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Formulation of A medicinal Shampoo from the Extract of *Ganoderma Chalceum* and Evaluation of its Anti-Dandruff Activity

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Abstract

This study aims to prepare and evaluate a natural shampoo made from *Ganoderma chalceum* mushroom extract, which is known to contain many active bioactive compounds, due to the need for the development of natural and environmentally friendly cosmetics. The samples were obtained from the mycology laboratory at the Biology Department, College of Education for Pure Science, University of Mosul. The samples of the fungus were extracted with ethanol to make a shampoo installation whose physio- chemical characteristics and biological activity were investigated with a cleaning activity of 76% as compared to 53% for commercial shampoo. The results elucidate that the produced shampoo performed better than commercial varieties in terms of enhancing hair softness and gloss. With an inhibitory zone of 36.0 ±0.5 mm as compared to 14.0 ±0.6 mm for commercial shampoo, the produced shampoo also demonstrated antifungal activity against *Candida albicans.* It was also efficient against pathogenic bacteria, *Pseudomonas aeruginosa* and *Staphylococcus aureus*, with inhibition rates of 56.0 ±1.0 and 49.07 ±0.40 mm, respectively, as compared to 12.17 ±1.04 and 16.83±0.76 mm for commercial shampoo. During storage, the produced shampoo's physicochemical characteristics demonstrated good stability. It was well received by volunteers in terms of performance, hydration, and simple to rinse. These findings elucidate the potential of employing *Ganoderma chalceum* mushroom extract in the creation of a safe and efficacious shampoo that assists the health of the hair and scalp in a friendly-environmental manner.

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1. Introduction

Fungi are a wide class of creatures that differ in size, structure, diet, and effect. They possess a unique capacity to carry out a variety of tasks that significantly affect human life, either favorably or unfavorably. Fungi are broadly used in the food, medical, industrial, and recycling sectors [1,2].

Macrofungi contain pharmacological properties like anti-inflammatory, antibacterial, antioxidant, and antiviral properties, and are significant suppliers of numerous pharmaceutical products [3]. Mushrooms have gained importance in recent years due to their active ingredients, which include fatty acids, alkaloids, phenols, glycosides, tannins, flavonoids, and volatile oils. These substances have a wide range of applications in the pharmaceutical and medical industries, and also in the treatment of different cancers and diabetes [4]. Mushrooms also include a variety of physiologically active compounds and fibers such as cellulose, chitin, hemicellulose, and mannan. Mushrooms contain numerous nutrients, including sterols, terpenoids, sugars, ascorbic acid, vitamin C, and vitamin [5]. Because of their antioxidant, anti-aging, and anti-inflammatory qualities, mushroom by-products have been used as active ingredients in numerous cosmetics, skin care products, and hair products on a large commercial scale in recent years [6].

Ganoderma lucidum is considered a conventional medicinal mushroom. It is used in many medical fields because it contains many active compounds, such as polysaccharides and triterpenoids. Mushroom extracts are used as natural alternatives for antimicrobial, antioxidant, anticancer, anti-inflammatory, and antidiabetic agents. The fungus Ganoderma lucidum belongs to the phylum Basidiomycota, family Ganodermataceae. It is a wood-decomposing fungus that breaks down lignin and grows mostly on weak or decaying trees. Some studies indicate that it contains many compounds, including polysaccharides and triterpenoids, which have medical importance as antioxidants, antibacterial agents, and immune boosters. [7, 8].

Hair care products such as shampoos, serums, conditioners, gels, and styling products are hair care are produced all over the world. Shampoo is a sticky liquid used to cleanse the hair and scalp of surplus oil and dirt. Traditional shampoos are usually made from artificial chemicals. Although they are effective at cleaning, long-term use of these chemical shampoos has harmful side effects such as hair agitation, hair loss, and dryness. Therefore, consumers are increasingly turning to safe alternatives derived from plants and fungi. Herbal shampoos are considered a natural solution prepared from plant and fungal extracts, herbal infusions, and essential oils [9, 10]. One study has suggested the use of *Ganoderma lucidum* mushroom extract as a treatment to reduce hair loss and aging of hair follicles caused by daily stress [11].

The objective of this research is to prepare a natural shampoo using *Ganoderma chalceum* mushroom extract and measure its cleaning efficacy and potential benefits in hair care. Furthermore, to discover its natural antimicrobial properties and use it as a friendly-environment product as a sustainable alternative to commercial shampoos.

2. Research Method

2.1. Sample source

The sample was obtained from the laboratories of the College of Education for Pure Sciences, Biology Department. The sample was pre-identified by Prof. Dr. Shamal Younis Abdel-Hadi and was kept under appropriate laboratory conditions until use.

2.2. Extraction

The fruiting body of the mushroom was washed with running water to remove dirt and contaminants from the fruiting body, dried, ground into a fine powder, and extracted by weighing 50 g of the fruiting body powder and soaking it in 400 ml of 70% ethanol. The solution was placed in a glass flask for seven days and left at laboratory temperature, stirring occasionally. At the end of the soaking period, the extract was filtered using filter paper to remove solid residues. The extract was centrifuged for 10 minutes at a speed of 5000 rpm. Using a rotary evaporator, the crude extract was concentrated at a temperature of 40°C. The crude extract was stored in sealed, opaque bottles at a temperature of 4°C until use. The raw extract was sent to GC-MS analysis to identify the active compounds present in the fungal extract.

2.3. Shampoo preparation

The shampoo was prepared from *Ganoderma* chalceum mushroom extract by mixing it with several natural ingredients that promote hair growth, shine, and moisture, and also fight microbes and dandruff, giving hair shine, reducing tangles, and minimizing hair loss. The ingredients are listed in Table 1. All ingredients were weighed separately and set aside. Distilled water was placed in a glass beaker, and polyquaternium-7, betaine, diethyl alcohol, and glycerin were mixed continuously until the ingredients were completely dissolved. Then, Tween 80 emulsifier and oils were added while continuing to mix the mixture. APG and camphor were added one after the other, stirring the mixture. Then, the rest of the ingredients, namely the fungal extract, fragrance, and a preservative, vitamins, were added with stirring continuously until they became completely homogeneous. Then the desired color was added (after dissolving it in a quantity of glycerin) with mixing, paying attention to adjusting the pH to between 6 and 5.5. Once the solution is homogeneous, the CMC is added and completely mixed until the required consistency is achieved. After that, sterilized containers were filled with the produced shampoo.

Table 1. The components of the medicinal shampoo are made from *Ganoderma chalceum* mushrooms.

Purpose of addition	1000g	Ingredients Quantity
Anti-allergenic	20	Argan oil
Anti-fungal	20	Castor oil
Emulsifier	12	Tween 80
Moisturizer	30	Glycerin
Thickener (replaces table salt)	20	CMC
Reduces surface tension	20	Betaine
Enhances foam	20	Diethylamine Amide
Foaming agent	40	Cocamidopropyl Betaine
Softness	20	Polyquaternium 7
Powerful cleansing	90	APG
Active ingredient	60	Mushroom extract
pH adjustment	10	Citric acid

Purpose of addition	1000g	Ingredients Quantity
Antioxidant	10	Vitamin E
Reduces hair loss	10	Panthenol
Fragrance	As desired	Rose Oil
Preservative	1 ml (0.05)%	Phenoxyethanol
Color	As desired	Color White mica
Solvent	700	Distilled water
Variable	Speed (rpm)	Power (kW)
x	10	8.6
y	15	12.4
z	20	15.3

2.4. Physical and chemical qualities of shampoo are evaluated

The following qualitative tests were carried out in order to assess the prepared shampoo's quality:

2.4.1. Visual stability and physical attractions

For 21 days, the produced shampoo was protected at room temperature and 65+-5% humidity to estimate its visual stability. Any color changes or separation between the water and oil phases were noted.

2.4.2. pH measurement

Ion-free distilled water was used to make a %10 weight/volume shampoo solution. The mixture was thoroughly shaken and allowed to stabilize at room temperature before the pH was determined using a pH meter.

2.4.3. Evaluation of skin inflammation

For five minutes, the prepared shampoos were tested for skin irritation and looked for any redness or irritation.

2.4.4. Determining the percentage of solids

Weigh a dry, clean ceramic dish, and its initial weight is recorded. Four grams of the prepared shampoo is placed in the ceramic dish, and the dish and shampoo are weighed together to find the initial total weight. Then the ceramic dish is placed on a hot plate until the liquid has completely evaporated. The dish is weighed again, and the weight of the shampoo is calculated after evaporation to determine the percentage of solids in the shampoo.

Solid content percentage = dry sample weight/original shampoo weight × 100

2.4.5. Organoleptic Evaluation

The shampoo was evaluated organoleptically through the senses of smell, sight, and touch, where the smell, color, texture, and overall appearance were examined, and the shampoo's spreadability was tested by spreading it on the palm and its foam formation when rubbed with water.

2.4.6. Foam Formation and Stability Test (Dirt Dispersibility)

The foam forming ability of the prepared shampoo was evaluated using a 250 ml graduated cylinder, into which 50 ml of the prepared shampoo solution was placed at a concentration of 50 ml of shampoo solution at a concentration of 1% weight/volume. After covering the cylinder nozzle with the hand, the cylinder was shaken vigorously for 8-10 minutes to measure the total volume of foam. The foam retention time was measured after 8, 4, and 1 minutes of shaking, and the results were recorded.

2.4.7. Dirt Dispersibility

The shampoo's dirt dispersibility was tested by adding two drops of the prepared shampoo to a graduated cylinder containing 10 ml of distilled water, then adding a drop of Indian ink, shaking the cylinder well, leaving it to settle, and observing the foam formed and the extent to which the ink dispersed in the prepared shampoo. Visually, the ink in the foam was assessed.

2.4.8 Washability

In order to test the shampoo's washability, a small amount was applied to the skin, washed under running water, and the amount of time it took to remove the shampoo and whether it left any viscous residue on the hands was noted.

2.4.9. The capacity to wet

One-inch-diameter, 0.44-gram cotton discs were cut and dipped in a glass beaker filled with a 1% shampoo solution. An index of the shampoo's capacity to moisturize was the amount of time needed for these discs to become saturated with the shampoo solution.

2.4.10. Cleaning Action

A cotton pad smudged with a little amount of fat was used to test the shampoo's cleaning ability after it had been weighed. Wool fibers were washed, allowed to air dry, and then reweighed after being submerged in a 1% shampoo solution for three to five minutes in a glass beaker. The dirt removal efficiency is calculated by dividing the weight of the treated sample by the weight of the untreated sample and multiplying the result by 100.

2.4.11. Antifungal activity

The efficacy of the shampoo as an antifungal agent against dandruff and skin fungi was evaluated using the spread plate method on Potato Dextrose agar media. The medium was prepared according to standard protocols, then it was placed into sterile 9-cm-diameter Petri plates and left to solidify. The surface of the medium was then inoculated using a sterile swab with a suspension of *Candida albicans* cells to ensure uniform distribution over the surface of the medium. After the dishes had dried, wells were made on the surface of the solid medium using a sterile cork borer at equal distances. 40 microliters of the prepared shampoo solution were added (at a concentration of 1%) to the first hole (The prepared shampoo was diluted to a concentration of 1% using sterile distilled water before being added to the drilling rig). Commercial shampoo was added at the same concentration to the other holes. The third hole, which was considered a positive control, was filled with a concentration of 50 micrograms/ml of the antibiotics Ketoconazole (prepared by dissolving 0.5 g in 10 ml of sterile distilled water). After incubation at 37°C for 48 hours, the diameter of the inhibition zone around the wells was measured with a millimeter ruler and a transparent ruler. The results were recorded and photographed with a digital camera [12].

2.4.12. Evaluation of the antibacterial activity of the prepared shampoo

The antibacterial activity of the prepared shampoo containing the fungal extract was tested against two types of pathogenic bacteria, one Gram-positive *Staphylococcus aureus* and the other Gram-negative *Pseudomonas aeruginosa* (obtained from the laboratories of the College of Education for Pure Science), using the spread plate method on Nutrient Agar medium prepared according to standard specifications. A sterile cotton swab was immersed in a test tube containing the bacterial suspension for each bacterial isolate (1×106 cells/ml) and wiped over the entire layer under sterile conditions to ensure uniform distribution. The plates were then left for 15 minutes to absorb the bacterial suspension. Then, holes were made using a sterile cork borer with a diameter of 6 mm and equal dimensions. In the first hole, the prepared shampoo was added at a concentration of 40 microliters and a concentration of 1%. (The prepared shampoo was diluted to a concentration of 1% using sterile distilled water before being added to the drilling rig. The same amount of commercial shampoo was added to the second hole. In the third hole, A disc of the commercial antibiotic Gentamycin as a positive control was added. The dishes were placed in an incubator at 37°C for 24 hours, then the diameter of the inhibition zones was measured with a transparent ruler and photographed with a digital camera [13].

2.4.13. Consumer evaluation test of the manufactured shampoo

The shampoo prepared from the fungal extract was evaluated according to the modified method of [14] using human hair strands. Volunteers were recruited from people suffering from hair problems such as dandruff, breakage, or hair loss. The samples were divided into two groups. The first group was washed with distilled water only (control sample), while the second group was washed with the prepared fungal shampoo. After washing, the hair strands were left to dry at room temperature and were washed several times to simulate repeated use and observe physical changes in terms of ease of combing, softness, texture, shine, and reduced hair loss.

A sensory evaluation was also conducted, and the test was carried out on a group of volunteers from the College of Pure Sciences/Department of Biology Sciences (30 female students). The test was conducted randomly and anonymously. Responses were evaluated on a four-point scale (excellent, good, acceptable, poor).

2.5 Statistical Analysis

The data were analyzed according to the simple experiments ANOVA system, using three replicates (n=3), and the arithmetic mean ± and standard deviation (Mean±SD) were calculated. Significant differences between groups were analyzed, and the data analysis was used considering probability values ($P > 0.05$).

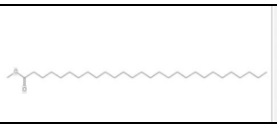
3. Results And Discussion

3.1. Diagnosis of the components of the Ganoderma chalceum mushroom extract using GC-MS technology.

GC-MS analysis of the mushroom extract revealed the presence of several compounds in different forms and percentages, as shown in Figure 1. The highest concentration was found for Dodecanoic acid at 12.93%, followed by Oleic acid at 10.29%, beta-Sitosterol at 9.34%, and Octacosanoic acid methyl ester at 9.03%, as shown in Table 2.

Table 1. Shows the identification of some of the components of the fungal extract *Ganoderma chalceum*

Arrange	Peak#	R.Time	Area	Area%	Name	Structure
1	3	14.439	14768510	12.93	Dodecanoic acid	
2	12	20.764	11761000	10.29	Oleic Acid	
3	17	23.940	10673546	9.34	Beta-Sitosterol	

Arrange	Peak#	R.Time	Area	Area%	Name	Structure
4	30	29.280	10315228	9.03	Octacosanoic acid Methyl ester	

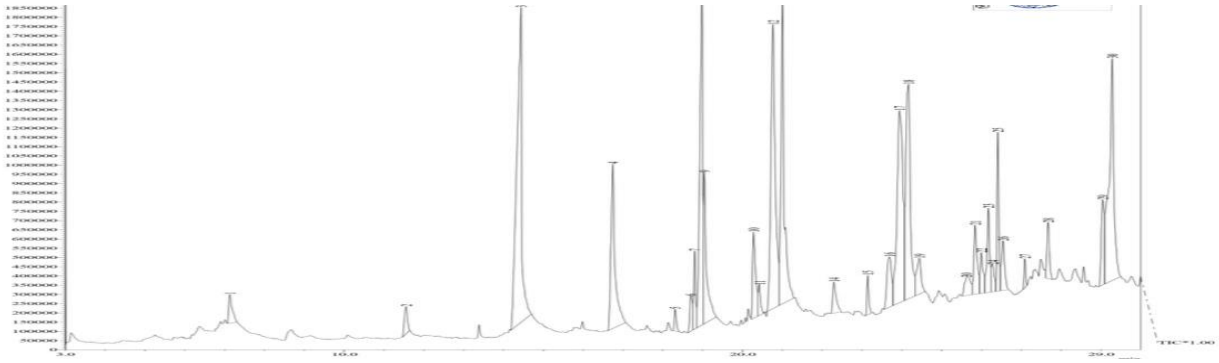


Figure 1. Standard curve of the constituent compounds of *G. chalceum* mushroom extract using GC-MS technology.

These compounds offer numerous medical benefits. Dodecanoic acid plays a crucial role in medicated shampoos, acting as a potent natural antimicrobial. It effectively treats dandruff and deeply nourishes hair by promoting follicle health. It also acts as a moisturizer and conditioner, improving the texture of dry and damaged hair. Similarly, oleic acid acts as an antimicrobial, helping to cleanse the scalp of excess oil and combating bacterial and fungal scalp infections, thus promoting overall scalp health[15,16].

3.2. Sensory characteristics

Sensory evaluation revealed that the prepared shampoo has an attractive, shiny, white appearance and a smooth texture with a pleasant and desirable scent. This gives a good impression in terms of appearance and general physical properties (Figure 2).

Figure 2. Shows the prepared shampoo with its bright white color, uniform texture, and distinctive aromatic scent, reflecting a harmonious aesthetic appearance that was confirmed by sensory characteristics.

3.3. Viscosity

The results obtained indicate that the manufactured shampoo has a suitable degree of viscosity from a visual and sensory point of view. No noticeable differences were recorded in comparison with the commercial shampoo used for comparison. This indicates the balance and stability of the shampoo's composition during storage.

3.4. Visual and physical properties of the prepared shampoo

The results show that the prepared shampoo has high visual and sensory stability, as no change in color or texture was observed, and no separation between the oil and water phases was observed from the manufacturing stage to the time of

evaluation. It is concluded that the stable composition of the prepared shampoo (in terms of sensory and visual appearance) is a good choice for shampoo, combining natural ingredients and physical stability [17].

3.5. pH measurement

The pH measurement results showed that the prepared shampoo falls within the scientifically acceptable range of 5.9, which is close to the ideal values for commercial shampoos, which range between 5-7 [14]. Any increase or decrease in this value beyond the mentioned range leads to hair breakage or skin irritation. Therefore, the fact that the prepared shampoo falls within this range indicates its compatibility with the nature of the scalp [18].

3.6. Foam

Tests on the shampoo showed that it produced a uniform and stable foam. With a foam height of 100 ml, which retained its shape for approximately 10 minutes, a result close to that of commercial shampoos, as shown in Figure 3, indicating that the ingredients of the prepared shampoo have good surface activity responsible for foam formation.

The stability and superiority of the foam compared to commercial shampoo are important factors that indicate the quality of the shampoo in the consumer's perception, but they are not considered a measure of its actual cleaning ability [19].

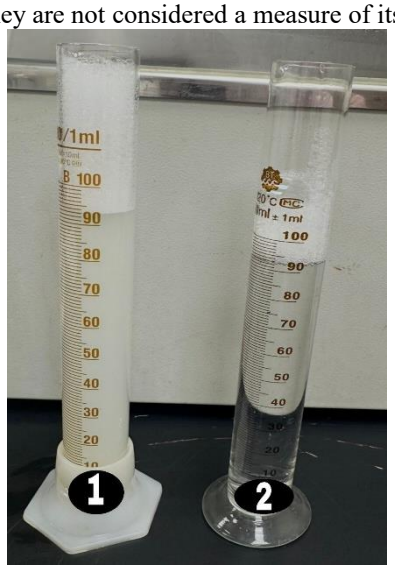


Figure 3. Foam stability after 8 minutes, illustrated by comparing prepared shampoo 1 and commercial shampoo 2

3.7. Cleanability (ink dispersion)

An ink dispersion test was conducted to evaluate the efficiency of the prepared shampoo and the effectiveness of the active agents in the prepared shampoo compared to the commercial shampoo. As shown in Figure 4, a quantity of Indian ink was added to both the prepared and commercial shampoo solutions, and the speed and spread of dispersion in the liquid and foamy medium were observed. The prepared shampoo 1 showed a homogeneous and rapid dispersion of ink throughout the solution with stable foam formation, indicating the high efficiency of the surfactants and good dirt removal ability, while the commercial shampoo 2 showed slow ink dispersion and less stable foam formation, indicating a relative decrease in the effectiveness of its components. Ink dispersion is an important criterion for evaluating the effectiveness of shampoo in cleaning hair, and low-quality shampoo concentrates ink in the foam, which means it remains in the hair [20].

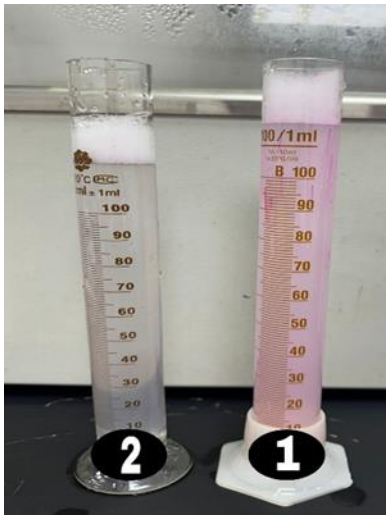


Figure 4. Ink dispersion experiment in the prepared shampoo solution to evaluate the shampoo's spreading ability, where 1 represents the prepared shampoo, and 2 represents the commercial shampoo.

3.8. Testing the moisturizing effect of the prepared shampoo

The ability of the prepared shampoo to moisturize hair was evaluated using the cloth disc method, which is one of the most effective methods for assessing moisturizing efficiency. As shown in Figure (4), the results showed that the wetting time for the prepared shampoo was 123 seconds compared to 138 seconds for the commercial shampoo, this means that the prepared shampoo has a higher ability to penetrate and spread over the hair surface, thus achieving better moisturization and more uniform distribution over the hair strands, which means better cleaning and conditioning efficiency [21].

3.9. Ease of use

The produced shampoo was applied to the hair and scalp, demonstrating its gentleness and lack of skin irritation. When contrasted to commercial shampoos that cause dryness or itching, it is easier to apply and wash off. Shampoo made from fungi is clearly very good at cleaning without removing natural oils, which is a problem with many strong commercial detergents that dry up and damage hair [22].

3.10. Cleaning rate test

The results showed the cleaning ability of the prepared shampoo in removing dirt, which is essential in evaluating the effectiveness of the shampoo in cleaning, as shown in Figure 5. Therefore, it was tested on a grease-treated cloth disc, and the results showed that the shampoo had a cleaning ability of 76%, which is good compared to commercial shampoos, which had a cleaning ability of 53%. The result is considered good because complete cleaning of the hair removes all the oils from the hair, which dries it out and reduces its manageability.

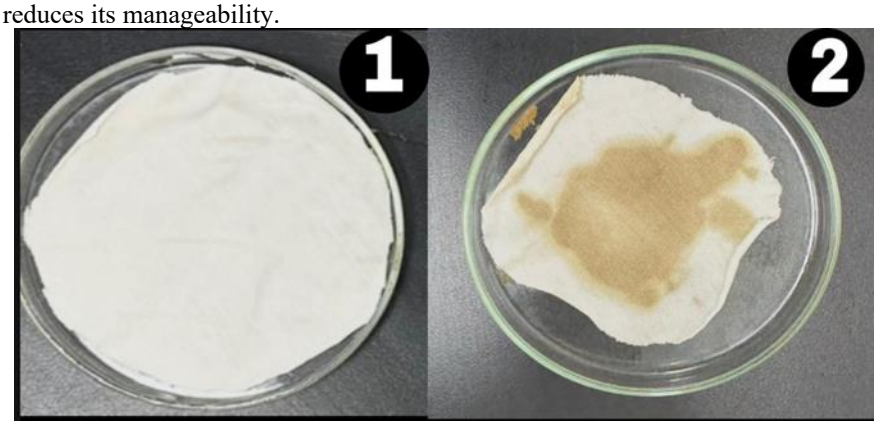


Figure 5. Test of degreasing from a cloth disc for the prepared shampoo compared to the commercial shampoo.

3.11. Number of microbes

The results in Figure 6 show that the produced shampoo, at a concentration of 1%, did not permit any microorganisms, including bacteria, yeasts, or fungi, to grow on the culture medium used for three months, indicating its excellent efficacy in

eliminating microbial pollutants. This performance is attributed to the composition containing essential oils and oxidizing compounds that contribute to protecting the scalp from microbial infection and prolong the shelf life of the preparation. This was confirmed by the study [23], where no harmful microbial growth was observed in the Challenge test, which reinforces the microbiological safety of the shampoo formulation.

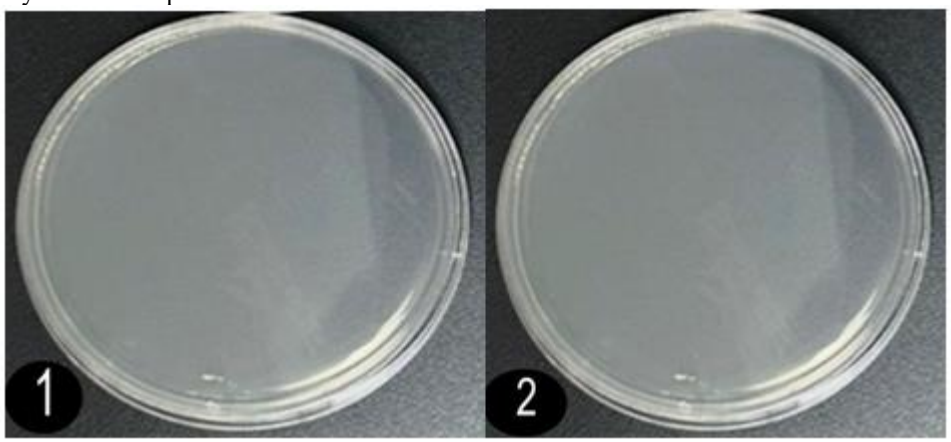


Figure 6. Shows the absence of microbial growth in bacterial (1) and fungal (2) culture media and treatment with the prepared shampoo.

3.12. Antifungal activity on the skin

The results showed that the prepared shampoo has a high ability to inhibit the growth of *Candida albicans*, with an inhibition zone diameter of 36 mm, compared to only 14 mm for the standard antibiotic fluconazole. The commercial shampoo did not inhibit yeast growth. As shown in Figure 7, these results confirm the effectiveness of the prepared shampoo in resisting the fungi that cause dandruff (The shampoo was diluted by 1% prior to testing to reduce viscosity and to ensure proper dispersion in the medium). *C. albicans* fungus is responsible for many skin and hair infections The study was limited to this fungus because it is a common opportunist, with a recommendation to use the *Malassezia* fungus, which has an important role in treating dandruff, in future studies., where some fungal extracts have been shown to inhibit biofilm formation and increase the permeability of the *C. albicans* cell membrane, as well as stimulate programmed cell death, meaning that their effectiveness is not only in inhibiting fungal growth but also in affecting the mechanisms of fungal survival, This inhibition is also explained by the presence of Dodecanoic acid and Oleic acid in the fungal extract, which act as a powerful natural antimicrobial [24, 25].

Figure 7. Anti-*Candida albicans* activity test showing the growth inhibition zones produced by the different samples. Number 1 indicates the prepared shampoo, 2 indicates the standard antibiotic used as a positive control, and 3 indicates the commercial shampoo.

3.13. Antibacterial activity

The results showed that the antibacterial activity of the prepared shampoos had an inhibition zone of 57 mm for *S. aureus,* while the commercial shampoo had an inhibition zone of 13 mm, and the control sample had an inhibition zone of 19 mm. As for *P. aeruginosa* bacteria, the inhibition zone was 49 mm for the prepared shampoo compared to 17 mm for the commercial shampoo and 21 mm for the control sample. As shown in Figure 8, these results indicate that the prepared shampoo has a broad spectrum against Gram-positive and Gram-negative bacteria and is more effective than commercial shampoos available on the market. The reason for this activity is the synergy of the active ingredients in the composition of the prepared shampoo, especially the antimicrobial effect. *P. aeruginosa* and *S. aureus* are among the most common contaminants of cosmetics and skin care products [26]. pointed out that controlling the growth of these bacteria is an indicator of product quality and safety [27]. explained that resistant strains of *P. aeruginosa* bacteria are mostly used as test organisms in testing the effectiveness of preservation. Based on these results, it appears that the prepared shampoo has anti-pathogenic properties, which

makes it stable during storage and use, and this complies with the requirements of the international standard [28] for evaluating the preservative efficacy of cosmetic products.

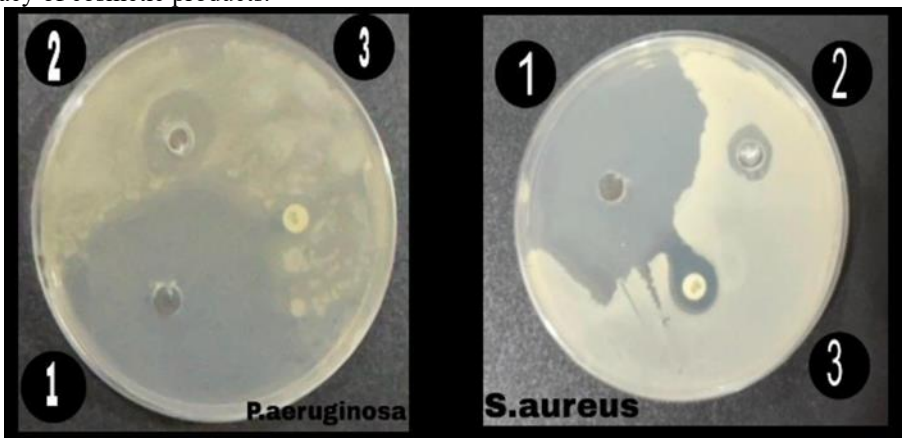


Figure 8. Testing the anti-bacterial activity of *Pseudomonas aeruginosa* and *S. aureus* using the agar diffusion method, where 1: prepared shampoo, 2: commercial shampoo, and 3: Gentamycin anti-bacterial agent.

3.14. Testing the adaptability and moisturizing effect of the prepared shampoo

The results of field trials on volunteers showed that most of them felt a noticeable increase in hair softness, elasticity, and ease of combing, in addition to a natural, shiny appearance. The results are shown in Table 2 show that most participants expressed high satisfaction with the prepared shampoo in terms of hair softness, cleaning effectiveness, and ease of rinsing. A significant improvement in scalp health was observed, in addition to a reduction in dandruff, indicating that the prepared shampoo has good moisturizing and soothing properties without causing dryness or irritation. This positive effect is attributed to the shampoo's formula containing vitamin B5 and antioxidants and being free of parabens and silicone, which gives the shampoo effective therapeutic properties that suit the nature of the scalp and give the hair improved vitality and shine. The presence of panthenol (vitamin B5) in the shampoo's recipe explains the clear feeling of softness and shine after using it. According to recent research, panthenol boosts the mechanical strength of hair by penetrating the protein structure of the hair and forming hydrogen bonds with proteins [29]. Additionally, because panthenol can draw in water molecules, it has a moisturizing action that increases the moisture content of hair [30]. Additionally, it affects hair follicle cells by encouraging growth factors like VEGF and cell survival, which improves scalp health and hair structure [31].

3.15. Assessment of the prepared shampoo's impact on the damaged hair's sheen and smoothness

To determine how well the prepared shampoo actually repairs damaged hair and enhances its external look in terms of softness and gloss, a test was performed on a strand of hair. One damaged hair strand was used for the test, and another strand served as an untreated control sample. In comparison to the control sample, the strand treated with the produced shampoo was shown to become smoother, shinier, and easier to handle after a period of use (Figure 9), demonstrating how well the prepared shampoo nourishes hair fibers and lessens external hair damage. A study conducted by [32] confirmed the improvement in hair appearance and reduction in damage to hair treated with the shampoo prepared from fungal extracts.

Figure 9. Testing the anti-bacterial activity of *Pseudomonas aeruginosa* and *S. aureus* using the agar diffusion method, where 1: prepared shampoo, 2: commercial shampoo, and 3: Gentamycin anti-bacterial agent.

4. Conclusion

In this work, developed and evaluated a novel, multipurpose natural shampoo was developed and evaluated using *Ganoderma chalceum* extracts from macrofungi found nearby. The created shampoo exhibited the finest possible physical and chemical qualities, including a balanced pH, exceptional wetting time, superb foaming capacity and stability, and an efficient cleansing action without depleting natural hair oils, according to the thorough characterization. Most importantly, the shampoo demonstrated strong antifungal action against *C. albicans*, underscoring its enormous promise as a safe and efficient anti-dandruff remedy. Volunteers reported better hair softness, luster, and manageability, as well as less dandruff and hair loss, according to consumer reviews, which largely confirmed its effectiveness. This study offers strong proof of the medicinal and aesthetic advantages of adding fungal extracts to hair care products. In line with the increasing demand for safe and natural personal care products, this study provides a sustainable and natural solution to common hair and scalp issues by utilizing the wide variety of local macrofungi. The created shampoo offers a safe, eco-friendly, and efficient substitute for traditional synthetic formulas, making it a promising advance in the cosmetics sector. Future studies should concentrate on separating and identifying the precise bioactive substances that are responsible for the effects that have been seen, streamlining the extraction and formulation procedures for industrial scale-up, and carrying out long-term clinical trials to confirm their advantages in a variety of demographics.

5. Acknowledgments

The authors would like to express their appreciation to the University of Mosul, the fungal laboratory in the College of Education for Pure Sciences, for supplying the materials for this study.

6. Declarations

6.1 Ethics approval and consent to participate

Not applicable.

6.2 Consent for publication

Not applicable.

6.3 Availability of Data and Materials

Data will be provided upon receiving a valid request.

6.4 Conflicts of interest

The author declares that there is no conflict of interest

6.5 Funding

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

7. References

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تركيبة شامبو طبي من مستخلص فطر *Ganoderma chalceum* وتقييم فعاليته المضادة للقشرة

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المستخلص:

نظراً للحاجة المتزايدة لتطوير مستحضرات تجميل طبيعية وصديقة للبيئة، تهدف هذه الدراسة إلى تحضير وتقييم شامبو طبيعي مصنوع من مستخلص فطر *Ganoderma chalceum* ، المعروف باحتوائه على العديد من المركبات النشطة بيولوجياً. وقد تم الحصول على هذه العينة من مختبر كلية العلوم البحتة بجامعة الموصل. تم استخلاصها باستخدام الإيثانول لتحضير شامبو، وجرى فحص خصائصه الفيزيائية والكيميائية ونشاطه البيولوجي. أظهرت النتائج فعالية تنظيف بلغت 76% مقارنةً بـ 53% للشامبو التجاري، مما يُشير إلى تفوق الشامبو المُنتج على الأنواع التجارية في تعزيز نعومة ولمعان الشعر. بفضل منطقة تثبيط قطرها 0.5±36.0 مم مقارنةً بـ 0.6±14.0 مم للشامبو التجاري، أظهر الشامبو المُنتَج فعالية مضادة للفطريات ضد *Candida albicans*. كما كان فعالاً ضد البكتيريا الممرضة (*Pseudomonas aeruginosa* و *Staphylococcus aureus*)، حيث بلغت معدلات التثبيط 1.0±56.0 و0.40±49.07 مم على التوالي، مقارنةً بـ 1.04±12.17 و0.76±16 مم للشامبو التجاري. وخلال التخزين، أظهرت الخصائص الفيزيائية والكيميائية للشامبو المُنتَج استقراراً جيداً. وقد لاقى استحسان المتطوعين من حيث الأداء والترطيب وسهولة الشطف. تُسلط هذه النتائج الضوء على إمكانية استخدام مستخلص فطر *Ganoderma chalceum* في ابتكار شامبو آمن وفعال يُعزز صحة الشعر وفروة الرأس بطريقة صديقة للبيئة.