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Review Article

Green Synthesis of Bio-polymer Composites of Iron for Pharmaceutical Applications

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ABSTRACT

Due to the capacity to moderate metals to their nanometer size, nanobiotechnology is gaining enormous popularity in this period, which effectively changes its chemical, physical and optical properties. Recent progress in nanoscience and technology has also managed to the growth of new nanomaterials (NMs), eventually increasing toxic and potential health effects. There has been growing attention in evolving eco-friendly methods for metal nanoparticles (NPs) synthesis. The main purpose of the study is to reduce the harmful influences of synthetic processes, associated substances alongside other derivatives. The use of diverse biomaterials (BMs) for NP synthesis is examined as a promising method in green nanotechnology. However, most of the techniques currently available are costly; utilizing the natural properties includes plants, bacteria, fungi and algae to manufacture low-cost, non-toxic and energy-efficient metallic NPs that are environmentally friendly. Besides, biologically synthesized NPs and their characterization are essential for their future utility in numerous deliveries of drugs and pharmaceutical utilizations. Here, the current analysis summarizes the synthesis and future use of iron nanoparticles (Fe NPs) by green nanobiotechnology in the arena of biomedical applications.

Keywords: Biopolymers; Green synthesis; Characterization; Pharmaceutical applications

INTRODUCTION

Nanotechnology (NT) is the utmost important and fast-budding fields of study using biosynthetic and non-polluting tools for nanoparticles (NPs) production. It mainly deals with handling and particle design techniques ranging from 1 to 100 nm. Generally NPs are tiny size of < 100 nm and display a huge ratio to the surface volume [1]. Owing to the mesmerizing properties including mechanical, sensing, physical, magnetic electronics, optical, NPs have fascinated particular consideration of the research community and differ considerably in many respects with that of solid counterparts [2]. NPs have been employed extensively in various fields comprising energy, food, engineering, cosmetics, agriculture and medicine [3,4]. The aforesaid extensive NP uses are owing to their special natural, biochemical alongside physical characteristics. Amongst numerous NPs, the Fe NPs are the marvelous research accomplishment in NT and also possess broad applications in various sciences. Nowadays, iron NPs have been enormously utilized in delivering the drugs, cancer treatment, gene therapy, enhancement of MRI, cell sorting, food usages, tissue engineering and anti-microbial and oxidant [5-7]. Additionally, iron NPs are employed extensively for exclusion of heavy metals and treating waste water (H_2O) of inert or organic impurities owing to the greater inherent reactivity of their exterior areas. Hitherto, iron particles have verified to be superior benefit for contaminant removal includes nitrate, insecticide, azo dye and so on [8]. Presently, these particles are produced with a help of diverse chemical and physical methods. Further, these physico-chemical strategies face frequent difficulties; utilize lavish metals, organic solvents, reducing agents, need high energy, expensive equipment, pressure and temperature. These approaches also produce harmful effects on humans, specifically in the clinical sector; these particles cannot be used in medicine [9,10]. Therefore, it's an urge to establish a viable, clean and healthier strategy to overcoming these limitations as biochemical production produce small volumes, involves intricate refining procedures and huge amount of energy intake. At present, significant advances in the biofabrication of NPs have been achieved using microorganisms and various other bio resources includes such as algae, floras and yeasts. NPs process is environmentally friendly, intensive, non-toxic alongside no requirement of costly

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chemicals. Thus, the process of NPs and several other materials using any bio sources, including algae, plants, microorganisms, actinomycetes and yeast has explicitly paying consideration of the worldwide scientific groups. This serious consideration to green bio synthesis is due to the environmentally sound nature and possible therapeutic applications [11,12]. The key downside related with bacterial causes is the preservation of pollutant free climate, huge costs of separation, and the preservation of these in suitable culture of microbes. Thus the plants maintain the potential to be an outstanding reduction in NP development. The floral extracts encompassed of a broad variety of biologically active complexes includes alkaloids, phenolic, vitamins, tannins, flavonoids, amino acids and inositol [13]. Further, the floral parts can serve as stable agents for reduction and stabilization, reducing costs alongside eliminating the utilization of toxic substances. The iron NPs is created from a small quantity of therapeutic plants [14]. In the hitherto analysis, extract of floral from *Rhamnella gilgitica* was used to produce iron NPs. For instance, *R. gilgitica* is a popular therapeutic flora from other countries, which exhibits huge flavonoid content namely, quercetin, kaempferol, chrysophanol, naringenin, gallic acid and mixed fatty acids alongside important anti-oxidant with inflammatory capacity. *Rhamnella gilgitica* is employed in the old-style Chinese drug method for rheumatism therapy, swelling and pain [15-17]. Floras and microbes in particular have been seen as novel tools with great possible for NPs synthesis. Hitherto, plentiful micro-organisms have been investigated for metal NPs process, namely bacteria, yeast and fungi as well as plants. Although the NPs synthesis has been comprehensively studied [18-20]. Therefore, herein discuss bring up-to-date on developments in the synthesis of biological iron NPs and outline their diagnoses in medicinal fields.

Types of biological synthesis of iron nanoparticles: Numerous merits of natural approaches over physical and chemical approaches, owing to the eco soundly nature, consuming less number of time, practically removal of commercial wastes, non-usage of toxic substances alongside safety and hold several uses are not probable with that of biochemical or physical processes.

NPs production through these physio-chemical routes is luxurious, perilous and takes lot of time. Hence, researchers focus mainly on bioresouces for NP production includes microbes and plants which is later named as 'green synthesis' [21,22]. The various modes of biosynthesis of iron NPs are outlined in Figure 1.

Biological synthesis of nanoparticles: The NPs production from floral leaf is superior than bacteria process because it doesnot

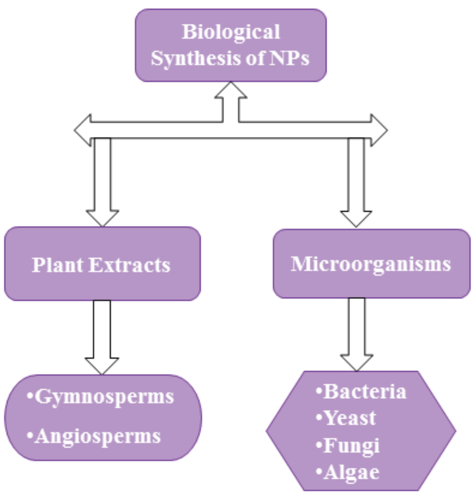

Figure 1: Flowchart illustration of green synthesis methods of NPs.

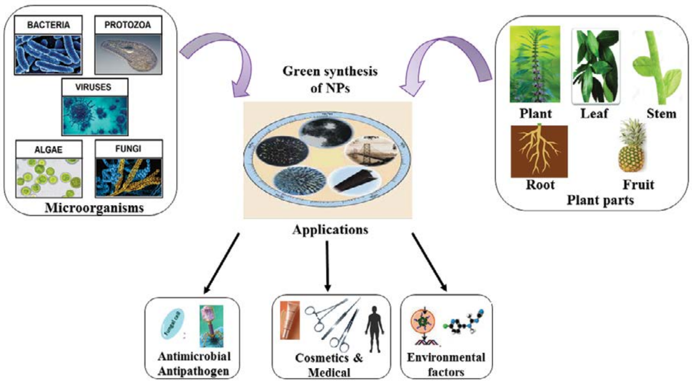

Figure 2: Green NPs synthesis from diverse floras and microbes.

contain slightly toxic chemicals and artificial procedures alongside hugerate of reaction essential to cultivate bacteria is eradicated [23-24]. The outline for the green NPs process from plant and microbes are illustrated in Figure 2.

Over the last few decades a significant amount of scientific papers has been published detailing the processing of iron NPs with flexible phases and compositions. The application of biosynthesis in NT has received a lot of interest from researchers around the world [25]. The approach to biosynthesis goal is to reduce or remove harmful substances discarded in the surroundings [26]. Biosynthesis of metal NMs from natural plant is presently under improvement and one among the peak studied areas underneath exploration. Syntheses from flora source is the utmost recent opportunity for scientists, conceded out by employing numerous floral extracts such as exudates, tissue and additional portions of the floral parts [27]. The NPs from green methods are eco-soundly, non-harmful and cost effective for the progress of trustworthy alongside environmental-soundly approaches to yield NMs are of abundant significance in the arena of therapeutic uses.

Biological resources comprising enzymes, microorganisms, plant extracts and fungi have been exploited as ecologically sound substitutes for NPs synthesis [28]. In few literatures they reported that, flora fragments demonstrated to be favorable compared to the other biotic strategies such as bacterial sources by enlarging effort to retain the culture media. Floral leaves are green raw materials for the biotic based NPs process which constitute reducing mediators such as ascorbic and citric acid, flavones, enzymes of crude nature such as extracellular electron shuttles, dehydrogenases and reductases which plays a pivotal role in the NPs process [29]. The floral extract of carob has been used efficiently as a simple, no toxic and easy bio resource for research into Fe NPs in a one-step process [30]. The response happened in a single vessel reaction at a fairly low temperature range within an ordinary distance of the monodispersed NPs of 4–8 nm and well covered with carboxyl moiety of particular amide-I, II sequence of the receptors available in the floral extract [31].

Since the biotic based process of NPs is a relatively new method and it is evolving, there are some drawbacks related with these process, for instance, flora generate less amounts of unknown receptors that contribute to lower synthesis levels, creating the following implications: time-consuming cultivation of microorganisms and the primary aim of NPs synthesis. Another downside is that not all of the plants can be used for NPs synthesis. Hitherto, the scientists are functioning on the insights of metallic ion intake and deduction by biotic strategy.

Merits of green synthesis of NPs: NPs with biomedical applications require the bioavailability of NPs, like reduced metal cytotoxicity. NPs attained from biological areas consists of non-toxic pollution of yields involved to NPs during chemical process compared to physio-chemically derived NPs, which led to reduces the therapeutic uses of the ensuing NPs [32]. There are many advantages in the biotic process of NPs, such as fast and environmentally sustainable processing strategies alongside the value-effective and non-harmful design of processed NPs. Moreover, it doesn't need additional elements for stabilization since the components of flora and microbes itself serve as capping agents and stabilizers [33]. In addition, the exterior of biotic NPs adsorb biomolecules gradually and specifically when they reach intricate bio-based solids, developing a surface that cooperates with biotic arrangements. These layers of protein have more worth compared to bare biotic NPs. Thus, the supplement of bio-active modules to the exterior of synthesized NPs from the bioactive compounds including microbes and plants makes biological NPs more effective. Specifically in biomedical floras, there are plentiful phenols with therapeutic activity and they are assumed to attribute to the NPs process, provided that extra profit by improving the usefulness of the NPs [34-36]. The extra benefit of NPs from biotic process is that it may minimize the amount of necessary stages, namely adding certain functional moieties to the exterior of NPs led to effective bio-product, a supplementary process needed in other physical and chemical methods. Therefore, for physiochemical methods the time needed whereas for biotic based NPs synthesis requires only less time. By using various plant sources, several scientists have established fast synthetic strategies with huge profits of biotic based NPs when comparison with other physical and chemical NPs medicinal uses. For example, biologically processed NPs shown higher anti-neoplastic activity in the A549, B16 and MCF7 cell lines of lung, mouse melanoma and breast cancer [37]. Furthermore, biotic based NPs syntheses are highly non-harmful with that of the H9C2 cell line and Chinese hamster CHO cells, than biochemically produced NPs. These particles maintenances the forthcoming uses of biotic based NPs as carriers of drug transport. Besides, NPs display red colour fluorescence emission inside the cells, which might be exploited to identify the druggable particles location in the cells of tumor [37].

Iron (Fe) nanoparticles: Nanoparticles such as iron (Fe), gold (Au) and silver (Ag) NPs, nanocages and nanoshells were used and changed continuously over the year to allow their use as a therapeutic and diagnostic agent. And we discussed iron oxide nanoparticles in this particular review article along with medicinal uses from numerous green syntheses.

These are then discussed briefly for their system development and some cited current examples which use their characteristic features as diagnostic and/or therapeutic agents for disorders [38]. Figure 3 explains outline for the synthesis of Iron (Fe) NPs from bio-Resouces and their diverse uses.

Fe NPs synthesis by flora materials: Researchers have documented the bio based synthesis of Fe NPs employing various floral parts. Literature evidence highlights that, the Fe NPs, the synthesis study is not entirely understood, because zero valent Fe NPs, iron oxides and a mixture of both have been recorded along the same synthetic path. Amongst the plants that is used in the metal NPs process are belongs to the genus of *Eucalyptus* employed for the NP process of Au, Ag, Fe and Ti [39-41]. Afterwards, this can be characterized by seed reproduction, rapid growth offering a superior root system.

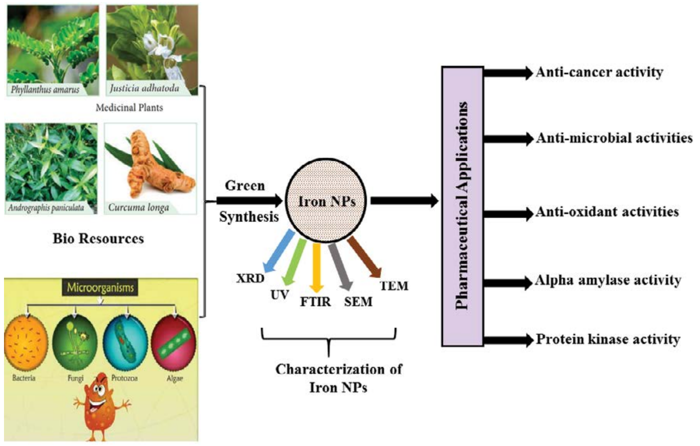

Figure 3: Visual workflow for Fe NPs synthesis from bio-resources and their applications.

This plant can able to adapt to the diverse soil conditions. The pharmacological activity, particularly in inflammation and cancer exhibited in *E. robusta* alongside antimicrobial and antioxidant. The phenolic compounds are present in the leaf namely epicatechin, syringic acid, gallic acid, quercetin and eucalyptin amid other polyphenols. As above-mentioned, it can be presumed that these types of species are beneficial marginal in the battle beside hazardous microbes, which in modern eras has been evolving conflict to traditional antibiotics (Abs), which has established resistance to traditional antibiotics in recent years, and have been liable for a large amount of demises worldwide. In effect, declining micro-organisms possess a tough effect in the nutrition based production, exclusively the flour decline, resulting in significant production losses and loss in the product quality control [41]. Therefore, our main purpose was to produce Fe NPs from the *E. robusta* leaves and then evaluate the antioxidant and antimicrobial activity.

Recently, Chandran et al. study proved that, production of Fe NPs utilizing *Dictyota dicotoma* and they interpreted the results utilizing diverse analytical instruments such as UV-Spectrophotometer to identify the iron NPs formation in nano-meter range of 320, 370 alongside 420 further carried out by Fourier transform infrared spectroscopy (FTIR) to ascertain the existence of functional moieties and further Scanning electron microscopic pictures prove the nano-meter size of the particles between 40 nm to 50 nm. The antimicrobial study was reported for the synthesized NP solution, antibiotic (Amoxicillin, Penicillin G) and their combined mixture against *Pseudomonas aeruginosa, Enterococcus hirae, Escherichia coli* by agar well diffusion method. The NP in combined with antibiotics showing huge inhibition zone than the non-conjugated one. The findings have been so promising that further work should be performed with drug conjugates unique to disease [42].

Kalaiarasi et al. [43] study reported that, biosynthesis of metal NPs by diverse parts of plant namely, stem, leaf, root and seed is the modest, reproducible and cost effective method. Plants definitely generate metal NPs in more stable form and it has proven as a greatest choice for the rapid and huge-scale process associated with microbes. Further, the inclination for florals with the byproducts in NM development in the range of regular alignment of diverse living reduces complexes in the plants, which are simply adapted to the NPs synthesis [44]. Various herbs and sources of plant contain greater antioxidants, which are present in leaves, fruits, stems and seeds as phytochemical components. The efficacy of flora-based chemicals in the whole architecture and production of NPs consequently establishes a major symbiosis between the plant or natural sciences and technology. This relationship brings the nanotechnology, called green nanotechnology, a distinctively green strategy. Such production progressions could be conceded lacking substantial surrounding emissions, thus providing novel principles in green and clean technologies which are extremely supportable and economically feasible [45].

The local resource and cheap green tea extract was further exploited for Fe NPs synthesis. The zero-valent iron synthesis using *Camellia sinensis,* apart of green tea consists of a poly-phenolic product. Thus the steady NPs without polymer coated were acquired at a temperature of 37 degree celsius. The phenols based substances can act as both a capping and dropping mediator in plants, resultant in constant zero-valent green nanoscale Fe elements with distinctive features. Green tea of 20 g/L was utilized to produce extract. A sample was then added with a required mixture of green tea materials in the ratio of 2:1 volume ensuing with a nanometer sized of 5 to 10 diameter [46].

Evidence also examined the efficiency of various tree floras for generating non-zero valent iron (nZVI) particles. Moreover, they evaluated the antioxidant property of the floral source. The findings unveiled that the dried floral parts possess greater antioxidant ability than the undried floral parts. Furthermore, the oak florals, green tea and pomegranate manufactured the ironic extracts and transmission electron microscope results confirmed that these non-zero valent iron (Fe) particles in the limit between 10 to 20 nanometer size and it can be synthesized from aforesaid floral resources. Utility of water molecules as the solute for the extract process of the extract is measured as the cheaper and better approach for NPs synthesis [47]. Similarly, Pattanayak et al., study employed a less cost effective reductant for nZVI particle synthesis from the flora of *Azadirachta indica* beneath the distinctive circumstances. The results revealed that the Fe NPs lies between 216 to 265 nanometer by Ultra violet spectroscopy whereas the size of spherical Fe NPs was primarily originate between 50 to 100 nanometer sizes [48]. They also examined the five diverse floral sources includes mango, rose, curry, green tea and oregano floral leaves for Fe NPs synthesis and they also evaluated the changes in the pH and color while deduction in the Fe salt [49].

The Wang and co-workers combined and produced the constant composite of NPs which contains iron and phenolic particle from the source of *Eucalyptus*[50]. Also, another researcher used three diverse floral leafs which includes, *Melaleuca nesophila, Eucalyptus tereticornis and Rosemarinus officinalis* for the complex of Fe-P (Fe polyphenol) particle synthesis and it was found in the range of 50-80 nm. Further study, they identified the Fe particle nano range of 60 diameters from the source of methanolic grape leaf. Further, gas chromatography study revealed the biomolecules present in the NPs synthesis [51].

Literature study also proved that, the *Hordeum vulgare* extract produced Fe oxide particles with a range of 30 nanometer and they identified that pH plays a dynamic role in the stable nature of the Fe NPs whereas 10 to 40 nm size NPs was obtained from the *Rumex acetosa* flora. They also proved that, stable nature of the *Hordeum vulgare* produced Fe NPs was improved by the addition of citrate buffer at 40 milli molar with a pH constant at 3. Ultimately, Makarov et al. [52] study proved that Fe NPs from *Rumex acetosa* was found to be more stable at a lower pH of 3.7 when compared to that of *Hordeum vulgare* at a pH of 5.8.

Synthesis by fruit extract: In some studies, scientist utilized fruits for iron NPs synthesis. For instance, the study has shown that iron and palladium NPs employing the *Terminalia chebula* fruit. The *T. chebula* showed an voltage of 0.63 of redox potential via cyclic voltammetry and it mainly aids to deduce the Fe precursors to Fe NPs [53].The ratio of 5:1 which includes extract and metallic NaCl solution was utilized and then the bulk product were divided through the centrifugation followed by washing was done using ethanol. Finally, the TEM and XRD study exposed that the Fe NPs were found to be at the nanometer of less than 80.

The researcher also utilized *Passiflora tripartitavar mollissima* fruit let for Fe NPs synthesis and further calculated their catalytic outcome on the 2-arylbenzimidazole synthesis at a room temperature and it was found to be 22.3 nm size. The synthesized particle is extremely active for the 2-arylbenzimidazoles synthesis. The structure of benzimidazole is a moiety of isostere from natural nucleotides; and it has been significant in the intermediates process of particles especially for biological and pharmaceutical uses. The production of 2-arylbenzimidazole consuming Fe3O4 NPs is eco-friendly benign, easy to manipulate alongside selective one. In addition, it can be recycled five times in order to get new reactions with a minor variation in reactivity and they are found to be eco-soundly in nature [54-61]. Table 1 briefly shows the reports on Fe NPs process obtained from the diverse biological sources.

Synthesis by microorganisms: It has been shown that microbes are significant nanofactories that carry an enormous potential as environment-soundly and less cost methods, non-toxic and the huge energy needs for physical and chemical methods. Since of numerous reductase enzymes, microbes has the capability to absorb and replenish heavy metals and thus deduce the metal to metal NPs with a small size distribution and with that of low polydispersity. A huge number of biological procedures for NP synthesis employing microbial biomass (BM), liquid supernatant and resultant components have been published. Amongst the countless procedures, process of extracellular has gained ample attention since it eradicates the stages in downstream processing (DSP) which is needed for NPs recovery in intracellular strategies, comprising breaking of cell by sonication, quite a few centrifugations, and purification of NP and so on. Additionally, metal-resistant genetic factors, receptors, peptides, cofactors for enzyme reduction and biological resources have important roles viaper forming as reducing agents. Eventually, this process aid in NP synthesis, thus precluding the accumulation of NPs and to endure constant for an extensive time, thereby provides the extra stability.

Bacteria: Fe (iron) reducing microbes are generally employed in the process of Fe NPs. Reports emphasized that, spherical shape Fe NPs from *Actinobacter sp.*beneath aerobic (presence of oxygen) conditions [62]. Also, they produced greigite and maghemite employing the similar species of microbes through changing the precursor of Fe. Herein, *Actinobacter species* have been found for the extracellular magnetic NP production when uncovered for an hour of 48-72 to the organic compound of Fe salts beneath the aerobic (presence of oxygen) conditions. The iron NPs was designated by altered in reaction colour, from moderate to dusky brown and further characterization of NPs were estimated using TEM, FTIR, magnetic measurements, XRD and so on. Microbial process of magnetic NPs is a multifaceted phenomenon and further process comprises the enzyme Fe reductase formed from *Actinobacer species* during the existence of Fe salt. The enzyme Fe reductase, alter from Fe^{3+} to Fe^{2+} for magnetic NPs production and

Table 1. Biological sources utilized for the iron NPs production and their uses.

S. No.	Names	Applications	Morphology	Size (nm)	References
		Plant sources			
1	*Tridax procumbens*	Antibacterial	Irregular and crystalline sphere	80-100	55
2	*Dodonaea viscose*	Antibacterial	Spherical	50-60	56
3	*Gardenia jasminoides*	Antibacterial	Rock like appearance	21	57
4	*Lawsonia inermis*	Antibacterial	Hexagonal	32	57
5	**Camellia** sinensis	Degradation of bromothymol	Spherical	5-15	46
6	Green tea	Dye degradation	Amorphous	40-60	58
8	Oolong Tea	Malachite green degradation	Spherical	40-50	14
9	Pomegranate	Antioxidant	Spherical	10-30	47
10	Grape	Antioxidant	Spherical	15-100	51
19	**Rosmarinus officinalis**	Leishmanicidal	Spherical	4	59
20	*Solanum tuberosum*	Antibacterial and antioxidant	Spherical	25-100	60
21	*Syzygium jambos*	Chromium removal	Spherical	5	8
22	*Platanus orientalis*	Antifungal			71
		Microbial source			
		Fungi			
1	*Alternaria alternate*	Antibacterial	Spherical	~ 9	61
2	*Aspergillus*	-	Spherical	50-200	70
3	*Verticillium*	-	Spherical	20-50	64
4	*Fusarium oxysporum*	-	Spherical	20-50	64
		Bacteria			
1	*Bacillus subtilis*	-	Spherical	60-80	71
2	*Actinobacter sp.*	-	Cubic	10-40	62
3	*Thermoanaerobacter sp.*	-	-	~13	72

further the Fe^{3+} reductase movement was examined by the assay of Ferrisiderophore reductase which designated that iron enzyme was produced due to the existence of extra Fe salt [63].

Fungi: Extracellular processing of the fungi, including *Verticillium* and *Fusarium oxysporum* species with blends of salts of ferrous and ferric at a constant room temperature (T) will create separate metal NPs size. Cationic receptors naturally formed from the yeasts induce the outer membrane hydrolysis of the anionic Fe complex substances. Subsequently, magnetite elements formed and it possesses a ferrimagnetic evolution mark with irrelevant quantity of impulsive magnetization at a short T [64]. Five diverse fungi species include *A. wentii, P. chlamydosporium, C. globosum, A. fumigates* and *C. lunata* and the bacteria, *B. coagulans, A. faecalis* were examined by Kaul et al. study for the creation of Fe NPs [65]. Another research group utilized a fungus *Alternaria alternate* for iron NPs production and it has been further characterized by the numerous spectroscopic methods. Further, these NPs exhibit 9 nm cubic shape and it showed an antimicrobial activity against the species including, *E. coli, B. subtilis, P. aeruginosa and S. aureus* [61].

Biological applications of iron NPs: Biological NPs were also utilized, in addition to the antibacterial and anticancer activities, sensors have proved to be extra effective in construction. For instance, silver NPs have been successfully employed in the manufacture of an optical fiber sensor to identify H_2O_2 which is portable and cost effective and can be employed in several commercial usages. In addition, based on the biocompatable nature and greater efficacy of biotic metal NPs, it was presumed that biotic-based NPs can boost the performance of traditional cancer drugs by assisting delivery to definite cells, decreasing the necessary dose of the molecule thus prevents the harmful health risk of the huge number of lead molecules. Besides, biotic NPs can change produced iron (Fe) and gold NPs in thermal therapies and photo-imaging. Moreover, it (biological NP) can also be utilized in medicinal and cosmetic applications [66]. Figure 4 clearly shows the pharmaceutical applications of Iron NPs from various types of green synthesis.

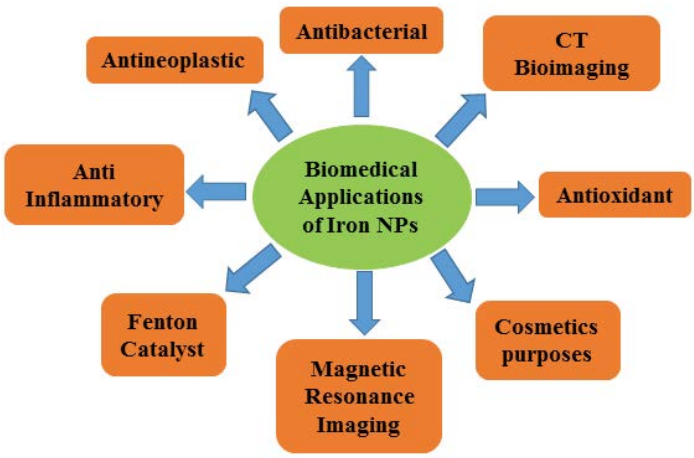

Figure 4: Pharmaceutical applications of Iron NPs from various Biological syntheses.

Antimicrobial activity: Further, studies also confirm that iron NPs have a better antibacterial properties. The antimicrobial effect of *Tridax Procumbens* produced Fe NPs was examined by Senthil et al. [55] against *Pseudomonas aeruginosa*. Also Kiruba et al. utilized the floral extract of *Dodonaea viscosa* for the copper, iron and silver NPs. The decrease of Fe salt to ZVI NPs was further evaluated based on the sudden alteration of reaction from pale yellow to greenish-black at normal T. The Fe zero-valent processed NPs exhibited a spherical shape within a range of 27 nanometer. The FTIR techniques confirm the existence of biological particles in *D. viscose* floras including flavonoids accomplish the deduction in salt metals, saponins and tannins as a covering mediators. Capping of nanoparticles (NPs) with floral biomolecules inhibit the oxidation of NPs to their oxide. Further, the antibacterial activities of produced NPs were examined against (gram-negative bacteria) *Escherichia coli*, *Pseudomonas fluorescens Klebsiella pneumonia*, and (gram-positive bacteria) *Bacillus subtilis* and *Staphylococcus aureus*. Ultimately, these processed nanoparticles were found to be as best efficient antibacterial mediators against explicit human pathogens [56].

Antineoplastic activity: Tumor is the prominent cause of demises around the worldwide. Latest report predicted that the approximately 7,45,000 people worldwide are falling victim because of the tumor threat [67]. The hepatocellular carcinoma is a communal type of cancer that affects both middle and adults age. Viral HBV and HCV infections may contribute to liver cancer, whereas consumption of heavy alcohol, aflatoxin (exposure to toxins), etc., can lead to hepatic cancers. Bioinspired iron particles were first studied beneath *in vitro* circumstances to examine the cytotoxic effect of HepG2 cells. Numerous concentrations in mg/mL of 500 to 7.8 μg/mL were examined via MTT assay. Their findings showed strong NPs activity against the HepG2 cells. However, at 500 mg/mL ~ 80% death was stated, whilst the activity declined as the lower concentration. The estimated median lethal concentration was found to be 20 μg/ml [68].

Report stated that tumor is a deadliest disease and continues to be a major origin of death in the developing and developed nations, and still the counts are constantly growing and expected to be ~21 million in the year 2030 [13]. Hepatocellular carcinoma is presently the 6^{th}utmostcommunalcancer amid the diverse forms and is measured to be the 2ndand 6^{th} deadliest cancer for men and women, representing 7,45,517 mortalities. Health risks related with the hepatic tumor include HCV and HBV viral infections, exposure of toxin and consumption of heavy alcohol. Iron particles ability for anticancer have been examined against cancer cell line HepG2. For 24 hours, cancer cells treated with diverse Fe concentrations between 500–3.9 μg /ml ensued in dose-dependent cancer cell inhibition. Our results displayed strong possible anticancer activity for iron based NPs. A dose-dependent inhibition with death of ~86 per cent was attained with the utmost reported inhibition at 500 μg / ml, whilst the possible for anticancer reduced as concentration reduced. The calculated ICI50 value was 13.47 μg / ml [69-72]. Interestingly, our results are well correlated with the Hassan et al., study on NPs synthesis.

CONCLUSION

Recently, a foremost effort of scientific community has been the improvement of effective investigational procedures for metal NPs with that of preferred shapes. Due to their distinctive properties, biological synthesis of metal NPs has mount up crucial attention since the decades which makes them pertinent in various areas of biosciences. A fascinating approach to the non-toxic and effective iron NPs process is found to be the use of plant extract. The constituents found in the flora exchange certain toxic reduction substances that are intricate in Fe NPs biochemical process. Therefore, the review emphasis on a number offloral extracts which are utilized as a reduction agent for Fe NPs process. They consider these iron NPs to be non-toxic and hydrophilic. Hence, Fe NPs processed by biosynthesis methods are ideally suited for therapeutic use. The traditional approaches of producing NPs are expensive and also produce a harmful end product, so there is an urge to reduce the threat of human health from the diverse elements employed in physio-chemical strategies. The alternative methods originate for developing NPs are "natural synthesis." In this present study, we discussed on the green synthesis methods for synthesizing NPs where the microbes such as flora, yeasts and algae are encompassed. The NPs from biological materials have many uses in numerous areas such as pharmaceuticals, bio-sensing and so on. Mostly floral substances can be produced nearby employing the natural properties in emerging nations where the substances can occur exclusively. Conclusively, this review mainly highpoints the evidence on the biological based synthesis of iron NPs and their diverse number of utilizations in the therapeutic fields.

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Conflict of interest

No conflicts of interest declared.

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