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Synthesis of Silver Nanoparticles by Green Process: Formulation and Characterization

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ABSTRACT

This work aims to study the synthesis of silver nanoparticles (AgNPs) by green process using Mentha pulgium L. extract as bioreductor and stabilizer of silver ions. The optimization of operating conditions was investigated and revealed that a maximum volume of the extract and a low concentration of $AgNO_3$ at a medium temperature, allow to increase the yield of AgNPs expressed by a fast change of color. The UV-visible characterization confirmed this result, which a wavelength around 400 nm. Other characterizations (FTIR, zeta potential, TDS and pH-meter) were also undertaken. In addition, a hydrogel based on this AgNPs solution was formulated and characterized by the determination of their rheological and sensorial behaviors, as well as a microbiological assessment; which have shown a good stability and conformity.

Keywords: *Mentha pulegium* L. extract, silver nanoparticles, hydrogel, characterisation.

1. Introduction

Nanotechnology is a multidisciplinary field, as it combines knowledge from different disciplines such as chemistry, physics and biology. Advancing the biological process of nanoparticles synthesis is becoming a key area of nanotechnology. The present study focuses on the synthesis and characterization of silver nanoparticles (AgNPs) using *Mentha pulgium* L. extract as a stabilizer and bioreductor of silver ions. This solution was valorized by the formulation of a hydrogel.

2. Experimental

The volume of extract used, the concentration of $AgNO_3$ solution chosen, the temperature and the extraction time were previously optimized (V=10ml, C=10-3, T=60°C, t=49s) with the aim of increasing the yield of AgNPs [1]. The chemical composition of the extract was analyzed by FTIR to identify the main biomolecules responsible for the reduction. The AgNPs solution thus obtained was characterized by UV-visible, zeta potential, TDS and pH-meter. Then, a hydrogel formulation based on this solution was developed and characterized by sensory and rheological analysis as well as microbial evaluation was undertaken.

Figure 1: AgNPs solution from *M.pulegium* extact

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3. Results and Discussion

The chemical composition of the active biomolecules revealed a good absorbance in favor of the C-H groups and an intense presence of the hydroxyl groups O-H and carbonyl groups C=O, which are manifested as reducers and stabilizers of AgNPs. The UV-visible characterization revealed a wavelength of the AgNPs solution of 423.5 nm which corresponds to a maximum absorbance of 1.347. As for the zeta potential, stability was observed with values higher than ±30 mV indicating that the electrostatic repulsion forces between the particles are very important ensuring the stability of the solution. The pH measurement of the colloidal solution reflected an approximately neutral pH between 7 and 8 which can be safely used. While the TDS indicated a value of 331ppm, this has brought us back to dilute the solution up to 22ppm for healthy use. The characterization of the hydrogel indicated a pH of 5.5 which is applicable on the skin, while the sensory test based on: texture, product spread, softness and stickiness gave according to all evaluators a weighted average score of 77.5/100. On the other hand, a good rheological behavior was observed, expressed by two distinct zones: a zone with Newtonian behavior and a second rheofluidifying zone.

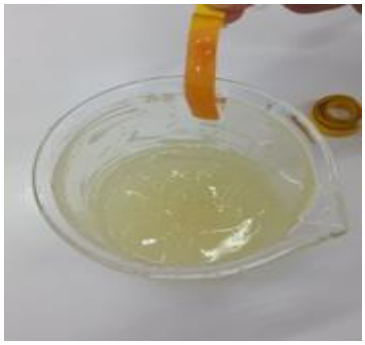
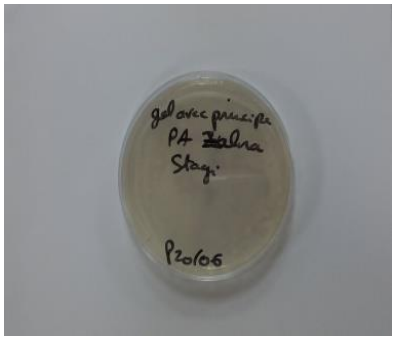


Figure 2: Formulated Hydrogel



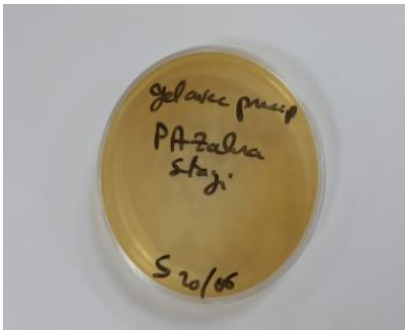


Figure 3: Antimicrobial effect of hydrogel on: total germs, yeasts and mould

The antimicrobial effect of the gel showed the absence of microbial colonies even for a second test after one month, indicating the stability and reliability of the formulation.

4. Conclusions

At the end of this research, it appears that the green synthesis of AgNPs is an ecological and profitable technique that offers a new and potential alternative to chemically synthesized nanoparticles, reducing the use of hazardous and toxic chemicals while preserving the environment.

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