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PREPARATION AND EVALUATION OF SILVER NANOPARTICLES USING PRAVAL PISHTI FOR WOUND HEALING

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Abstract

Silver nanoparticles are synthesized using an extract obtained from Praval Pishti powder following the Soxhlet extraction process. The chemical reduction method is employed for nanoparticle synthesis, where silver nitrate ($AgNO_3$) and glucose are reduced in the presence of polyvinylpyrrolidone (PVP) as a stabilizing agent. Sodium hydroxide (NaOH) is added to accelerate the reaction. After synthesis, the silver nanoparticles (AgNPs) are evaluated to determine whether they fall within the standard particle size range. Once confirmed to be within the desired size range, a nanogel formulation is prepared. The nanogel is composed of Carbopol 934, methyl paraben, propyl paraben, propylene glycol, and triethanolamine, which help maintain its pH within the physiological skin range (6.8–7.0) and enhance its consistency.

Following formulation, the nanogel is assessed based on various physicochemical properties, including uniform texture, smooth consistency, and non-irritating nature, ensuring its suitability for topical application.

Keywords: Silver Nanoparticles, Scanning Electron Microscopy, Nanoparticles, Nanotechnology, World Health Organization, Praval Pishti, Silver nitrate.

Introduction

Ayurveda is among the oldest medical traditions in the world. A plethora of knowledge regarding medicinal plants that can be used to treat, manage, and/or prevent a range of disorders can be found in classic Ayurvedic literature. Knowledge of the therapeutic qualities of medicinal plants used in Ayurvedic treatments documented in texts has been gathered through astute clinical observations made over millennia. Information about their properties and therapeutic applications can be found in ancient writings such as the Vedas, Samhitas, and Puranas. The compilations of so-called Nighantus from later periods are also quite instructive.[1]

The usage of medicinal plants contributes significantly to the development of potent therapeutic medicines. Traditional medicine, which is mostly based on plant and animal species, continues to provide primary medical care for about 80% of people in underdeveloped countries. Herbal therapies are currently becoming more and more popular. About 800 plant species have been included into conventional medical systems, and about 500 plants have been mentioned as therapeutic in ancient writings. Herbal medicines, also referred to as plant materials or herbals, are drugs used to heal wounds or illnesses that are manufactured from complete plants or plant

parts. As our lifestyle becomes increasingly focused on technology, we are losing our connection to the natural world.[2] Even though we are a part of nature, we cannot really escape it. Herbs are natural products that are easily accessible in the area, safe, and innocuous compared to other things. Historically, a variety of plants have been utilized to heal ailments related to the different seasons. They need to be promoted in order to save lives. Nowadays, herbal remedies are considered safer than synthetic ones, which are seen to be bad for the environment and humans. Although herbs have traditionally been prized for their therapeutic, flavorful, and aromatic qualities, contemporary synthetic products momentarily overshadowed their importance. However, as people's careless reliance on synthetics declines, they are returning to naturals in search of stability and safety. Now is the time to sell them abroad.[3]

Herbal medicines are naturally occurring substances derived from plants that are used to cure illnesses in local or regional healing practices. These products are complex mixtures of organic substances that can come from any part of a plant, whether it is treated or not. Herbal medicine has roots in every culture on the planet.[4] Innovations in areas such as energy, biotechnology, information technology, materials and manufacturing, nanoelectronics, medicine and healthcare, and national security are made possible by nanotechnology research in science and technology. Most people agree that nanotechnology will be the next industrial revolution.[5] Nanotechnology enables drugs in the nanoscale size range, which enhance performance in a variety of dosage forms. In order to generate new insights into the development of materials to address a wide range of issues in the fields of medicine, engineering, agriculture, biology, chemistry, surface science, space exploration, ocean and marine science, geography, and geology, the multidisciplinary field of nanotechnology manipulates atoms, electrons, protons, and neutrons in different ways. Nanotechnology is used in science to organize materials at the molecular level.[6]

Nanotechnologies can be broadly divided into three categories: computational, dry, and wet. Wet nanotechnology is associated with living things, such as tissues, membranes, enzymes, and other cellular components.[7, 8,9]

Silver Nanoparticles

For thousands of years, silver and its compounds have been utilized for medicinal and antimicrobial purposes. To prevent food, wine, and water from spoiling, the ancient Greeks and Romans stored them in silverware. Hippocrates promoted wound healing and treated ulcers with silver concoctions. Additionally, silver nitrate was used to sterilize instruments and treat wounds. Sims employed thin silver wires to repair the vesicovaginal fistulas brought on by childbirth in 1852, greatly reducing infection.[10--16]

Methods of synthesis of nanoparticles

Nanostructure materials have attracted a lot of attention because of their strikingly different sizes and shapes from their larger dimensional counterparts in terms of their electrical, magnetic, chemical, and physical characteristics. Many methods have been developed to produce nanostructure materials with exact dimensions, shape, dimensionality, and structure. The properties of materials dictate their performance. The properties of the material are influenced by the kinetics and thermodynamics of the synthesis, which control the atomic structure,

composition, microstructure, defects, and interfaces. Physical method of nanoparticle synthesis, Photochemical Approach, Biological Approach, and Chemical Approach. [16-21]

Applications of Silver Nanoparticles:

Silver nanoparticles are among the most desirable nanomaterials for industrial applications. The food preservation industry, textile coatings, antibacterial agents in the medical field, electrical products, and several environmental applications have all found extensive use for them. Silver nanoparticles have been used as antimicrobial agents in a number of applications, such as disinfecting medical equipment and domestic appliances and treating water. Furthermore, this encouraged the textile sector to use AgNPs in a variety of textile textiles. In this direction, silver nano composite fibers were produced by incorporating AgNPs into the fabric. Cotton fibers with AgNP shown strong antibacterial activity against Escherichia coli. In the luminol-hydrogen peroxide system, silver nanoparticles were found to have higher catalytic activity than Au and Pt colloid to catalyze the chemiluminescence. [22-25]

Plant Profile:

For millennia, numerous Ayurvedic formulations and medications that have benefited humanity have been made using Rasa Shastra, an ancient Indian alchemy. One such Ayurvedic formulation is Praval Pishti. Pishti is a finely ground powdered raw material that is incompatible with heat treatment. Pishti is smooth, fine, and has a distinct color. Praval, often known as coral, is a calcium and mineral type that occurs naturally. Praval belongs to the Coelenterate family of aquatic animals. Praval is a type of microscopic marine organism found in tropical oceans.

Composition of Praval Pishti

Chemically it consists of 87% calcium carbonate, 3% magnesium carbonate, iron, traces of magnesia, 2% silica, 8% organic matter and water. Detail composition is given in Table 1.

Table 1: Chemical Composition of Praval Pishti

Sr.No	Content	Composition
1	Calcium Carbonate	87%
2	Magnesium Carbonate	3%
3	silica	2%
4	organic matter	8%

Material and Method

Soxhlet Extraction Process

Extraction is the process of using particular solvents and standard operating methods to separate the portion of a plant that has therapeutic qualities. The goal of each extraction procedure is to remove the insoluble cellular waste while removing the soluble plant metabolites. The first crude extract produced using these methods has a complex mixture of several plant metabolites, including as alkaloids, glycosides, tannins, terpenoids, and flavonoids. Some of the initially obtained extracts may be appropriate for use as medicinal agents in the form of tinctures and fluid extracts, while others need further processing. Praval Pishti is in powder form, is used in the process of extracting flavonoid form. Its flavonoid extract has anti-oxidant, anti-microbial,

and anti-inflammatory properties. Effective compound extraction, lower solvent and raw material consumption, and quicker extraction times are some benefits of Soxhlet extraction. [26-28]

The Praval Pishti power is placed inside a thimble made of thick filter paper, which is loaded into the main chamber of the Soxhlet extractor. [29]

Stepwise Process

- During the reflux process, ethanol solvent is heated. As it evaporates and ascends through the distillation arm, the solvent vapor enters the chamber containing the thimble filled with Praval Pishti powder (Figure 1).
- The heated ethanol solvent gradually accumulates in the chamber containing the Praval Pishti powder.
- Simultaneously, the ethanol vapour is cooled and condensed, ensuring its return to the condenser. Some of the desired Praval Pishti molecules dissolve into the ethanol solvent.
- Once the Soxhlet chamber nears its maximum capacity, the siphon side arm automatically empties it, allowing the solvent to flow back into the distillation flask.
- This cycle may be repeated multiple times over several hours or days. With each cycle, a fraction of the non-volatile component dissolves into the ethanol solvent.
- After multiple extraction cycles, the desired component becomes concentrated in the distillation flask. Following the extraction process, ethanol is removed to obtain the extracted material, while the insoluble portion of Praval Pishti remains in the thimble for disposal. [30]

Figure 1: Soxhlet Extraction of Praval Pishti

Table 2: Preparation of Silver Nanoparticles

Sr. No	Ingredients	Quantity
1	PVP	1.27 gm
2	NaOH	0.96 gm
3	Glucose	5.94 gm
4	Silver Nitrate	0.01M
5	Distilled Water	q.s

Polyvinylpyrrolidone (PVP) (1.27 g), sodium hydroxide (NaOH) (0.96 g), and glucose (5.94 g) were dissolved in 15 mL of deionized water. The mixture was stirred continuously while being heated to 60°C., A 0.01 M silver nitrate solution (prepared in 5 mL of water) was gradually

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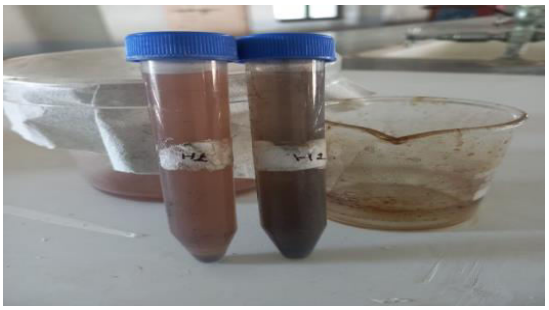
added to the PVP solution. After the complete addition of the silver nitrate solution, the mixture was shaken for an additional ten minutes. The resulting particles were separated by centrifugation and repeatedly washed with distilled water until nitrate ions (NO_3^-) were no longer detectable. The purified particles were then dried at 80°C, resulting in grey-colored silver nanoparticles in powdered form (Figure 2).[31]



Preparation of solution for AgNp Centrifugation of solution.

Figure 2: Preparation Of Silver Nanoparticles

Preparation of Silver Nanoparticles Gel Formulation:

Table 3: Preparation of Silver Nanoparticles Gel Formula

Sr.No	Ingredient	Quantity
1	Carbapol 934	1 gm
2	Methyl Paraben	0.3 gm
3	Propyl Paraben	0.2 gm
4	Propylene Glycol 40	5 ml
5	Triethanolamine	2 ml
6	Distilled Water	q.s

One gram of Carbopol 934 was dissolved in 50 mL of purified water under continuous stirring. Subsequently, 5 mL of distilled water was used to dissolve the required quantities of methyl and propyl paraben in a water bath. After allowing the solution to cool, 400 mg of propylene glycol was added. The prepared mixture was then combined with the required amount of silver nanoparticles (SNPs), and the remaining distilled water was added to adjust the final volume to 100 mL. Triethanolamine was gradually incorporated into the formulation to adjust the skin-compatible pH (6.8–7.0) and achieve the desired gel consistency. The ingredients were thoroughly mixed and uniformly dispersed into the Carbopol 934 gel. [32-33]

Evaluation of Gel Formulation

Physical Evaluation:

Physical attributes such as homogeneity, color, and appearance were investigated. The produced nanogel compositions were visually inspected to make sure they were uniform and the proper color after the gels had had time to settle in the container. Tests were then carried out to check

for the presence of aggregates. A visual examination of the topical nanogel was used to look into the uniformity investigation. To ascertain whether or not the prepared topical nanogel contained aggregates, all of the produced topical nanogel were placed into vial containers of varying colors and examined visually.

Measurement of pH

The pH of the gel was ascertained by measuring it with a pH meter. A digital pH meter was used to measure the pH of each batch of topical nanogel. Before the measurement, 1 gram of topical nanogel was added to a 50 ml beaker that held 20 ml of filtered water. The electrode of the PH meter was dipped into the topical nanogel to determine its PH. [34]

Viscosity

The viscosity of the gel was measured using a Brookfield viscometer equipped with a spindle. The viscosity of every topical nanogel batch was measured using a Brookfield Rheometer. The sample holder was filled with topical nanogel until the mark was achieved. The spindle was attached to the Brookfield Rheometer. Before the spindle was put into the topical nanogel, the sample holder was filled with it. The sample holder for the device was then fitted, and the viscosity of the topical nanogel was ascertained.

Spreadability

Two slides, each divided into squares with 5 mm sides, were sandwiched with a 0.5 g sample of each formula. No further spreading was expected for the five minutes or so when the samples were left. The diameters of the spread circles were measured in millimeters to assess the spreadability of the circles. [35]

Results and Discussion

Praval Pishti extract is used to create silver nanoparticles for the nanogel formulation. Three batches of nanogel formulations, F1, F2, and F3, were made with carbapol 934, triethanolamine, propylene glycol, methyl paraben, and propyl paraben. Once the nanogel formulations F1, F2, and F3 are prepared, they are assessed for various evaluation parameters, such as physical appearance (color, odor, and homogeneity), PH measurement using a PH meter, viscosity using a Brookfield viscometer, and formulation spreadability. The F1, F2, and F3 batches are tested to ensure that the nanogel formulation is stable, non-irritating, homogeneous, and has good spreadability. The PH of the F1, F2, and F3 batches is also examined to ensure that it is within the skin's pH range.

Physical Appearance:

The formulated nanogel formulations batch F1, F2, F3 showed a clear appearance and all the formulations were found to be homogenous and free of aggregates. Color of nanogel found to be slightly yellowish and it has pleasant odor.

pH Measurement:

The PH of produced nanogels formulations F1, F2, F3 found to be 6.76, 6.82, and 7.0, which is optimally close to the skin's pH to prevent irritation. Thus, it can be said that nanogels do not cause irritation to the skin.

Viscosity:

Viscosity of Nanogel formulation measured by using Brookfield viscometer. The viscosity of nanogel formulations batch F1, F2, F3 found to be 3659 cp , 5926 cp and 6799cp.

Spreadability:

The spreadability of the nanogel formulation batch F1, F2, F3 found to be 4.6 cm ,4.9 cm, and 5.2 cm .

Table 4: Evaluation of Gel Formulation

Nanogel	Physical appearance	pH	Viscosity at 10 rpm	Spreadability (cm)
F1	slightly yellowish	6.76	3659 cp	4.6 cm
F2	slightly yellowish	6.82	5926 cp	4.9 cm
F3	slightly yellowish	7.00	6799 cp	5.2 cm

Conclusion:

Silver nanoparticles are synthesized using an extract from Praval Pishti powder following a Soxhlet extraction process. The chemical reduction method is employed for nanoparticle synthesis, wherein silver nitrate ($AgNO_3$) is reduced by glucose in the presence of polyvinylpyrrolidone (PVP) as a stabilizing agent. To accelerate the reaction, sodium hydroxide (NaOH) is added to the mixture.

The synthesized silver nanoparticles (AgNPs) are evaluated to determine whether their diameters fall within the standard size range. Once the nanoparticles meet the required size specifications, a nanogel formulation is prepared. The nanogel is composed of Carbopol 934, methyl paraben, propyl paraben, propylene glycol, and triethanolamine, which help maintain the pH within the physiological skin range (6.8–7.0) and enhance its consistency.

Following formulation, the nanogel is assessed based on various physicochemical parameters, including its uniform texture, smooth consistency, and non-irritating nature. It exhibits a pleasant odor and a pale yellow appearance. The nanogel demonstrates good spreadability, and its pH, measured using a pH meter, remains between 6.8 and 7.0, aligning with the natural pH of the skin. Additionally, the viscosity of the nanogel is determined using a Brookfield viscometer, with values ranging between 3,659 and 6,799 cP.

Conflict of Interest: The authors declare that they have no conflict of interest.

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