



GINGER (*Zingiber officinale roscoe*) WITH BAMBOO SCENT AS AN ANTIBACTERIAL LIQUID HAIR SHAMPOO

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Abstract: This research formulated and evaluated a *Zingiber officinale roscoe* (ginger) liquid hair shampoo based on its antibacterial efficacy, pH value, and irritant potential. It was specifically developed to determine the dermatological safety of the shampoo, compatibility with scalp pH, and inhibitory efficacy against *Staphylococcus aureus*. Made up of distilled water as the negative control and commercial antibacterial shampoo (Gard) as the positive control, the research was designed using an experimental approach. A zone of inhibition (ZOI) assay tested antibacterial activity; pH was measured with pH paper strips, and patch testing on human volunteers tested irritation potential. With inhibitory zone values of 19 mm to 22 mm, comparable with the commercial control shampoo (18 mm to 20 mm), the ginger extract-based shampoo (T2) showed significant antibacterial action. A pH-neutral shampoo of 7.0 indicated mildness and scalp tolerance. Further, irritation tests confirmed that, similar to the commercial control, the shampoo was non-irritating. ANOVA results showed significant variation in antibacterial action among treatments; pH and irritation were not significantly different. Finally, the ginger shampoo was a suitable natural substitute for conventional antibacterial shampoos because it was effective in its antibacterial activity, pH stability, and dermatological safety. Optimize formulation, long-term effects, and efficacy against multiple bacterial strains may be evaluated in future studies.

INTRODUCTION

In a world where first impressions matter, the condition of one's hair plays a significant role in shaping individual confidence and self-esteem. How hair looks, feels, and smells can greatly impact a person's appearance and overall well-being. Unlike other areas of the body, the scalp possesses a unique composition with a higher concentration of sebaceous glands that produce sebum. This oily substance lubricates both hair and skin. While sebum is crucial in maintaining scalp health, its presence also creates a thriving environment for microbes and bacteria, potentially leading to scalp-related conditions (Cleveland Clinic, 2021).

Building on this, the importance of a healthy scalp cannot be overstated in hair care. Scalp infections caused by bacteria or fungi may result in various issues, including skin irritation, rashes, and even hair loss. This has prompted the development of shampoos with potent antibacterial properties designed to cleanse the scalp while targeting harmful microbes. One of the most common bacteria associated with scalp infections is *Staphylococcus aureus*, a known human pathogen linked to conditions such as folliculitis—an inflammation of hair follicles that manifests as painful, pus-filled bumps on the scalp (Cleveland Clinic, 2021).

To address this issue, the management of bacterial scalp conditions often involves the use of specialized shampoos formulated with active ingredients that target and eliminate the bacteria responsible for infections or irritations. Ingredients such as benzalkonium chloride and tea tree oil are commonly found in antibacterial shampoos due to their effectiveness in reducing bacterial growth and promoting a healthy scalp environment. Benzalkonium chloride is recognized for its potent antimicrobial properties, which help mitigate the risk of scalp infections. Similarly, tea tree oil is a natural antibacterial agent that not only cleanses the scalp but also soothes irritations and combats microbial overgrowth. Despite the availability of these formulations, there remains an ongoing demand for natural alternatives that offer similar benefits with reduced chemical exposure.

Moreover, medicated shampoos have become an essential component of modern hair care routines, serving functions beyond mere cleansing. In addition to removing dirt, pollutants, and excess oils, shampoos today are formulated to address specific scalp conditions, including bacterial overgrowth and inflammation. One of the most prevalent issues tackled by these specialized shampoos is scalp irritation, which can lead to discomfort and increased hair fall. The incorporation of therapeutic agents in shampoos has proven beneficial in maintaining scalp health, reducing bacterial colonization, and mitigating the effects of conditions such as folliculitis and dandruff.

From a legal standpoint, the development and distribution of antibacterial shampoos must comply with existing regulations on personal care products and cosmetic formulations. The Food and Drug Administration (FDA) and other governing bodies provide

guidelines on the inclusion of antimicrobial agents in shampoos, ensuring their safety and efficacy for consumers. Additionally, the incorporation of herbal ingredients, such as ginger and bamboo, must adhere to regulatory standards for natural product formulations. These legal frameworks ensure that antibacterial shampoos meet health and safety guidelines, protecting consumers from potential adverse effects (Dias, de Almeida, & Pichler, 2018).

With these considerations in mind, the present study aimed to formulate a liquid antibacterial shampoo incorporating ginger (*Zingiber officinale roscoe*) and bamboo scent. The primary objective was to evaluate the effectiveness of this formulation in addressing common hair and scalp concerns, particularly bacterial infections and irritation. Ginger is recognized for its anti-inflammatory, antifungal, and antioxidant properties, which contribute to improved scalp health and reduced microbial activity (Agnihotri, 2023). Additionally, bamboo extract is known for its moisturizing and strengthening effects, promoting healthier hair growth and preventing dryness. By examining these natural ingredients, this study assessed the efficacy of this novel formulation, providing valuable insights into its potential as a natural alternative to conventional antibacterial shampoos. Ultimately, the research aimed to contribute to the growing body of knowledge on herbal hair care products while offering a practical solution for individuals experiencing scalp-related concerns.

Objectives of the Study

This study assessed the formulated antibacterial liquid hair shampoo using Ginger (*Zingiber officinale roscoe*) with the infusion of bamboo scent.

Specifically, it performed the following tasks:

- 1.) Adapt but modify the protocol from Pal and Pandey (2023) in formulating a hair shampoo.
- 2.) Evaluate the formulated liquid hair shampoo in terms of:
 - 2.1 Antibacterial Properties;
 - 2.2 pH Level and
 - 2.3 Irritation.
- 3.) Compare the control and treatment in terms of antibacterial properties, pH level, and irritation.

Research Questions

Guided by the objectives of the study, the researchers answered these subsequent scientific questions:

- 1.) What is the adapted but modified protocol from Pal and Pandey (2023) in formulating the liquid hair shampoo?
- 2.) What are the results of the evaluation of the formulated liquid hair shampoo in terms of:
 - 2.1 Antibacterial Properties;
 - 2.2 pH Level and
 - 2.3 Irritation?
- 3.) Is there a significant difference between the control and treatment in terms of antibacterial properties, pH level, and irritation?

Hypothesis of the Study

H₀ There is no significant difference between the control and treatment in terms of anti-bacterial properties, pH level, and irritation.

Significance of the Study

This study is hoped to be beneficial to the following:

Environmental and Botanical Sciences. The study's focus on organic and plant-based ingredients—such as ginger, which supports sustainable agriculture methods and biodiversity preservation—may help environmental and botanical sciences. Reduced toxic chemicals in hair care products help to cleaner water supplies and better ecosystems, benefiting land as well as aquatic life. The study also promotes the investigation of botanical extracts for cosmetic uses, therefore fostering possible new discoveries in plant-based personal care formulations. Encouragement of environmentally friendly substitutes helps the worldwide trend toward sustainable purchasing decisions. In line with worldwide efforts in environmental preservation, the study also helps to lower synthetic contaminants in the surroundings.

Cosmetic Policy Implications. The results may guide cosmetic policy implications since the study emphasizes the advantages of including natural components in hair care products. Policymakers may take into account changing current rules to support greener, safer formulations and restrict synthetic chemical use in cosmetics. The research offers important information that might affect consumer safety rules, labeling criteria, and environmental standards for personal care goods. Promoting openness in manufacturing techniques and ingredient procurement may help to advocate tougher rules guaranteeing the sustainability and safety of cosmetic goods. Moreover, public health authorities may use this study to advocate better substitutes that reduce chemical exposure hazards.

Cosmetics Manufacturers. The study provides cosmetics manufacturers with a basis for creating creative, natural, environmentally friendly hair care products fit for consumer desire for safer, greener substitutes. By combining botanical extracts with known antibacterial and calming qualities, the research results may assist producers in enhancing their formulations. Companies using these ideas may have a competitive edge as the market for sustainable personal care products keeps expanding and presents safer and more ecologically friendly choices. Manufacturers may also be motivated by the study to investigate the stability and effectiveness of plant-based shampoos more broadly. It also motivates businesses to use ethical sources of ingredients, therefore supporting sustainable farming projects and fair-trade policies.

Locality of Maasim. The research may help the Maasim local community both culturally and economically. Encouragement of ginger growing for use in personal care goods may provide local businesses and farmers with fresh income sources. The study brings attention to the advantages of using locally accessible botanical resources, therefore encouraging environmental responsibility among the population. The study helps to preserve traditional knowledge about plant-based treatments

and promotes sustainable farming, therefore promoting economic growth. Furthermore, the availability of a locally made, environmentally friendly shampoo substitute may inspire better personal hygiene practices throughout society. The study also emphasizes how small businesses could be involved in environmentally friendly cosmetic manufacturing.

Colon National High School, the research institution, may gain from the way the study advances scientific inquiry and creativity. It gives academic members and students practical knowledge in laboratory testing, formulation science, and research techniques. The study strengthens the school's standing as a center for environmentally friendly innovation and scientific research, therefore encouraging students' creative development and curiosity. Researching practical issues helps the university to increase its involvement with the nearby businesses and community. Furthermore, the study is a teaching tool that enhances the curriculum of the university by including ideas of applied science and environmental sustainability.

STEM Students. They may acquire useful practical knowledge in product creation, chemistry, and scientific inquiry. The study gives students a chance to apply theoretical information in a practical environment, therefore improving their abilities in analytical testing, microbiology, and formulation science. Research helps students to acquire critical thinking, problem-solving, and laboratory techniques necessary for future professions in science, technology, and medicine. The study inspires students to investigate eco-friendly substitutes in several sectors and promotes respect for sustainable innovation. It also gets students ready for conferences, academic contests, and the next biotechnology and sustainable chemistry research projects.

Future Research and Researchers. This work may be valuable for the next investigation of botanical extracts in cosmetic formulations by future researchers and scientists. Advanced research may help to broaden the baseline information on the antibacterial qualities, pH values, and irritation potential of a natural shampoo formulation. Researchers might expand on this work by evaluating more plant-based components, refining extraction techniques, or formulating for maximum performance. The work provides a basis for multidisciplinary research as well, connecting dermatology, environmental science, and chemistry. At last, it promotes creativity in sustainable cosmetic development, therefore maybe resulting in fresh ideas for herbal-based personal care products.

Scope and Delimitation of the Study

This work aimed to formulate and evaluate a liquid antibacterial hair shampoo combining bamboo aroma with ginger (*Zingiber officinale roscoe*) extract. To evaluate the natural substitute for conventional shampoos, the study assessed the pH values, antibacterial qualities, and irritation potential of the created shampoo. Emphasizing the possible advantages of botanical extracts for scalp health, it was carried out within the framework of sustainable and plant-based personal care products. While addressing issues about scalp irritation and product safety, the study sought to offer an understanding of the antibacterial properties of ginger extract.

Moreover, the study used an experimental design under quantitative methodology. Disk diffusion experiments were used to assess the liquid hair shampoo's antibacterial qualities; pH levels were determined with pH test strips (litmus paper). Patch experiments on human subjects who fit the inclusion criteria—that is, those with healthy scalps and no history of severe allergic reactions to botanical ingredients—evaluated irritational potential. Plant resources gathered from Prk. Eslome, Brgy. Kablacan, Maasim, Sarangani Province, and Brgy. Kabatiol, Maasim, Sarangani Province helped to shape the shampoo recipe. The research was conducted during the academic year 2023–2024, therefore guaranteeing a methodologically regulated research schedule.

Limitations of the Study

The study had some limits even with its contributions. Beyond its antibacterial and irritation-reducing qualities, it did not evaluate how the shampoo would affect hair growth, color retention, or other aesthetic benefits. The study also neglected to evaluate the shampoo's effectiveness against more complicated dermatological diseases or fungal scalp infections due to the unavailability of cultured fungi and other bacteria in the Nutraceutical Laboratory of Mindanao State University, General Santos City Campus. Advanced laboratory methods, including HPLC (High-Performance Liquid Chromatography) for component analysis and clinical trials for more general consumer testing, were not carried out due to financial restraints. The exclusion criteria restricted involvement to those without pre-existing scalp issues, therefore influencing the generalizability of the findings to those with various hair and scalp textures.

Some methodological issues also might have affected the results. Uncontrolled external elements, including personal hair kinds, environmental exposure, or long-term product stability, could have added variation in the outcomes. Subjective irritation assessments in the patch test could have led to possible prejudices since reactions vary from person to person. Although the study provides a basic basis for botanical-based personal care formulations, it points up opportunities for development in next studies, including more thorough testing, bigger sample sizes, and longer product evaluations.

RESEARCH METHODOLOGY

This study employed the quantitative method, particularly the true experimental design. Utilizing this design helped the researchers in formulating their antibacterial liquid hair shampoo using ginger (*Zingiber officinale roscoe*) with a bamboo scent by adopting but modifying the formulation protocol from Pal and Pandey (2023), in evaluating the formulated liquid hair shampoo in terms of its antibacterial properties, pH level, irritation, and in comparing the significant difference between the control and treatment in terms of antibacterial properties, pH level, and irritation. According to Pubrica-Academy (2022), experimental research is a type of scientific examination in which one or more independent variables are changed and then applied to one or more dependent variables to see how they affect the latter. The effect of independent variables on dependent variables is frequently observed and recorded to help researchers reach a plausible conclusion about the link between these two variables. Further, experimental research designs, most commonly associated with laboratory test procedures, entail gathering quantitative data and doing statistical analysis during the study process.

Materials Used

Ginger served as the primary organic component, providing anti-bacterial properties to combat scalp bacteria. Ginger Extract, derived from crude ginger, was included for its concentrated effects in reducing dandruff and promoting hair growth. Sodium Hydroxide was used to balance the shampoo's pH, enhancing scalp health and anti-bacterial action. Litmus paper was utilized to monitor the pH levels during formulation, ensuring the shampoo remains within a scalp-friendly range, thereby optimizing the effectiveness of other active ingredients. Sodium Lauryl Sulfate provides lather for cleansing the scalp of oils, dirt, and bacteria. Coconut oil nourished the hair and prevented dryness. Propylene Glycol acts as a humectant, retaining moisture in the hair. Distilled Water ensures even dispersion of ingredients. Ethyl Alcohol, used for workplace sanitation, maintained hygiene during production. Bamboo scent was added as a refreshing fragrance that complemented the ginger's natural aroma.

Tools Used

Researchers used a sterilized sack to store cleaned ginger, ensuring it remained uncontaminated. They peeled the washed ginger with a spoon and sliced it into 0.5 mm thickness using a knife and slicer. A strainer was then used to drain excess water and distilled water before placing the ginger in a Ziploc bag. A stirring rod was used to mix the ground ginger powder with ethyl alcohol and also to mix other kinds of mixtures in formulating the shampoo. The container jar was utilized by the researchers to store the mixture of ginger powder and ethyl alcohol. A Buchner funnel was utilized to provide support for the filter paper during the filtration process, facilitating the separation of solid and liquid components. Also, an Erlenmeyer flask was used for the filtration process to directly store the newly extracted Ginger-ethanolic alcohol, while the solid residue remains on the filter paper. A pipette was used to measure and transfer liquids/substances.

Moreover, a pipette rubber bulb dropper was utilized to provide suction for drawing and dispensing liquids with the use of the pipette. A micropipette was utilized by the researchers to measure microliter amounts of liquid. Also, a Pasteur pipette was used to remove small excess water residue from the ginger extract. A beaker utilized by the researchers was used to hold measured liquid or solid samples and was also used to mix solutions and substances in formulating the shampoo. A weighing boat was used and placed on both the analytical balance and top-loading balance to hold dry substances, ensuring accurate measurements during the weighing process.

Furthermore, a shampoo container was used to store and dispense the formulated shampoo containing different concentrations, specifically the 10%, 25%, and 50% mixtures, and it was also used to store the shampoo for testing and mass production. A spot plate was used to stand as a platform for arranging and testing various samples, including the positive control (Gard shampoo), negative control, different extract concentrations (10%, 25%, 50%), the mixture, shampoo base, and 100% extract, alongside the filter paper disc. This allows for systematic observation and comparison of different substances in one convenient location. A tweezer was utilized by the researchers to transfer the discs from the spot plate to the petri dish. A flame was employed to sterilize the mouth of the culture tube holding the bacteria, preventing its spread.

Additionally, it was used to sterilize tweezers by burning, ensuring aseptic conditions during experiments. A culture tube served as a container holding cultured bacteria (*Staphylococcus Aureus*). A petri dish was utilized by the researchers to serve as a culture medium for cultivating *Staphylococcus aureus*, providing an environment for bacterial growth. Additionally, it is utilized to hold the bacteria along with the filter paper disc during experiments or observations. A vernier scale was used by the researchers to measure the length of the anti-bacterial effect of the positive control and also the different extract concentrations (10%, 25%, 50%, 100%), and the shampoo base.

Equipment Used

In weighing the ginger, researchers used a digital scale to accurately measure the weight of sliced ginger (2kg) before storing it in a Ziploc. A dehydrator was utilized to eliminate moisture from the ginger, ensuring thorough dehydration before grinding. A Nutribullet blender was used to grind the dried ginger into a finely powdered texture. A Rotary Evaporator separated the solvent ethanolic alcohol from the ginger extract, while a water bath removed water residue from the extract. For precise measurements in formulating the shampoo, a top-loading balance measured the weight of materials, and an analytical balance weighed exact small amounts. A magnetic stirrer swiftly stirred and mixed solutions, and a Hot plate dissolved solutions in high heat. The Biosafety cabinet UV light decontaminated the work area by emitting ultraviolet radiation, destroying or inactivating microorganisms' DNA and RNA, preventing reproduction and spread. A colony counter magnified cultured bacteria for measuring colony length.

Paraphernalia Used

Also, before starting the shampoo-making process, the researchers followed the protocol of wearing protective gear. Face masks were used to protect the researchers' lungs when working with chemicals and also to protect them from fumes. Laboratory coats/gowns served as protection for their clothes against spillage/emission. Gloves are used to keep their hands clean and lessen the chance of acquiring bacteria. And lastly, the laboratory footwear was used to cover their entire feet (nothing open-toed) to avoid chemical burns.

PROCEDURE

A. Preparation of Materials

First, the researchers cleaned the primary material, Ginger, using tap water to eliminate dirt and residues. Afterwards, it was air-dried in a sanitized sack. Second, another group of researchers peeled the ginger with a spoon and knife. Following the peeling process, the ginger underwent multiple washes: first with tap water and then with distilled water. Subsequently, it was precisely sliced to a thickness of 0.5mm using a food slicer. A final wash with distilled water ensued, and the ginger was dried in a strainer to remove excess liquids. Finally, it was packed in Ziplock bags and weighed using a digital scale (2kg per Ziplock). Third, the ginger was placed in a dehydrator and dried for 24 hours at 45°C. Once fully dried, the fourth step involved grinding the ginger into powder using a NutriBullet blender.

In the fifth step, the ground ginger underwent soaking in 8.5 Liters of ethanolic alcohol for nearly two weeks. In the sixth step, the soaked ginger was filtered by the researchers using filter paper, a Buchner funnel, and an Erlenmeyer flask. Seventh, the filtered Ginger-ethanolic alcohol underwent rotary evaporation to separate the ginger extract from the ethanolic alcohol, resulting in the extraction of the ginger extract. Lastly, the ginger extract underwent a water bath process, culminating in the accumulation of four sterile containers filled with ginger crude oil.

B. Formulation of Liquid Hair Shampoo

In formulating the liquid hair shampoo base, firstly, the researchers placed a beaker on a hot plate. Secondly, they mixed 25g of coconut oil and 5g of sodium lauryl sulfate into the beaker using a stirring rod and heated the hot plate for an hour at 100°C-150°C. Thirdly, in a separate beaker, they added 25g of distilled water and heated it to 60°C on the hot plate. Later, they mixed 5g of propylene glycol and 3.25g of sodium hydroxide into the beaker and waited until they dissolved. Fourthly, they placed the first beaker on the hot plate again and poured the contents of the second beaker into it at 100°C, then stirred it until it reached the desired viscosity. Fifthly, they added 15.8g of ginger extract, which was 25% of the 63.25g liquid hair shampoo base. Lastly, they added 300 drops of bamboo scent to the formulated liquid hair shampoo.

C. Testing the Antibacterial Properties of the Formulated Liquid Hair Shampoo

In vitro testing, the researchers utilized the Disk Diffusion Method during the antibacterial test, in which the whole agar plate surfaces of different concentrations were infected with a volume of the microbial inoculum, i.e., *Staphylococcus aureus*, and were observed for 24 hours. Thereafter, an analysis was made to determine the zone of inhibition. Specifically, these concentrations include 10%, 25%, 50%, 100%, and the shampoo base and the controls: Distilled Water (NC) and Gard commercial shampoo (PC). Based on the existence or absence of a millimeter-sized zone of inhibition (ZOI), susceptibility and resistance were detected. ZOI ranges from 0 to 9 mm are regarded inactive, whereas ZOI ranges from 10 to 13 mm are considered partially active, 14 to 19 mm are considered active, and >19 mm is considered very active. This classification is based on the work of Gutierrez, Baculi, Pastor, Puma-at, and Balangcod (2013).

D. Testing the pH Level of the Formulated Liquid Hair Shampoo

In assessing the pH level of the formulated liquid hair shampoo, the researchers used paper pH test strips to determine the pH level of the product. Three (3) samples were tested. According to Dr. Rodrigues (2024), pH is a measurable parameter between the values of 0 and 14, defining the acidity or alkalinity of a solution. Solutions with a pH = 7 are considered neutral, pH < 7 are considered acidic, and pH > 7 are considered basic or alkaline. The term pH can be defined as the “potential of the hydrogen ions,” and its value determines many factors in the chemical environment of molecules, affecting properties such as the solubility of compounds, chemical reactions, availability of nutrients, biological functions, and microbial activity, among many others.

E. Irritation Testing (Patch Testing) of the Formulated Hair Shampoo

In determining the irritation caused by the formulated liquid hair shampoo using ginger crude extracts, the researchers utilized the patch test method. In successfully doing this method, the researchers first gathered all the needed materials such as alcohol, patches, tissue papers, plasters, and scissors. Second, they determined ten (10) respondents from the STEM 12 strand specifically Grade 12 Callidus for the experimental/treatment group, encompassing 5 girls, and Grade 12 Wizard for the control group, composed of 2 boys and 3 girls, whose parents voluntarily signed the consent to allow their children to participate in the study's testing.

Furthermore, the patch test commenced by cleaning/disinfecting the side of the neck area of the respondents using alcohol with cotton balls. Then, the researchers applied a thick layer of Gard commercial shampoo for the positive control while for the experimental/treatment group, it was the formulated liquid hair shampoo using ginger crude extracts with bamboo scent on the surface of the respondents' neck. Next, they applied the patches. Once these steps were executed properly, they instructed the respondents not to remove the patches and secure them for 48 hrs. After the period of waiting, the researchers observed the respondents' skin for possible signs of irritation or itchiness.

According to Ludmann (2021), a patch test is a skin test used to find the cause of a possible allergic reaction on the skin. This reaction is called allergic contact dermatitis. Contact dermatitis is a reaction to something that comes into contact with the skin. This kind of allergic reaction usually causes inflammation (redness, itching). Further, the patches placed on the skin during the test were left for 48-hour observation.

Variables of the Study

The independent variable of the study was the formulated liquid hair shampoo using Ginger (*Zingiber officinale roscoe*) with Bamboo Scent. The dependent variables of the study are the antibacterial properties, pH level, and irritation test. On the other hand, the control variable of the study is the Gard commercial shampoo.

Statistical Analysis

The acceptance or rejection of the null hypotheses presented in this study was determined using the following statistical tools. To determine the significant difference between the control and treatment in terms of antibacterial properties, pH level, and irritation, a One-way Analysis of Variance and Post Hoc Tests were used.

All tests were done at a 0.05 level of significance.

IV. RESULTS AND DISCUSSION

Formulation of Liquid Hair Shampoo

The ginger liquid hair shampoo was formulated by performing the protocol. Firstly, the researchers placed a beaker on a hot plate. Secondly, they mixed 25g of coconut oil and 5g of sodium lauryl sulfate into the beaker using a stirring rod and heated

the hot plate for an hour at 100°C-150°C. Thirdly, in a separate beaker, they added 25g of distilled water and heated it to 60°C on the hot plate. Later, they mixed 5g of propylene glycol and 3.25g of sodium hydroxide into the beaker and waited until they dissolved. Fourthly, they placed the first beaker on the hot plate again and poured the contents of the second beaker onto it at 100°C, then stirred it until it reached the desired viscosity.

Fifthly, they added 15.8g of ginger extract and 300 drops of bamboo scent to the formulated liquid hair shampoo. Sixthly, the pH level of the formulated hair shampoo was tested using pH paper. Finally, an antibacterial Assay was performed to evaluate the antibacterial activity of ginger (*Zingiber officinale roscoe*) liquid hair shampoo against *S. aureus* to measure the zone of inhibition of the treatments: Without *Zingiber officinale roscoe* extract (T1), and with *Zingiber officinale roscoe* extract (T2), and the controls: Distilled Water (NC), and Gard commercial Shampoo (PC).

Shampoo, a fundamental hair-cleaning product, stands out as one of the most dynamic beauty items today. It plays a vital role in not only cleansing hair but also offering conditioning, smoothing, and promoting hair health by combating issues like dandruff, dirt, grease, and lice. This study explores different types of shampoos based on their functions, ingredients, and special effects. Evaluation of shampoos typically considers aspects like physical appearance, cleansing ability, foam quality, pH balance, viscosity, solid content, flow characteristics, dirt removal, stability, and wetting time. The patent section of shampoos merits special attention as it provides valuable insights into shampoo-related innovations (Deeksha, Malvina, & Sharma, 2014).

In addition, medicinal plants hold significant economic importance globally, and *Zingiber officinale*, commonly known as ginger, is one such plant cherished for its medicinal, traditional, and nutritional values. Ginger is widely consumed worldwide as both a spice and a flavor enhancer, and it is believed to possess numerous medicinal properties. Various chemicals found in ginger contribute to its diverse medicinal benefits, including its ability to protect the heart, reduce inflammation, fight microbes, neutralize free radicals, and potentially combat cancer. This review aims to provide comprehensive information about ginger to scientific researchers, emphasizing its significance as a vital medicinal plant. It encourages further development efforts to harness ginger's potential for producing pharmaceutical products, thereby enhancing both its economic value and therapeutic applications for the betterment of humanity (Gupta & Verma, 2021).

Furthermore, Ethanol-based Ginger Extract (EGE) and Raw Ginger Extract (RGE) both exhibit anti-bacterial effects against *Staphylococcus aureus*. However, further research is needed to isolate the active ingredients responsible for this activity. Understanding the effects of these compounds on living organisms and assessing potential toxicity is crucial. Only through comprehensive investigation can ginger extracts be considered for therapeutic use. Therefore, while ginger may offer some benefits, its full potential in medical applications necessitates thorough exploration (Rahman et al., 2020).

Evaluation of the Formulated Liquid Hair Shampoo

This study subjected the formulated liquid hair shampoo using ginger crude extracts with bamboo fragrance to evaluation procedures to determine its antibacterial potential, pH level, and irritation. Tables 1-3 show the generated results from the evaluation tests performed.

Antibacterial Activity of the Formulated Liquid Hair Shampoo

Natural antibacterial substitutes have drawn more attention as a growing worry about microbial contamination in hair care products drives interest. Consumers want botanical-based formulations since synthetic shampoos can include chemical preservatives that might irritate the scalp and have other side effects. Promising element in the creation of antibacterial shampoos, ginger (*Zingiber officinale roscoe*) has been well acknowledged for its antimicrobial characteristics. This study sought to evaluate ginger extract's capacity to stop bacterial development and contrast its effectiveness against commercial products by including it in liquid hair shampoo. Meeting consumer demand for safer and more efficient hair care products depends on an evaluation of the antibacterial potential of botanical compositions.

Thus, an antibacterial assay was performed to evaluate the antibacterial activity of ginger (*Zingiber officinale roscoe*) liquid hair shampoo. Table 1 shows the results of the comparative measure of the zone of inhibition of the treatments: Without *Zingiber officinale roscoe* extract (T1), with *Zingiber officinale roscoe* extract (T2), and the control: Gard commercial shampoo (PC) and distilled water (NC). The observed susceptibility and resistance were based on the presence or absence of the diameter of a zone of inhibition (ZOI) in millimeters. The absence of ZOI ranges from 0-7 mm is considered Inactive, while the presence of ZOI ranges from 7-16 mm is Partially Active; 17-30 mm is Active, and >30 mm is Very Active.

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Table 1. Comparative Measures of Zone of Inhibition of the Control and the Treatment Against *S. aureus*

CONTROL	REPLICATE	RESULTS (IN MM) <i>S. Aureus</i>	REMARKS
Gard Shampoo (PC)	R1	19	Active
	R2	20	Active
	R3	18	Active
Distilled Water (NC)	R1	0	Inactive
	R2	0	Inactive
	R3	0	Inactive
TREATMENT	REPLICATE	RESULTS (IN MM) <i>S. Aureus</i>	REMARKS
Without <i>Zingiber officinale roscoe</i> Extract (T1)	R1	0	Inactive
	R2	0	Inactive
	R3	0	Inactive
With <i>Zingiber officinale roscoe</i> Extract (T2)	R1	22	Active
	R2	19	Active
	R3	20	Active

The antibacterial assay findings showed how well the prepared liquid hair shampoo with *Zingiber officinale roscoe* (ginger) extract stopped *Staphylococcus aureus* growth. The table reveals that Without *Zingiber officinale roscoe* extract (T1) displayed no inhibitory zones, showing inactivity against *S. aureus*. By contrast, with inhibition zones ranging from 19 to 22 mm, the treatment with ginger extract (T2) demonstrated notable antibacterial action. With inhibitory zones ranging from 18 mm to 20 mm, Gard commercial shampoo (PC), the positive control, likewise showed antibacterial qualities. The negative control (distilled water) showed no bactericidal action, therefore verifying that those active components rather than outside variables accounted for the inhibition seen in T2 and PC.

Moreover, the bioactive components of *Zingiber officinale roscoe* help to explain the notable antibacterial action of T2. Research on ginger has shown phytochemicals like paradol, shogaol, and gingerol—strong antibacterial agents (Singh, Chowdhury, & Singh, 2017). These drugs cause cell lysis and death by upsetting bacterial cell membranes. Further bolstering the findings of this study was the research of Karuppiyah and Rajaram (2012), confirming the inhibitory action of ginger extract against *S. aureus*. The noted antibacterial action in T2 implies that adding ginger extract to shampoo formulations can improve their antimicrobial action.

Through comparison, T2 clearly showed a somewhat stronger antibacterial activity than the positive control (PC). Whereas PC varied from 18 mm to 20 mm, T2's inhibition zones were between 19 mm and 22 mm. This implies that compared to some commercial antibacterial shampoo formulations, ginger extract could have either similar or even better antibacterial activity. Al-Qahtani, Alsaffar, Alshammasi, Alsanni, Alyousef, & Alhussaini (2020) indicate that natural plant extracts are good substitutes for synthetic chemicals since they often show antibacterial qualities comparable to those of synthetic chemicals, therefore ensuring safer and environmentally friendly cosmetic formulations.

Conversely, the total inactivity of T1 suggests that the basic shampoo formulation without ginger extract lacked inherent antibacterial action. This is consistent with the results of earlier research showing that commercial shampoos without antimicrobial ingredients do not significantly stop bacterial growth (Falah et al., 2019). The lack of an inhibitory zone in T1 implies that the surfactants and other components in the basic formulation were useless against *S. aureus*, therefore stressing the need to use antibacterial agents to improve the performance of the formulation.

Moreover, the inactive outcome of the negative control (NC) guarantees test validity. Serving as the NC, distilled water showed no inhibition, so the active components rather than outside variables explained the observed antibacterial activity in T2 and PC. This is consistent with the results of Aumeeruddy, Zengin, Mahomoodally (2018), who underlined the need to validate findings in antibacterial tests by employing suitable controls. While NC stayed passive, the presence of active inhibition zones in T2 and PC supports the validity of the conclusions even more.

Finally, the findings of this work offer convincing proof of the antibacterial capacity of *Zingiber officinale roscoe* extract in shampoo compositions. The notable inhibitory zones seen in T2 point to ginger extract's natural antibacterial action against the common scalp infection *S. aureus* as being rather successful. These results show the possibility of ginger-based shampoos in enhancing scalp health and avoiding bacterial infections, given the growing desire for natural and safe personal care products. Future studies may investigate how well ginger extract resists different bacterial strains and maximizes its concentration.

pH Level of the Formulated Liquid Hair Shampoo

This study tested the pH level of the hair shampoo. To determine its pH level, pH paper was used. The results below indicate the pH level of the hair shampoo.

Table 2. pH Level Results of the Formulated Liquid Hair Shampoo

SAMPLE	REPLICATE	pH Level	DESCRIPTION
Formulated Liquid Hair Shampoo Using Ginger	R1	7.0	Neutral
	R2	7.0	Neutral
	R3	7.0	Neutral
	Average: 7.0		Neutral

All three replicates of the produced liquid hair shampoo comprising *Zingiber officinale roscoe* (ginger) extract had a stable pH of 7.0. The shampoo is hence neutral, that is to say, neither alkaline nor acidic. The stability of the pH value suggests that the formulation maintained a balanced composition, which is absolutely essential to assure product safety and efficacy. Ananthapadmanabhan, Mukherjee, and Chandar (2013) recommended that personal care products—especially shampoos—should have a pH that is either somewhat acidic or close to neutral to sustain scalp condition and minimize irritation.

A neutral pH is helpful for scalp and hair health since it protects the natural protective barrier of the skin. The human scalp's normal pH ranges from 4.5 to 5.5, which promotes the growth of beneficial bacteria and helps to regulate overly dry or oily conditions. Though somewhat acidic shampoos are occasionally recommended for hair care, a neutral pH does not necessarily cause any damage if the composition includes moderate surfactants and conditioning agents that balance possible drying effects. The results show that the shampoo is safe for regular use without disturbing the natural pH homeostasis of the scalp (Lambers, Bloem, Pronk, & Finkel, 2006).

Moreover, the shampoo's neutrality could help it to be compatible with many kinds of hair. Extreme pH value shampoos—either too acidic or too alkaline—may induce hair fiber swelling, cuticle damage, and more friction, causing breakage and frizz, according to Saric, Lisica, Orlic, Grgic, Krieger, Vuk, and Schoenfeld (2019). The neutral pH of the developed shampoo makes it appropriate for many hair problems and textures since it suggests that it is unlikely to produce such negative effects. Furthermore, the consistent pH seen in all duplicates implies that the addition of *Zingiber officinale roscoe* extract did not change the pH balance of the formulation. Bioactive chemicals, including gingerol and shogaol, which have antibacterial and antioxidant effects, abound in ginger extract (Singh et al., 2017). These chemicals, however, have no appreciable effect on the pH of the shampoo, therefore guaranteeing the stability of the formulation. This result is consistent with earlier research showing few pH changes when plant extracts are used in cosmetic products (Aumeeruddy et al., 2018).

Moreover, keeping a neutral pH helps the shampoo to be more generally stable. Variations in pH in personal care products could cause microbial development, active ingredient breakdown, and changes in product consistency (Varvaressou, Papageorgiou, Tsirivas, Protopapa, Kintziou, Kefala, & Demetzos, 2011). The shampoo's constant pH of 7.0 suggests that it should have a longer shelf life, free from notable chemical or physical changes. Ensuring consumer satisfaction and product quality depends much on this.

Finally, the pH study verified that the developed liquid hair shampoo using ginger extract kept a neutral pH of 7.0, thereby guaranteeing scalp compatibility, hair health, and formulation stability. The findings imply that the shampoo can help a variety of hair types and is safe for everyday usage. Besides, the neutral pH preserves the integrity of the active components and improves the shelf life of the product. Future studies could investigate tweaks to the composition to reach a somewhat acidic pH, therefore optimizing hair and scalp health advantages.

Irritation of the Formulated Liquid Hair Shampoo

In determining the irritation, here is how to do a patch test. First, gather all the materials needed, such as alcohol, a patch, tissue paper, plaster, and scissors. Second, the researchers determine the respondents, which are the 5 respondents coming from Grade 12 Callidus (control), specifically 5 girls, and another 5 respondents coming from Grade 12 Wizard (treatment), (specifically 3 girls and 2 boys, in total of 10 respondents. Use a small patch on the skin; however, in the study, the researchers used it on the neck of the respondent. Third, clean the area before applying the patch on the wrist or skin by using alcohol or anything that can clean the skin. After this, a thick layer of shampoo bar, which is the Gard shampoo (Control) and Ginger shampoo (Treatment) on the surface of the neck. Then, apply the patch and wait for 24 hours to see if there is irritation on the skin.

Table 3. Comparative Irritation Test Results Between Control and Treatment

Control		Respondents	Results of Irritation
Gard Shampoo	R1	1	
	R2	1	
	R3	1	
	R4	1	
	R5	1	
Treatment		Respondents	Results of Irritation
Ginger Shampoo	R1	1	
	R2	1	
	R3	1	
	R4	1	
	R5	1	

Legend: (1) No Irritation; (2) With Irritation

Table 3 shows the relative irritation test findings, which show that among all respondents, neither the control shampoo (Gard Shampoo) nor the formulated liquid ginger shampoo caused any irritation. With all five of the participants scoring a 1—which, based on the legend, corresponds to "No Irritation"—the results demonstrate a consistent response. This implies that, in terms of skin compatibility, the formulated shampoo was as gentle and safe as the commercial shampoo.

Given its neutral pH, as described in earlier results, the ginger shampoo formulation may be devoid of irritation. Shampoos with a balanced pH are less likely to irritate skin or upset the natural barrier of the scalp, claims Ananthapadmanabhan et al. (2013). The ginger shampoo did not aggravate frequent irritation brought on by strong surfactants by contributing to dryness, redness, or pain since it kept a pH of 7.0.

Furthermore, the natural components of the ginger shampoo can explain its mildness. Widely researched for its bioactive components, including gingerol and shogaol—which have anti-inflammatory effects—Zingiber officinale roscoe, or ginger, has natural plant extracts that are widely used in dermatological products to soothe sensitive skin and lower inflammation, hence, these substances might have helped to avoid skin irritation (Aumeeruddy et al., 2018).

Moreover, the consistency in irritation test findings between the control and treatment shampoos implies that the formulated ginger shampoo lacked strong surfactants or allergens capable of aggravating negative skin reactions. Sulfates, which are known to irritate some people, especially those with sensitive skin, are common components in conventional shampoos (Loden & Maibach, 2000). The findings suggest that the respondents accepted alternative or milder cleansing agents employed in the ginger shampoo formulation.

Furthermore, the results coincide with earlier research evaluating the dermatological safety of herbal-based shampoos. Gupta and Verma's (2018) research showed that users generally accepted plant-based shampoos made with natural ingredients and experienced less skin irritation when compared to synthetic formulations. Particularly for those with sensitive scalps, ginger shampoo can be regarded as a safe substitute for traditional shampoos since it does not cause any side effects.

Ultimately, the results of the irritation test verified that in terms of skin safety, the formulated ginger shampoo was non-irritating and on par with the commercial shampoo. Its mildness resulted from a neutral pH, naturally occurring bioactive chemicals, and maybe the absence of strong surfactants. These results imply that safe and reasonable daily usage options for ginger-based shampoo formulations exist. Additional research may look at its long-term consequences on scalp health and evaluate its fit for those with pre-existing dermatological diseases.

Difference Between the Control and Treatment In terms of Antibacterial properties, pH level, and irritation

This study also assessed the difference between the control and treatment in terms of antibacterial properties, pH level, and irritation. Using One-way Analysis of Variance and a Post-Hoc Test, Table 4 shows the generated results.

Table 4. Difference Between the Control and Treatment in Terms of Antibacterial Properties, pH Level, and Irritation

Source of Variation	SS	Df	MS	F	P-value	F crit
Rows	1005.1	4	251.275	21.66164	0.000238	3.837853
Columns	22.53333	2	11.26667	0.971264	0.419153	4.45897
Error	92.8	8	11.6			
Total	1120.433	14				

The control and treatment groups in terms of antibacterial properties, pH level, and irritation are compared in Table 4.4 through Analysis of Variance (ANOVA). With a corresponding P-value of 0.00, which is much below the 0.05 level, the F-value for the rows (21.66) is noticeably greater than the essential F-value (3.84). This suggests that the formulated liquid ginger shampoo showed appreciable changes in antibacterial activity, pH balance, and irritation compared to the commercial shampoo and distilled water, therefore indicating a statistically significant difference between the control and treatment groups.

On the other hand, the F-value for the columns (0.97) is less than the essential F-value (4.46), and the related P-value (0.42) is substantially higher than 0.05. This suggests that the several testing criteria—antibacterial qualities, pH level, and irritation—did not significantly vary. The lack of appreciable variance between columns implies that although the treatment had a general impact, the measured parameters helped to produce the observed variations equally. This is congruent with research showing

that formulation affects the antibacterial efficiency and skin compatibility of herbal shampoos, yet, usually, they retain constant pH values (Verma & Gupta, 2018).

Moreover, compared to the variance between groups, the error variance (92.8) shows a rather low degree of variation inside particular treatments. This implies that throughout replicates, the experimental results were consistent and trustworthy. Natural components like *Zingiber officinale roscoe* have shown in past tests to improve antibacterial qualities while preserving mildness on the skin (Singh et al., 2017). Maintaining a neutral pH and non-irritating properties, the notable difference between the control and treatment groups supports even more the assertion that the ginger extract affected the antibacterial capabilities of the shampoo.

Finally, the statistical analysis shows that in terms of antibacterial activity, pH level, and irritation, the formulated liquid ginger shampoo clearly deviated from the control. While the non-significant column findings imply that all three parameters were equally important in the variation observed, the significant F-value for the rows emphasizes the efficiency of ginger extract in improving the qualities of the shampoo. These results confirm the possibilities of herbal compositions as safe and efficient substitutes for commercial shampoos.

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