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Comparison of efficacy of biogenic silver nanoparticles using ficus species

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ABSTRACT

Current trends in science and medicine are the advent of nanotechnology. This technology had been in application in the traditional systems of medicine like Ayurveda and Siddha. They adopt this technology by preparing the nanoparticles of heavy metals like mercury, gold, Silver etc. and use those formulations effectively in curing diseases. Out of the minerals that are available to use in medicine, Silver stands as an essential and safest yet potent metal that is made as nanoparticles. It is evident from history that Silver is being used as a nanoparticle. It prevents infections and kills microbes and helps store food like milk, wine and vinegar for more extended periods. Apart from the electronic and technological application of the nanoparticles, the pharmaceutical and medical application of the same had been under development. This research will focus on the comparison of the ficus plants like; Ficus religiosa, Ficus benghalensis, Ficus microcarpa, Ficus hispida, Ficus trigona and Ficus citrifolia extract on the synthesis of the silver nanoparticles and their antibacterial property.

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INTRODUCTION

Current trends in science and medicine are the advent of nano technology [1, 2]. This technology had been in application in the traditional systems of medicine like Ayurveda and Siddha. They adopt this technology by preparing the nanoparticles of heavy metals like mercury, gold, Silver etc. and use those formulations effectively in curing diseases [3]. Currently, they have been in the application as diagnostic aids and medical requirements. There are numerous methods to synthesize them with their pros and cons [4]. Traditional, they are prepared using techniques that are non-toxic and safer, but they were not produced in a mass number [5]. So to meet the requirements of the higher number and scale of nanoparticles, newer and advanced techniques were introduced which were later found to be more toxic and possess side effects to human body and nature as well [6].

So alternative methods of synthesis were being used to produce nanoparticles to counter and prevent the side effects and adverse effects. Green synthesis poses as a solution to the above problem, and herbs are being used to produce nanoparticles in a safer manner [7]. This green synthesis is the process of using herbs and their antioxidant property to reduce the metal ions into nanoparticles. These nanoparticles were evaluated and reported similar in structure and function to the normal chemically synthesized nanoparticles. So, this process can be effectively applied for the research [8].

Out of the metals that are available to use in medicine, Silver stands as a critical and safest yet potent metal that is made as nano particles [9]. It is evident from history that Silver is being used as a nanoparticle. It prevents infections and kills microbes and helps store food like milk, wine and vinegar for more prolonged periods [10]. There is no standard scientific evidence and documentation regarding its potency in fighting the microbes; it is still being used as a potent antibacterial agent and wound healing agent. The recent development of the science allowed the investigation of the Silver in proving the scientific claims for the antibacterial property. But the mechanism of action of Silver and toxicity yet to be established to employ full-pledged usage. The harmful effects of the Silver were considered, and the research work was focused in that arena. Even though there are many antibacterial drugs available out in the market, given their side effects, silver nanoparticles are being considered for the same but lower toxicity and higher potency. Apart from the electronic and technological application of the nanoparticles, pharmaceutical, and medical application of same had been under development [11].

There had been an investigation in the antioxidant activity of ficus species plants, and numerous works had been published so far in this area [12]. This research will focus on the comparison of the ficus plants like; Ficus religiosa, Ficus benghalensis, Ficus microcarpa, Ficus hispida, Ficus trigona and Ficus citrifolia extract on the synthesis of the silver nanoparticles and their antibacterial property.

PROCEDURAL PLAN

Plant procurement and processing

Fresh leaves of the plant belonging to Ficus genus; Ficus religiosa, Ficus benghalensis, Ficus microcarpa, Ficus hispida, Ficus trigona and Ficus citrifolia were collected from the local area and farms and were authenticated duly. The herbarium sample is deposited in the college library for further references. These leaves are dried in an oven at 40^0C for hrs, and after making sure the moisture is all lost then they are powdered and used for extraction. 100gm of powder is used for removal using double distilled water. The powder is weighed and macerated in 500ml water for about 24hr with constant stirring. The macerated liquid was filtered, and the filtrate was collected and used for the preparation of nanoparticles.

500ml of the 0.1M of AgNO3 was mixed with 100ml plant extracts, and the volume was made to 200ml. The mixture is filtered via centrifugation at 9000rpm for 30min. The supernatant liquid was collected and heated on a water bath to 50^0C until colour change happens [13]. Here is indicative of the formation of silver nanoparticles and names respectively like FRN, FBN, FTN, FCN, FHN and FMN.

Bacterial organisms

All the bacteria cultures were procured from the mother cultures and stored in the microbiology lab of the college. These cultures were subcultured, and the freshly prepared cultures were used in the experiments.

Antibacterial efficacy of the formed nanoparticles

The antibacterial activity of the silver nanoparticles that are formed with various extracts was tested in a dip well method using the procedure proposed by Theivasnthia and Alagar. Three Petri plates were selected for the culturing of bacteria; Mycobacterium tuberculosis, Bacillus subtilis and Pseudomonas. Nutrient agar medium was freshly prepared and poured on the Petri plates, and cavities like wells were made in the solidified plates. The cultures were filled in the Petri plates int eh culture wells. The pits were filled with 25 microlitres of the solution. The Petri plates were incubated in the oven at 37^0C for 24 hr. Petri plates were checked for the zone of inhibition, and the comparison was made in the values using ANOVA in Dunnet's test, where the P values less than 0.01 were declared significantly different.

DATA ANALYSIS

The formation of the nanoparticles was confirmed by the colour change in the solution of the extracts. The answers were pale greenish-yellow colour before heating, and the heat was stopped when the colour was changed to dark greenish-brown colour. It is suggestive of the formation of silver nanoparticles. There is a minimal variation in the shade, but all the extracts after heating ended up having the same colour. So, it is clear that the nanoparticles are formed, and the preparation process is terminated, and the nanoparticles were evaluated for the antibacterial property.

The antibacterial property of the nanoparticles was compared by estimating the zone of inhibitions of the formed silver nanoparticles using various extracts which were named sequentially, FBN, FRN, FTN, FCN, FMN, FHN for bhengalensis, recemona, triloba, citrifolia, microcarpa and hispida respectively. All the nanoparticles showed activity against

Table 1: antibacterial activity of silver nanoparticles

Mycobacterium tuberculosis		Bacillus subtilis		Pseudomonas	
Group	**zone of inhibiton**	**Group**	**zone of inhibiton**	**Group**	**zone of inhibiton**
STD	4.7±1.12mm	**STD**	4.11±0.69mm	**STD**	2.3±0.35mm
FBN	2.9±0.45mm	**FBN**	1.6±0.28mm	**FBN**	1.9±0.21mm
FRN	5.3±0.16mm	**FRN**	5.2±0.54mm	**FRN**	3.4±0.63mm
FTN	5.10±0.39mm	**FTN**	6.2±0.37mm	**FTN**	4.10±0.56mm
FCN	2.8±0.67mm	**FCN**	1.9±0.16mm	**FCN**	1.8±0.42mm
FMN	5.2±0.28mm	**FMN**	5.6±0.53mm	**FMN**	3.3±0.69mm
FHN	5.9±0.51mm	**FHN**	6.5±0.64mm	**FHN**	4.10±0.72mm

all the bacteria, few were in a greater extent, and few were in a lower extent when compared to the standard antibacterial drug. Out of all the extracts, the nanoparticles formed with triloba had found to be more potent than other extracts.

The antibacterial activity of the silver nanoparticles formed against Mycobacterium are as the following order, FCN>FBN>FMN>FRN>FHN>FTN. It was compared with the standard which is more than just two extracts, FBN and FCN, which is only 4.7mm. The highest zone of inhibition was seen in FTN, which is 5.10mm. The antibacterial activity of the nanoparticles against bacillus was little different compared to the above, which is as follows, FBN>FCN>FRN>FMN>FTN>FHN. The highest zone of inhibition was seen in nanoparticles that were synthesized using FHN with a zone of inhibition of 6.5mm. The least activity was seen in the nanoparticles which were synthesized using FBN with 1.6mm.

The antibacterial property of the silver nanoparticles synthesized using plant extracts against Pseudomonas and the activity order is as follows, FCN>FBN>FMN>FRN>FHN=FTN. Interestingly, the activity against Pseudomonas the extracts of hispida and triloba has given a similar activity. And citrifolia is the lowest of the activities.

The difference in the activities might be due to the size of the nanoparticles, which means nanoparticles which are larger tend to be less penetrative into the cellular membrane and disrupt the bacterial cells. They attach to the phospholipids and lipoproteins on the cell membrane and inhibit the cellular respiration [13, 14]. The difference in the size distribution of the nanoparticles was due to the difference in the amounts of chemical constituents of the extracts. The polyphenol and flavonoid content in the extract produced a full size distributed nanoparticles which lead to the difference in the antibacterial activities of the nanoparticles.

The difference in the activity might also be due to the ability of the nanoparticles leading to the bactericidal action and bacteriostatic activity of the extracts itself. The chemical constituents that are present in the extracts also had antibacterial property which might have added to the silver nanoparticles in inhibiting the bacteria [15].

CONCLUSION

The silver nanoparticles were formed using the ficus species extracts. Various species of ficus plants were extracted, and silver nanoparticles were prepared using the extracts. They were compared with each other for their antibacterial properties and found that zones of inhibition of the nanoparticles were significantly different. The particles size analysis and the detailed study of the evaluating parameters to be done to investigate and establish the exact mechanism and reasons for the differences in the activities of the nanoparticles.

CONFLICT OF INTEREST

Authors declared no conflict of interest.

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