Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 7
Open Access

Formulation and Assessment of Topical Gel Containing *Ocimum gratissimum* Derived Silver Nanoparticles for the Treatment of Acne

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Cite this paper as: Keshava KS, Praveencumar R, Rucha Pusegaonkar, J. K. Shyamala, V.V.S.S. Appalaraju, Sonali Ankush Barke, Sandesh Rangnath Wayal, Vasuki K* (2024) Formulation and assessment of an acne gel containing *Ocimum gratissimum* - derived silver nanoparticles. *Frontiers in Health Informatics, 13* (7), 101-109

ABSTRACT

Background: Nearly eighty percent of all teenagers will deal with acne vulgaris, a common skin condition. Resistance develops when a certain drug-bacteria interaction occurs over an extended period of time. Discovering the phytochemical content of *Ocimum gratissimum*, developing an environmentally friendly method of synthesizing silver nanoparticles, and developing a gel to treat acne were the objectives of this study.

Methods: *Ocimum gratissimum* is an excellent option due to its antibacterial properties. Alkaloids, flavonoids, tannins, and saponins are some of the phytoconstituents identified in the phytochemical analysis of the extract. One millimoles of silver nitrate in one milliliter of water was prepared using *Ocimum gratissimum* leaf extract. The next step was to confirm the synthesis of silver nanoparticles using ultraviolet spectroscopy and evaluation of antiacne property of developed gel using agar well diffusion method.

Results: Scientists examined its viscosity, pH, and ability to disseminate and kill the microorganisms *Propionibacterium* *acnes*, *Staphylococcus aureus*, and *Escherichia coli*. There were no lumps, fibers, or fragments in the final product; the colors were distributed uniformly and observed significant anti acne activity. It was also seen to be easily removed and to have a strong spreading potential. **Conclusion**: *Ocimum gratissimum* silver nanoparticles gel may work well to treat acne vulgaris.

Keywords: *Ocimum gratissimum* leaf extract, Silver nanoparticles, Topical gel formulation and antiacne property

INTRODUCTION

This is due to the fact that skin is the most common entry point for bacteria into the body. The age group typically between eleven to thirty consists acne vulgaris infection. Nearly half of all males and half of all women in this age bracket will experience acne vulgaris at some point [1-3]. Inflammation, hormonal and immunological shifts, and uneven keratinization are among the several factors that can lead to acne. A number of mental health concerns, including depression and anxiety, have been associated with acne vulgaris, a prevalent skin ailment [2-4].

Acne is caused by germs such as *Propionibacterium*, *Staphylococcus*, and *Escherichia* species. The germs that antibiotics are meant to kill can develop resistance to them after prolonged medical usage, rendering them ineffective. Because of the special relationship between bacteria and antibiotics, the problem of antibiotic resistance is rapidly worsening. Phytomedicines, or cures derived from plants, have a long history of use as folk remedies for health issues [4-6].

In terms of primary healthcare, plants are relied upon by approximately 75% to 80% of the global population, as reported by the World Health Organization (WHO). With antibiotic resistance on the rise and medicinal plants still being widely used [5-7], researchers are concentrating on developing and designating novel natural antimicrobial compounds for use in treatment and prevention. Herbs have long been an integral part of ancient medical practices such as Siddha, Ayurveda, and Unani [5-7].

Many medicinal plants can be found in India. More study of these age-old remedies has the potential to produce more affordable and effective pharmaceuticals. Topical mixes containing antibacterial nanoparticles are widely believed to be effective in treating acne vulgaris. For the purpose of eliminating bacteria and viruses, silver nanoparticles are widely believed to be the most effective metallic nanoparticles [6-8]. *Ocimum gratissimum* is a plant with several potential traditional medicinal uses due to its abundance of phytochemicals. *Ocimum gratissimum* has been effective in treating a variety of skin disorders due to its high concentration of combustible oil. The goal of this research, discovering the phytochemical content of *Ocimum gratissimum*, synthesizing silver nanoparticles and developing a gel to treat acne were the objectives of this study [7-9].

MATERIALS AND METHODS

Materials

The materials required for the proposed study were procured from their respective reliable sources. Fresh leaves of *Ocimum gratissimum* were collected from a verified botanical source and authenticated with well qualified botanist Dr. Kannan, HOD, Department of Botanist, Swamy Vivekananda College of Pharmacy, Tamilanadu.

Preparation of Extract

The leaves of the *Ocimum gratissimum* were thoroughly rinsed with water to remove any debris or dust, and then allowed to dry in the shade at room temperature. The air-dried leaves were crushed into minute pieces. It was then treated with methanol and subjected to Soxhlet extraction. It was vacuum-dried and stored in desiccators for further procedure [8-10].

Phytochemical Screening

The presence of phytosteroids, flavonoids, triterpenoids, alkaloids, carbohydrates, and anthraquinone glycosides was examined by using standard procedures in methanolic extract [9-11].

Green Synthesis of Silver Nanoparticles

Incorporated 95ml of water with a 1 mM silver nitrate solution and 5ml of leaf extract was the first step in a one-step green synthesis. The concoction was kept in the dark place at room temperature. Silver nanoparticles are formed by dissolving silver ions. Using UV spectrophotometry, the absorbance of the reaction medium is determined in the 300-700nm wavelength range. The synthesized AgNPs were centrifuged for 15 minutes at 10,000rpm. AgNPs were identified after transferring the supernatant to a new, dry beaker to facilitate further particle sedimentation [11-13].

Particle size, PDI and zeta potential

The average size of the silver nanoparticles was determined using photon correlation spectroscopy. This scientific study demonstrates the average particle size at 25°C and a 90-degree angle. The PCS investigation discovered two important parameters: the mean diameter, which indicates the size of the bulk population according to light strength, and the polydispersity index, which assesses the width of a particle size distribution. A Laser Doppler Anemometer connected to the Malvern Zeta Sizer was employed to verify the manufactured silver nanoparticle's zeta potential. Once the material was thoroughly mixed with 5mL of water, it was transferred to the electrophoretic cell of the instrument, which was calibrated to ±150 mV. The Smoluchosky equation was utilized to determine the zeta potential number [12-14].

Formulation of topical Gel

Using a cold mechanical process, topical gel was formulated using predetermined amount of carbopol-934 and HPMC polymer. Carefully measured 1 gram of the polymers - a mixture of HPMC and Carbopol 934 was added clean water's surface. After thoroughly mixing in the appropriate volume of double-distilled water, the mixture was permitted to dissolve the polymer overnight [13-15]. The polymer solution was continuously supplemented with the medicinal silver nanoparticles. It was meticulously blended using a magnetic mixer after adding the correct amount of glycerol. The pH of the gel was adjusted to a normal 7 using sodium hydroxide once everything had been equally distributed. Once the weight hit 100 g, additional distilled water was added. Table 1 displays the components of the herbal blend [14-16].

Table 1: Composition of formulation

Sr. No.	**Gel A**	**Qty. (gms)**	**Gel B**	**Qty. (gms)**
1	Carbopol	5	HPMC	5
2	Glycerin	5	Glycerin	5
3	*Ocimum gratissimum* AgNPs	0.05	*Ocimum gratissimum* AgNPs	0.05
4	Water	q.s.	Water	q.s.

Evaluation of formulated topical gel

Physical evaluation, pH and Viscosity

The naked eye was used to examine outward characteristics such as color, appearance and consistency. A 1% water solution containing the formulation was subjected to pH determination using a digital pH meter. The therapeutic gel

was evaluated for its viscosity using a Brookfield viscometer. The viscometer had a spindle number of 50-1 and was set to 50 rpm. We evaluated the viscosity three times [15-17].

Spreadability

Glass slides that are standard sizes and are 6 cm long were used. On one side of the glass slide, the topical gel mixture was sealed with a second slide. To get rid of the sticky glue, clean the outside of the glass slides. The slides are set up on a base, and the attached weight (20g) makes it easy to take off just the top slide. It was written down how long it took for the upper slide to move 6.0 cm [16-18].

Preparation of inoculum

A fresh 24-hour bacterial culture was floated in clean water to make a uniform microbial solution that could be used to test the effectiveness of antibiotics [19-24].

Zone of inhibition study

The effectiveness of antibiotics was evaluated using the agar well diffusion method. This procedure involved adding 0.1 mL of a uniformly hazy bacterial suspension to a previously liquefied medium. We had to accomplish this at 40°C. 20 milliliters of growth medium were added to a sterile Petri dish that had an inner diameter of 8.5 cm. The media was meticulously prepared to ensure that each plate had an identical thickness. After the liquid-contaminated material had set completely, a 6-mm-diameter cork cutter was utilized to cleanly create wells. Each of these plate extracts had a combination of topical gels and carefully selected silver nanoparticles applied to it. The blocking zones were determined after incubation at 37°C for 24 hours and a 30-minute cooling period to aid in pre-diffusion [25-30].

RESULTS AND DISCUSSION

Evaluation of Extract

The results showed that the extracts had a very dark green hue. The extract contains phytochemicals such as phytosterols, alkaloids, glycosides, carbs, tannins, and flavonoids. As you can see from Table 2, the extract passed the phytochemical test [31-34].

Table 2: Phytochemical screening of methanolic extract of *Ocimum gratissimum*

S. No	Test	Procedure	Observation	Result
1	Carbohydrate	Molish's test Benedicts test Fehling's test	Violet ring Orange red color Red color	Absent
2	Alkaloids	Mayer's test Wagner's test	Yellow color Brownish color	Present
3	Phytosterols	Salkowski's reagent Libermann Burchard's reagent	Golden yellow color Formation of brown	Absent
4	Phenols	Ferric chloride test	Bluish black color	Present
5	Glycoside	Modified Bontrager's test	No rose-pink color	Absent
6	Tannins	Gelatin test	White	Present
7	Saponins	Froth test Foam test	Formation of foam. Formation of foam	Present
8	Flavonoids	Lead acetate	Yellow color	Present

Green Synthesis of Silver Nanoparticles

Leaf extract was used in a green way to synthesize silver nanoparticles (AgNPs). When leaf extract was added to the silver nitrate solution, the color changed from pale yellow to dark brown. This showed that the silver ions were being reduced and silver nanoparticles were synthesized [35-42].

Evaluation of Silver Nanoparticles

Particle Size, PDI and Zeta Potential

When the reaction was complete, the zeta sizer was set to dynamic light scattering mode to determine the average particle size in the water-based reaction mixture. The transformation of silver ions into nanoparticles was demonstrated by the average particle size of 916.1 nm. The PDI, which measures the dispersion of globules, was determined to be 0.345 for the silver nanoparticle. Using a Malvern Zetasizer, the zeta potential was determined to be -20.8 mV. Figure 1 displays the particle size and polydispersity score [43-48].

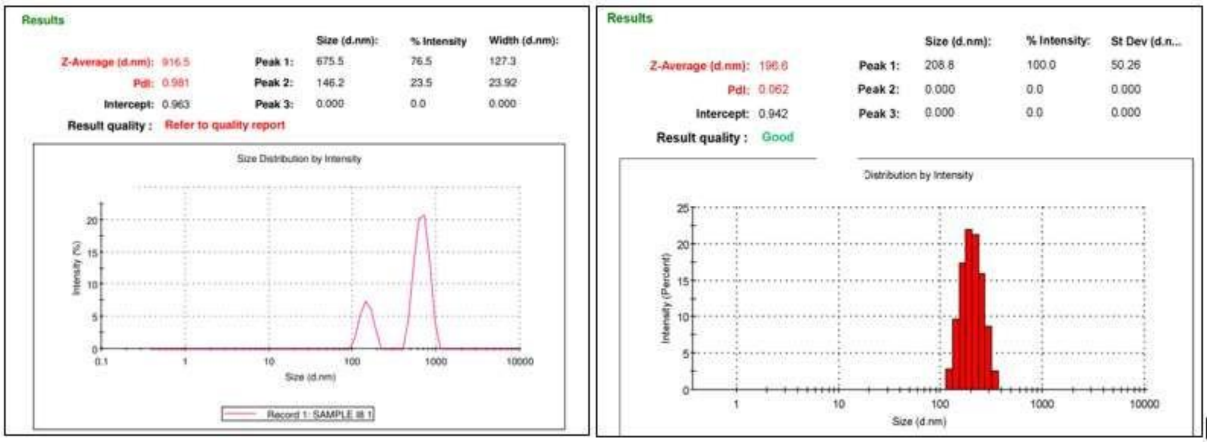

Figure 1: Particle size optimization, PDI, and Zeta potential

Physicochemical evaluation of topical gel

Because of its superior rate of medication release compared to other topical forms, gel is ideal for use in pharmaceutical and cosmetic applications. The numerous advantages of gel include its thixotropic properties, lack of grease, ease of application and removal, moisturizing effects, lack of staining, and compatibility with a wide range of other components. Color regularity, fiber and contaminant content, pH, and viscosity are some of the physical and chemical characteristics examined in the test. Based on the visual inspection results, the topical gel formulation is smooth and evenly colored, and it does not have any lumps, fibers, or other foreign particles. The mixture was easy to wash because the pH values of the gel bases were 6.72 for Carbopol and 6.80 for HPMC. It is believed that these figures are skin-compatible since they are near to the skin's pH. The Carbopol gel basis had a viscosity of 6406 cps, whereas the HPMC gel base had a viscosity of 6642 cps [49-54].

Spreadability

How efficiently the topical formulation can be applied determines its bioavailability and the efficacy of the treatment. When subjected to specific stresses, the spreadability is evaluated in seconds by observing how readily the top slide separates from the gel. The reduced time required to separate the two photos demonstrates that the topical formulation is simpler to disseminate. The ease of spreading the gels produced with HPMC and Carbopol was measured at 7.0 ± 0.1 (g.cm/sec) and 6.9 ± 0.1 (g.cm/sec) respectively. Consistent with previous research, these findings show promised [55-59].

Antibacterial Activity of the formulated topical gel

antibacterial properties of the formulated topical gel revealed that it effectively combated acne-causing bacteria, such as *Propionibacterium acne*, *Staphylococcus aureus*, and *Escherichia coli*. Antimicrobial activity testing revealed that silver nanoparticles incorporated with *Ocimum gratissimum* leaf extract were against to all tested microorganisms. Figure 2 displays the study's findings about the substance's effectiveness in killing bacteria [60-62].

Figure 2: Antibacterial activity against *E. coli, S. aureus* and *P. acne*

CONCLUSION

The study successfully formulated and evaluated a topical gel containing *Ocimum gratissimum*-derived silver nanoparticles (AgNPs) for the treatment of acne. The phytosynthesized silver nanoparticles demonstrated potent antimicrobial activity against *Propionibacterium acnes* and other acne-causing pathogens, confirming their suitability for therapeutic application. The gel formulation exhibited desirable physicochemical properties, including homogeneity, spreadability, stability, and appropriate pH for skin application. This present study, revealed sustained drug release and excellent skin permeation, indicating the gel's potential for efficient delivery of the bioactive nanoparticles. Additionally, biocompatibility and safety assessments showed minimal skin irritation, making it a promising alternative to conventional acne treatments. This research highlights the potential of integrating green-synthesized nanoparticles with topical formulations for enhanced therapeutic outcomes. Future studies, including in vivo clinical trials, are recommended to further validate the efficacy and safety of this novel approach to acne treatment.

Funding

None

Conflict of Interest

None

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