make the pH of the reaction mass 11 to 12. The prepared material was heated to 80 °C for 1.5 h. further cooled at room temperature and filtered. The resulting solid material (Arginine ferrite) was then washed with pure water followed by ethanol and dried at 50 °C in an oven under a vacuum. In 100 mL round bottom assembly 1.0 g Arginine ferrite (solid material) with 0.6 g of $Zn(NO_3)_2$ and 0.2 g of $AgNO_3$ with 10 % SDS (Sodium dodecyl sulfate) in 50 mL water sonicated for 1.5 h. The pH of the resultant solution maintains at 10 to 11 by adding hydrazine hydrate and heating for 3 h at 80 °C. The resultant material cooled for 1.5 h at room temperature and filtered solid material was washed with water followed by ethanol.

Typical experimental procedure:

General procedure for the synthesis of 2-aryl-substituted benzimidazoles:

The Zn-Ag@L-arginine Fe_3O_4 (5 mol%) catalyst was added to a solution of o-phenylenediamine (1 mmol) and aldehyde (1 mmol) in 5 mL

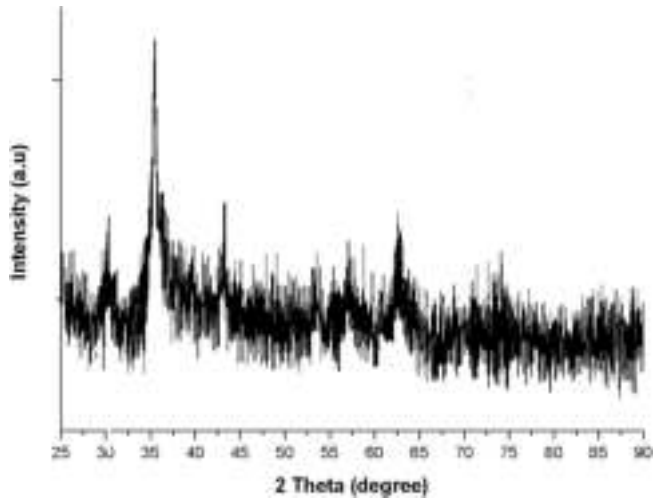


Fig. 1. XRD of Zn-Ag@L-arginine Fe_3O_4.

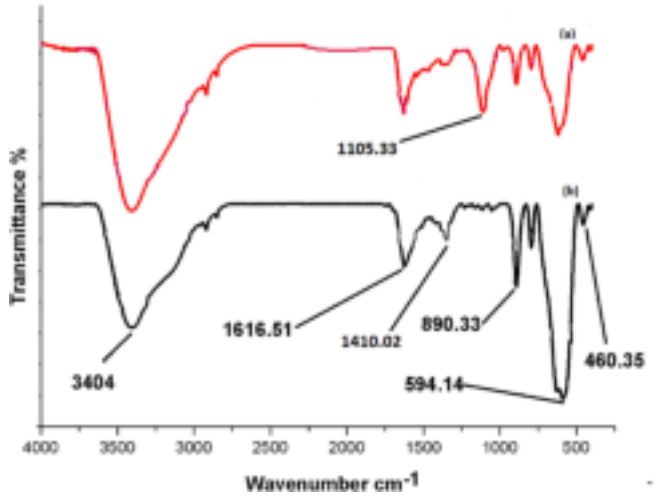


Fig. 2. FT-IR spectra of (a) arginine Fe_3O_4 (b) Zn-Ag@L-arginine Fe_3O_4.

of ethanol. The mixture was stirred and heated at 65 °C for 20–45 min. and reaction progress was monitored by using TLC. After completion of the reaction, the catalyst was recovered using an external magnet. The reaction mixture was quenched and extracted with dichloromethane (25 mL) and washed with water. The organic phase was separated, dried on Na_2SO_4 and concentrated in a vacuum to get the crude solid. The crude compounds were purified by silica gel column chromatography.

General procedure for the synthesis of pyrimidines:. The Zn-Ag@L-arginine Fe_3O_4 (5 mol %) catalyst was added to a solution of aldehyde (1 mmol), urea (1 mmol) and ethyl acetoacetate (1 mmol), in 5 mL of ethanol. The mixture was stirred and heated at 45 °C temp. for 30–60 min. and reaction progress was monitored by using TLC. After completion of the reaction, the catalyst was recovered using an external magnet. The reaction mixture was quenched and extracted with dichloromethane (25 mL) and washed with water. The organic phase was separated, dried on Na_2SO_4, and concentrated in a vacuum to get the crude solid. The crude compounds were purified by silica gel column chromatography.

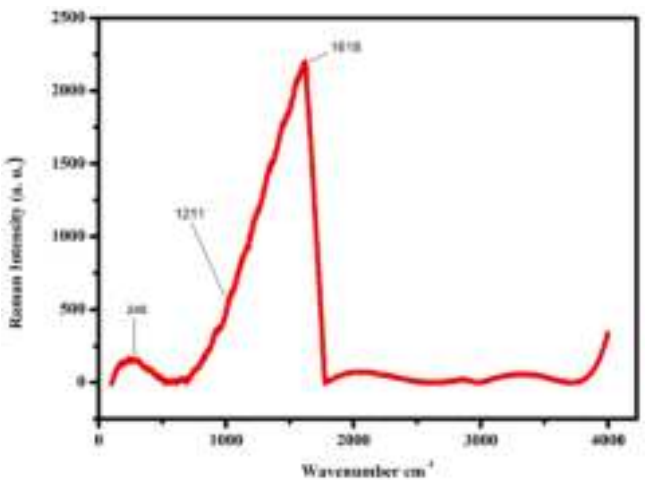


Fig. 3. Raman spectra of Zn-Ag@L-arginine Fe_3O_4.

Results and discussion

Characterization of catalyst

X-ray diffraction (XRD)

The structural analysis of the Zn-Ag@L-arginine Fe_3O_4 was investigated by using powder X-ray diffraction (XRD) in the range of 2θ between 25° to 90°. From the XRD pattern of the catalyst (Fig. 1), it can be observed that all the reflection peaks match well with the standard lattice parameter of magnetite nanoparticles. Strong diffraction peaks at 2θ of 30.10°, 35.48°, 43.15°, 53.47°, 56.97°, and 62.43° belong to the peaks of (220), (311), (400), (422) (511) and (440) of the Fe_3O_4(JCPDS card No. 19–0629) [48,49]. Due to the low percentage of Zn (6.01 % by EDS) and Ag (0.46 % by EDS), the peaks of Zn and Ag are not detectable in the XRD spectrum [3]. The average particle size of nanoparticles obtained was 27 nm using the Scherrer equation.

FT-IR and Raman spectra

The FT-IR spectrum of Zn-Ag@L-arginine Fe_3O_4 in the spectral range from 400 to 4000 cm^{-1} is shown in Fig. 2 **(a-b)**. The Fe-O lattice vibration is characterized by a prominent IR band at around 594 cm^{-1} (Fig. 2**b**) [50], while the N—H stretching vibrations at 3404 cm^{-1} and the bending mode of the free NH_2 group at 1616 cm^{-1} confirm arginine coating (Fig. 2**b**) [51]. IR peaks in the region of 760–1180 cm^{-1}, mainly due to the C—C stretching and C—N stretching vibrations in the catalyst [52]. The low intensity peak formed at 1410 cm^{-1} which indicates the symmetric stretching of the CO_2^-. An absorption band was observed at around 460 cm^{-1}; which corresponds to the shifting of the *v*2 band of the Fe–O bond of magnetite to a higher wavenumber [51]. Thus, confirming the existence of arginine molecules on nanoparticle surfaces. As a result, magnetite nanoparticles are stabilized by arginine via the carboxyl group, forming an attachment of the arginine to the magnetite particle.

The Raman spectra of the Zn-Ag@L-arginine Fe_3O_4 (Fig. 3) show a strong peak at 1618 cm^{-1} assigned to mainly antisymmetric stretching of the CO_2^- group. The weak band appeared at 1211 cm^{-1} assigned to the wagging mode of the NH_2 group of the arginine [53]. The spectrum shows a sharp band at 248 cm^{-1}, ascribed to the stretching vibrations of Ag–N which confirms the formation of silver nanoparticles [46,54].

FEG-SEM

The surface morphology of Zn-Ag@L-arginine Fe_3O_4 heated for 3 hr. at 80 °C was characterized by using the scanning electron microscopy technique. The SEM micrographs of Zn-Ag @L-arginine Fe_3O_4 results as shown in Fig. 4 a-c. EDS confirms the presence of Zn and Ag metals in the prepared nanomaterial (Table 1, Fig. 4 d).

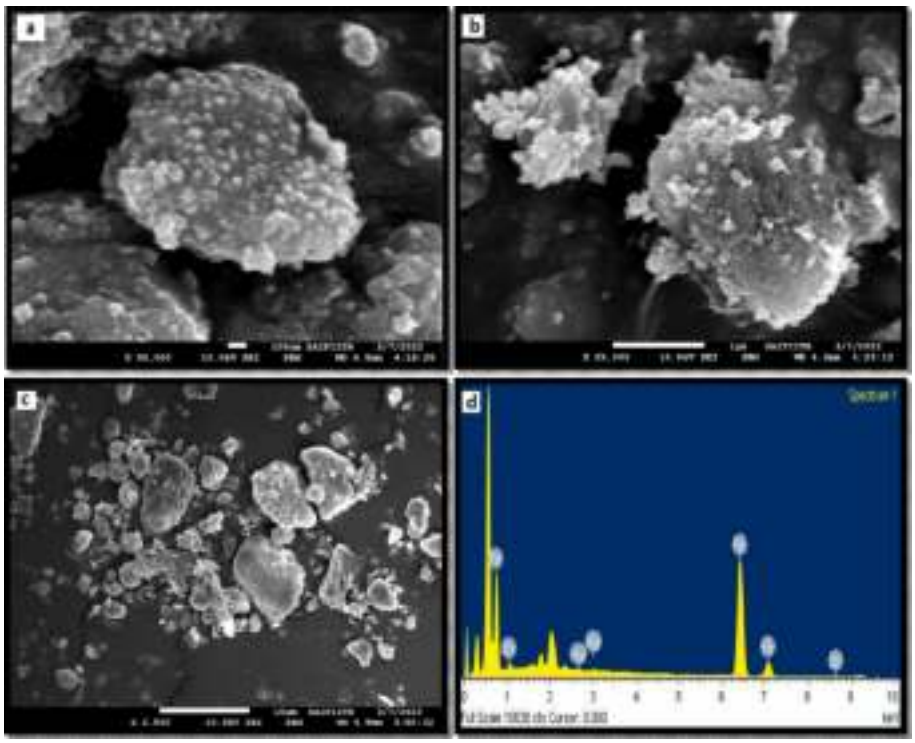


Fig. 4. (**a-c**) FEG-SEM image of Zn-Ag@L-arginine Fe_3O_4, (**d**)EDS profile of Zn-Ag@L-arginine Fe_3O_4.

Table 1
Elemental composition of the Zn-Ag @L-arginine Fe_3O_4.

No.	Element	Weight%	Atomic%
1	Fe	92.20	93.54
2	Zn	6.93	6.01
3	Ag	0.87	0.46

Transmission electron microscopy (TEM)

A TEM micrograph of Zn-Ag@L-arginine Fe_3O_4 was acquired to obtain additional information on particle size and shape. The TEM images of Zn-Ag @L-arginine Fe_3O_4 results confirm the formation of Fe_3O_4 nanoparticles. (Fig. 5, a-d) In XRD analysis an average particle size was calculated and found to be 27 nm using the Scherrer equation.

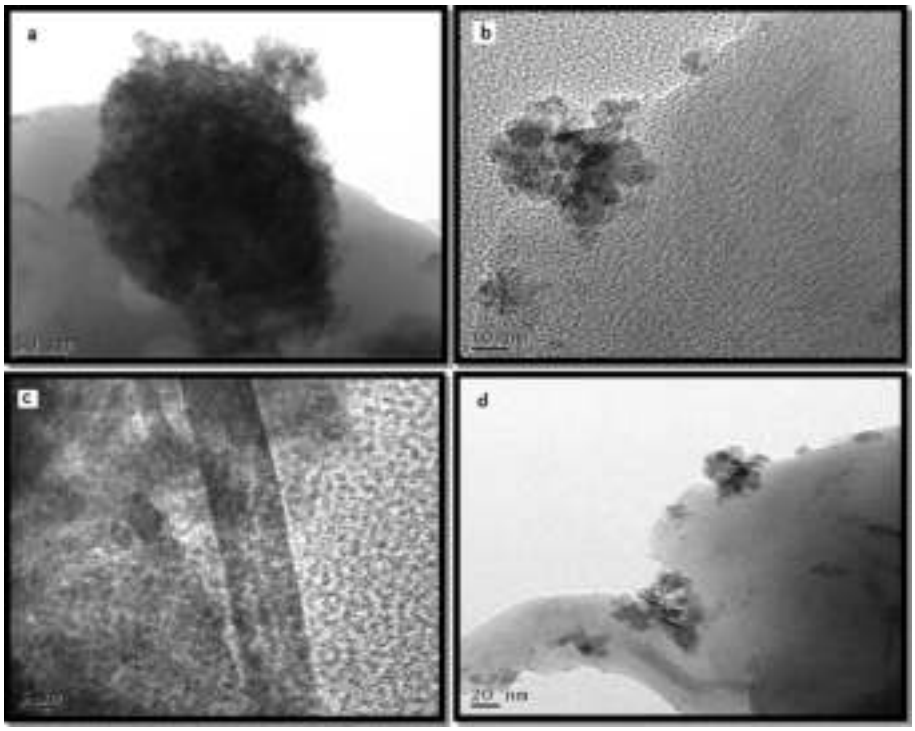


Fig. 5. (**a-d**) TEM of Zn-Ag @L-arginine Fe_3O_4.

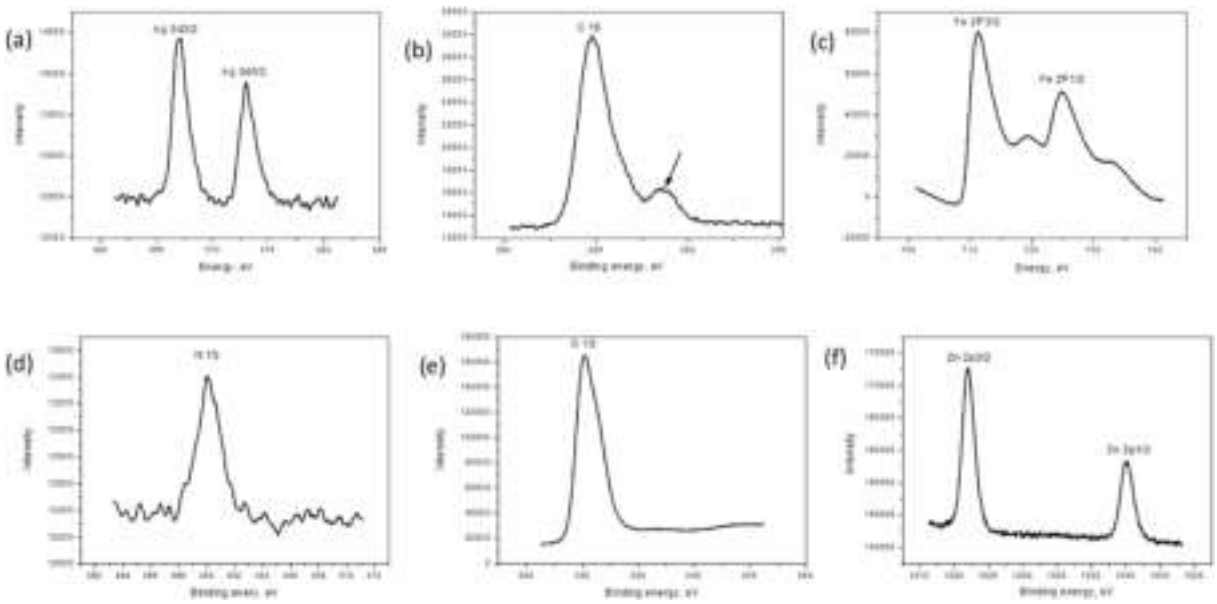
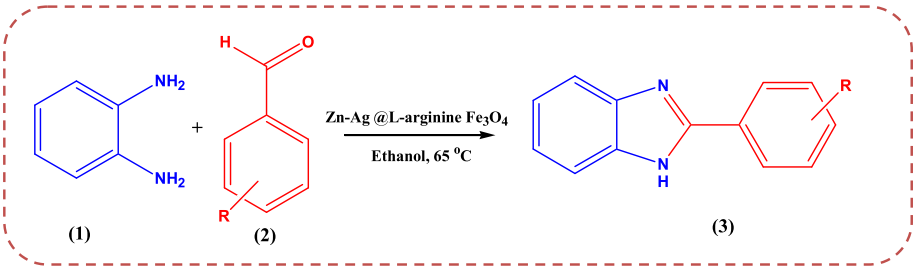


Fig 6. XPS spectra of Zn-Ag@L-arginine Fe_3O_4 catalyst **(a)** Ag 3 d, **(b)** C 1 s, **(c)**Fe 2p, **(d)**N 1 s,**(e)**O1s, **(f)**Zn 2p.



Scheme 2. Synthesis of 2-aryl-substituted benzimidazoles catalyzed by Zn-Ag @L-arginine Fe_3O_4.

X-ray photoelectron spectra

The results of the XPS measurements are shown in Fig. 6. After getting an idea about the elemental profile the high-resolution spectra of Ag, C, Fe, N, O and Zn are shown in the plot. The peaks for both Ag $3d_{5/2}$ and Ag $3d_{3/2}$ appeared in spectra with a peak separation of 5.9 eV indicating the formation of metallic silver [55,56]. The XPS peak of C 1 s is characterized with the peak at its usual position, additionally, the peak at around 288 eV is indicative of the presence of functionalized carbon. The XPS spectra of Fe has been characterized with two peaks Fe $2p_{3/2}$ and Fe $2p_{1/2}$, additionally, a satellite peak has been observed at around 719 eV. In the O 1s spectra, the peak can be seen with a hump at 532 eV, which is indicative of the oxygen present as C═O. The XPS peaks for N and Zn are observed at their usual position. The peaks of both Zn $2p_{1/2}$ and Zn $2p_{3/2}$ appeared in spectra with bonding energies difference of 23.15 eV suggesting + 2 oxidation state of zinc [56,57].

Catalytic activity studies:

Initially, in order to explore the applicability of Zn-Ag@L-arginine Fe_3O_4 catalyst, the model reaction of o-phenylenediamine **1** and aldehyde **2** (1.0 mmol each) for the synthesis of benzimidazoles **3** (Scheme 2**)** was carried out. In case of heterogeneous catalyzed reactions, catalyst concentration is one of the most important factors and hence, we have screened the amount of catalyst required for the maximum yield of the product. It is noteworthy that, in the absence of a catalyst no significant product formation was observed even after an extended reaction time of 60 min (Table 2**,** entry 1**)**. In presence of Zn-Ag @L-arginine Fe_3O_4 catalyst, 5 mol % amount was found to give 96 % yield of the desired product as compared to 2 mol% (Table 2**,** entries 2–3). Further, an increase of catalyst amount from 5 to 20 mol% shows a slight decrease in catalytic activity from 96 to 95 % yield of the product (Table 2**,** entries 4–5).

The effect of the temperature study revealed that product yield significantly increases when temperature increases from room

Table 2
Effect of various reaction conditions on the synthesis of 2-aryl-substituted benzimidazoles[a].

Entry	Catalyst (mol %)	Solvent	Temp. (°C)	Time (min.)	Yield[b](%)
Effect of catalyst loading					
1	–	EtOH	65	60	20
2	2	EtOH	65	60	89
3	5	EtOH	65	30	96
4	10	EtOH	65	30	95
5	20	EtOH	65	30	95
Effect of temperature					
6	5	EtOH	r.t.	60	45
7	5	EtOH	45	60	68
8	5	EtOH	65	30	96
Effect of solvents					
9	5	solvent free	65	30	80
10	5	acetonitrile	65	30	56
11	5	CH_2Cl_2	Reflux	60	40
12	5	water	65	60	60
13	5	EtOAC	65	90	70

[a] Reaction conditions: benzaldehyde (1 mmol), o-phenyldiamine (1 mmol), solvent 5 mL, catalyst mol % (w.r.t. benzaldehyde), [b]Isolated yield.

Table 3
Reaction between various aldehydes and o-phenyldiamine catalyzed by Zn-Ag@L-arginine Fe_3O_4[a].

Entry	R	Product	Time (min)	Yield[b](%)
1	H	3a	25	96
2	4-CH_3	3b	40	96
3	4-Cl	3c	20	98
4	4-Br	3d	30	95
5	4-F	3e	25	94
6	2-OH	3f	30	92
7	4-OH	3 g	25	97
8	2-OCH_3	3 h	30	93
9	4-OCH_3	3i	35	91
10	3-NO_2	3j	30	95
11	4-NO_2	3 k	20	98
12	-C_4H_4	3 l	45	91

[a] **Reaction conditions**: aldehyde (1 mmol), o-phenyldiamine (1 mmol), ethanol- 5 mL, temp-65 °C, catalyst – 5 mol %, (w.r.t. aldehyde),[b]Isolated yield.

temperature to 65 °C (Table 2**,** entries 6–8). The effect of the reaction medium was also evaluated with solvents such as acetonitrile, CH_2Cl_2, water, and EtOAc (Table 2**,** entries 10–13). Under solvent-free conditions, a good amount of product yield was obtained (Table 2**,** entry 9), whereas ethanol mediated reaction provided 96 % yield within 30 min. of reaction time (Table 2**,** entry 3).

To study the wide applicability of Zn-Ag@L-arginine Fe_3O_4, we have carried out a substrate study using structurally varied aldehydes. The catalyst afforded good to moderate product yields for both electrons donating (–CH_3, –OH, –OCH_3, -C_4H_4) and electron withdrawing (-Cl, -Br, –NO_2) substituents (Table 3**,** entries 1–12). In all cases, the reaction smoothly took place under optimized reaction conditions.

The applicability of the prepared catalyst was further explored for the synthesis of pyrimidines **7** by taking a mixture of aldehyde **4** (1 mmol), urea **5** (1 mmol), and ethyl acetoacetate **6** (1 mmol), in presence of Zn-Ag@L-arginine (Scheme 3). In the broad optimization study, the amount of catalyst was tested for the model reaction. In absence of a catalyst, no significant product formation was observed under the same set of conditions even after an extended reaction time of 90 min (Table 4, entry 1). An increase in catalyst loading from 2 to 5 mol % enhanced the product yield from 75 to 98 % (Table 4, entries 2–3). Further, an increase in catalyst loading had no remarkable effect on product yield (Table 4**,**entries 4–5). Thus 5 mol % of catalyst loading was selected as the optimum concentration for further studies (Table 4, entry 3). Similarly, temperature dependence was found for the model reaction, the optimum results were found at 45 °C in comparison to other temperatures evaluated (Table 4**,** entries 6–8).

The effect of solvents has been screened by using toluene, dichloromethane, water, and ethyl acetate (Table 4, entries 10–13). Interestingly in solvent free conditions, a moderate yield of 65 % was obtained for the model reaction (Table 4**,** entry 9). In ethanol mediated reaction highest 98 % yield of the desired product was furnished within 25 min of reaction time (Table 4**,** entry 3).

To check the versatility of the Zn-Ag@L-arginine Fe_3O_4, we have shown a wide substrate scope by using structurally diverse groups on aldehydes. The catalyst afforded a good to moderate product yield for both electrons donating (–CH_3, –OCH_3,) and electron withdrawing (-Cl, –NO_2) substituents on benzaldehyde (Table 5**,** entries 1–7). The reaction between, thiophene-2-carboxaldehyde, urea, and ethylacetoacetate also provided 91 % yield of the product within 45 min of reaction time (Table 5**,** entry 8). However, in most cases, benzaldehydes containing electron withdrawing groups took a long time to complete the reaction.

Based on the results of these experiments, a plausible reaction pathway for the synthesis of benzimidazoles involves the formation of imine (c) in the first step via condensation of o-phenyldiamine (a) in presence of electron-deficient carbonyl carbon of aldehyde (b) activated by the silver metal sites [46] of Zn-Ag@L-arginine Fe_3O_4 with the removal of one H_2O molecule (Scheme 4**).** Furtherimine intermediate undergoes the ring closure by attachment of a nitrogen atom lone pair to Lewis acid sites of the catalyst (ZnO) to form unstable benzimidazoline (d) [24].Then, two hydrogen atoms were removed in the presence of silver metal from the catalysts and finally, benzimidazole derivatives (e) were prepared [58]. However, further study is needed to support the

Table 4
Effect of various reaction conditions on the synthesis of pyrimidines[a].

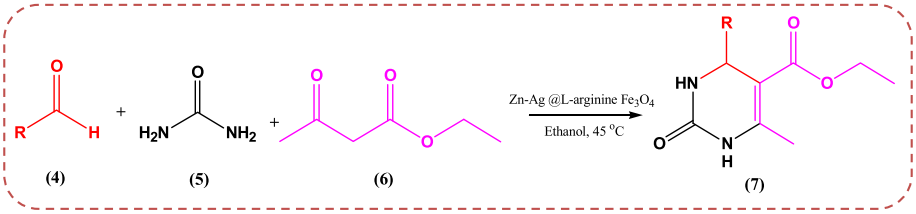
Entry	Catalyst (mol %)	Solvent	Temp. (°C)	Time (min.)	Yield[b](%)
Effect of catalyst loading					
1	–	EtOH	45	90	34
2	2	EtOH	45	45	75
3	5	EtOH	45	25	98
4	10	EtOH	45	30	98
5	20	EtOH	45	30	98
Effect of temperature					
6	5	EtOH	r.t.	30	42
7	5	EtOH	45	25	98
8	5	EtOH	65	30	96
Effect of solvents					
9	5	solvent free	45	25	65
10	5	toluene	45	60	85
11	5	CH_2Cl_2	Reflux	80	70
12	5	water	45	40	65
13	5	EtOAc	45	140	89

[a] **Reaction conditions**: benzaldehyde (1 mmol), ethylacetoacetate (1 mmol), urea (1 mmol), solvent- 5 mL, catalyst mol % (w.r.t. benzaldehyde), [b]Isolated yield.

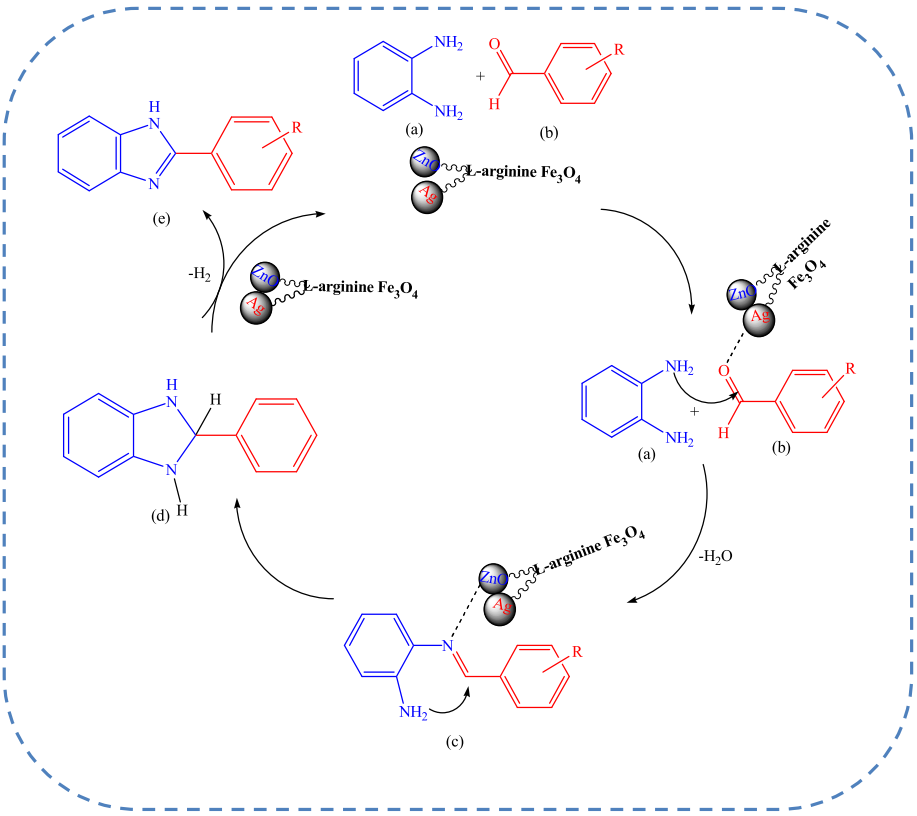
Table 5
Three component reaction between various benzaldehyde, ethylacetoacetate, and urea catalyzed by Zn-Ag@L-arginine Fe_3O_4[a].

Entry	R	Product	Time (min)	Yield[b](%)
1	C_6H_5	7a	30	98
2	4-CH_3-C_6H_4	7b	40	96
3	2-Cl-C_6H_4	7c	55	95
4	4-Cl-C_6H_4	7d	30	96
5	4-OCH_3-C_6H_4	7e	45	97
6	3-NO_2-C_6H_4	7f	60	93
7	4-NO_2-C_6H_4	7 g	40	95
8	C_4H_3S	7 h	45	91

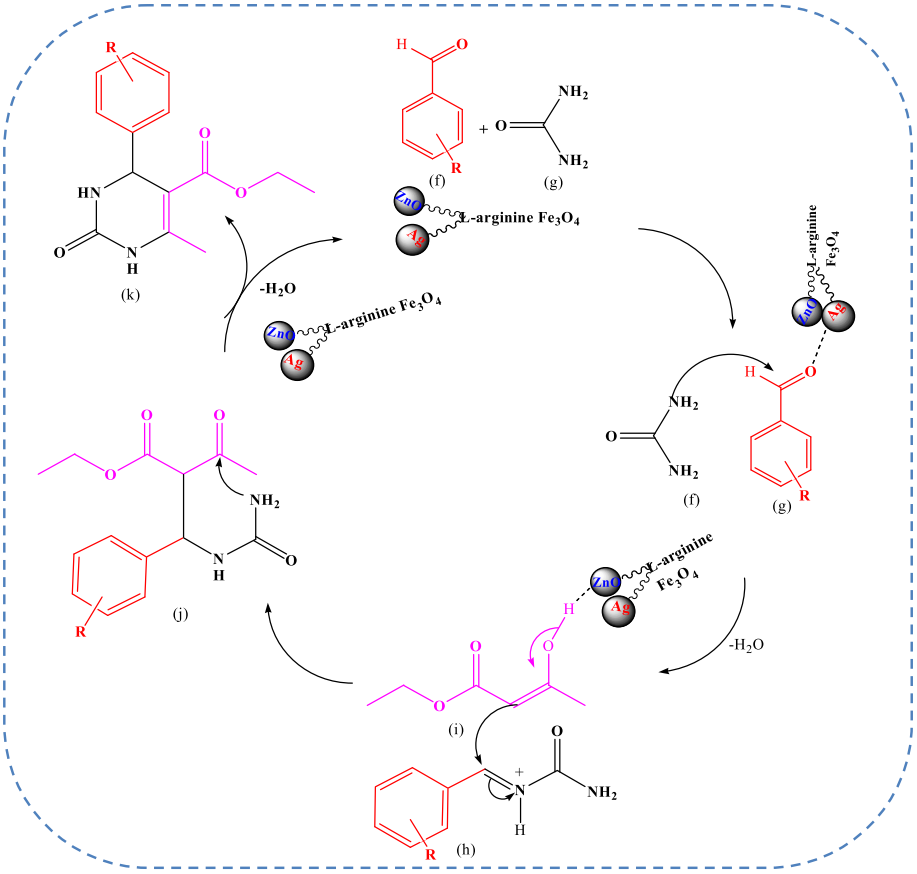
[a] **Reaction conditions**: aldehyde (1 mmol), ethylacetoacetate (1 mmol), urea (1 mmol), ethanol- 5 mL, temp- 45 °C, catalyst – 5 mol %, (w.r.t. aldehyde), [b]Isolated yield.



Scheme 3. Multicomponent synthesis of pyrimidines catalyzed by Zn-Ag@L-arginine Fe_3O_4.



Scheme 4. A plausible reaction mechanism for the synthesis of benzimidazoles.



Scheme 5. Proposed reaction pathway for synthesis of pyrimidines catalyzed by Zn-Ag@L-arginine Fe_3O_4.

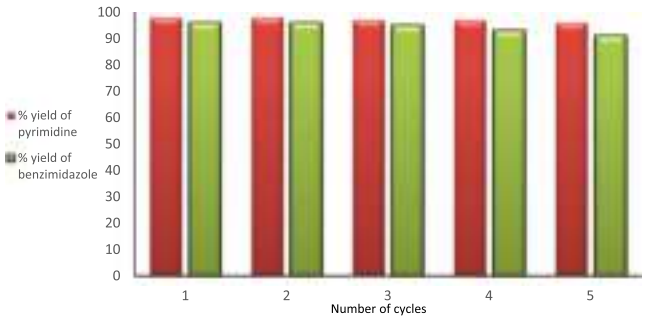


Fig. 7. Recyclability study of Zn-Ag @L-arginine Fe_3O_4.

Table 6
Comparison of the present work with some reported methods for the synthesis of benzimidazoles.

No.	Catalyst and Conc.	Time	Yield (%)	Temperature (°C)	Reference
1	Fe_3O_4@SiO_2@$(CH_2)_3N^+Me_3I^-_3$, (0.007 g for 1 mmol of OPD)	13–20 min	88–94	100 °C	18
2	Clay-supported titanium catalyst, (0.25 g for 1 mol of OPD)	2 h	62–82	120 °C	19
3	Lanthanum Chloride (10 mol %)	2–4 h	85–95	r.t	20
4	NaY Zeolite (100 mg for 0.0025 mol of OPD)	48 h	26–93	r.t.	21
5	Ceric ammonium nitrate/ polyethylene glycol (5 mol %)	1.5–3 h	90–98	50 °C	22
6	$CoFe_2O_4$ (5 mol%), grinding	7–11 min	88–97	–	23
7	Zn-Ag @L-arginine Fe_3O_4(5 mol %,w.r.t. aldehyde)	20 – 40 min	91–98	65 °C	**Present work**

postulated reaction mechanism.

The possible reaction mechanism of pyrimidine synthesis catalyzed by Zn-Ag@L-arginine Fe_3O_4 as a catalyst is depicted in Scheme 5. The reaction between benzaldehyde (f) and urea (g) generates iminium cation (h) via the addition of urea to electron-deficient carbonyl carbon of aldehyde (b) activated by the silver metal sites [46] of the catalyst. Subsequently, the addition of 1,3 dicarbonyl compound (i) with iminium cation (h) to form (j), which on cyclization and dehydration forms the corresponding product (k) in presence of Lewis acid sites of the catalyst. Following the formation of the product, the catalyst is free to participate in the next catalytic cycle [59]. However, further investigation is required to confirm the proposed reaction mechanism and synergetic effect of Ag and ZnO may play an important role in the reaction.

The reusability of catalysts is an important factor in determining the industry's potential applications. The recyclability of the catalyst was studied for five successive cycles for the synthesis of benzimidazoles and pyrimidines (Fig. 7). During the investigation, it was observed that the catalyst could be successfully separated and recycled by using a magnet without diminishing any catalytic activity. These results reveal that the given approach is effective and has several advantages over earlier protocols.

The study was further extended to confirm the heterogeneous nature of the catalyst by a hot filtration method. Both model reactions were carried out using optimized reaction conditions and the reaction mass was separated from the catalysts after 10 min of reaction time. The reaction mass was subsequently agitated for further 60 min without catalysts, and no further product formation was noted, showing the heterogeneous nature of the catalyst.

Table 7
Comparison of the present work with some reported methods for the synthesis of pyrimidines.

Sr. No	Catalyst and conc.	Time	Yield (%)	Temperature	Reference
1	Magnetic core–shell Carrageenan moss/ Fe_3O_4(10 mg for 1 mmol of aldehyde)	45–90 min.	73–95	H_2O-Reflux	26
2	Fe_3O_4@C@OSO_3H (8.1 mol%)	15–105 min	80–97	80 °C	27
3	$TiCl_3OTf$-[Bmim]Cl (15 % mol)	15–40 min	70–95	140 °C	28
4	Iron (III) Tosylate (5 mol%)	2.5 – 43 h	62–9	70–125 °C	29
5	Cp_2TiCl_2 (0.1 mmol)	9 h	12–93	70 °C	30
6	Zn-Ag @L-arginine Fe_3O_4(5 mol %w.r.t. aldehyde)	30–60 min	91–98	45 °C	**Present work**

The current methodology for the synthesis of benzimidazole (Table 6) and pyrimidine (Table 7) is compared with some of the reported methods in the literature, and it is concluded that the present protocol offered a valuable improvement over the existing techniques.

Conclusion:

In summary, we have developed a green and efficient protocol for the synthesis of 2-aryl-substituted benzimidazoles and pyrimidines in ethanol using a magnetically separable Zn-Ag@L-arginine Fe_3O_4 catalyst. The material shows remarkable activity tolerance for aldehydes with both electron withdrawing and donating substituents present on the aromatic compounds. The catalytic material can be easily retrieved by using a magnet and reused without further treatment up to five catalytic cycles without a remarkable decline in catalytic activity. The protocol outperforms previous approaches due to its simple work-up procedure, mild reaction conditions, magnetically separable material, and reusability of the catalyst, which make the protocol more attractive and a useful contribution to the present methodologies.

CRediT authorship contribution statement

Padmakar A. Kulkarni: Conceptualization, Methodology, Formal analysis. **Sandeep S. Kahandal:** Data curation, Writing – original draft. **Nitin A. Mirgane:** Visualization, Investigation. **Ashis Kumar Satpati:** Formal analysis. **Suresh S. Shendage:** Supervision, Writing – review & editing.

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.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rechem.2022.100655.

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IMPACT OF COVID-19 IMPOSED ONLINE LEARNING ON PHYSICAL-MENTAL HEALTH OF UNDERGRADUATE STUDENTS FROM THANE REGION OF INDIA

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Abstract: The unprecedented COVID-19 pandemic has imposed lockdowns but opened gates to e-learning across the globe. Despite challenges, India opted for online learning for the first time. It brought novelty in pedagogy but increased health concerns and snatched away the co-learning experience of students. The current research project enquires about psycho-physical issues faced by undergraduates of VPM's B.N. Bandodkar Autonomous College of Science from Thane region of India. The research presents extensive statistical analysis of responses obtained through a well-structured online questionnaire. The results of inferential statistical tools of one-way ANOVA and Chi-square tests indicated that a significant number of college students suffer from various temporary illnesses which are induced due to prolonged exposure to gadgets. Around 70% of students preferred to take self-medication on health issues using home remedies and inculcated habits of regular physical exercise, yoga and meditation. About 65-70% students expressed considerable degree of emotional attachment towards many facets of Offline College which cannot be satisfied in the e-learning process. The degree of emotions differs significantly among male and female candidates who are from nuclear family. Such study may become useful in designing a few strategies to overcome shortcomings of e-education up to certain extent.

Keywords: Online pedagogy, Psychological issues, Health problems, Questionnaire

I. INTRODUCTION

Recently due to the sudden outbreak of novel corona virus and subsequent fetal results of COVID-19 cases, restricted mobility and social distancing became a major preventive measure across the world. Undoubtedly, it severely hampered not only the economy but also education. According to All India Survey on Higher Education (AISHE 2018-19), the Indian Higher Education sector included 993 Universities and 39931 Colleges imparting education to 37.3 million students (Raj, 2020). India used to greatly rely on offline mode of teaching-learning process. The country started a nationwide lockdown for educational institutes from March 2020 after confirmation of COVID cases. It took place in different phases. Since then, Indian school children, college students and teachers have undergone an immensely challenging situation. The transition to virtual modes was difficult due to issues related to access towards digital technology, lack of gadgets, inconsistent internet access, cost factor and adaptation to new methods involved in online classes (Agarwal, 2020; Pednekar, 2020). With respect to the same, Bhukta and Nayak (2021) mentioned that India is not completely prepared for the reach of digital education in all corners of the country. Khare, Mahour, Ohary, & Kumar (2021) stated the difficulties of students such as no eye contact with teacher, disturbance during lecture because of family members, notifications on WhatsApp, inferior quality of video, mismatch with screen and writing notes, etc. Bartanwala, Malandkar, Linar, Manjrekar, & Kumavat (2021) has also presented a comprehensive study indicating the degree of difficulty faced in adapting to novel online learning. Undoubtedly, the online version has its own advantages such as flexibility and convenience for learners, resolved travelling issues, reduced time and

effort to reach institutes and quick access to multiple e-resources, etc. (Muthuprasad, Aiswarya, Aditya, & Jha, 2021; Welsh, Wanberg, Brown, & Simmering, 2003).

But the term 'Education' is applied to acquire a set of skills, techniques, values, beliefs and habits which can lead to social stability and in turn build-up a strong nation. With this regard, educational institutes play a vital role in upbringing socially responsible citizens (Little, 2016). The major drawback of online learning is lack of experience of co-learning, social interactions, cultural exchange, team work through participation in games/ competitions/ research activities, etc. These characteristics lay down the foundation for personality development which may not be completely achieved by e-learning. Another equally alarming issue is related to the impact of online classes on health. Prolonged screen hours of laptops and mobiles are a matter of concern for health of sensory organs (Borwankar, 2020). Previous studies done by Khattar, Jain, & Quadri, (2020), revealed that significant respondents from their study missed their meetings with friends personally. Various other factors like absence of physical activity, extended screen time, change in sleep patterns, inadequate diet, fear of many things like infection, financial problems, loneliness could be harmful to the young students.

Therefore, the present work was initiated with the objective to find out the effect of online education on psycho-physical aspects of college going students. It involved an extensive survey of second year and third year undergraduate students of VPM's B.N. Bandodkar Autonomous College of Science (BNB) which is affiliated to University of Mumbai, located at Thane, Maharashtra, India. This survey aimed to understand online learning induced health problems with preferred treatments. Along with it, the study intended to know the extent to which students are missing the learning environment of Offline College.

II. MATERIAL AND METHODS

In the present research work, information about various aspects involved in the e-learning experience of BNB students has been gathered by conducting extensive survey. The highly structured questionnaire was developed on the basis of expert comments from teachers and speculative discussions with students using 'Google Form Application'. The pilot survey was carried out in August 2020 using 10 individuals including teachers and students by circulating link of form by 'WhatsApp' tool of mobile. After a pilot survey, the questionnaire was refined and the final copy was developed into a simple, short and precise questionnaire. It had subsections of personal information, health issues suffered after attending online sessions, preferred choice of treatments and extent to which students are missing different facets related to Offline College.

In order to prevent any random response from students, open ended questions were completely excluded. All the questions were framed carefully in multiple choice questions format by giving an elaborate list of options as probable answer/s. Provisions of options like 'Not Suffered', 'Never felt so' and 'Preferred Not to Say' were also incorporated to certain questions. The questions related to psycho-physical factors were designed with Likert scale options depicting the intensity of a particular issue or frequency of a treatment taken.

The survey was conducted on a total 834 admitted students of second and third-year Bachelor Degree (B.Sc.) students. It started on 5th September 2020 by sending a link of Google Form. The link was kept active till one week period and responses were collected from 440 students within this period. The collected data was further validated and further subjected to statistical analysis using inferential tools like 'One way ANOVA' and 'Chi-square test'. The obtained results are expressed in the form of mean, standard deviation, percent values, kurtosis, skewness, F-values and X^2- values (Kothari, 2002; Pozgaj, and Knezevic, 2007; Hasan, and Bao, 2020; Dewaele, Magdalena & Saito, 2019; Abdollahi, Talib, Yaacob, & Ismail, 2015).

III. RESULTS AND DISCUSSION

3.1 The survey of BNB students received responses from 440 undergraduates out of a total 834 admitted students. After data validation, 417 responses were considered for final data analysis. The demographic profile (as per Table No. 1) shows the prevalence of candidates with age ranging from 19-20 years. Gender-wise female candidates are more in comparison with males and more than 90% of students use android mobile for e-learning. Usage of mobile is serious concern as it is reported that mobile emits harmful electromagnetic radiations which may act as potential carcinogen (Miller et al., 2019).

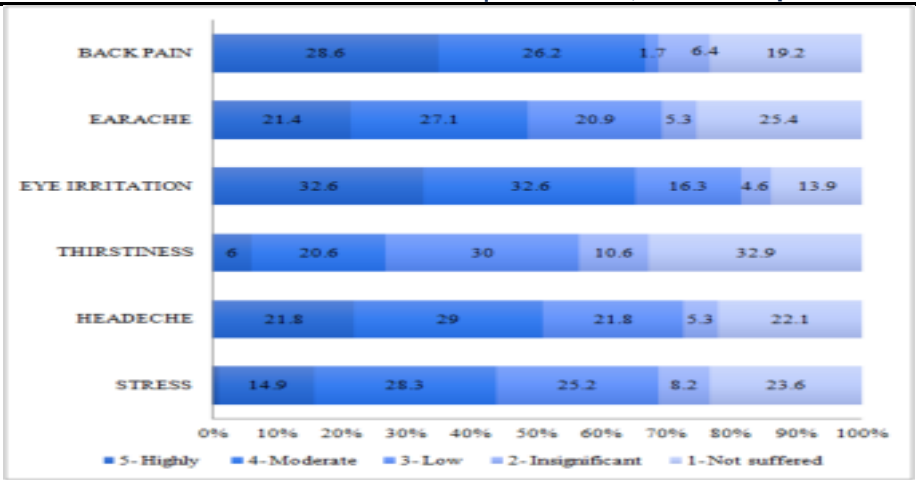
Table No. 1 Demographic profile of College Students			
Parameter	**Groups**	**N = 417**	**Percentage**
AGE	17-18 yrs	66	15.83
	19-20 yrs	**304**	**72.9**
	21 yrs and above	47	11.27
GENDER	Male	145	34.77
	Female	**270**	**64.75**
	Not preferred to say	2	0.48
CLASS	S.Y.B.Sc.	217	52.04
	T.Y.B.Sc.	200	47.96
GADGET	**Mobile**	**388**	**93.06**
	Laptop and PC	29	6.94
BACKGROUND	Joint Family	92	22.06
	Nuclear Family	325	77.94
Key - N = Number of responses			

3.2 Analysis Of Issues Related To Health Problems Faced Due To Online Learning

In the questionnaire, the candidates were asked about health issues faced after attending long sessions of online learning. The question was developed with a 5-point Likert scale in order to understand the intensity of probable health problems. The obtained observations are depicted in Table No. 2 with the values of maximum, minimum, mean, standard deviation, skewness and kurtosis. **The normality of data has been confirmed on the basis of skewness values (in the range of -2 to +2) and kurtosis values (in the range of -7 to + 7)** (Abdollahi et al., 2015).

Table No. 2 Effect of Online learning on Health of Students								
Parameter	**N**	**Min**	**Max**	**Mean**	**Variance**	**SD**	**Skewness**	**Kurtosis**
STRESS	417	2	4	3.029	1.903	1.3795	-0.2494	1.8184
HEADACHE	417	2	4	3.2326	2.0491	1.4315	-0.4172	1.8702
THIRSTINESS	417	5	3	2.5635	1.6792	1.2959	0.1053	1.7688
EYE IRRITATION	417	2	5,4	3.6547	1.8083	1.3447	-0.8437	2.5603
EARACHE	417	2	4	3.1367	2.1808	1.4767	-0.3121	1.7093
BACK PAIN	417	2	5	3.3837	2.0928	1.4467	-0.5016	1.9272
Key – N- Number of Responses, Min – Minimum, Max – Maximum, SD – Standard Deviation								

The responses of Likert scale are expressed in the form of Graph No.1 which revealed that almost every health problem suffered with a considerable amount of intensity except the perception of thirstiness. **Among all eye irritation is a major concern which is followed by back pain, headache, stress (tiredness) and thirstiness. The probable reasons are long hours of screen time, sitting in one posture and constant usage of headphones.** Prior studies on self-illuminating gadgets suggest that these devices cause water loss and oxidative stress (Arjmandi, Mortazavi, Zarei, Faraz, & Mortazavi, 2018; Khare et al., 2021).



Graph No. 1 Intensity of Health Problem suffered due to online learning

Further for the one way analysis of data only positive responses (i.e. responses with 'Highly', 'Moderate' and 'Low' opinions) about health issues were selected while others (i.e. responses with 'Not suffered' and 'Insignificant' opinions) were omitted for analysis. **It was performed by setting the H_0 and H_1 hypotheses where the H1 Hypothesis proved to be true and shows that the intensity of occurrence of health problems differs significantly (Table No. 3).**

Table No. 3 Statistical analysis of data related to health problems by One Way ANOVA						
H_0 - There an equal intensity of occurrence of health problems due to online learning						
H_1 - There unequal intensity of occurrence of health problems due to online learning						
Health problems suffered	**STRESS**	**HEADACHE**	**THIRSTINESS**	**EYE IRRITATION**	**EARACHE**	**BACK PAIN**
Total N	285	303	236	340	289	310
Mean	3.8491	4	3.5763	4.2	4.0069	4.1194
SD	0.7518	0.7763	0.6767	0.7494	0.7817	0.7976
F- Value	**22.9462**					
Conclusion- H1 accepted, significant difference exist in intensity of health problems caused by online learning						
Key – N- Number of Responses, SD – Standard Deviation						

Similarly Chi-square test was applied by sorting gender wise data by setting H0 and H1 hypotheses for cases which suffered from health issues. **It was found that health issues induced irrespective of gender with the same proportion in male and female candidates** (Table No. 4).

Table No. 4 Statistical analysis of Gender wise occurrence of health problems by Chi-square test												
H0 - Males and females are equally suffered by the given health problems due to online learning												
H1 - Males and females are not equally suffered by the given health problems due to online learning												
Health problems suffered	**STRESS**		**HEADACHE**		**THIRSTINESS**		**EYE IRRITATION**		**EARACHE**		**BACK PAIN**	
Gender	M	F	M	F	M	F	M	F	M	F	M	F
Total N	93	192	92	211	80	156	115	225	97	192	99	211
X^2 Value	**1.282**											
Conclusion- H_0 accepted, males (M) and females (F) are equally suffered by the given health problems due to online learning												
Key – N- Number of Responses, SD – Standard Deviation, M – Males, F - Females												

3.3 Analysis Of Treatments Followed For Given Health Problems

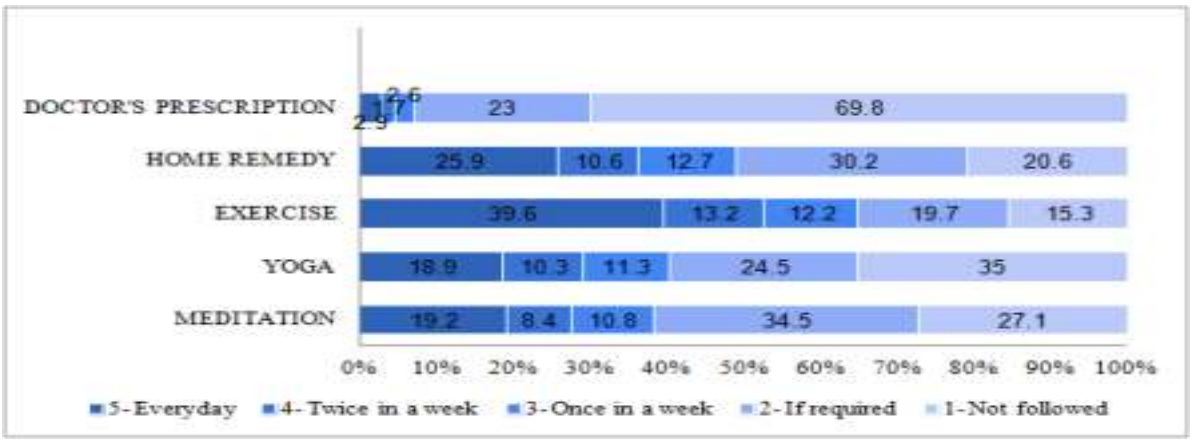
Pertaining to health factors, another question was framed in order to know treatment taken by students to overcome above mentioned health issues. The responses obtained through the 5-point Likert scale indicated variable choice of medication which is depicted in Table No. 5. It was found that data of opinions regarding the first four modes, viz., meditation, yoga, physical exercise and home remedy was normal in distribution. **However the data of medication using Doctor's prescription has high values of Skewness and Kurtosis which are indicative of presence of greater number of values at the tail region.** Therefore this parameter has been skipped for further statistical analysis of one way ANOVA and Chi-square test.

Table No. 5 Modes of Treatments followed by UG students

Parameter	N	Min	Max	Mean	Variance	SD	Skewness	Kurtosis
MEDITATION	417	4	2	2.5803	2.1095	1.4524	0.5984	1.9484
YOGA	417	4	2	2.5372	2.2973	1.5157	0.5339	1.7897
EXERCISE	417	3	5	3.4197	2.3547	1.5345	-0.3214	1.5451
HOME REMEDY	417	4	2	2.9089	2.2657	1.5052	0.2481	1.5712
DOCTOR'S PRESCRIPTION	417	4	1	1.4484	0.7479	0.8648	**2.5449**	**9.8418**

Key – N- Number of Responses, Min – Minimum, Max – Maximum, SD – Standard Deviation

Graph No.2 shows that undergraduate students preferred to follow self medication on health issues induced by online learning experience. **The habit of physical exercise is very common among students with lesser extent of practices of yoga and meditation. If required, the college students preferred to take home remedies on temporary illnesses such as headache, back pain, eye irritation and stress. However it is very clear that the Doctor's prescription is not followed by the majority of students for given health issues.**



Graph No. 2 Modes of Treatment followed by Undergraduate students

Further to add information to the graphical data, one way ANOVA applied on the positive responses (Everyday, Twice a week, Weekly, If required) towards health treatments by setting appropriate hypotheses. **As given in Table No.6, the statistical tool proved that the preference of modes of treatments followed by students significantly vary from each other.**

Table No. 6 Statistical analysis of data related to Modes of treatments by One Way ANOVA				
H0 - All modes of treatments are used in equal proportion				
H1 - All modes of treatments are used in unequal proportion				
Modes of treatments followed	**MEDITATION**	**YOGA**	**EXERCISE**	**HOME REMEDY**
Total N	304	271	353	331
Mean	3.1678	3.3653	3.8584	3.4048
SD	1.2723	1.2544	1.235	1.2884
F- Value	**17.8564**			
Conclusion - H1 accepted, preference to modes of treatment is significantly variable				
Key – N- Number of Responses, SD – Standard Deviation				

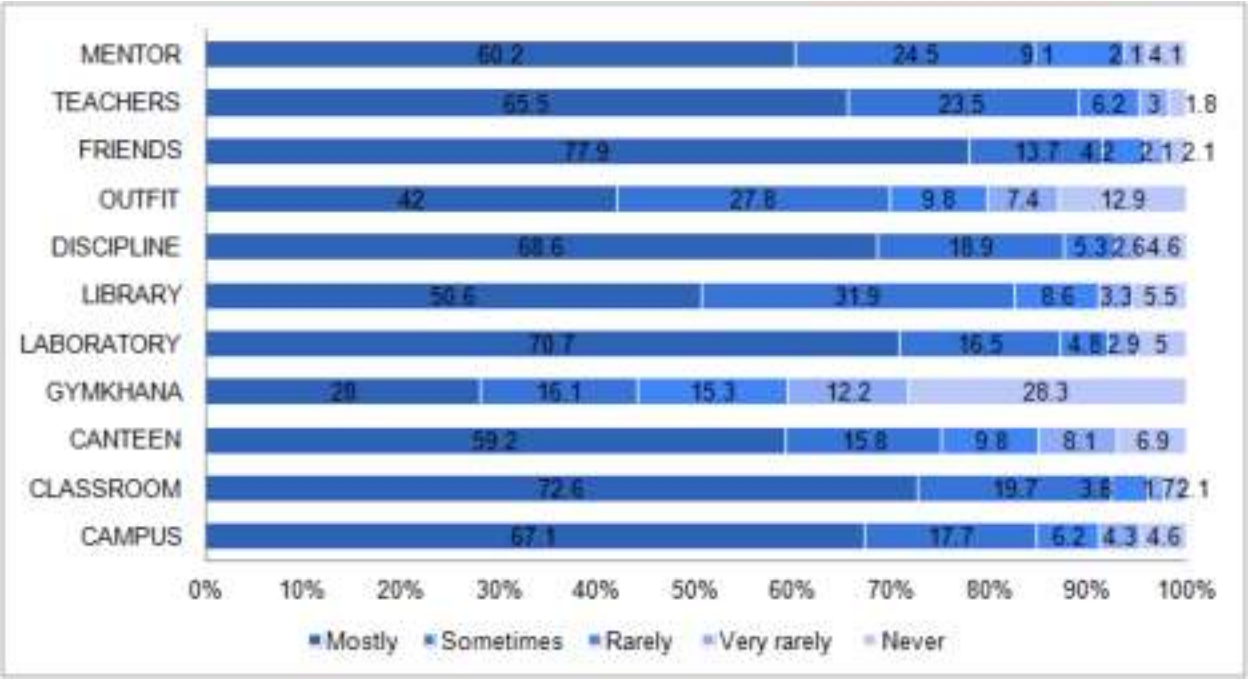
The choice of treatments was also compared by taking gender into consideration. The Chi-square test was applied on the positive responses by omitting responses of treatments 'Not followed' option. **The result indicated that the males and females significantly differ in their choice of medication (Table No. 7).**

Table No. 7 Statistical analysis of Gender wise preference to modes of treatments by Chi-square test								
H0 - Males and females give equal preference to given method of treatments								
H1 - Males and females do not give equal preference to given method of treatments								
Modes of Treatments	**MEDITATION**		**YOGA**		**EXERCISE**		**HOME REMEDY**	
Gender	M	F	M	F	M	F	M	F
Total N	94	210	86	185	129	224	100	231
X^2 Value	**3.84**							
Conclusion- H_0 accepted, males (M) and females (F) do not give equal preference to given method of treatments								
Key – N- Number of Responses, M – Males, F - Females								

3.4 Analysis Of The Extent To Which Students Miss Offline College

It was very difficult to gauge the emotional problems of college students undergoing online learning due to sudden imposed lockdowns. Their age is a crucial turning point where they absorb a lot of qualities through peer groups, social interactions, cultural exchange, group studies, etc. Therefore to ascertain the emotional status, 5- point based Likert Scale questions were framed in such a way that it can provide some clue towards to what extent these students missed various meeting places and the related activities of offline college. **Data of Table No. 8 exhibits that all questions received the highest response for missing all aspects of Offline College 'Mostly' in their day today life. The Graph No. 3 goes concurrent with the same.** However the Skewness and Kurtosis values of data regarding factors like activities of 'Classroom' and meeting with 'Friends' do not favour normal distribution. Hence these two factors are not considered in one way ANOVA and Chi-square tests.

Table No. 8 The extent at which students missed places and activities related to offline college								
Parameter	**N**	**Min**	**Max**	**Mean**	**Variance**	**SD**	**Skewness**	**Kurtosis**
CAMPUS	417	2	5	4.3861	1.1703	1.0818	-1.8815	5.6492
CLASSROOM	417	2	5	4.5899	0.68	0.8246	**-2.5646**	**10.0361**
CANTEEN	417	1	5	4.1223	1.6316	1.2774	-1.2673	3.3025
GYMKHANA	417	2	5	3.0336	2.5421	1.5944	-0.0584	1.4448
LABORATORY	417	2	5	4.4508	1.1232	1.0598	-2.1369	6.7249
LIBRARY	417	2	5	4.1871	1.1909	1.0913	-1.5514	4.8426
DISCIPLINE	417	2	5	4.4436	1.0599	1.0295	-2.1154	6.8262
OUTFIT	417	2	5	3.7842	1.9389	1.3924	-0.931	2.5303
FRIENDS	417	1,2	5	4.6307	0.7046	0.8394	**-2.7076**	**10.3134**
TEACHERS	417	1	5	4.4796	0.7646	0.8744	-1.9763	6.8562
MENTOR	417	2	5	4.3453	1.0295	1.0146	-1.7923	5.8367
Key – N- Number of Responses, Min – Minimum, Max – Maximum, SD – Standard Deviation								



Graph No. 3 Extent of missing various aspects of Offline College by students

The data has been sorted for positive responses including opinions like 'Mostly', 'Sometimes', 'Rarely' and 'Very Rarely' which was further subjected to one way ANOVA. **The Table No. 9 i.e. results of ANOVA revealed that all factors related to Offline College contribute variably in mental status of students.**

Table No. 9 Statistical analysis of data related to the extent at which students miss Offline College by One Way ANOVA									
H0 - All aspects of offline college are equally contribute to affect mental health of students									
H1 - All aspects of offline college variably contribute to affect mental health of students									
Aspects of Offline College	**CAMPUS**	**CANTEEN**	**GYMKHANA**	**OUTFIT**	**LABORATORY**	**LIBRARY**	**TEACHERS**	**DISCIPLINE**	**MENTOR**
Total N	398	388	299	363	396	394	410	398	400
Mean	4.5477	4.3557	3.8361	4.1983	4.6338	4.3731	4.539	4.608	4.4875
SD	0.8071	0.9843	1.1247	0.9486	0.7185	0.7946	0.7529	0.7183	0.7591
F- Value	**29.4887**								
Conclusion - H1 Accepted, therefore all aspects of offline college variably contribute to affect mental health of students									
Key – N- Number of Responses, SD – Standard Deviation									

Similarly the responses obtained for positive opinions (excluding opinion of 'Never') were also categorized according to two distinct parameters, viz., family background (Joint family vs Nuclear family) and gender (Male vs. Female). The detailed statistical analysis was carried out by the 'Chi-square test'. **Table No. 10 indicates that all respondents irrespective of their family background are equally sensitive towards emotions involved in various activities/ meetings which often take place in offline college. Moreover, the male and female candidates who are from the joint family, they also expressed equal degree of sentiments towards offline college and its environment. However gender wise analysis of only nuclear family candidates show significantly high differences in the magnitude of psychological involvement in offline college aspects. The probable reason could be the absence of siblings and other elderly people who contribute in emotional support.**

Table No. 10 Statistical analysis of Family Background and Gender wise magnitude of getting mentally affected by various aspects of Offline College by Chi-square test									
Parameter - Family Background H0 - All candidates from joint family and nuclear family are equally affected with regard to various activities related to offline college									
H1 - All candidates from joint family and nuclear family are not equally affected with regard to various activities related to offline college									
Parameter - Gender of Joint Family Candidates H0 - Males and females from Joint family background are equally sensitive towards to different emotional factors pertaining to activities of offline college									
H1 - Males and females from Joint family background are not equally sensitive towards to different emotional factors pertaining to activities of offline college									
Parameter - Gender of Nuclear Family Candidates H0 - Males and females from Nuclear family background are equally sensitive towards to different emotional factors pertaining to activities of offline college									
H1 - Males and females from Nuclear family background are not equally sensitive towards to different emotional factors pertaining to activities of offline college									
Aspects of Offline College	**CAMPUS**	**CANTEEN**	**GYMKHANA**	**LABORATORY**	**LIBRARY**	**DISCIPLINE**	**OUTFIT**	**TEACHERS**	**MENTOR**
Joint Family (M)	32	32	29	31	33	32	33	32	32
Joint Family (F)	59	57	42	57	57	57	58	59	57
Joint Family	**91**	**89**	**71**	**88**	**90**	**89**	**91**	**91**	**89**

Total N									
Nuclear Family (M)	107	100	86	104	200	105	90	109	104
Nuclear Family (F)	200	200	141	203	104	204	188	209	206
Nuclear Family Total N	**307**	**300**	**227**	**307**	**304**	**309**	**278**	**318**	**310**
	Parameter - Family Background Joint Family Total N vs. Nuclear Family Total N = 1.123								
X2 Values	**Conclusion- H_0 accepted, all candidates from joint family and nuclear family are equally affected with regard to various activities related to offline college**								
	Parameter - Gender of Joint Family Candidates Joint Family (M) vs. Joint Family (F) = 0.798								
X2 Values	**Conclusion- H_0 accepted, males and females from Joint family background are equally sensitive towards to different emotional factors pertaining to activities of offline college**								
X2 Values	**Parameter - Gender of Nuclear Family Candidates Nuclear Family (M) vs. Nuclear Family (F) = 116.466**								
	Conclusion- H_1 accepted, males and females from Nuclear family background are not equally sensitive towards to different emotional factors pertaining to activities of offline college								
Key – N- Number of Responses, M – Males, F - Females									

IV. CONCLUSION

In India, the offline mode of learning was prevalent prior to the COVID imposed lockdown. UGC (University Grant Commission) i.e. the authoritative body of Indian higher education accepted online mode of learning because that was the only choice available which assured continuous learning in severe crisis of COVID. Due to unpredictable periods of closure of educational centres, college students underwent sudden change in delivery of learning materials. Through current study, it is found that college students affected significantly by variable physical and emotional issues. It is observed that, majority of students use android mobiles for attending class and accessing study materials. Such prolonged exposure may prove harmful in long run of e-education. Hence students should be made aware about health impacts and advised to use personal computers or laptops if possible. In order to reduce intensity of eye irritation which frequently occurred due to long screen time, use of screen guards and spectacles with antiglare coatings can be recommended to students. They should prefer correct sitting posture, minimize use of headphones and drink sufficient quantity of water to avoid risk of chronic ailments. As the intensity of health problems occurred due to online sessions is same in both genders, these recommendations are same for male and female candidates.

It is proved that a practice of 'Yoga' is a promising option for healthy life. It does not only reduce physical pain, stress, anxiety and depression but also bring mental healing (Woodyard, 2011). In the present study, modes of treatment for problems suffered reveals that 65 % of students chose the yoga option which is quite appreciable. In future, UGC may go for blended learning approach so it is advisable for all educational institutes to insert 'Yoga' module in their curriculum, which will be ultimately helpful to the students.

Due to obligatory norms of social distancing and restricted mobility, college student are compelled to stay disconnected from friends, peer group, teachers and mentors. The e-learning method offers a solitary learning experience as there are no physical meetings among people who are involved in exchange of information (Alkhalaf, Drewa, & Alhussain, 2012). This is the additional taxing feature of online learning. The study reveals that students are emotionally connected to learning environment of Offline College irrespective of gender. The factors like campus, canteen, gymkhana, classrooms, labs and library are not mere structures for social gathering but they are platforms for personality development among students. Similarly direct contact with teachers/mentor and their body language also influence student's personality in multiple ways. The analogous observations are also reported by Khattar, Jain, & Quadri (2020). However, if teachers could design the learning modules in more interactive ways, it may minimize the emotional burden of students.

In conclusion, e-learning approach is appropriate to meet requirement of continuous education in situations of COVID crisis. But in comparison to offline learning, it demands responsible behaviour from learner's end (Zhang, Zhao, Zhou, & Nanumaker, 2004). The learners should be vigilant with regard to physical health and also should able to mingle with fellow friends and teachers at virtual front.

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ARTICLE

Wild Edible Plants Used by the Tribes of Panvel and Uran Tahsils in Alibaugh District, India: Ethnobotanical Application and Tribal Recipes

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Recipe

ABSTRACT

The "Indus-Vedic" cultural heritage of India is well-known. Wild edible plants, sometimes known as weeds, are widely consumed in India's varied areas. Wild edible plants and weeds are essential for tribes' survival, both as a source of food and as a source of money, such as timber. This study aims to identify wild vegetables collected for ethnomedical purposes and their recipes by the local people, as well as determine the local uses and names of these plants, with the goal of closing the gap in traditional knowledge regarding the utility of wild plant species and tapping the hidden potential resources for proper utilization, exploitation, and nutritive evaluation. A field research study was conducted two years 2020-2021. 34 wild vegetable plant specimens were collected during this time. The names of the plants found in the area, as well as the parts that were used and how they were prepared, were examined and recorded. This type of extensive survey technique could assist aspiring scientists in learning about the health advantages of wild food plants and weeds, which can subsequently be combined to generate successful crop plants. Such a system will benefit in the mitigation of food shortages, the regeneration of infertile lands, and the enhancement of rural economies.

1. Introduction

Tribes' dependence on unconventional wild vegetables is because of their habitat in hilly areas surrounded by forest. The majority of their agricultural fields are on hills and are therefore less productive. The scarcity of cereals and pulses begins with the arrival of winter. Tribes go to the nearby forest on a regular basis to obtain forest produce to augment their nutrition. To fulfil their hunger, the tribals are constantly on the lookout for unusual wild foods that have been growing for years [1].

For the uncommon wild vegetables, the monsoon is the most abundant season. These vegetables are abundant from July to September in forests, along hill slopes, nearby river banks, around ponds, and in and around their hamlets where abundance of cow dung is available for their good growth. The majority of wild vegetables are accessible for good growth throughout the first two

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months of the monsoon. Though the majority of wild vegetables are available to tribals during the first two months of the monsoon, just a few are left behind for their family members due to strong demand in the local taluka market. Because of their ethnomedicinal value, the unusual wild vegetable brings in extra money for the tribals.

Though functional food is higher in minerals, proteins, and beta-carotene than unusual green leafy vegetables, tribals' intake of functional food is lower due to non-availability in bulk, improper cooking methods, and an excess of crude fibre; thus, tribals exhibit signs and symptoms of malnutrition, with growing children and lactating mothers being the main victims [2]. Fruits contribute more to tribal diets than cereals, however not to the extent recommended by the ICMR, which could be one of the causes of vitamin A deficiency among them.

The diets of diverse Indian tribal tribes were found to be seasonal, lacking in green vegetables, and high in crude fibre, according to studies [3]. Children, breastfeeding moms, and pregnant women are the most susceptible to such imbalanced nutrition. During the monsoon season, infectious disorders linked to malnutrition are especially common among tribals. In this season, tribal people's diets contain only a small amount of leafy vegetables, despite the fact that green leafy vegetables are readily available [4]. Fibre is abundant in a variety of wild vegetables. The primary impediment to the biological availability of proteins and vitamins is fibre. The oil is not included in the diet of the tribes. Milk and milk products are completely absent from their everyday dietary intake.

Several research on wild edible plants used by various groups in India have been undertaken, including edible plants from Maharashtra's Melghat forest [5], plant resources from Maharashtra's Thane area [6], and wild edible plants from India's Arunachal Pradesh [7], wild edible plants from Annamalai [8], Coimbatore district, Western Ghat [9], Sikkim Himalayan plant dietary applications [10,11]. Tripura, India and Ahmednagar, Maharashtra [12], biodiversity in Konkan Wild Vegetables [13,14]. Rural people eat wild edible plants as vegetables. Several investigations on traditionally used herbal remedies have been undertaken in Maharashtra (especially on the Western Ghat). In the Panvel and Uran regions, no effort had been done to document the diversity and utility of wild vegetables. As a result, the current research was designed to describe the variety of wild vegetables consumed by rural and urban residents in the Panvel and Uran areas of Albaugh, Maharashtra, India.

2. Materials and Methods

Selection of the site

Panvel and Uran are the most economically underdeveloped places since their human habitats are inaccessible to modern culture and civilization. The tribals in this area are still surrounded in a past era, without access to all of the modern amenities. Their anthropological dictionary is totally lacking of the magical word "science". For our research, we chose a rural location in Panvel and Uran taluka.

Collection of Wild Vegetables

Vegetable samples were collected on a quarterly basis in the study locations. In the Panvel and Nerul Navi Mumbai areas, vegetable samples were also collected from village elders, farmers, vegetable merchants, customers, and vegetable middlemen.

Plant Identification

Specimens were identified using standard procedures [15,16] and Flora of Gujrat) with supporting information for ethnomedical uses and recipes [17-19]. Tribes were interviewed to learn about local vegetable names, habits, habitats, cooking methods, ingredients, current availability, distance travelled to acquire the vegetables, time gap before cooking, and quantity used in preparation.

3. Results and Discussion

Tribes consume largely leafy vegetables that grow like weeds in the wild [20]. According to the findings of this research, the Panvel and Uran areas are rich in wild vegetable species with enormous potential for human use, contributing favourably to the local economy and livelihoods of the many populations. In this work, a total of 34 wild edible plant species from 22 families and 29 genera have been found, classified, and discussed. Plant species' botanical names, as well as local names, habits, families, parts used, modes of usage, ethnomedicinal applications, and tribal recipes, are arranged alphabetically. With five species, the Cucurbitaceae family takes the lead, followed by Araceae with four species, the Yam family or Dioscoreaceae with three species, Vitaceae, Fabaceae, and Chenopodiaceae with two species respectively, and the rest with one species each.

The leaves, which represent 18 species, were found to be the most consumed part of the plant, followed by fruit (15 species), bulb/rhizome/corm/tuber (08 species), tender shoots (06 species), flowers/inflorescence (06 species), and seeds (02 species). Wild edible plants found in the

research area were frequently used as vegetables in curry, soups, and pickles. Many of them are utilized for healing purposes due to their ability to cure a variety of diseases. Some are eaten raw, while others are cooked, and many are used as food substitutes when food is scarce.

According to the findings of this study,98 percent of all plants documented have medicinal properties and are commonly used for common ailments such as coughs, asthma, stomach issues, skin infections, urine, and so on. According to the market survey, a total of 34 wild edible plants have commercial value among locals and are frequently sold in small markets or even transported to larger marketplaces nearby. The market price of these plants has been compared between the remote Uran market and Navi Mumbai town, and it has been discovered that the selling price of these plants doubles to triples once they reach urban areas. Some of these wild edible plants are isolated to rural populations and are not very popular in urban markets, according to reports.

1) *Alylosia lineta* Wight and Arn's. (Local Name: Jangli Tur Sheng, Family-Fabaceae).

Edible parts: Fresh leaves, young pods, and seeds are all edible portions.

Tribal recipe: young leaves are utilised as vegetables in this traditional dish. Salt is added to mature pods before they are boiled. The seeds are removed and consumed. Young pods are eaten directly.

Ethnomedicinal applications: Its ethnomedical uses include itching relief and the treatment of blood impurities. The malnourished child is given plain boiled seeds.

2) *Amaranthus gangeticus* (Local Name-Ran Math, Family-Amaranthaceae).

Edible parts: young leaves and tender shoots are edible parts.

Tribal recipe: Fresh young leaves and stem portions are boiled and served in curries or as a vegetable with a pinch of salt and chilies in a tribal dish.

Ethnomedicinal applications: Applications include wound healing, cough relief, and reducing the effects of alcohol.

3) *Amorphophallus commutatus* (Local Name: Shevli, Family: Araceae).

Edible Parts: All parts of the plant are edible, including tender shoots, leaves, flowers, and fruits.

Tribal recipe- Open inflorescence is fried on a light flame and served as a vegetable in a tribal dish. The leaves are cooked in water before being eaten.

Ethnomedicinal applications: Infusion is used to treat stomach issues in traditional medicine.

4) *Amorphophallus sylvaticus*, Roxb. Kunth. (Local name: Jangli Suran, Family- Araceae).

Edible parts- Corm, tender petiole, and young leaf are all edible components.

Tribal recipe- The corm is edible after being washed and boiled for a long time. Cut fresh young petioles into pieces, boil them, and eat them. Chopped young leaves are used as a vegetable.

Ethnomedicinal applications: Piles, coughing, and asthma are all treated with this herb.

5) *Atriplex hortensis var. hortensis*, (Local name: Chandan Batwa or Ran Batwa. *Family* Chenopodiaceae).

Edible part-The leaves are edible.

Tribal recipe-Cooked and consumed like a vegetable, the fresh leaves are used. Ingredients include salt and chilies.

Ethnomedicinal applications: A decoction of the leaves is used as a tonic, providing energy to weak patients. Lactating women should consume the vegetable to increase the amount of breast milk they produce.

6) *Bambusa arundinacea* Linn. (Local Name: Bamboo Comb), Family: Gramineae (Poaceae)

Edible parts-Part-tender shoots that are edible

Tribal recipe-The combs are peeled and sliced into little pieces, then heated in boiling water for a while before being thrown in with water. Bamboo is boiled and eaten with salt, chili and peppers.

Ethnomedicinal applications: Bambusa leaves, shoot and seeds used as astringent and laxative.

7) *Brassica nigra Linn.* (Local Name: Rai, Family-Cruciferae/Brassiceae).

Edible part- The leaves are edible.

Tribal recipe- Fresh leaves are cooked with onions and eaten as part of a tribal dish. Salt and chillies are the major ingredients.

Ethnomedicinal applications: Intestinal worms, skin infections, indigestion, stomach pain, and swellings are all treated with this herb.

8) *Capparis moonii* Wight. (Local Name-Pendra), Family-Capparaceae)

Edible part-Fruit

Tribal recipe- The fruits are sliced and the seeds are removed in this tribal dish. With some oil, chilies, and salt, the sliced pieces are fried on a low burner.

Ethnomedicinal applications: Seed paste is used as an antibacterial on wounds in traditional medicine. Also known as Anasarca.

9) *Chenopodium album* (Local Name: Chakwat, Family-Chenopodiaceae).

Edible part: Leaves

Tribal recipe- Fresh leaves are cooked with salt and chiles as a vegetable.

Ethnomedicinal applications: Used to treat throat infections. After the symptoms of chickenpox appear, that plant's juice is mixed with honey and used to make the person suffer vomiting.

10) *Colocasia antiquorum* L. (Local Name-Arve, Family-Araceae).

Edible parts: Tubers

Tribal recipe- The tubers are pilled and cut into pieces, then washed in water and cooked as a vegetable; they can also be eaten raw after washing and roasting in hot ash, or cooked with oil, salt, and chilies and then consumed.

Ethnomedicinal applications: It has digestive qualities.

11) *Colocasia esculenta* (Local Name: Alu, Ghuiyan, Family: Araceae).

Edible parts: Leaves with a long succulent petiole and rhizome are edible.

Tribal recipe-Rhizomes are washed often, then cooked and eaten with salt and chiles after the skin has been removed.

Ethnomedicinal applications: Astringent, stimulant, and rubefacient effects are found in the leaf juice. Corm juice is a laxative that can also be used to reduce bleeding in piles. It is used to help breastfeeding women produce more milk.

12) *Cucurbita maxima* (Local Name: Danger, Family-Cucurbitaceae).

Edible parts-Tender shoots, leaves, flowers, and fruits are all edible components of the plant.

Tribal recipe-Open flowers are fried on a low flame and used as vegetables in a tribal dish. Cut the leaves into pieces, boil them in water, and eat them.

Ethnomedicinal applications: Flowers are used as an ethnomedicinal treatment for skin infections.

13) *Dioscoria pentaphylla (Local Name: Gabholi, Family-Dioscoreaceae).*

Edible parts-Flowers in inflorescence form are edible.

Tribal recipe- When male flowers are green, they are consumed, while female flowers are cream-colored. Male and female plant flower buds are used in curries as vegetables. Flower buds that have been cooked are delicious popular food delicious.

Ethnomedicinal applications: Aphrodisiac, it is said that eating a lot of flowers and vegetables can make you more attractive to other people.

14) *Dioscorea bulbifera (Local name-Kadukand, family- Dioscoreaceae).*

Edible part- The underground tubers are known as "kadukand" and are edible.

Tribal recipe- Underground kadukand can be made edible by treating it as follows: It is cleansed initially by removing the root hairs. They are properly washed in running water, peeled, and sliced into slices before being served with salt. They can be placed in hot ash for 2 to 3 hours before being cut into pieces and fried. Bulbul's vegetables are prepared in a manner that is comparable to that of potato tubers. The outside warty layer is removed first, and the inside section is used to prepare vegetables. It can also be roasted and eaten with salt in hot ash.

Ethnomedicinal applications: Ulcers, piles, diarrhea, and syphilis are all treated with dried and powdered tubers. The sedative qualities of young bulbils are well-known.

15) *Dioscorea oppositifolia* L. (Local Name Dukkar-Paspoli, Family-Dioscoreaceae).

Edible parts-Underground tubers, flowers, and aerial bulbils are all edible.

Tribal recipe-Tubers are edible after several items of washing and boiling, and long-duration leaves are consumed when food is scarce. Bulbils are boiled after turning brown-black, the outer wart removed, and the interior starch consumed. Bulbils are also roasted and consumed after the outer coating has been removed.

Ethnomedicinal applications: The use of flowers is common. It promotes sexual desire in the diet. It's used to cure piles and stomach pain, among other things.

16) *Garuga pinnata* Roxb. (Local Name- Kakad, Family-Burseraceae).

Edible part: Fruits

Tribal recipe: the drupes can be eaten fresh, boiled, or pickled. They are highly acidic and have a cooling effect on the digestive system. To neutralize the raphides, fruits were combined with shevli during vegetable preparation.

Ethnomedicinal applications: The juice of the stem is used as a treatment for conjunctivitis opacity. Asthma can be helped by mixing leaf juice with honey.

17) *Guizotia abyssynica* Cass. (Local Name-Karale, Family-Compositae).

Edible part-Leaves

Tribal recipe- The leaves are finely chopped and fried on a low temperature, with salt and chillies added.

Ethnomedicinal applications: The oil is derived from seeds and has ethnomedicinal applications. It has a laxative effect. It can also be used on a person who is suffering from joint discomfort or Rheumatism. Ginger and castor oil are tainted with it.

18) *Hibiscus cannabis Linn*. (Local name: Ambadi.) Family Malvaceae

Edible part-Leaves

Tribal recipe-Fresh leaves are cooked with salt and chilies and consumed as a vegetable in this tribal dish.

Ethnomedicinal applications: cooked leaves with rice are given to people who have dyspepsia caused by

Mahuwa oil. It's a pain reliever. If there is a problem passing urine, a decoction of seeds is given.

19) *Holarrhena antidysentrica* Wall. (Local Name-Kuda Sheng), Family-Apocynaceae).

Edible part: Pods

Tribal recipe-The pods are fine chopped in this tribal dish. These pieces are rinsed and cooked in a mild amount of oil with salt and chiles. It was prepared over low heat.

Ethnomedicinal applications-Alkaloids with therapeutic characteristics are abundant in plant parts, especially fruits. Roots and bark are used to cure diarrhea since they are anti dysenteric drugs. It's acidic, and it's good for digestion and cooling.

20) *Leea indica* Burm (Local Name-Bhane, Family-Vitaceae).

Edible part-young leaves and stem

Tribal recipe-There are two different types of tribal recipes.

• Pilled and chopped into small pieces, the young stem is boiled in water and eaten with salt. • The water is discarded, and the young stem is pilled and chopped, along with the leaves, and cooked on a low flame, sometimes with crabs.

Ethnomedicinal applications: The stem juice is used as an anthelmintic, and the tuber is used as an antiseptic for wound care.

21) *Leea macrophylla* Roxb. (Local Name- Dinda, Family-Vitaceae).

Edible part-The tender leaves and fruits

Tribal recipe-Fresh leaves and fruits are cooked with salt and chiles as a vegetable.

Ethnomedicinal applications: The root tubers are astringent and also have ethnomedicinal applications. Because of its healing properties, mucilage is applied to wounds and sores.

22) *Luffa tuberosa* Roxb. (Local Name-Satpute, Family-Cucurbitaceae).

Edible part-Fruits

Tribal recipe-The fruits are cut open and the seeds are removed in this tribal dish. Then it was sliced, salted, and set aside for a while. Then they were rinsed and cooked on low heat.

Ethnomedicinal applications: a decoction of the roots is used as a stomachic medicine. The seeds are crushed into a paste and applied to swollen areas of the body.

23) *Madhuca longifolia* Linn. (Local Name-Mahuwa, Mowa, Tode, Family -Sapotaceae).

Edible parts: Flowers, seeds and fruits

Tribal recipe-Flowers and fruits are lightly cooked and eaten with salt in a tribal recipe. Seeds that have been extracted for oil can also be eaten.

Ethnomedicinal applications: Madhuca leaves are effective in the treatment of Eczema. Tree flowers help to breastfeed women produce more milk. Snake poisoning is treated with seeds. Seeds are used to extract oil, which is then consumed. Flowers are combined with putrefied jaggery to make Mahuwa liquor, a fermented wine.

24) *Manihot esculana* Pohl (Local Name: Tapioca, Family- Euphorbiaceae).

Edible part: Tuberose roots

Tribal recipe-Tapioca roots are consumed after boiling and roasting in a tribal recipe. Root flour meal is consumed after it has been boiled or roasted.

Ethnomedicinal applications: If you have a constipation problem, use it as an appetizer. Wounds and ulcers are also treated with this treatment. In dyspepsia and anorexia, it is used as an aperient.

25) *Melothria heterophylaa* Cogniaux (Local Name-Gomati, Family-Cucurbitaceae).

Edible part-Fruit

Tribal recipe-The fruits are chopped into little pieces, sprinkled with salt, and left for a few minutes in this tribal recipe. Then they're rinsed and fried in a small amount of oil on a low flame.

Ethnomedicinal applications: Its juice is used to treat stomach pain in folk medicine. Carminative

Social Application-A person whose parents have passed away is not permitted to eat the vegetable.

26) *Momordica dioca* Roxb. (Local Name-Kartoli, Family-Cucurbitaceae).

Edible parts- The immature fruits, as well as young leaves and tubers, are edible.

Tribal recipe-In urban areas, young fruits are in high demand. Curries with young green fruits are tribal recipe.

Ethnomedicinal applications: Tuberose roots are used in traditional medicine to treat bleeding piles, digestive and urinary problems.

27) *Moringa oleifera* Linn. (Local Name: Shevaga, Family-Moringaceae).

Edible parts-Fresh leaves, tender pods, and even flowers are edible.

Tribal recipe-young leaves and flowers are steamed before being mixed with gram flour, salt, and chilies in a tribal recipe. Only salt and chilies are used in the tribal habitat's inner.

Ethnomedicinal applications: This vegetable is used to treat eye issues, indigestion, and snake poisoning.

28) *Nymphaea lotus* Linn. (Local name-Bhishi, Kamal, Family-Nymphaeaceae).

Edible part: Underground tubers

Tribal recipe-Washing 4-5 times and then cooking with salt is a tribal dish.

Ethnomedicinal applications: Rhizome is utilised in the treatment of diarrhoea, dysentery, general debility, and heart problems. In indigestion, vomiting, and dysentery, root stock churna is employed. A decoction of tubers is provided in the case of excessive heat in the body, as well as during the passage of seminal fluid through the urine.

29) *Paracalyx scariosus* Roxb. (Local Name-Ran Ghevda, Family-Fabaceae).

Edible part-young leaves and pods

Tribal recipe- Fresh young leaves are cooked with onion, salt, and chilies in a tribal recipe. Beans are removed from the pods and consumed after they have been boiled with salt.

Ethnomedicinal applications: Ethnomedicinal uses include scorpion bites and leg cramps.

30) *Portulaca oleracea* Linn. (Local name-Ghol, Family-Portulaceae).

Edible part- Stem and leaves

Tribal recipe-Fresh stems and leaves are lightly cooked and eaten with onions and chilies in the tribal recipe.

Ethnomedicinal applications: Seeds are a cooling diuretic that can be used to treat jaundice and diarrhea. They can also be used to treat burns and scalds. Skin problems, abscesses, wounds, coughs, and swellings are all treated with this herb. Also used for tiredness, difficulties breathing, and vision problems.

31) *Praecitrullus fistulous* Stocks (Local Name-Dhemse, Family-Cucurbitaceae).

Edible part-Fruit

Tribal recipe-Fresh fruits are eaten like a vegetable with salt and chilies in tribal recipes, and they are also utilized in curries.

Ethnomedicinal applications: Ethnomedicinal uses include the treatment of fevers, blood infections, and asthma.

32) *Smithia purpurea* (Local Name-Kaula), Family-Papilionaceae

Edible part-Leaves

Tribal recipe-Chopped leaves are cooked for a few minutes on a low flame in this tribal recipe. A sufficient amount of oil, salt, and chili is used. When combined with crab legs, it is supposed to form a delicious dish.

Ethnomedicinal applications: Anthelmintic properties are found in the juice of the leaves. Malnourished babies are fed a paste made from young leaves to help them gain strength.

33) *Solanum verbascifolium* Linn. (Local Name Jungli Wangi, Family-Solanaceae).

Edible part-young fruits

Tribal recipe-Fruits are usually cooked for a few minutes in tribal dishes. Boiled water is discarded, and curries are made with vegetables.

Ethnomedicinal applications—In tribal medicine, leaves and fruits are used. Fruits have a laxative effect. Toothaches are treated with seeds.

34) *Spondius pinnata* (Linn.) Kurz. (Local Name-Ambada, Family-Anacardiaceae)

Edible part-Fruit

Tribal recipe: The fruits are sliced and the seeds removed, then cut into pieces and cooked as a dry vegetable with salt and chilies in a small amount of oil. Fruits are also cooked in curries.

Ethnomedicinal applications: The seeds are powdered and applied to rashes, eruptive acne.

Many people in rural areas around the world depend on wild edible plants for food., made several attempts to compile a list of the wild foods found in Maharashtra's Vidarbha region [21-24]. Vegetables are high in vitamin A, and the vitamin B complex, as well as dietary fibre and phytochemicals. The nutrients found in wild vegetables also safeguard our bodies from starvation and nutrient deficiencies. That's why they're referred to as "protecting foods" [25]. These unusual wild edible plants are rich in micronutrients and trace elements, as well as proteins and lipids [26,27]. According to a review of the research, eating enough vegetables can prevent you from chronic diseases like cancer, obesity, diabetes, cardiovascular disease, and metabolic syndrome.

4. Conclusions

People will have to depend on wild edible plant resources as an alternative to conventional ones in the near future to meet the increasing demands for food and nutritional requirements due to the increasing population pressure. As a result, plant resources play an important role in resolving a variety of issues such as shelter, food, and medicine. As a result, many of these wild plants have a high cultural value among the locals and are thus linked to their indigenous traditions.

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Qualitative Study of Fisheries Species Diversity

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ABSTRACT

Ulhas River Estuary and Thane creek are two adjacent brackish water bodies lying in the vicinity of Thane City. These are highly impacted by various anthropogenic activities mainly due to urban, industrial, and reclamation activities. Artisanal fisheries from these water bodies have been under threat for decades. The qualitative fisheries diversity study revealed that the water body has declined further in fisheries catches. Nevertheless, a total of 31 fisheries species were observed in the study. Some species viz. Mystus gulio, Oreochromis mossambicus, and bivalves which were previously reported to be abundant were found to be dwindling in the present scenario. However, species like mullets, crabs, Acetes indicus, shrimps sciaenids, and clupeiformes were abundant in the present study Moreover the marketing and dealing have no proper facilities. The perennial estuarine fish species were high in landings followed by estuarine seasonal species. The marine migratory fish dominated the landing as compared to the riverine migratory species.

Keywords: Qualitative fisheries diversity, Ulhas River Estuary, Thane Creek, Artisanal fishe small-scale scale fisheries,

INTRODUCTION

The fisheries play important role in the livelihood of the local fishermen community in the vicinity of various water bodies. The estuaries and harbour marine and freshwater fishery species and support an artisanal fishery. In recent years the inward waters in the vicinity of urban areas have received lots of pollution pressure due to increasing industries and human population, the world over (FAO, 2007; Barletta, 2012). It has been found that many such urban water bodies been declined in fisheries due to various anthropogenic activities (Pawar, 2011; Chaudhari et *al.*, 2012; Krina Kumar and Rajan, 2012; Lima et *al.*, 2016; Paul et *al.*, 2018; Barletta and Lima, 2019; Kurve and Patil, 2019).

The fisheries sector has been contributing to the socioeconomic development of India for centuries. Presently it is a source of over 14 million people. The total fishermen population as per Livestock Census, 2003 was 14,485,354, which includes 4,696,158 males, 4,033,963 females and 5,755,233 children. Fishermen engaged full-time in fishing operations were 933,124 and part-time were 1,072,079 (Handbook on Fisheries Statistics, 2014). Artisanal fisheries, classified by FAO as small-scale fisheries are neglected in India (Muralidharan,

2017). Thane is credited with 112 km of coastal lines and about 2 560 mechanized boats against 318 non-mechanized boats engaged in fishing activities (FAO, 2007). FAO (2007) reported that Thane had 427 tonnes of brackish water prawn landing alone. Quadros and Athalye (2012) reported a 75% decline in fish catches from the shallow area of TC during their study. Artisanal fisheries of Thane from URE and TC have been under a declining phase since 1996 (Rathod, 2016) in addition the COVID-19 pandemic lockdown worsened the situation. FAO (2007) reported that Thane had 427 tonnes of brackish water prawn landing alone.

Ulhas River Estuary (URE) and Thane Creek (TC) lie near the Thane City near Mumbai, Maharashtra State, India. The estuarine part of the Ulhas River commences from S-E (Lat. 19º 16' N and Long.72º 45'E) near Kalyan –Dombivli railway station head wards, meanders for about 40 km. before it joins the Arabian Sea towards N-E at Vasai creek situated between the (Latitude 18º .45' to 19º .16' N and longitude 72º .42' to 73º .20', E). Whereas Thane Creek occurs between Latitude 19º, 00 to 19º.15; longitude 72º.55 to 73º.55 eastwards of Thane City. It is 26 km long opening at its northern end to the Ulhas River Estuary by a narrow connection. The creek receives both treated and untreated water domestic as well as industrial wastewater from the nearby urban areas. It is 26 km long opening at its northern end to the Ulhas River Estuary by narrow connections. The Creeks receive both treated and untreated water domestic as well as industrial wastewater from the nearby urban areas. The fishery from these two water bodies has been historically recorded as the support of the economy of the local population.

Thane city has been overpopulated for the last few decades due to immigration from state the as well as outer people due to the economic downfall at their native places. This has put enormous pollution pressure on the existent inward water bodies in the vicinity viz. Ulhas River Estuary (URE) and Thane Creek (TC). However, 30% of the population in Thane City is belong to the fishing community. It has been observed in recent years that most of the people from the fishermen community of Thane City have abandoned fishing due to a decline in the ambient fisheries (Rathod and Patil, 2012). It has been reported earlier about the decline in fisheries from the ambient water bodies (Quadros and Athalye, 2012).

The present study envisages characterizing the distribution pattern of fish species diversity through the survey of the fish market post-COVID-19 pandemic Lockdown. The study will carry the out frequency of occurrence from the capture fisheries landings from URE and TC through a survey of their respective landing centres and local markets. The study will provide a database and also will be compared with earlier similar findings from the ambient water bodies. The study will carry the diversity of fishes from the capturing landing URE and TC through the local market. The study will provide a database and will compare it with earlier data.

MATERIAL AND METHODS

The study was carried out in a phase: data collection and data analysis. The primary data collected by carrying out field surveys were collected for a period of three months from October 2020 to December 2020 covering maximum fish catch landing centers and the ambient retail/wholesale markets. The According to earlier studies, the period stands in the Early-Post-Monsoon (EPM) season, which is the second-highest season in fish catches (Rathod, 2016). The fish landing centers at Vashi, and Ghasoli along Thane Creek whereas Kasheli- Kalher and

Kevani-Diva located along Ulhas River Estuary, were studied. The wholesale fish market at Thane and retail markets at Vashi, Ghansoli, Airoli, Vitawa, Mankoli, Kalwa, Kharegaon, and Kalher, were studied.

Sampling

The fish market where visited regularly or the fishes were observed and identified the data of fish diversity was also collected and studied through the information provided by the local fisherman. The study was carried out at the landing centres and wholesale markets of estuarine and creek fisheries (Fig.2). Fishes were identified and recorded on observation cards. The species-wise occurrence and 'Catch Density' (quantity) of fish caught were recorded on spot. Unidentified fish were carried to the laboratory for identification using relevant literature (Day, 1889; FAO, 1984; WoRMS).

Fig.1: The Glimpses of Landings of Fish in the Local Markets viz. Thane Main Market and Mankoli Naka Market showing Marketing Procedure of Commercially Important Species.

A. Thane City Wholesale Fish Market
The fisherwomen-dominated market is customary practice. The sale may be conducted in a wholesale or retail manner dependent on the landing size. However, the picture of the marketing itself is self-explanatory that the brackish water fisheries are dwindling to an alarming status.

B. Mankoli Naka Fish Market
This market is mostly dominated by the catches from URE. Hence it is a common scenario that freshwater fish species are encountered in the catches. Also, the URE is rich in crab, prawn, and mudskipper fisheries.

RESULTS AND DISCUSSION

The pooled data of the abundance regime of fish catches from URE and TC were dominated by mullets, clupeids, *Acetes indicus*, shrimps, and crabs (*Scylla serrata*). *Oreochromis mossambicus* was moderate (Fig.2). As an individual species, the highest catch was observed for *Scylla serrata*. The species diversity was represented by a total of 31 species along with some commercially important species viz. mullets, crabs, *Acetes indicus,* shrimps sciaenids, and clupeiformes. Others were *Mystus gulio*, *Megalops cyprinoides*, *Lates calcarifer, Oreochromis mossambicus, Boleophthalamus dussumieri, Labeo calbasu, Strongylura strongylura, Trypauchen vagina, Terapon spp., Caranx sexfasciatus, Sillago sihama, Scatophagus argus,* and *Channa punctata*. Clams were contributed by four species but the catch was negligible (1.71%) (Table1, Fig.2 and Fig.4).

Table1: Abundance of fish Species from the Survey markets in EPM Season from URE and TC

Category	Species	Local Name/ Common Name	Family	Abun.	Grp. Percent	Percent
Estuarine Perennial	*Mugil cephalus*	Mangin/ Flathead grey mullet	Mugillidae	+++++	46.61	14.08
	Planiliza subviridis	Boi/ Greenback mullet	Mugillidae	++++		7.96
	Paramugil paramatus	Boi/ Broad-mouth mullet	Mugillidae	++		3.93
	Mystus gulio	Chimni/ Long whiskered catfish	Bagridae	+		0.99
	Boleophthalamus dussumieri	Nivti/ Eshlambo Mudskipper	Oxudercidae	+		0.35
	Trypauchen vagina	Kaleti/ Burrowing goby	Gobiidae	+		0.09
	Scylla serrata	Chimbori /Mud crab	Portunidae	++++++		15.31
	Oreochromis mossambicus	Kala masa/ Mozambique tilapia	Cichlidae	++++		3.90
Estuarine Seasonal	*Lates calcarifer*	Khajura, Jitada, Fitadar/ Barramundi	Latidae	+	29.82	0.31
	Sillago sihama	Mudadi, Rinvi/ Northern whiting	Sillaginidae	+		0.19
	Metapenaeus affinis	Kolabi/ Jinga-shrimp	Penaeidae	+++++		10.79
	Metapenaeus monoceros	Kapsi, Chamari/ Speckled shrimp	Penaeidae	++++		8.99
	Acetes indicus	Jawla/ Paste shrimp	Sergestidae	+++		7.83
	Meretrix meretrix	Tigri, Shivali/ Asiatic hard clam	Veneridae	++		0.88
	Meretrix casta	Tisrya/ Backwater hard clam	Veneridae	++		0.36
	Paphia malabarica	Tigri, Shivali/ Tisreo	Veneridae	++		0.28
	Villorita cyprinoides	Tisrya/ Black clam	*Cyrenidae*	+		0.19
Marine Migratory	*Megalops cyprinoides*	Varas/ Indo-Pacific tarpon	Clupeidae	++	21.43	1.66
	Terapon jarbua	Naveri, Hajam/ Crescent grunter	Tetrapontidae	++		0.49
	Terapon theraps	Dada-dada / Banded grunter	Tetrapontidae	+		0.29
	Tenualosa toli	Bhing, Pala/ Toli shad	Clupeidae	+		0.25
	Strongylura strongylura	Toka/ Spot-tail needlefish	Belonidae	+		0.33
	Caranx sexfasciatus	Kala bangda/ Bigeye trevally	Carangidae	+		0.40
	Coilia dussumieri	Mandeli/ Goldspotted grenadier anchovy	Clupeidae	++++		10.64
	Stolephorus indicus	Modaka/ Snubnose anchovy	Engraulidae	+++++		0.36
	Johnius carouna	Dhoma/ Caroun Croaker	Sciaenidae	++		6.56
	Johnius amblycephalus	Dhomi/ Bearded croaker	Sciaenidae	+		0.21
	Scatophagus argus	Kaski, Dada, Vada/ Spotted scat	Scatophagidae	+		0.25
Freshwater Migratory	*Labeo calbasu*	Kalbasu/ Orangefin labeo	Cyprinidae	+	2.14	1.46
	Channa punctata	Maral, Daku/spotted snake head	Channidae	+		0.34
	Clarias batrachus	Magur/ walking catfish	Calriidae	+		0.34

The fishery catches from URE and TC were very alarming. TC lacked fishing activities in upper regions. While URE represented with sporadic fishing activities in riverine zones. Clam fishing was absent in TC entirely. Certain species which were recorded abundant viz. *Mystus gulio*, *Terapon* spp., *Lates calcarifer*, *Boleophthalmus dussumieri*, *Acetus indicus*, *Megalopes cyprinoides*, *Scylla serrata*, *Scatophagus argus* in previous study (Rathod, 2002) were dwindled to very low catches. However, species like *Anabas testudineous*, *Boleophthalmus boddarti*, *Acanthopagrus datnia*, *Eleotris amboinensis*, *Anodontostoma chacunda*, *Sciaena dussumieri*, *Kowala coval*, *Trichiurus savala*, and some *Engraulis* spp., were lacking from the catches in the present study.

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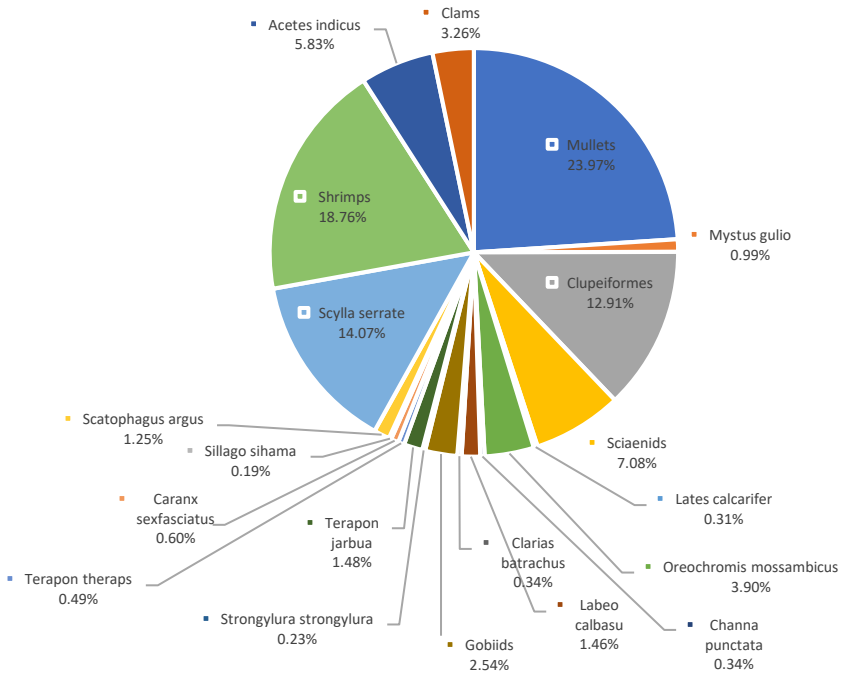
Fig. 2 : Percent Composition of Fisheries from URE and TC



The fish landings were dominated by perennial estuarine fishes throughout the study period followed next by seasonal estuarine species. Marine migratory fish species were observed in the winter season only. Both seasonal estuarine and marine migratory species improved the landings during the winter season. The freshwater migratory species were negligible in the catches (Fig. 3). Rathod (2016) reported that freshwater fishes were caught in a considerable amount during the rainy season. Earlier studies (Tandel, 1984; Pejaver, 1984) also depicted that the catches from these two water bodies were very high in URE and TC. The decline in fish landing is highly alarming from not only a fishery point of view but also depicted the health of two ambient waterbodies. Over a period of 35 years the rate of fall in fish landings is very rapid and probably will exterminate the fisheries from URE and TC in near future.

Fig.3 Abundance of Fishery Species in URE and TC

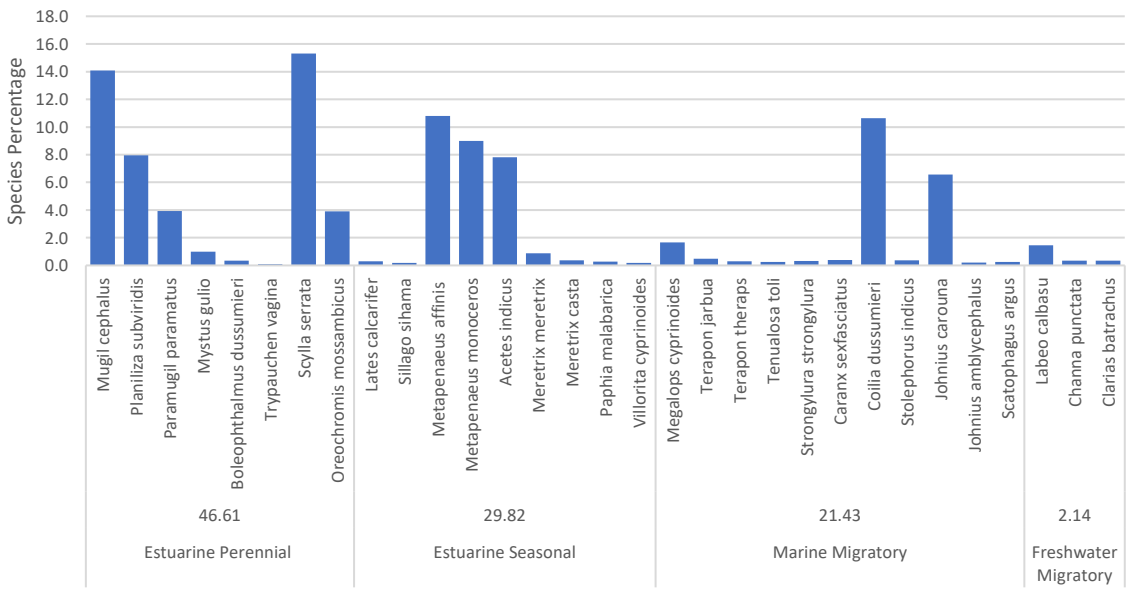


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Fig. 4: Different fish species recorded from two study markets during the present study

Mugil cephalus

Megalops cyprinoides

Sciaenid spp. (Juveniles)

Clupiids, anchovy, sciaenids, shrimps

Shell fishes: prawns (*Penaeus semisulcatus*) and clams

Caranx sexfasciatus (Juveniles)

Scylla serrata (mud crab)

Mugil sp. Mullets

Penaeus indicus Shrimps (juveniles)

Acetes indicus Jawla

Stolephorus indicus

Mystus gulio

Oreochromis mossambicus

Boleophthalmus dussumieir

Lates calcarifer, Barramundi

The fish market was poor with landings, the catches were hardly about 25% as compared to an earlier study (Rathod, 2016). Fishers had no proper place and facilities for marketing. However, the wholesale dealings ended within an hour during the present study. In the present study clupeiformes and mullets dominated the catches in EPM (Table1 and Fig.2).

Mullets were most abundant (23.97%) followed by shrimps (18.76%), *Scylla serrata* (14.07%), clupeiformes (12.91%), Sciaenids (7.08%), *Acetes indicus* (5.83%), *Oreochromis mossambicus* (3.9%) and, Gobiid (2.54%). Whilst the others remained below 4% (Table1 and Fig.3). Rathod (2016) observed that the catches in URE and TC were moderately high in EPM season and were dominated by Mullets, *Mystus gulio*, *Scylla serrata*, prawns,

Oreochromis mossambicus, and bivalves (clams). In the present study, however, the *Mystus gulio, Oreochromis mossambicus,* and bivalves were negligible in catches in almost all the samples (Fig.2). The study indicated that the present quantitative landings of small-scale fisheries from URE and TC have declined to an alarming level. The TC has decline approximately eight-fold as compared to the landings observed in 2002 (Rathod *et al*.2002). the present study species like *Labeo calbasu*, *Lates calacarifer*, *Caranx sexfasciatus,* anchovies and shrimps were landed in a meager amount.

CONCLUSION

The study indicated that the present quantitative landings of small-scale fisheries from URE and TC have declined to an alarming level. The TC has decline approximately eight-fold as compared to the landings observed in previous studies. The fisheries catches of URE and TC were represented by a total of 31 fisheries species in the present study. The fish catches were very poor and dominated by mullets, shrimps, clupeids *Scylla serrata,* and *Acetes indicus.* The market conditions and overall artisanal fisheries have declined in present conditions. *Mystus gulio, Oreochromis mossambicus,* and bivalves which were earlier reported to be dominant in catches were found very poor in the present study.

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Folklore Usage of Meswak (*Salvadora Persica L.*) in Oral Care: A Review

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ABSTRACT

Meswak is being used as a folk medicine for a very long time for various medical condition treatments. The cultural and religious use of meswak for dental hygiene is widely spread in the geographical areas of Asia, Africa, and Middle East because of its wide distribution. The therapeutic aspects of meswak and its major role in plaque control, tooth wear, bleeding gums, and periodontal health as well as its availability and cheap cost factor could also be the important reasons for its usage. Meswak is used for oral hygiene as an alternative to various oral devices. Oral hygiene is the most remarkable factor when itinvolves prevention of oral diseases and oral health. Previous literature reveals that meswak has effective antimicrobial (antibacterial, antifungal, and antiviral) and pharmacological (hypoglycemic, anti-ulcer, and anti-oxidative) activities. The useful effects of meswak with respect to oral hygiene and dental health care because of its pharmacological actions. It is estimated that different natural chemical compounds that are considered good for both oral and dental hygiene are present in meswak according to several researchers. Meswak offers itself as an effective and traditional oral medicine affordable to use as oral hygiene device. The study done in this paper reveal about the usefulness of meswak for oral care.

Key words: Meswak, oral care, antimicrobial activities, pharmacological activities.

INTRODUCTION

Salvadora persica L. belonging to family Salvadoraceae is an well-branched evergreen tree or shrub, 4-6 meter tall having short trunk, white bark,aromatic roots, soft white yellowish wood leaves and smooth green leaves that are glaucous.Salvadora persica, or the Arak tree known in English as the "tooth brush tree" is a large, and somewhat fleshy [1, 10]. In ayurvedic system of medicinesS. persicais reported to own potent activity for dental complaints. Meswak (also called miswak) is a chewing stick prepared from the roots or twigs of S. persica [19]. It is additionally referred to as Meswak tree, for the roots and twinges of this tree are used for teeth improvement since the ancient times. It is one in all the foremost unremarkably used medicative plants for oral hygiene among world Muslim community [34]. The history and therefore the use of meswak as an oral tool are used because of the biological effects of S. persica extracts which are reviewed by many researchers [28].

The use of meswak for oral hygiene includes a long tradition in Middle Eastern and African countries, going back many centuries [11]. Moreover, in the Middle East, the utmost common source of chewing sticks is Arak (Salvadora persica) [5]. Sticks of these plants are chewed usually at one end until they become frayed into a brush likeappearance, which is then used to clean the teeth in a similar manner like a toothbrush. Additionallyin strengthening the gums, it prevents tooth decay, eliminating toothaches and stop further increase in decay that has already set in. It creates fragrancewithin the mouth, eliminates bad odours, improves the sense of taste, and causes the teeth to glow and shine. The other parts of the tree have therapeutic values as corrective, liver tonic, diuretic, analgesic, anthelmintic, astringent, carminative, diuretic, and gastric[24].Moreover, the useful effects of meswak in respect of oral hygiene and dental health are partly because of its mechanical action and pharmacological actions. It's been shown that the utilization of meswak chewing sticks might

contribute to a higher level of gingival recession [17, 18].The study done in this paper reveal about the usefulness of meswak for oral care.

CLASSIFICATION

The term Salvadora, in 1749, was put forward in honour of an apothecary of Barcelona, Juan SalvadoryBosca (1598-1681), Laurent Garcin, botanist, traveller and plant collector. While as persica term indicates Persia and the standard author abbreviation L. is used to indicate Carl Linnaeus (1707–1778), a Swedish botanist and the father of modern taxonomy[23].

Class	: Magnoliopsida
Subclass	: Dilleniidae
Order	: Capparales
Family	: Salvadoraceae
Genus	: Salvadora
Species	: persica

Pharmacology of S. persica

Phytochemical constituents like alkaloids, flavonoids, tannins, phenols, saponins and various other aromatic compounds are secondary metabolites of plants that serve a defense mechanism against prediction by several microorganisms, insects and other herbivores[12].The aqueous extracts of S. persica contains important phytoconstituentslike vitamin C, salvadorine, salvadourea, alkaloids, trimethylamine, cyanogenic glycosides, tannins, saponins,flavonoids, sterols, salts mostly as chlorides and basic alkaloidswere succeeded to evaluate the chemical composition of S. persica[6-8, 29, 30, 33].

Anti-microbial activity of S. persica

Biological activity of various parts of S. persica recent studies have demonstrated that there is antibacterial, anti-periopathic, anti-fungal and anti-caries properties in aqueous extract of meswak. Studies have also proven oral [14] disinfectant and anti-plaque agents present in meswak.Different antimicrobial activity was performed and an in vitro study showed that the aqueous extract of S. persica had an inhibitory effect on the growth of Candida albicans that may be attributed to its high sulfate content [4].

Antibacterial activities

The meswak exhibited stronger antibacterial activity against the Gram-negative bacteria tested within the study than the Gram-positive bacteria evaluated, as proven by the pronounced differences in inhibition zones associated with the Gram-negative species A. actinomycetemcomitans, P. gingivalis, H. influenzae, and theGram-positive species S. mutansand L. acidophilus. . S. persica roots contain compounds with potent antibacterial activity against the Gram-negative bacteria with some effect against the Gram-positive bacteria [2]. Some studyrecommend that gram-positive bacteria are generally more sensitive to the Salvodora persica extracts than gram-negative might be because of the structure of membrane that the gram-positive bacteria are simpler than gram-negative ones [13].

According to [3] aqueous extract of plant inhibited microorganisms, showing greater activity on Streptococcus species. Methanolic extract was resisted by L. acidophilus and P. aeruginosa. At highest concentration tested (200 mg/ml); the aq. extract of meswak was more efficient than the methanolic extract but were less efficient than the positive control streptomycin and amphotericin B. Study done by[27]reveal that ethanol extract of S. persicashowed more effective than the aqueous extract in inhibiting the S. mutans, L. acidophilus, E. coli, S. aureus, and P. aeruginosa microorganisms.Inhibition zone studied by [33]showedeffective results against Staphylococcus aureus followed by Streptococcus mutans, Lactobacillus acidophilus, E. coli and Pseudomonas aeruginosa respectively. The aqueous extract exhibited antibacterial activity on M. bovisstudy done by[20].

Role of S. persica in dental plaque control

The extract of meswak has found its way into the dentifrices in the recent years as anti-plaque and antigingivitis agents [22]. It is believed that chewing of these stems facilitate salivary secretions which possibly help in oral cleaning and control of plaque [16]. In the endodontic treatment of teeth with necrotic pulps the aq. extract (10%) of S. persica is an effective

antimicrobial agent when utilized clinically as an irrigant [32]. An additional study compared the oral health efficacy of persica mouthwash (containing an extract of S. persica) with that of a placebo. Further the study reveals that the use of persica mouthwash lower carriage rate of cariogenic bacteria and improves gingival health when compared with the pretreatment values [26].

Scientific evaluation of using meswak revealed that it is at least as effective as tooth brushing for reducing plaque and gingivitis and that the antimicrobial effect of S. persica is beneficial for prevention of periodontal disease [35]. A clinical study was carriedusing patients' saliva and measuring the effect of meswak (chewing stick), meswak extract, toothbrush, and normal saline on mutans and lactobacilli by [15]. The results showed that there was a distinct reduction in Strep. mutansamong all groups. After comparison within the group, the reduction in Strep.mutans was significantly greater using meswak in comparison to tooth brushing and there was no significant difference for lactobacilli reduction. The investigators concluded that meswak has an immediate antimicrobial effect. Strep.mutans were more susceptible to meswak antimicrobial activity than lactobacilli [9]. Persica mouthwash significantly lowers the gingival index, plaque index, and bleeding index in case group without any reported side effects according to [25].

CONCLUSION

Oral health has gained increased attention as a considerable public health concern. In several studies, medicinal plant extracts and isolated phytochemical constituents showed highly significant antimicrobial activity. S. persica, commonly called Meswak or Toothbrush tree, is one of the most popular medicinal plants that has proved to be effective in the prevention of tooth decay and mouth infections [31]. From the ancient meswak to the electric toothbrush, oral hygiene practices have come into daily use throughout the world being either mechanical or manual. Meswak offers itself as an effective and affordable oral hygiene device. Many researchers recommend and encourage the use of meswak as an inexpensive and effective oral hygiene tool in areas where it is customary. Its availability, low-cost, simplicity, and use have been extensively studied in regions around the world where meswak can play a significant role in the promotion of oral hygiene. The practice of using meswak regularly proves its major properties of bactericidal effect. S. persica and other related plants are reported to be effective against broad spectrum microbes that are imperative for the development of dental plaque. As a result, current and upcoming public health practitioners and the dental profession should become familiar with the application of meswak within its traditional customs. There is also evidence that meswak is more effective as an oral hygiene tool in buccal than lingual tooth surfaces [21].

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TITLE OF INVENTION	DEEP LEARNING BASED ANALYSIS TO IDENTIFY THE IMPACT OF VARIOUS SOCIAL MEDIA PLATFORMS ON ACADEMIC PERFORMANCE OF STUDENTS

FIELD OF INVENTION	COMPUTER SCIENCE
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TITLE OF INVENTION	ARTIFICIAL INTELLIGENCE-BASED APPROACH TO STUDY THE AGE ASSOCIATED ALTERATIONS OF BRAIN MITOCHONDRIA ENERGETICS

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TITLE OF INVENTION	ARTIFICIAL INTELLIGENCE BASED APPROACH FOR PREDICTING THE IMPACT OF ANTIOXIDANTS IN DELAYING CELL DAMAGE IN CANCER PATIENTS

FIELD OF INVENTION	CHEMICAL
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TITLE OF INVENTION	INTEGRATING THE TECHNIQUES OF COMPUTER VISION ALONG WITH MACHINE LEARNING ALGORITHMS TO DETECT THE DISEASE OF PLANT BASED ON LEAF STRUCTURE

FIELD OF INVENTION	COMPUTER SCIENCE
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TITLE OF INVENTION	EVALUATION OF CELLULAR PROPERTIES FOR NON-SMALL CELL LUNG CANCER TREATMENT BASED ON ADVANCED NANOPARTICLE DRUG DELIVERY SYSTEMS

FIELD OF INVENTION	CHEMICAL
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Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen.

(54) Bezeichnung: **Hydrolase-Enzymkomplex für die Behandlung von Abwässern**

(57) Hauptanspruch: Hydrolase-Enzymkomplex für die Behandlung von Abwasser, bestehend aus:
Endo-Pektat-Lyase;
Lipase;
Xylanase;
Endo-Cellulase;
Laccase; und
ein Stabilisator.

Beschreibung

BEREICH DER ERFINDUNG

[0001] Die vorliegende Offenbarung bezieht sich auf die Abwasserbehandlung und insbesondere auf einen Hydrolase-Enzymkomplex für die Behandlung von Abwasser.

HINTERGRUND

[0002] Die Verschmutzung von Wasser ist ein ernstes Umweltproblem. Die Wasseraufbereitung von Abwässern umfasst in der Regel die Verwendung von Belebtschlamm mit Sedimentation der groben Feststoffe, gefolgt von einem aeroben Abbau der organischen Stoffe und einer anschließenden Sedimentation zur Entfernung der Biomasse. Danach kann das Wasser einer chemischen Behandlung unterzogen werden. Bestimmte Schadstoffe werden jedoch durch herkömmliche Sedimentationstechniken nicht vollständig aus dem Wasser entfernt.

[0003] Abwasserbehandlungsverfahren umfassen in der Regel mehrere Behandlungsstufen. Zunächst wird es einer Vorbehandlung unterzogen. Danach erfolgt die Erstbehandlung, ein physikalischer Prozess, bei dem ein Teil der organischen Stoffe durch Flotation oder Ausfällung entfernt wird. Zu den entfernten organischen Stoffen gehören Fäkalien, Lebensmittelpartikel, Fett, Papier usw., die als Schwebstoffe bezeichnet werden. Die dritte Behandlungsstufe wird als Zweitbehandlung bezeichnet und ist in der Regel ein biologisches Behandlungsverfahren, bei dem Bakterien unter kontrollierten Bedingungen eingesetzt werden, um Nährstoffe oder nicht abgesetzte schwebende und lösliche organische Stoffe aus dem Abwasser zu entfernen. Bleibt dies unbehandelt, führen diese Stoffe zu einem unannehmbaren biologischen Sauerstoffbedarf.

[0004] Der Nitratgehalt des von der Industrie eingeleiteten Abwassers nimmt zu. Die Entfernung von Phosphor oder Stickstoff aus dem Abwasser kann sich als schwierig erweisen und erfordert kostspielige Verfahren, bei denen dem Abwasserbehandlungsprozess Zusätze wie Metallsalze und/oder Kohlenstoffquellen hinzugefügt werden müssen. Da das Volumen des behandelten Abwassers jedoch sehr groß ist, muss eine große Menge an Kohlenstoffquellen zugesetzt werden, um die Konzentration im Abwasser effektiv zu erhöhen. Daher erhöht die Zugabe einer Kohlenstoffquelle zum Abwasser die Kosten der Abwasserbehandlung.

[0005] In der Vergangenheit wurden bereits Anstrengungen unternommen, um geeignete Systeme für die Abwasserbehandlung zu entwickeln. So untersuchten Delgadillo-Mirquez et al. die Auswirkungen der Mischung von Mikroalgen und Bakterienkulturen auf die Entfernung von Stickstoff und Phosphat aus dem Abwasser (Delgadillo-Mirquez et al. Biotechnology Reports, Vol. 11, September 2016, Seiten 18-26). Es ist jedoch bekannt, dass Mikroalgen das Verhältnis zwischen Nährstoffaufnahme und Wachstum stören. Darüber hinaus kann ein Zellbruch, der den interzellulären Phosphatgehalt in das Kulturmedium freisetzt, die Phosphatkonzentration im Abwasser weiter erhöhen.

[0006] Daher bestand die Notwendigkeit, einen Hydrolase-Enzymkomplex zu entwickeln, der eine wirksame und sichere Abwasserbehandlung ermöglicht und die Zugabe von externen Kohlenstoffquellen bei der Abwasserbehandlung reduziert. Um diese Ziele zu erreichen, wird ein Hydrolase-Enzymkomplex für die Behandlung von Abwasser offenbart.

[0007] In der vorliegenden Erfindung wurde ein Hydrolase-Enzymkomplex für die Abwasserbehandlung hergestellt, der Endo-Pektat-Lyase, Lipase, Xylanase, Endo-Cellulase, Laccase und einen Stabilisator umfasst. Der Hydrolase-Enzymkomplex hat das Potenzial für eine effiziente Abwasserbehandlung, da er eine synergistische Wirkung hat. Es wurde festgestellt, dass bei der Verwendung des Hydrolase-Enzymkomplexes für die Entfernung von Verunreinigungen und Nährstoffen geringere Mengen oder gar keine Zugabe einer externen Kohlenstoffquelle zur Abwasserbehandlung erforderlich sind, da beim Abbau des Schlamms unter Verwendung des Hydrolase-Enzymkomplexes vor der Fermentierung mehr Kohlenstoffquelle entsteht.

[0008] Alle hierin enthaltenen Forschungspublikationen werden durch Verweis in demselben Umfang einbezogen, als ob jede Publikation oder Patentanmeldung ausdrücklich und einzeln als durch Verweis einbezogen angegeben wäre. Wenn eine Definition oder die Verwendung eines Begriffs in einer inkorporierten Referenz nicht mit der hier angegebenen Definition dieses Begriffs übereinstimmt oder im Widerspruch dazu steht, gilt die hier angegebene Definition dieses Begriffs. Dementsprechend sind bei einigen Ausführungsformen die in der schriftlichen Beschreibung und den beigefügten Ansprüchen angegebenen numerischen Parameter Näherungswerte, die je nach den gewünschten Eigenschaften, die mit einer bestimmten Ausführungsform erreicht werden sollen, variieren können.

GEGENSTAND DER ERFINDUNG

[0009] Das Hauptziel der Erfindung ist die Bereitstellung eines Hydrolase-Enzymkomplexes für die Behandlung von Abwässern.

[0010] Ein weiteres Ziel der Erfindung ist die Bereitstellung eines Hydrolase-Enzymkomplexes mit hohem Aktivitätsniveau für die Fermentation.

[0011] Ein weiteres Ziel der Erfindung ist es, einen Hydrolase-Enzymkomplex bereitzustellen, der den Zusatz von Kohlenstoffquellen bei der Abwasserbehandlung reduziert.

ZUSAMMENFASSUNG DER ERFINDUNG

[0012] Die vorliegende Erfindung offenbart einen Hydrolase-Enzymkomplex zur Behandlung von Abwasser, umfassend Endo-Pektat-Lyase, Lipase, Xylanase, Endo-Cellulase, Laccase und einen Stabilisator.

[0013] In einem Aspekt der vorliegenden Offenbarung liegt die Endo-Pektat-Lyase in einer Menge von 27%, die Lipase in einer Menge von 8%, die Xylanase in einer Menge von 30%, die Endo-Cellulase in einer Menge von 30% und die Laccase in einer Menge von 3% vor.

[0014] In einem Aspekt der vorliegenden Offenbarung liegt der Stabilisator in einer Menge von 2 % vor.

[0015] In einem Aspekt der vorliegenden Offenbarung ist der Stabilisator ausgewählt aus Dextrin und Polysaccharid.

[0016] In einem Aspekt der vorliegenden Offenbarung wird die Endo-Pektat-Lyase durch Fermentieren von Bacillus cereus hergestellt.

[0017] In einem Aspekt der vorliegenden Offenbarung hat die Endo-Pektat-Lyase ein durchschnittliches Aktivitätsniveau für die Fermentation von 225000 µ/ml.

[0018] Ein Aspekt der vorliegenden Offenbarung ist, dass der Hydrolase-Enzymkomplex den Zusatz von Kohlenstoffquellen bei der Abwasserbehandlung um 20-100% reduziert.

[0019] In einem Aspekt der vorliegenden Offenbarung erhöht der Hydrolase-Enzymkomplex die Menge der Kohlenstoffquelle im Abwasser um mindestens 20 Massenprozent.

[0020] In einem Aspekt der vorliegenden Offenbarung liegt der Hydrolase-Enzymkomplex zur Behandlung von Abwasser im Bereich von 54-256 ppm.

[0021] Es ist zu beachten, dass, obwohl die vorliegende Offenbarung in Bezug auf einen definierten Satz von Funktionsmodulen erläutert wurde, jedes andere Modul oder jeder Satz von Modulen hinzugefügt/gelöscht/geändert/kombiniert werden kann und alle derartigen Änderungen in der Architektur/Konstruktion des vorgeschlagenen Systems vollständig in den Anwendungsbereich der vorliegenden Offenbarung fallen. Jedes Modul kann auch in ein oder mehrere funktionale Untermodule unterteilt werden, die alle ebenfalls vollständig in den Anwendungsbereich der vorliegenden Offenbarung fallen.

[0022] Verschiedene Objekte, Merkmale, Aspekte und Vorteile des Erfindungsgegenstandes werden aus der folgenden detaillierten Beschreibung der bevorzugten Ausführungsformen deutlicher werden.

DETAILLIERTE BESCHREIBUNG DER ERFINDUNG

[0023] Aspekte der vorliegenden Offenbarung beziehen sich auf einen Hydrolase-Enzymkomplex zur Behandlung von Abwasser.

[0024] Es folgt eine detaillierte Beschreibung von Ausführungsformen der Offenbarung. Die Ausführungsformen sind so detailliert, dass sie die Offenbarung klar vermitteln. Es ist jedoch nicht beabsichtigt, mit der gebotenen Ausführlichkeit die vorhersehbaren Variationen der Ausführungsformen einzuschränken; im Gegenteil, es ist beabsichtigt, alle Modifikationen, Äquivalente und Alternativen abzudecken, die in den Geist und den Anwendungsbereich der vorliegenden Offenbarung fallen, wie sie durch die beigefügten Ansprüche definiert sind.

[0025] Jeder der beigefügten Ansprüche definiert eine eigene Erfindung, die für Verletzungszwecke als Äquivalent zu den verschiedenen in den Ansprüchen angegebenen Elementen oder Einschränkungen anerkannt wird. Je nach Kontext können sich alle nachstehenden Verweise auf die „Erfindung“ in einigen Fällen nur auf bestimmte Ausführungsformen beziehen. In anderen Fällen wird anerkannt, dass sich die Bezugnahmen auf die „Erfindung“ auf einen Gegenstand beziehen, der in einem oder mehreren, aber nicht notwendigerweise in allen Ansprüchen aufgeführt ist.

[0026] Verschiedene Begriffe, die hier verwendet werden, sind nachstehend aufgeführt. Soweit ein in einem Anspruch verwendeter Begriff nachstehend nicht definiert ist, sollte ihm die weiteste Definition gegeben werden, die Personen auf dem einschlägigen Gebiet diesem Begriff gegeben haben, wie sie in gedruckten Veröffentlichungen und erteilten Patenten zum Zeitpunkt der Anmeldung wiedergegeben ist.

[0027] Ein Hydrolase-Enzymkomplex zur Behandlung von Abwasser wurde hergestellt. Der Hydrolase-Enzymkomplex umfasst Endo-Pektat-Lyase; Lipase; Xylanase; Endo-Cellulase; Laccase; und einen Stabilisator. Der Stabilisator wird aus Dextrin und Polysaccharid ausgewählt.

[0028] In einer Ausführungsform der Erfindung ist der Hydrolase-Enzymkomplex ein Gemisch aus Endo-Pektat-Lyase in einer Menge von 27 %, der

Lipase in einer Menge von 8 %, der Xylanase in einer Menge von 30 %, der Endo-Cellulase in einer Menge von 30 % und der Laccase in einer Menge von jeweils 3 %. Der Stabilisator ist in einer Menge von 2% enthalten.

[0029] Die Endo-Pektat-Lyase wird durch Fermentieren von Bacillus cereus hergestellt. Der Bacillus cereus wird auf einem Kulturmedium kultiviert. Das Kulturmedium enthielt Rindfleischextrakt, Hefeextrakt, Pepton, Glukose, Natriumchlorid und Agar. Das Kulturmedium hatte einen pH-Wert von 7,4 ±0,1. Der Nährboden wurde dreißig Minuten lang sterilisiert. Der Nährboden wurde mit dem Bacillus cereus-Stamm beimpft und 24 Stunden lang bei 30 ±1 °C kultiviert.

[0030] Die zweite Stufe der Fermentation von Bacillus cereus wurde durchgeführt, um die fermentierte Flüssigkeit als rohe Enzymflüssigkeit zu erhalten. Das Nährmedium enthielt Sorbit, Weizenkleie, Molkepulver, Mais-Sumpflauge, Natriumchlorid, Maiskeimpulver und Wasser. Der pH-Wert wurde mit Natriumcarbonat auf 6,0-6,5 eingestellt. Das Kulturmedium wurde dreißig Minuten lang sterilisiert. Die Kulturtemperatur betrug 34±1 °C, und die Kulturdauer betrug 10-12 Stunden.

[0031] Die rohe Enzymflüssigkeit wurde gewonnen. Die Flüssigkeit wurde filtriert, um Endo-Pektat-Lyase-Enzym zu erhalten. Das durchschnittliche Aktivitätsniveau des Endo-Pektat-Lyase-Enzymsystems wurde bestimmt. Das durchschnittliche Aktivitätsniveau für die Fermentation betrug 225000 µ/ml.

[0032] Der Hydrolase-Enzymkomplex wurde durch Mischen von Endo-Pektat-Lyase, Lipase, Xylanase, Endo-Cellulase und Laccase hergestellt. Der Stabilisator wurde hinzugefügt, um den Hydrolase-Enzymkomplex zu stabilisieren.

[0033] Der Hydrolase-Enzymkomplex wird dann für die Abwasserbehandlung verwendet. Das Abwasser wurde durch ein Vorklärbecken geleitet, um Abwasser mit organischen Verbindungen und Primärschlamm zu trennen. Das Abwasser mit organischen Verbindungen wurde in ein Nachklärbecken geleitet, um einen gereinigten Überstand und einen Sekundärschlamm abzutrennen. Der Primärschlamm und der Sekundärschlamm werden mit einem Hydrolase-Enzymkomplex in Kontakt gebracht, um einen Überstand zu erzeugen, der eine Kohlenstoffquelle enthält. Dadurch werden Verunreinigungen und Nährstoffe wie biologischer Sauerstoffbedarf, Phosphor und Stickstoff aus dem Abwasser entfernt.

[0034] Die Primär- und Sekundärschlämme enthalten organische Stoffe wie Zellulose, Proteine, Lipide, Zucker, Stärke usw., die durch Hydrolase-Enzyme abgebaut werden können. Der Hydrolase-Enzymkomplex kann mit dem Primärschlamm oder den Sekundärschlämmen in einem Primär- oder Sekundärklärbecken oder insbesondere in einem Fermenter zur Vergärung in Kontakt gebracht werden.

[0035] Im Rahmen der vorliegenden Erfindung fördert der Hydrolase-Enzymkomplex die Hydrolyse und anschließende Fermentation des Primärschlamms, wodurch mehr Kohlenstoffquelle erzeugt wird. Die Menge an Kohlenstoffquelle, die bei der Fermentation durch die Zugabe des Hydrolase-Enzymkomplexes erzeugt wird, ist ausreichend, so dass die Menge an Kohlenstoffquelle, die ansonsten dem Abwasser zugesetzt wird, reduziert oder eliminiert werden kann. Die Menge der zugesetzten Kohlenstoffquelle hängt von der Menge des zu entfernenden Stickstoffs und Phosphors ab.

[0036] In einer Ausführungsform wird durch die Zugabe des Hydrolase-Enzymkomplexes die Menge der Kohlenstoffquelle im Überstand aus der Fermentation des Primär- und Sekundärschlamms um mindestens 20 Massenprozent erhöht, verglichen mit dem Fall, dass der Primär- und/oder Sekundärschlamm nicht mit dem Hydrolase-Enzymkomplex in Kontakt gebracht wird. Die zusätzliche Zufuhr von Kohlenstoffquellen während der Abwasserbehandlung wurde um 20 bis 100 % reduziert. In einer Ausführungsform der Erfindung wird die zusätzliche Kohlenstoffquelle aus dem Prozess eliminiert, so dass die Kohlenstoffquelle dem Prozess nicht zusätzlich zugeführt wird.

[0037] Die Abwasserreinigung durch Zugabe des Hydrolase-Enzymkomplexes ist eine energie- und kosteneffiziente Methode zur Entfernung oder Beseitigung von Verunreinigungen und Nährstoffen wie biologischem Sauerstoffbedarf, Phosphor und Stickstoff aus dem Abwasser. Die Zugabe von Kohlenstoff in Abwasserbehandlungsverfahren ist problematisch, da in Kläranlagen große Mengen an Abwasser behandelt werden. Die Menge der Kohlenstoffquelle, die zur Erhöhung der Kohlenstoffkonzentration benötigt wird, um eine bessere Phosphorentfernung zu erreichen, ist groß und teuer.

[0038] Da viele Systeme große Mengen an Kohlenstoffquellen und anderen Zusätzen benötigen, minimiert die vorliegende Erfindung, d. h. der Hydrolase-Enzymkomplex, den Bedarf an extern zugesetzten Kohlenstoffquellen im Vergleich zu den üblicherweise in Abwasseraufbereitungssystemen verwendeten Mengen oder macht sie überflüssig.

[0039] Die Wirksamkeit des Hydrolase-Enzymkomplexes bei der Behandlung von Primärschlamm wurde ermittelt. Als Probe wurde Primärschlamm aus einer Industrieanlage entnommen. Der Primärschlamm hatte einen Gesamtfeststoffgehalt von 40.875 ppm, einen prozentualen Gesamtfeststoffge-

halt von 4,1 %, einen CSB von 45549 und einen pH-Wert von 5,89. Der Primärschlamm wurde mit dem Enzymkomplex Hydrolase behandelt. Die Menge des zugesetzten Hydrolase-Enzymkomplexes lag im Bereich von 54-256 ppm.

[0040] Nach der Behandlung wurde die Probe analysiert. Die behandelte Probe hatte einen Gesamtfeststoffgehalt von 22.238 ppm, einen prozentualen Gesamtfeststoffgehalt von 2,3 %, einen CSB-Wert von 26528 und einen pH-Wert von 5,3. Es wurde festgestellt, dass bei der Verwendung des Hydrolase-Enzymkomplexes für die Entfernung von Verunreinigungen und Nährstoffen eine geringere oder gar keine Zugabe einer externen Kohlenstoffquelle zur Abwasserbehandlung erforderlich ist, da beim Abbau des Schlamms unter Verwendung des Hydrolase-Enzymkomplexes vor der Fermentierung mehr Kohlenstoffquellen entstehen.

[0041] Während das Vorstehende verschiedene Ausführungsformen der Erfindung beschreibt, können andere und weitere Ausführungsformen der Erfindung entwickelt werden, ohne vom grundsätzlichen Umfang der Erfindung abzuweichen. Der Umfang der Erfindung wird durch die folgenden Ansprüche bestimmt. Die Erfindung ist nicht auf die beschriebenen Ausführungsformen, Varianten oder Beispiele beschränkt, die enthalten sind, um eine Person mit gewöhnlichem Fachwissen auf dem Gebiet der Technik in die Lage zu versetzen, die Erfindung herzustellen und zu verwenden, wenn sie mit Informationen und Wissen kombiniert wird, die der Person mit gewöhnlichem Fachwissen auf dem Gebiet der Technik zur Verfügung stehen.

Schutzansprüche

1. Hydrolase-Enzymkomplex für die Behandlung von Abwasser, bestehend aus:
Endo-Pektat-Lyase;
Lipase;
Xylanase;
Endo-Cellulase;
Laccase; und
ein Stabilisator.

2. Hydrolase-Enzymkomplex zur Behandlung von Abwasser nach Anspruch 1, wobei die Endo-Pektat-Lyase in einer Menge von 27%, die Lipase in einer Menge von 8%, die Xylanase in einer Menge von 30%, die Endo-Cellulase in einer Menge von 30% und die Laccase in einer Menge von 3% vorliegen.

3. Hydrolase-Enzymkomplex zur Behandlung von Abwasser nach Anspruch 1, wobei der Stabilisator in einer Menge von 2 % vorliegt.

4. Der Hydrolase-Enzymkomplex zur Behandlung von Abwasser nach Anspruch 1, wobei der Stabilisator aus Dextrin und Polysaccharid ausgewählt ist.

5. Der Hydrolase-Enzymkomplex zur Behandlung von Abwasser nach Anspruch 1, wobei die Endo-Pektat-Lyase durch Fermentieren von Bacillus cereus hergestellt wird.

6. Hydrolase-Enzymkomplex zur Abwasserbehandlung nach Anspruch 1, wobei die Endo-Pektat-Lyase ein durchschnittliches Aktivitätsniveau für die Fermentation von 225000 µ/ml aufweist.

7. Der Hydrolase-Enzymkomplex für die Behandlung von Abwasser nach Anspruch 1, wobei der Hydrolase-Enzymkomplex den Zusatz von Kohlenstoffquellen bei der Abwasserbehandlung um 20-100% reduziert.

8. Der Hydrolase-Enzymkomplex für die Behandlung von Abwasser nach Anspruch 1, wobei der Hydrolase-Enzymkomplex die Menge der Kohlenstoffquelle im Abwasser um mindestens 20 Masseprozent erhöht.

9. Der Hydrolase-Enzymkomplex zur Behandlung von Abwasser nach Anspruch 1, wobei der Hydrolase-Enzymkomplex zur Behandlung von Abwasser im Bereich von 54-256 ppm liegt.

Es folgen keine Zeichnungen

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