PREPARATION OF MEDICAL SHAMPOO FROM POMELO (Citrus grandis L.) PEELS, LIME (Citrus aurantiifolia) PEELS, AND FABACEAE (Fructus Gleditsiae) FRUIT

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GENERAL INFORMATION

Received date: 07/03/2024

Revised date: 21/05/2024

Accepted date: 24/07/2024

KEYWORD

Shampoo,
Pomelo peel,
Lime peel,
Fabaceae fruit

ABSTRACT

Shampoo is a necessary hair care item for every person's everyday routine. The quest for environmentally friendly and naturally sourced products has led to an investigation into the production of synthetic shampoos using natural components such as fabaceae fruit, pomelo peel, and lime peel. In this study, we investigated the effects of pomelo peel, fabaceae fruit, and lime peel in the ratios 1:1:1, 1:2:1, 2:1:1, and 1:1:2. Analyze the extract percentages of fabaceae, pomelo, and lime (40, 60, and 80%). Examine the effects of glucose D MGT thickener (5%, 10%, 15%, and 20%) on shampoo qualities in compliance with TCVN 6972:2001 criteria. Consequently, the shampoo formula selects a 1:2:1 ratio with the extract of the raw material. In order for the shampoo to satisfy the requirements for assessing shampoo qualities, it contains 60% extract and 15% glucose D MGT.

1. INTRODUCTION

In order to satisfy demands for beauty and care while enhancing consumer safety, individuals these days frequently utilize components with a natural origin. To increase the efficacy of these goods and assist consumers in selecting and using them appropriately, a full analysis of their formula, purpose, and usage is necessary. Customers also like medicated shampoo solutions since they nourish healthy hair without harming the scalp. Fabaceae fruit has been used by women as a hair shampoo since ancient times. Fabaceae fruit is high in fatty acids, saponin, and vitamin E, which nourish, soften, and moisturize hair while protecting it from UV radiation and environmental factors (Dimitar G. Bojilov et al., 2013). Pomelo peel is rich in phytonutrients, vitamin C, and antioxidants (Shahnawaz Ahmed et al., 2019). These ingredients have the power to balance natural oils, cleanse the hair and scalp, and aid in the prevention of dandruff. Antioxidants and vitamin C are abundant in lime peel (Somayeh Sadat Fakoor Janati et al, 2012). These ingredients have antimicrobial properties, balance natural oils on the scalp, and aid in deep cleaning. Additionally, thickeners are needed in products like shower gel and shampoo to make them easier to use and maintain the homogeneity of the other

ingredients. PEG-120 Methyl Glucose Dioleate, scientifically known as DOE 120 or glucose D MGT thickener, has water (29.99%), tocopherol (0.01%), and methyl glucose triisostearate (70%) as its constituent ingredients. The cosmetics industry makes extensive use of this plant-based raw material (Charoenchai, et al., 2020; Jongrungruangchok, et al., 2020). This is a surfactant that is made of ethylene glycol and glucose. It reacts with oxidation processes to form a material with plastic qualities. Because of its propensity to foam, soothe, and moisturize the skin, this material is frequently used in washing and skin care products, such as lotions, shower gels, and facial cleansers.

Furthermore, we investigated the impact of the glucose thickener D MGT % on the shampoo's quality in order to determine the ideal ratio for producing a natural shampoo that deters dandruff, nourishes hair, and is safe for the environment.

2. METHODS

2.1. Subjects of research

Ingredients from Thai Son Pharmaceutical Company include fabaceae (*Fructus Gleditsiae*) fruit, limes (*Citrus aurantiifolia*), and pomelo **(***Citrus grandis L.)*.

Chemicals supplied by Organic Company include glucose D, dimethicone, DMDM Hydantoin, and vitamin B5. Vietnam's NaCl and China's Citric Acid were supplied by Trung Son Technology Co., Ltd.

2.2. The process involves extracting a mixture of lime peel, pomelo peel, and fabaceae fruit ingredients.

Weigh 50g each of pomelo peel, fabaceae fruit, and lime peel accurately into a 1000ml flask. Extract using the reflux method at 80 °C for 60 minutes, using a drug-to-solvent ratio of 1:10 and water as the extraction solvent. We blended each extract from the first and second.

2.3. Shampoo preparation process

With reference to a few documents (Jaganadathan, 2009; Tomasin, 2011; Hati Deepak, 2010), the group suggested a recipe for making shampoo that would include extracts from lime and pomelo, as shown in table 1.

The following processes are followed in order to prepare the shampoo. To make a homogenous solution, first dissolve the glucose D MGT and NaCl in the extract over low heat on the stove (1). To achieve a homogenous solution, first dissolve vitamin B5 completely in distilled water. Then, add citric acid and dimethicone and stir vigorously at a speed of 300 rpm to obtain a transparent solution (2). Third, combine (1) and (2), then use a magnetic stirrer set to 300 rpm for 10 minutes to fully mix the mixture. Add the DMDM hydantoin and stir well. Lastly, fill the bottle with the product and screw on the cap.

Table 1. Shampoo formulation with fabaceae fruit, lime peel, and pomelo peel

Material	Role	Ratio(% w/w)
Glucose D MGT	Surfactant	Change
Extract of Pomelo, Lime and fabaceae fruit	Solvent	Change
Sodium chloride (NaCl)	Thickener	6
Citric acid ($C_6H_8O_7$)	pH regulator	4
Vitamin B5	moisturizer and a solvent for essential oil dissolution	6
Dimethicone	Shine and smoothes hair	8.5
DMDM Hydantoin	Preservative	0.5

2.4. Survey the variables influencing the quality of shampoo.

We looked into the component ratio: Pomelo peel Fabaceae fruit: Lime peel (1:1:1, 1:2:1, 2:1:1, 1:1:2); Examine the impact of applying shampoo containing varying extract ratios (40%, 60%, and 80%); Examine the effects of thickeners with 5%, 10%, 15%, or 20% glucose D MGT content. Sensory criteria, foaming and foam stability, filth dispersion ability, and wetting time are among the monitoring criteria that are constructed in accordance with the general standards of shampoos (TCVN 6972:2001) and study by (Azadbakht M. et al., 2018). The following are the specific ways that each indicator is being monitored.

Through the shampoo's clarity, color, and aroma, sensory factors are assessed. We used a Hanna pH meter to determine pH at ambient temperature.

We measured the foaming ability and foam stability by adding about 5 ml of shampoo solution and 50 ml of distilled water to a 250 ml measuring tube. Cover the tube tightly with paraffin film and shake it rapidly ten times. Next, note the amount of foam produced at the first 0 minute mark and the 5 minute mark after shaking. Finally, apply the following formula to determine the foaming ability and foam stability:

$$V = \frac{V_1}{V_2} \times 100 \qquad (1)$$

In which:

V_0 is the foam volume at 0 minutes (ml).

V_1 is the foam volume at 5 minutes (ml).

We determined the ability to disperse dirt by transferring 50 ml of shampoo solution into a 250 ml measuring cylinder, adding a drop of ink, covering it with sturdy paraffin film, and shaking quickly 10 times. Observe the color of the foam that develops. We categorize the amount of ink in the foam into four groups: none, little, medium, and much. The shampoo is deemed to be of low grade if there is a noticeable concentration of ink in the foam. If the foam contains dirt, it will stick to the hair and make cleaning impossible. To be able to clean, the dirt needs to be in the water.

To determine the wetting time, prepare a 25 mm-diameter circular piece of cloth. Gently drop 50 cc of shampoo solution onto the cloth's surface. Timing the start of the solution's drop until the cloth begins to get completely wet determines the soaking time.

Weigh precisely about 4 g of shampoo into a clean, dry petri dish to determine the solids ratio. Then dry at 70 °C for 6 hours to let the liquid in the shampoo evaporate. After drying, re-weigh the shampoo disc. The following formula determines the percentage of solids:

$$T = \frac{M_2 - M_1}{m} \times 100 \qquad (2)$$

In which:

T: the percentage of solids (%).

M1: Disc mass of shampoo before drying (g).

M2: The mass of the shampoo disc in grams following drying.

m: the shampoo's initial volume (g).

Three runs of the tests were conducted. We use Excel to process the experimental data, and Minitab is used to evaluate the anova one factor at the 95% significant level.

3. FINDINGS AND DISCUSSION

3.1. Results of the survey of the appropriate raw material ratio

Table 2. Displays the results of the ingredient ratio of Pomelo peel: fabaceae fruit: lime peel (1:1:1, 1:2:1, 2:1:1, 1:1:2).

Table 2. Raw Material Ratio Survey Results

Raw material ratio	Sensory	Foaming ability	pH
1:1:1 samples 1	Light brown, clear, lightly fragrant	48ml After 5 minutes: 37.5ml	6.3
1:2:1 samples 2	Brown, clear, fragrant of Pomelo and Lime	52ml After 5 minutes: 50ml	6.4
2:1:1 samples 3	Light brown color, lightly fragrant	48ml After 5 minutes: 31ml	6.5
1:1:2 samples 4	Dark brown color, lightly fragrant with fabaceae scent	50ml After 5 minutes: 50ml	6.1

Current trends encourage users of herbal shampoos. Typically, people use alkanolamides to create stable foams, but they can also cause cancer because they produce nitrosamines. Natural items are starting to emerge as a new category in home goods. To substitute materials, use the saponins found in herbs such as lime peel, fabaceae fruit, and pomelo peel. As surfactants and emulsifiers, saponins are employed (Dinh Nhat Do et al., 2019).

Research has shown that the pH of herbal shampoos affects hair quality, reduces ocular discomfort, and maintains the scalp's natural equilibrium. Mild acidity, which also helps to tighten flakes and reduce puffiness, produces shine. As can be observed from the table below, all shampoos have an acid balance that is close to skin pH, ranging from 6.1 to 6.4 (Dhayanithi S.et al., 2021).

Samples 1, 3, and 4 all have a slight aroma, but not enough to meet the standards based on sensory ratings. Sample 2 has a combined scent of pomelo and lime. In this sense, samples 1 and 3 are less able to form foam than samples 2 and 4. The samples' pH is within acceptable limits and does not harm the scalp. We chose Sample 2 (ratio 1:2:1) as the raw material ratio for the extract because it best meets the evaluation criteria of pH, foaming ability, and sensory aspects.

3.2. Findings regarding the impact of the raw material mixture extract%

Table 3. Results of the survey on extraction ratios

% extract	40%	60%	80%
Sensory	Light brown color, mild aroma, thick consistency	Brown, fragrant, paste form	Brown, fragrant, liquid
pH	6.0 ± 0.3^{a}	6.4 ± 0.2^{a}	6.2 ± 0.3^{a}
Foaming ability	75ml After 5 minutes: 67.5ml	80ml After 5 minutes: 78ml	75ml After 5 minutes: 60ml
Capacity to disperse dirt	None	None	Medium
Wetting time (seconds)	270 ± 5.5^{a}	205 ± 7.5^{b}	180 ± 3.7^{c}
Solid Percentage (%)	47.5 ± 0.3^{a}	22.5375 ± 1.1^{b}	20.25 ± 0.5^{c}

Table 4. Findings from an analysis of the impact of adding glucose-D MGT thickener to shampoo formulation

% Glucose D MGT	5%	10%	15%	20%
Sensory	Brown, fragrant, liquid	Brown, fragrant, liquid	Brown, fragrant, paste form	Light brown color, mild aroma, thick consistency
pH	6.0±0.3[a]	6.1±0.6[a]	6.3±0.2[a]	6.2±0.1[a]
Foaming ability	118ml After 5 minutes: 104ml	110ml After 5 minutes: 95ml	104ml After 5 minutes: 100ml	83ml After 5 minutes: 79ml
Capacity to disperse dirt	None	None	None	Medium
Wetting time (seconds)	170±13[a]	180±10[b]	205±9[c]	234±11[d]
Solid Percentage (%)	20.25±0.5[a]	21.65±0.5[b]	22.54±1.1[c]	37.5±1.7[d]

Table 3's findings demonstrate that all three samples' pH levels are acceptable. However, 80% of the extract sample failed the test that measured its ability to disperse dirt, while 40% of the extract sample failed the test that measured the amount of solids in the sample and the wetting time. Quality shampoos usually comprise solid components ranging from 20% to 35%. A low solids content will make the product watery and rapidly wash off, whereas a high solids content will make it difficult to work on the hair or wash out (Malpani T. et al., 2020). The surfactant's concentration determines how well it wets (Manikar and Jolly, 2000). An excessively extended wetting period will make the user uncomfortable. One crucial factor in assessing a shampoo's cleansing efficacy is its capacity to disperse dirt. Shampoo cannot remove dirt if it concentrates ink in the foam, according to tests on this function (Ali and Kadhim, 2011). Therefore, shampoo is most likely to work when the water phase contains all of the toner and the foam is colorless. Customers place a high value on foaming ability. Low foam makes the shampoo seem like it's not cleaning the hair well, and high foam makes it take a long time to wash. Therefore, it is considered a vital component in the evaluation of shampoos. When test samples are available in about the same amount of foam volume in five minutes, it means that there is good foam stability. The combination of soap nuts, sheekakai, and ziziphus may be the cause of the shampoo's higher foaming qualities (Sarath et al., 2013). Consequently, a 60% extract sample is appropriate.

3.3. The survey results determine the ratio of thickener, specifically glucose D-MGT, in shampoo

A very efficient and user-friendly polyether thickener, glucose-MGT works with many kinds of surfactants, including cationic, anionic, non-ionic, and amphoteric ones. Skin and eyes can be safely exposed to it. There is no need for heating (J. Kleinen et al.,

2024). We are investigating the effects of 5%, 10%, 15%, and 20% ratios of glucose-D MGT thickener in shampoo formulations. Table 4 displays the results, which indicate that the sensory qualities of glucose D MGT thickening are not good at 5%, 10%, and 20%. The 15% thickening sample met sensory expectations. All three models satisfy the requirements in terms of pH and foaming ability. Nevertheless, sample 3's wetting time and solids percentage were both higher than necessary. As a result, the group decided to add 15% thickening to the shampoo recipe. This outcome is comparable to Charoenchai's shampoo recipe, which calls for propylene glycol (6-7%) and polyethylene glycol-120 methylglucose (2–3%) as a thickening (Charoenchai et al., 2020).

4. CONCLUSION

Research has suggested a natural shampoo recipe that helps nourish hair, get rid of dandruff, and safeguard the environment. We select an extract whose components are divided 1:2:1 between pomelo peel, fabaceae fruit, and lime peel. Glucose D MGT (15%), Extract (60%), Vitamin B5 (6%), Citric Acid (4%), Dimethicone (8.5%), DMDM Hydantoin (0.5%), and NaCl (6%), are the constituents in the shampoo formula. This result is the basis for many shampoo formulations made from natural medicinal herbs in the future.

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