RASĀYAN *J. Chem.*
Vol. 18 | No. 2 |832-841| April - June | 2025
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

ASSESSMENT OF THE QUALITY OF A SHAMPOO FORMULATION MADE FROM CELERY (*Apium graveolens*) AND GIANT GINGER (*Zingiber officinale var. Officinarum*)

R. Mulyani[1,✉], D. Mulyadi[1], J. Ratnasari[2] and F. Maulana[3]
[1]Department of Chemistry, University of Muhammadiyah Sukabumi, West Java, 43113, Indonesia
[2]Department of Biology, University of Muhammadiyah Sukabumi, West Java, 43113, Indonesia
[3]Department of Quality Control, Proswealt Indonesia, West Java, 43359, Indonesia
✉Corresponding author: renimulyani@ummi.ac.id

ABSTRACT
Shampoo is an essential hair care product designed to cleanse the hair and scalp effectively. This study aims to formulate an anti-dandruff shampoo incorporating extracts of celery (*Apium graveolens*) and Giant ginger (*Zingiber officinale var. Officinarum*). Giant ginger is rich in antifungal compounds, including alkaloids, flavonoids, and saponins, while celery contains limonene, known for its antifungal properties. The study involved extracting and analyzing these bioactive compounds through Thin Layer Chromatography (TLC) and LC-MS. Celery extract exhibited a yellow color, a distinct celery aroma, a specific gravity of 0.8834 g/ml, and a yield of 1.22%, whereas Giant ginger extract was dark yellow with a strong ginger aroma, a specific gravity of 0.8833 g/ml, and a yield of 0.883%. Two shampoo formulations, F1 (9:4.69) and F2 (9:2.5), were tested for pH, foam stability, and antimicrobial activity. Formulation F1, with a pH of 7.90% foam stability, and an 18.36 mm microbial inhibition zone, demonstrated the highest effectiveness against dandruff. This study highlights the potential of celery and Giant ginger extracts in developing a natural, effective anti-dandruff shampoo.
Keywords: Shampoo, Formulation, Anti-Dandruff, Celery, Ginger, Antifungal, Bioactive
RASĀYAN *J. Chem.*, Vol. 18, No.2, 2025

INTRODUCTION

The public increasingly favors herbal shampoos, believing they contain safer natural ingredients with minimal side effects. Dandruff is a sign of fungal growth on the scalp, which can be inhibited by anti-dandruff shampoos. In Indonesia, celery and ginger have been traditionally used to treat dandruff. Celery (*Apium graveolens* L.) is widely cultivated and commonly used as a vegetable, in salads, and as a seasoning. It is also believed to have medicinal properties and benefits for hair care, including promoting hair growth.[1,2] Anti-dandruff gel shampoo containing celery essential oil has shown a strong ability to inhibit the growth of *Candida albicans*, a primary cause of dandruff.[3] Ginger is also beneficial as an antioxidant, analgesic, antibacterial, antiviral, and anti-inflammatory agent.[4,5,6] It contains phytochemical compounds, including alkaloids, flavonoids, phenolics, triterpenoids, and saponins, which have antifungal and antioxidant activities.[7,8] Celery contains essential oils and flavonoids, such as graveobioside A (1-2%) and B (0.1-0.7%), which function as antibacterial and antifungal agents.[9,10] The part of the ginger plant utilized is its rhizome. There are three common types of ginger consumed in Indonesia: Giant ginger (*Zingiber officinale* var. A*marum*), Giant ginger (*Zingiber officinale* var. *Officinarum*), and red ginger (*Zingiber officinale* var. *Rubrum*). Among these, red ginger has the highest content of oleoresin and essential oil, as well as the highest level of spiciness, making it widely used in traditional medicine.[11-13] The spiciness of ginger is influenced by phenolic compounds, which are part of the oleoresin components of ginger.[14,15] Giant ginger (*Zingiber officinale* var. *Officinarum*) extract can be formulated into shampoo using two different bases: Na CMC and HPMC.[7,16] Based on this background, the researcher is interested in creating a shampoo formulation with Giant ginger. This formulation will be evaluated for its physical quality.

The research focuses on several key questions aimed at developing an effective anti-dandruff shampoo. First, it seeks to identify the optimal formula that combines extracts of Giant ginger and celery. Additionally, it evaluates the formulation through various tests, such as measuring foam height and

http://doi.org/10.31788/RJC.2025.1829196

stability,[6,2] assessing surface tension,[20] conducting organoleptic examinations, and analyzing viscosity and pH levels.[10] Another critical aspect of the study is to determine the efficacy of Giant ginger. This research utilizes the essential oils from celery (*Apium graveolens*) and Giant ginger (*Zingiber officinale* var. *Officinarum*).[5,14]

EXPERIMENTAL

Material and Methods

The equipment used in this study includes a microscope, pH meter, viscometer, analytical balance, caliper, thin-layer chromatography (TLC) plates, Liquid Chromatography-Mass Spectrometry (LC-MS), UV light, mortar and pestle, beaker glass, hot plate, stirring rod, watch glass, measuring cylinder, shampoo container, and pycnometer. The materials used include celery (*Apium graveolens*), Giant ginger (*Zingiber officinale var. Officinarum*), anhydrous sodium sulfate, n-hexane, ethyl acetate, distilled water (aquadest), sodium carboxymethyl cellulose (Na-CMC), sodium lauryl sulfate (SLS), menthol, ethanol, propylparaben, citric acid, Coco-DEA, Potato Dextrose Agar (PDA), and sodium chloride (NaCl).

The experiment involved several procedures aimed at extracting essential oils from celery and Giant ginger, formulating a shampoo, and evaluating its quality.

1. Plant Determination: Morphological characteristics of celery and Giant ginger were analyzed through direct observation, with additional data gathered from the literature.
2. Extraction Using Distillation: The plants were distilled separately to obtain essential oils. After distillation, the oils were separated from water, and any residual moisture was absorbed using anhydrous sodium sulfate. The oil yield was measured, and identification was done using Thin Layer Chromatography (TLC) and LC-MS.
3. Shampoo Formulation: The shampoo was prepared by gradually adding ingredients like sodium carboxymethyl cellulose (CMC), sodium lauryl sulfate (SLS), menthol, and other components into heated distilled water, mixing them thoroughly.
4. Evaluation of Shampoo Quality: The shampoo's quality was assessed through several tests, including organoleptic (appearance, smell, color), homogeneity, pH, foam height, spreadability, and stability under cycling conditions.
5. These steps focused on extracting essential oils, creating a shampoo formulation, and testing its physical properties for quality control.

General Procedure

Plant Determination

The method used for plant determination was descriptive and qualitative. The data collected included both primary and secondary data. Primary data involved observing the morphology of celery and Giant ginger, while secondary data were obtained from relevant literature and journals. The morphological characteristics noted for celery included the shape of its stems and leaves, while the characteristics of Giant ginger included the shape of its rhizome, the color and texture of its skin, and the color of its flesh.[17]

Essential Oil Extraction

The extraction process began with cutting Giant ginger rhizomes into small pieces to facilitate the release of essential oil components. Extraction was performed using steam distillation involving several main steps. The rhizome pieces were placed in a distillation flask, and distilled water was added up to 2/3 of the flask volume.[1,5] The flask was heated for four hours until all the essential oil was distilled or until the temperature reached 100°C with no further distillate production. The distilled essential oil was separated from water using anhydrous sodium sulfate to bind any residual water. The volume of the obtained essential oil was then measured to determine the yield.[5,18]

Essential Oil Characterization

The essential oil underwent organoleptic testing to evaluate its color, odor, and physical appearance. Specific gravity was measured using a pycnometer to determine its physical characteristics. Preliminary identification of essential oil components was conducted using Thin-Layer Chromatography (TLC) with n-hexane and ethyl acetate (8:2) as solvents. Observations were made under UV light at wavelengths of 254 nm and 366 nm. The results indicated the presence of bioactive components in the essential oil samples.

LC-MS analysis of Giant ginger essential oil began with sample injection using an autosampler with an injection volume of 5–10 µL. Injection modes could be direct or gradient, depending on the analytical needs. The components of the essential oil were separated using liquid chromatography techniques based on polarity and other physicochemical properties, utilizing a C18 column commonly employed in organic compound analysis.[1,10] Detection was conducted using a mass spectrometer (MS) to determine the molecular mass of each separated component. Tandem MS (MS/MS) analysis provided additional data on the fragmentation spectra of the analyzed compounds. The final stage involved data analysis. Component identification was performed by comparing the obtained mass data (m/z) with standard libraries such as NIST or mzCloud. Fragmentation spectra were examined to confirm the identity of detected compounds. Quantification of components was based on standard curves created using specific concentrations of target compounds to determine their absolute concentration in the essential oil. The LC-MS analysis was conducted in the small molecule application mode over a 43-minute duration. The H-ESI ion source was used, operating with static spray voltage conditions. For positive ions, a voltage of 3500 V was applied, while 2500 V was used for negative ions. The static gas mode was employed, with sheath, auxiliary, and sweep gas flow rates set to 35, 7, and 0 arbitrary units, respectively. The ion transfer tube and vaporizer temperatures were maintained at 320°C and 275°C. The APPI lamp was not utilized, and ion source settings from tuning were disabled. The system was not equipped with a FAIMS source, and liquid chromatography served as the infusion mode, with an expected LC peak width of 6 seconds. Mild trapping was disabled, and internal mass calibration was turned off. The MS experiment ran for the entire 43 minutes, with the Orbitrap resolution set to 120.000 and a scan range from 50 to 750 m/z. The RF lens was set at 70%, using a standard AGC target. Maximum injection time was set to auto, and each scan included one microscope. Data was acquired in profile mode with a positive polarity, and source fragmentation was disabled. The column used is a reverse-phase C18 column (2.1 × 100 mm, 2 µm particle size). The temperature is set to 40°C to ensure stable separation and better reproducibility. The solvent composition for Mobile Phase A: Water with 0.1% formic acid or ammonium formate (pH ~3–4) to enhance ionization in positive or negative mode. Mobile Phase B: An organic solvent, typically acetonitrile, with 0.1% formic acid. The flow rate is 0.5 mL/min for analytical-scale columns, and the injection volume is 5 µL, depending on the matrix complexity and sample concentration.

Preparation of Shampoo Formulation

The shampoo formulation, using Giant ginger and celery extracts, was prepared with a CMC base. First, 60 ml of distilled water was heated in a beaker, and Na CMC was gradually added while stirring until it expanded. In another beaker, 50 ml of distilled water was heated, and SLS was added slowly while stirring until it dissolved, with the temperature monitored to reach 60°C. Menthol was dissolved in ethanol in an Erlenmeyer flask and stirred until completely dissolved. Then, propylparaben, citric acid, and more distilled water were added. The SLS solution was slowly mixed with the Na CMC solution while stirring until homogeneous. Finally, Coco-DEA was added and mixed well, followed by the addition of the menthol solution to the Coco-DEA mixture.[19,20]

Table-1: Shampoo Formulation

Material	F1 Celery-Giant ginger (15:4,69)	F2 Celery-Giant ginger (15:2,5)
Giant ginger extract (g)	4.69	2.5
Seledri(g)	9	9
Coco DEA(g)	6	6
Na CMC(g)	4.5	4.6
Methyl Paraben(g)	0.3	0.3
Citric acid(g)	0.15	0.15
Menthol(g)	0.37	0.37
Distilled water(ml)	150	150
Sodium Lauryl Sulfonate(g)	15	15

Evaluation of the Physical Quality of Shampoo Formulations.

Several tests were conducted to evaluate the physical quality of the shampoo formulations:[21,22]

1. Organoleptic Test: Changes in the form, odor, and color of the anti-dandruff gel shampoo, containing various concentrations of celery and ginger essential oils, were observed.
2. Homogeneity Test: This test ensured that all ingredients in the shampoo were thoroughly mixed and that there was no phase separation.
3. pH Test: The pH level of the shampoo was measured using a pH meter by immersing the sensor probe into the shampoo. The pH should fall within the skin-friendly range of 4.5 to 6.5. pH measurements were taken both immediately after formulation and at various points during storage.
4. Foam Height Test: This test assessed the shampoo's foaming ability by dissolving 10 ml of shampoo in a graduated cylinder, stirring it three times, and measuring the foam height after 15-45 minutes. Foam stability was calculated by taking measurements before and after allowing the foam to settle for 5 minutes.
5. Spreadability Test: A 0.5-gram sample of shampoo was weighed on a microscope slide. A second slide, with a weight of 50-150 grams, was placed on top for 1 minute. The spreadability was then measured and averaged. A good spreadability value typically ranges from 3-5 cm.
6. Cycling Test: This physical stability test involved repeatedly heating and cooling the shampoo to check for any physical changes or deterioration in product quality.

The Activity Test of an Anti-Dandruff Shampoo Formulation was Conducted using a Series of Specific Steps.[23,24]

A potato Dextrose Agar (PDA) medium was prepared. This involved weighing 1.75 grams of PDA powder and dissolving it in 80 mL of distilled water within a 250 mL Erlenmeyer flask. The mixture was stirred until homogeneous and heated to boiling until the solution became clear, ensuring the medium was fully prepared for fungal growth. a fungal suspension was created from cultures of *Candida albicans*. These fungi were taken from slant agar cultures and suspended in 3 mL of NaCl solution. An appropriate amount of this suspension was transferred into an inoculation medium, thoroughly mixed, and the turbidity adjusted to ensure consistency for testing. For the anti-dandruff shampoo testing, the good diffusion method was employed. Wells with a diameter of 5 mm were made on the PDA medium within Petri dishes. Each well was filled with the respective test samples: a positive control (e.g., a standard antifungal agent), a negative control, and the formulated anti-dandruff shampoo containing celery and ginger at predetermined concentrations. The Petri dishes were then incubated at a temperature of 25°C for 48 hours. Following the incubation period, the clear zones (inhibition zones) surrounding the wells were measured using a caliper across their centers. These zones indicated the extent of antifungal activity exhibited by each sample, allowing for the comparison of the shampoo's efficacy against the controls. This method effectively demonstrated the potential of the shampoo formulation in inhibiting fungal growth, providing insights into its suitability as an anti-dandruff product.

Detection Method

Detection methods include Descriptive and Qualitative Observation for plant determination (morphology). Organoleptic Testing for sensory assessment of oil and shampoo. Physical Detection methods, including specific gravity measurement, homogeneity, pH, foam height, and spreadability. Chemical Detection using TLC, LC-MS and UV light for essential oil identification.

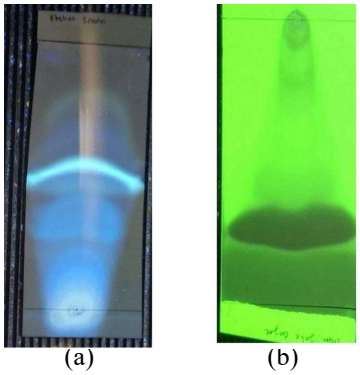
RESULTS AND DISCUSSION

Magnoliophyta, Giant ginger (*Zingiber officinale* Rosc var. *officinale*) is a notable variety of ginger, easily identifiable by its large, fleshy rhizome. It belongs to the kingdom Plantae, subkingdom Tracheobionta, and is classified under the superdivision Spermatophyta, division subdivision Angiospermae, class Liliopsida, order Zingiberales, family Zingiberaceae, genus Zingiber, and species *Zingiber officinale* Rosc var. *officinale*. Locally, it is commonly referred to as Giant ginger. The rhizomes are large and fleshy, typically exhibiting a yellowish-brown skin color. The flesh ranges from yellow to reddish-yellow and has a strong, distinctive aroma. The leaves are lance-shaped or oval with pointed tips, measuring approximately 20-25 cm in length and 2–3 cm in width. They are dark green with short petioles. The plant has a false stem

formed from a cluster of leaf sheaths and reaches heights of 1 to 1.5 meters, often displaying ridges. Although the flowers of Giant ginger are rarely observed, they are generally yellowish-green and emerge from the rhizome on short flower stalks. This plant thrives in tropical climates, preferring temperatures between 20–30°C. It requires loose, fertile soil with excellent drainage and is best planted at altitudes of 200–600 meters above sea level. While sufficient rainfall is necessary, excessive moisture should be avoided to prevent rhizome rot. In culinary applications, Giant ginger is a popular spice, often used in traditional beverages and as a raw ingredient in the food industry. Additionally, it is valued in traditional medicine for its ability to aid digestion, alleviate nausea, and provide anti-inflammatory benefits. Thus, Giant ginger is recognized as a versatile and beneficial plant across various domains. In this study, the yield of celery extract was 1.22%, while the yield of Giant ginger was 0.8833%. The extracts were then analyzed using Thin Layer Chromatography (TLC) to determine the purity of the compounds obtained. The principle of TLC involves the processes of adsorption, desorption, and elution. Adsorption occurs when the sample solution is applied to the stationary phase (the TLC plate) using a capillary tube, causing the components of the sample to adsorb onto the stationary phase.[25] Desorption is the process by which the adsorbed components are displaced by the mobile phase (the eluent), while elution refers to the movement of the components as they are carried by the eluent.[26] The separation of compounds takes place due to competition for binding sites on the solid phase. For instance, when silica gel is used as the stationary phase, its polar nature influences the interactions with the compounds. If two compounds with different polarities are involved, the more polar compound will interact more strongly with the silica gel, whereas the less polar compound will interact more weakly. As a result, the less polar compound will travel further up the plate, resulting in a higher Rf value. If a more polar solvent or solvent mixture is used as the mobile phase, it will facilitate the release of solutes from the silica gel, allowing all compounds to move further along the plate. Typically, a "strong" eluent will push the analyte further than a "weak" eluent, with the elution strength depending on the stationary phase of the TLC plate. The mobile phase used in this TLC process consisted of methanol, ethyl acetate, and n-hexane in a ratio of 7:7:6, determined based on the container used. To achieve optimal results, the amount of eluent used must be carefully considered. In this study, 20 mL of the eluent was used in the specified ratio. During the TLC process, the extracts from the maceration were applied to the TLC plate. Observations under UV light at 254 nm and 366 nm revealed the following distances: the distance of the developing line (or eluent front) was 7.9 cm, while the distance of the extract stain was 1.5 cm. The resulting Rf value, calculated by dividing the distance of the extract stain by the distance of the developing line, was 0.18 minutes. The results of organoleptic observations of the celery and Giant ginger extracts, including their physical properties, are presented in Table-2.

Table-2: Organoleptic Observations of The Celery and Giant Ginger Extracts

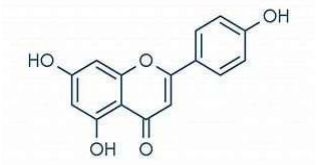
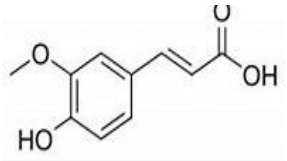
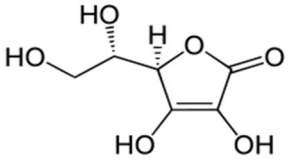
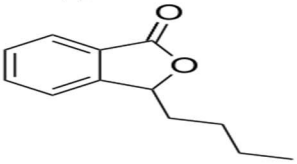
Property	Celery Essential Oil	Giant Ginger Essential Oil
Color	Yellow	deep yellow,
Odor	A pungent odor typical of celery	pungent odor typical of ginger
Consistency	Liquid	Liquid
Specific Gravity	0.8834	0.8833



(a) (b)

Fig.-1: Thin Layer Chromatography (TLC) of Celery and Giant Ginger Essential Oils**:** (a) Celery Essential Oil, (b) Giant Ginger Essential Oil

Table-3: LC-MS Results of Active Compounds in Celery

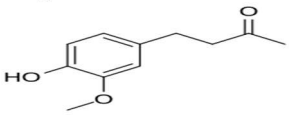
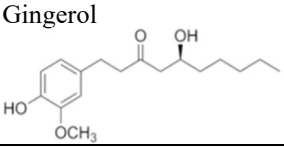
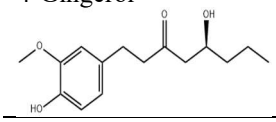
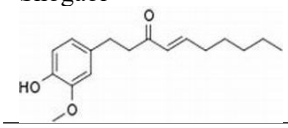
Active Substance	Annot. DeltaMass [ppm]	Calculated MW (g/mol)	m/z (Experimental)	Retention Time (RT) [min]	Area (Max.)
Apigenin 	-0.45	270.24	253.17969	8.879	8.781.816.312
Ferulic acid 	-0.35	194.19	195.13789	19.425	43.549.206.63
Ascorbic acid 	-0.65	176.12	176.12801	3.17	16.892.483.4
3-n-butylphthalide (NBP) 	-0.51	190.238	191.14294	14.501	32.783.330.42

To identify the active compounds and analyze the chemical components present in Giant ginger, Thin Layer Chromatography (TLC) and Liquid Chromatography-Mass Spectrometry (LC-MS) were used. TLC was employed for initial separation, while LC-MS provided a more detailed analysis of the structure and mass of the active compounds in Giant ginger (Tables-3 and 4). The analysis of celery essential oil revealed several active compounds with notable benefits. One key compound is apigenin**,** which has a retention time of 8.879 minutes and an area under the curve of 8.781.816.312. Additionally, ferulic acid was detected, exhibiting a retention time of 19.425 minutes and an area of 43.549.206.63. Ascorbic acid was also measured, with a retention time of 3.17 minutes and an area of 16.892.483.4. Finally, 3-n-butylphthalide (NBP) was recorded at a retention time of 14.501 minutes and an area of 32.783.330.42. Zingerone has a retention time of 19.425 minutes and an area under the curve of 43.549.206.63. Gingerol has a retention time of 10.03 minutes, with an area of 16.516.032.96. Additionally, 4-Gingerol has a retention time of 21.346 minutes and an area of 79.877.518.93, while Shogaol has a retention time of 8.744 minutes and an area of 23.680.349.63. These findings highlight the significant potential benefits of celery essential oil.

Apigenin is known to stimulate hair follicles, promoting increased hair growth. It has anti-inflammatory and antioxidant properties that help reduce inflammation on the scalp, a common factor contributing to hair loss. Moreover, apigenin supports scalp health, creating an optimal environment for hair growth.[27] Ferulic acid provides antioxidant benefits, protecting hair from damage caused by free radicals and environmental factors. It strengthens hair strands, reducing brittleness and breakage, while also aiding moisture retention for healthier, shinier hair.[28] Vitamin C offers several important benefits for hair health, including protection for both the hair and scalp against damage from free radicals, which can lead to hair loss and premature aging. As a crucial player in collagen synthesis, vitamin C helps maintain the structure and strength of hair. Additionally, it enhances iron absorption from food, which is vital for preventing anemia conditions that can contribute to hair loss. Its anti-inflammatory properties soothe scalp irritation, reduce dandruff, and improve blood circulation to the scalp, supporting healthy hair growth.[29] 3-n-butylphthalide (NBP) has been

studied for its various functions and potential benefits. It is known to improve blood flow to the brain, supporting cognitive function and overall mental health. NBP also possesses anti-inflammatory properties that can alleviate inflammation in the body, potentially benefiting various health conditions. Several studies suggest that NBP may enhance memory function and cognition, particularly in individuals experiencing cognitive decline.[30]

Table-4: LC-MS Results of Giant Ginger

Active Substance	Annot. DeltaMass [ppm]	Calculated MW (g/mol)	m/z (Experimental)	Retention Time (RT) [min]	Area (Max.)
Zingerone 	-0,35	194.2271 g/mol	195.13789	19.425	43.549.206.63
Gingerol 	-0,3	294.38 g/mol	294.16989	10.03	16.516.032.96
4-Gingerol 	-0,09	266.33g/mol	267.17196	21.346	79.877.518.93
Shogaol 	-0,75	276 g/mol	276.21674	8.744	23.680.349.63

Zingerone offers several health benefits, including stimulating blood flow to the scalp, which can enhance hair growth by providing better nutrition to hair follicles. It also possesses anti-inflammatory properties that help reduce irritation and inflammation on the scalp, creating a healthier environment for hair growth. By improving scalp health and minimizing inflammation, zingerone can help decrease hair loss. Furthermore, its antimicrobial properties may prevent infections on the scalp that could lead to hair problems. As an antioxidant, zingerone protects hair from damage caused by free radicals and environmental factors, keeping it healthy and shiny.[31] Gingerol has notable anti-inflammatory properties that can reduce inflammation in the body, including the scalp. This compound acts as an antioxidant, safeguarding cells from damage caused by free radicals, which is essential for maintaining cell health, including hair cells. Gingerol also increases blood flow to the scalp, supporting hair growth by delivering better nutrition to hair follicles. By promoting scalp health and enhancing circulation, gingerol can help reduce hair loss. Additionally, its antimicrobial properties help prevent infections on the scalp, thus maintaining overall hair health. Good digestive health also plays a crucial role in supporting hair health, as optimal nutrient absorption is enhanced.[32] The observations from the homogeneity test indicate that all formulations are homogeneous, as evidenced by the absence of sediment or clumps. The pH of the shampoo is 7, which is in line with shampoo standards. There is no difference between the two formulas, as both have a pH value that meets the required standards.

This pH value is close to the skin's natural pH range (4.5–6.5) and is important for maintaining the health of both skin and hair. Shampoo with a pH between 5.0 and 9.0, in accordance with SNI No. 06-2692-1992, can help maintain natural balance, prevent irritation, and ensure the product works effectively. With the right pH, the shampoo can cleanse without damaging the natural protective layer of the skin and hair. A shampoo with a pH that is too acidic or too alkaline can cause irritation to the scalp. Based on pH measurements using a digital pH meter (Table-5), this pH range still meets SNI requirements as it falls within the established range of 5.0 to 9.0.[33]

Table-5: pH Levels of Shampo Celery and Giant Ginger

Formula Type	pH Level	pH SNI standard requirements no. 06-2692-1992
F1	7	5-9
F2	7	

The foam height test for the shampoo formulation is crucial for assessing the product's effectiveness and quality (Table-6). This test measures the shampoo's ability to generate and maintain foam during use. Foam plays a vital role in distributing the product to the hair and scalp and aids in the cleansing process. The aim of the foam height test is to evaluate the shampoo's effectiveness in producing sufficient foam for efficient hair cleansing and to ensure that the formulation does not negatively affect the shampoo's foaming ability.

Table-6: The Foam Height Test

Test foam height (cm)	F1	F2	SNI standard requirementsno. 06-2692-1992
15 minutes	1.5	1.8	
5 Minute Stay	1.35	1.65	13-220 mm
25 minutes	2	1.5	
5 minutes stay	1.8	1.35	

The results of the foam height measurements reflect the surfactant's capacity to generate foam. Foam is critical because it helps the shampoo adhere to the hair, making the washing process easier and preventing hair strands from tangling.[34] The foam heights produced by the three shampoo formulations ranged from 1.5 to 4 cm, which meets Wilkinson's requirement (1982) of 1.3 to 4 cm and also complies with the foam stability criteria of 13 to 220 mm.[35] Stated in SNI No. 06-2692-1992. Foam stability is defined as the ability of bubbles to remain intact over a certain period.[36] After five minutes, the foam should be able to retain between 60% and 70% of its initial volume. In this study, formulations containing celery and Giant ginger extracts exhibited better stability compared to other formulations. The foam stability for formulation F1 reached 90%, while formulation F2 reached 90.83% (Table-7). These results indicate that both formulations have excellent foam retention.

Table-7: Foam Stability

Foam Stability (%)	F1	F2	SNI No. 06-2692-1992
	90	90.83	13-220 mm

The cycle test for the shampoo formulations was conducted to evaluate their stability, effectiveness, and physical properties. The method used involved alternating storage of the shampoo at 4°C and 40°C over four cycles. The results for F1 showed a pH of 7, with stable color and aroma, although the aroma slightly decreased in subsequent cycles. F2 exhibited similar results, with a pH of 7. The cycling test involved exposure to extreme storage temperatures, and observations were made to assess the stability of the formulations. Based on the results of the cycling test, the shampoos containing celery extract and Giant ginger extract showed no phase separation upon organoleptic observation. This indicates that the shampoo formulations with varying concentrations of celery and Giant ginger extracts are stable under extreme storage conditions. Most physical parameters remained consistent throughout the testing. In research on the antifungal effectiveness of the shampoo against *Candida albicans* using the well method, the diameter of the fungal growth inhibition zone was an important indicator. The larger the diameter of the inhibition zone, the more effective the shampoo formula is in inhibiting the growth of *Candida albicans* (Table-8).

Table-8: Inhibition Zone *Candida albicans*

Formula	Inhibition zone	Clinical and Laboratory Standards Institute (CLSI)	Information
Kontrol +	8.1	≥ 18 mm Strong 13-17 mm Medium ≤ 12 mm Less	
Kontrol -	0.0		
F1	18.43		Strong
F2	9.73		Less

The results of the inhibition zone diameter measurements were compared with the bacterial growth inhibition response classification, as stated in the fungal growth inhibition response classification table according to the Clinical and Laboratory Standards Institute (CLSI) (Poeloengan, 2010).

CONCLUSION

Giant ginger (*Zingiber officinale* Rosc var. *officinale*) is a variety of ginger that offers various health benefits, as well as applications in culinary and traditional medicine. Active compounds such as apigenin, ferulic acid, vitamin C, and 3-n-butylphthalide demonstrate significant potential in enhancing hair and scalp health through their anti-inflammatory and antioxidant properties, as well as their ability to improve blood circulation. Analysis using Thin Layer Chromatography (TLC) and LC-MS successfully identified the compound profile that supports the efficacy of the extract. Testing of the shampoo formulation revealed that its pH and foaming ability meet the required standards, showing good stability under extreme storage conditions. Microbial testing indicated that formulation F1 exhibited a larger inhibition zone against *Candida albicans* compared to the other formulations. Overall, this study demonstrates that Giant ginger extract can be effectively and safely utilized in hair care products.

ACKNOWLEDGMENTS

Thanks to the Ministry of Education, Culture, Research, Technology, and Higher Education for their funding support for this research, as well as to the Chemistry Laboratory of the Muhammadiyah University of Sukabumi, the Microbiology Laboratory of Griya Inovasi, and the Testing Laboratory of PT. Proswealt Indonesia.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

All the authors contributed significantly to this manuscript, participated in reviewing/editing and approved the final draft for publication. The research profile of the authors can be verified from their ORCID ids, given below:

Reni Mulyani https://orcid.org/0009-0002-5615-9697
Jujun Ratnasari https://orcid.org/0000-0003-0653-6511
Dikdik Mulyadi http://orchid.org/0009-0002-5183-8922
Ferdi Maulana https://orcid.org/0009-0007-7790-746X

REFERENCES

1. Z. I. N. Adnan, M. A. Megasilvia, A. B. Suwardi, B. M. Yakob, *Biodiversitas Journal of Biological Diversity*, **23(7)**, 3836(2022), https://doi.org/10.13057/biodiv/d230761
2. R. D. Supu, A. Diantini, J. Levita, *Fitofarmaka: Jurnal Ilmiah Farmasi*, **8(1)**, 25(2018), https://doi.org/10.33751/jf.v8i1.11768
3. National Standardization Agency, SNI 06-2692-1992, National Standardization Agency, Jakarta (1992).
4. R. J. Hendra, R. Asra, S. Misfadhila, *EAS Journal of Pharmacy and Pharmacology*, **4(3)**, 50(2022), https://doi.org/10.36349/easjpp.2022.v04i03.002
5. Z. Yang, Z. Guo, J. Yan, J. Xie, *Journal of Food Composition and Analysis*, **128**, 106057(2024), https://doi.org/10.1016/j.jfca.2024.106057
6. Y. Di, J. Dong, *Computers and Electronics in Agriculture*, **198**, 107066(2022), https://doi.org/10.1016/j.compag.2022.107066
7. A. Arfan, *Doctoral Dissertation*, STMIK Widya Cipta Dharma (2024).
8. T. Sulistyaningsih, D. Harjunowibowo, R. Wulandari, A. R. Ulfana, I. R. Putri, A. W. Rahmawati, F. A. Rindiani, *Penerbit Tahta Media*, Jakarta (2023).

9. H. M. Almohanna, A. A. Ahmed, J. P. Tsatalis, A. Tosti, *Dermatology and Therapy (Heidelberg)*, **9(1)**, 51(2019), https://doi.org/10.1007/s13555-018-0278-6
10. K. A. Khan, M. H. Saleem, S. Afzal, *Plant Growth Regulation*, **104,** 1329(2024), https://doi.org/10.1007/s10725-024-01243-w
11. R. Novitasari, P. Harsadi, M. Hasbi, *Jurnal Informatika Universitas PGRI Semarang*, **8(1)**, 75(2022), https://doi.org/10.26877/jiu.v8i1.10012
12. H. D. Setyaningrum, C. Saparinto, *Penebar Swadaya Group*, Jakarta (2013).
13. R. K. Chaudhuri, T. A. Meyer, R. Blinder, M. Vethamuthu, V. George, A. A. Adeniyi, N. Manhas, P. Singh, *International Journal of Cosmetic Science*, (2024), https://doi.org/10.1111/ics.13000
14. J. Wilkinson, *Journal of Colloid and Interface Science*, **85(1)**, 155(1982).
15. H. Fang, *Frontiers in Neuroscience*, **14**, 345(2020).
16. I. Edo et al., *Food Chemistry: Advances*, **4**, 1(2024). https://doi.org/10.1016/j.focha.2024.100625
17. L. W. Putra, A. A. G. Karnata, *Gara: Jurnal Ilmiah Kependidikan*, **16(2)**, 1572(2022), https://doi.org/10.35327/gara.v16i2.322
18. A. F. Iskandar et al., *TEKNOTAN: Jurnal Ilmu dan Teknologi Pertanian*, **17(1)**, 53(2023), https://doi.org/10.24198/jt.vol17n1.7
19. A. S. Andy et al., *Jambura Journal of Chemistry*, **3(2)**, 84(2021), https://doi.org/10.34312/jambchem.v3i2.11199
20. A. V. A. Asjur et al., *Jurnal Sains Kesehatan*, 4(5), 481(2022). https://doi.org/10.25026/jsk.v4i5.1265
21. A. R. Erwiyani et al., *Majalah Farmasetika*, **8(2)**,164(2023), https://doi.org/10.24198/mfarmasetika.v8i2.43686
22. A. D. Pravitasari et al., *Majalah Farmasetika*, **6(2)**,152(2021), https://doi.org/10.24198/mfarmasetika.v6i2.27629
23. F. Y. Ngelu et al., *Jurnal Jamu Kusuma*, **2(1)**,23(2022), https://doi.org/10.37341/jurnaljamukusuma.v2i1.22
24. A. S. Andy et al., *Jambura Journal of Chemistry*, **3(2)**,84(2021), https://doi.org/10.34312/jambchem.v3i2.11199
25. H. Husna, M. Mita, *Farmaka*, **18(2)**, 16(2020), https://doi.org/10.24198/farmaka.v18i2.25955
26. K. Kamar et al., *QUIMICA: Jurnal Kimia Sains dan Terapan*, **3(1)**, 24(2021), https://doi.org/10.33541/quinmica.v3i1.2300
27. S. Huh et al., *Archives of Dermatological Research*, **301**, 381(2009), https://doi.org/10.1007/s00403-009-0931-0
28. K. H. Kim et al., *Biomedicines*, **9(5)**, 459(2021), https://doi.org/10.3390/biomedicines9050459
29. R. Grover, A. Khurana, *Indian Journal of Dermatology, Venereology and Leprology*, **79(5)**, 591(2013), https://doi.org/10.4103/0378-6323.116731
30. Q. Zhou et al., *CNS Neuroscience & Therapeutics*, **28(11)**, 1706(2022), https://doi.org/10.1111/cns.13952
31. R. V. Trivedi et al., *International Journal of Research in Pharmaceutical Sciences*, **10(4)**, 3498(2019), https://doi.org/10.26452/ijrps.v10i4.1538
32. X. Hou et al., *Anais da Academia Brasileira de Ciências*, **89(4)**,2707(2017), https://doi.org/10.1590/0001-3765201720170354
33. T. K. Sari et al., *mSphere*, **5(1)**, e00826-19(2020), https://doi.org/10.1128/mSphere.00826-19
34. T. Mitsui, *New Cosmetic Science*, 1st Edition, Elsevier, Amsterdam (1997), https://doi.org/10.1016/B978-0-444-82654-1.X5000-5
35. W. S. Perkins, R. P. Walker, *Textile Research Journal*, **52(9)**, 592(1982), https://doi.org/10.1177/004051758205200901
36. N. Israelachvili, R. M. Pashley, *Journal of the American Chemical Society*, **91(11)**, 2789(1969), https://doi.org/10.1021/JA01090A003

[RJC-9196/2024]