Majalah Obat Tradisional (Trad. Med. J.), September-December 2024
Vol. 29(3), p 249-259
ISSN-p : 1410-5918 ISSN-e : 2406-9086
Submitted : 29-08-2023
Revised : 18-11-2023
Accepted : 09-07-2024

The Effect of Cocamide DEA on the Characteristics of Ginger and Celery Extract Shampoo Preparations

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ABSTRACT

Ginger and celery extracts are recognized anti-dandruff agents. Managing dandruff can be accomplished by creating a cleanser formulation. Shampoo contains an essential cleansing ingredient known as surfactant. Sodium lauryl sulfate (SLS) enables suitable foams but irritates skin at >10% concentration. Adding a non-ionic surfactant like cocamide diethanolamide (cocamide DEA) reduces irritation. This study examined how the concentration of cocamide DEA affects panelists' physical properties and preferences in a shampoo formulation that includes ginger and celery extracts. The shampoo was produced in three formulas with differing cocamide DEA concentrations: F1 (6%), F2 (8%), and F3 (10%). The formulation is evaluated using organoleptic, homogeneity, viscosity, pH, bulk density, foam height, foam stability, cycling, hedonic, and irritant studies. The result is shampoo had a brownish-orange color, a ginger-mint scent, and different looks. All three formulations were homogeneous and did not separate during cycling. The variation of cocamide DEA concentration in the shampoo formula had significant viscosity variances (*p-value= 0.000* < 0.05), pH (*p-value* = 0.001 < 0.05), bulk density (*p-value=0.007* < 0.05), foam height (*p-value= 0.000* < 0.05), and foam stability (*p-value= 0.000* < 0.05). The formula with an 8% cocamide DEA concentration was the most liked by panelists and did not produce irritation. Based on the results obtained, it concluded that the concentration of cocamide DEA affects panelists' physical properties and preferences in a shampoo formulation that includes ginger and celery extracts.

Keywords: Celery; Cocamide DEA; Ginger; Shampoo; Surfactant

INTRODUCTION

Ginger and celery extracts are known to act as anti-dandruff agents. The 3% ginger ethanol extract concentration inhibited the Malassezia sp. fungus in 28 out of 30 people with dandruff (Aprilia, 2010). Celery ethanol extract as an anti-dandruff agent in shampoo preparation was able to inhibit the growth of the fungus Pityrosporum ovale at a concentration of 0.1% with an inhibition zone of 20.98 mm (Mahataranti et al., 2012). The combination of ginger and celery extracts is expected to increase the effectiveness of antifungal shampoo preparations way to treat dandruff.

Surfactants are essential cleaning agents in shampoo because they can lower the surface tension of the solution so that dirt is suspended in the aqueous phase (Lestari et al., 2021). The surfactant often used is sodium lauryl sulfate (SLS), which is an anionic surfactant, but at concentrations >10%, it can irritate and dry the skin (Indrawati et al., 2011). Therefore, a combination with non-ionic surfactants such as cocamide DEA is required to reduce the irritation caused (Prayadnya et al., 2017).

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In a study comparing the physical test of different concentrations of Cocamide DEA in shampoo preparations, it was found that the concentration of Cocamide DEA affected the physical properties of Alamanda leaf extract shampoo, which included pH, viscosity, and foam height, but did not affect the inhibition of fungi (Nasmety et al., 2019). Other studies mention that different concentrations of Cocamide DEA affect the preparation's pH and the foam height's stability. In addition, other studies mention that different concentrations of cocamide DEA affect the preparation's pH and the foam height's stability in liquid soap preparations (Indrawati et al., 2011). Foam in shampoo is not an absolute requirement for a suitable shampoo formulation. However, the stability and height of the foam will depend on individual preferences (Lailiyah et al., 2022). Based on previous research, the effect of cocamide DEA variation on the stability of lather height affects the hedonic test, as a more stable lather is preferred to a less unstable lather (Prayadnya et al., 2017). Based on this description, the researcher is interested in formulating ginger and celery extract shampoo preparations using variations in cocamide DEA concentration as a surfactant. This study aims to determine the effect of cocamide DEA variations on the physical properties of shampoo preparations.

MATERIALS AND METHOD

Materials

Tools: rotary evaporator R-100 *(Buchi, Swiss),* oven dry Steril 28 *(Reverberi), Brookfield DV-E* viscometer *(Ametek, United States)*, dry blender *(Philips, Belanda)*, vacuum pump *(Rocker),* analytical balance AS 220.R2 *(REDWAG, Polandia))*, hot plate *(Schott, Germany)*, moisture balance DLB 160-3A *(Kern MAX, Germany),* UV lamp *(Camag, Germany),* water bath shaker WNB7 *(Memmert, Germany)*, weighing bottle, analytical balance *(Radwag, Polandia)*, maceration vessel, evaporator cup, mortar-stamper, test tube rack, glassware *(Iwaki, Japan)*, pH-meter, and picometer *(Iwaki, Japan)*.

Ingredients: celery herb (Indonesia), ginger rhizome (Indonesia), 96% ethanol, silica gel plate F_{254}, filter paper, mayer reagent, dragendroff reagent, Wagner reagent, $FeCl_3$, $AlCl_3$, distilled water, acetic acid, sulfuric acid, acid chloride, magnesium, gelatin, sodium chloride, toluene, ethyl acetate, formic acid, sodium lauryl sulfate cosmetic grade (PT KAO, Indonesia), viscolam cosmetic grade, propylene glycol cosmetic grade (SK Picglobal, Korea) triethanolamine cosmetic grade, cocamide DEA cosmetic grade (PT KAO, Indonesia)), dimethicone cosmetic grade, methylparaben cosmetic grade (Salicylates and chemicals, *India*), menthol cosmetic grade.

Methods

Plant Extract Preparation

Celery and ginger plants were extracted using the maceration method with 96% ethanol as a solvent (Mahataranti *et al.,* 2012). The yield obtained is weighed and calculated using the formula (Kementrian Kesehatan RI, 2017).

$$\%\,Extract\,Yield = \frac{extract\ yield\ weight\ (gr)}{initial\ simplicia\ weight\ (g)}\ x\ 100\%$$

Extract Standardization

The Non-specific Parametric of Extract

Organoleptic extract

Extracts were observed and described in terms of color, smell, and taste (Kementrian Kesehatan RI, 2017)

Determination of Ethanol Soluble Juice Content

Weigh accurately ± 5 grams of simplicia powder and put it into the corked flask. Add 100 mL of ethanol, shake for 6 hours using a shaker, and let stand for 18 hours. Filter and evaporate 20 mL of the filtrate to dryness in a preheated evaporator cup at 105°C and tare. Heat at 105°C until constant weight. Requirements for determination of ethanol-soluble essence content in ginger extract not less than 5.8% and celery not less than 5.2% (Kementrian Kesehatan RI, 2017). Calculate the % soluble essence of ethanol using the formula (Supriningrum *et al.,* 2019):

$$\%\,Ethanol\ soluble\ essence\ content = \frac{ethanol\ essence\ weight\ (gr)}{initial\ material\ weight\ (gr)}\ x\ \frac{100}{20}\ x\ 100\%$$

The Non-specific Parametric of Extract

Drying Shrinkage

Drying shrinkage test using moisture balance. The drying shrinkage requirement for ginger and celery plants is no more than 10% (Kementrian Kesehatan RI, 2017)

The Qualitative Analysis of Extract

Alkaloid Test

Put the extract in a test tube and add 1 ml of 2N HCL and 9 ml of distilled water. Heat for 2 minutes, calm, and strain. The filtrate obtained was divided into three test tubes. Add Mayer, Wagner, and Dragendorf reagents, giving rise to white, brown, and orange-red precipitates (Rahmi *et al.,* 2017).

Flavonoid Test

The extract was put into a reaction tube, 5 ml of ethanol was added, and the mixture was heated for 5 minutes. Add magnesium powder and a few drops of concentrated HCl. Shake and observe the changes that occur. The formation of a yellowish-black to reddish color indicates the presence of flavonoids (Septia Ningsih et al., 2020).

Saponin Test

The extract was put into a reaction tube, added 10 ml of distilled water, and heated for 5 minutes. It was then cooled, shaken vigorously for 10 seconds, and left for 10 minutes (Minarno, 2015) (Rahmi et al., 2017). The saponin test showed a positive result, indicated by the presence of 1 cm of foam for 10 minutes (Rustini et al., 2022).

Test Steroids and Terpenoids

The extract was added with 3 mL of ethanol. Add 2 mL of anhydrous acetic and sulfuric acid through the tube wall. A red color change indicated the presence of triterpenoids, while a green color change indicated the presence of steroids (Rahmi et al., 2017) (Ningsih et al., 2020).

Tannin Test

The extract was put into a test tube, and 5 ml of NaCl and gelatin solution were added. A positive result is indicated by the presence of a precipitate (Ikalinus et al., 2015).

Phenol test

The extract is put into the reaction tube; add 3–4 drops of $FeCl_3$. Positive results are indicated by a change in color from bluish-black to dark-black (Ningsih et al., 2020).

Identification of Active Compounds with TLC

Flavonoid Test

A flavonoid identification test was carried out on celery extract. The mobile phase was toluene: ethyl acetate: formic acid (7:2.5:0.5) (Kementrian Kesehatan RI, 2017). The stationary phase used was a silica gel GF254 plate. The spot viewer was the AlCl3 spot viewer (Rusmawijayanto and Luliana, 2019). A yellow stain indicated the presence of flavonoids—detection using UV366 and UV254 light (Nurmila et al., 2019).

Phenol Test

A phenol identification test was carried out on ginger and celery extracts. The ginger extract uses toluene as its mobile phase. Ethyl acetate (7:3) (Talia at al., 2019). Meanwhile, the mobile phase of celery uses toluene: ethyl acetate: formic acid (7:2.5:0.5) (Kementrian Kesehatan RI, 2017). The stationary phase used GF254 silica gel plates. The spots will be seen under UV366 and UV254. The spot viewer used with FeCl 3 will show a blackish-blue color. Spots will be seen under UV366 and UV254 light (Manongko et al., 2020).

Terpenoid Test

A terpenoid identification test was carried out on ginger and celery extracts. The ginger extract used the mobile phase of toluene and ethyl acetate (93:7) (Kementrian Kesehatan RI, 2017). Meanwhile, celery uses toluene: ethyl acetate (93:7) mobile phase (Fajriaty et al., 2018).

Shampoo Formulation

The shampoo formulation can be seen in Table I. To begin formulating the shampoo, Sodium Lauryl Sulfate (SLS) must first be dissolved in distilled water. While waiting for the dissolution process, put the viscolam into the beaker and add a small amount of distilled water as the viscolam forms a gel in liquid media (Yoshita, 2003). Next, dissolve the methylparaben into the propylene glycol and add it to the viscolam. Once the propylene glycol and methylparaben solution are homogeneous in the viscolam, gradually add the triethanolamine while stirring until a clear base is obtained (Nurdianti, 2015).

To make a shampoo, mix ginger extract and dimethicone with cocamide Dea until they are well-blended. Then, slowly pour the mixture into the gel base while stirring continuously until thoroughly mixed. Next, add the SLS solution in a small amount while stirring until thoroughly blended. Dissolve the menthol in a few drops of ethanol and pour it into the mix while stirring until thoroughly mixed. Add celery extract and continue to stir until everything is homogeneous. The shampoo will change from green to orange in color. Lastly, add distilled water until it reaches 100 ml (Sari et al., 2021) (Nasmety et al., 2019).

Shampoo Characteristics Testing

Organoleptic Test

Organoleptic testing looks at the shape, color, and scent (Sambodo and Salimah, 2021).

Homogeneity Test

The homogeneity test on the shampoo preparation was carried out by applying the shampoo preparation to the glass slide and then observing the parts that did not mix well (Sambodo and Salimah, 2021)

Viscosity Test

Brookfield DV-E viscometer. The testing method is done by placing the shampoo into a beaker glass and then under the Brookfield Viscometer model DV-E. The spindle is inserted into the shampoo preparation until submerged (Rashati and Eryani, 2019). Viscosity is measured with the appropriate speed and spindle. The test was carried out three times (triple). Conditions for acceptable viscosity in shampoo based on SNI are 400–4000 cp (Tee and Badia, 2019).

Foam Height and Stability Test

The ability of surfactants to form foam was determined by taking 1 mL of a sample. Please put it in a test tube and add 9 mL of distilled water. Shake for 1 minute, calculate the foam height after shaking, and calculate the final foam height after standing for 5 minutes (Purwati *et al.,* 2021) (Gunawan, 2020). According to Harbone (1996), the height requirement for shampoo foam is 1.3–22 cm (Lailiyah *et al.,* 2022). Meanwhile, according to Rosmainar (2021), the foam stability requirement is > 60%. The foam stability value

Table I. Formulation of Shampoo

No	Material	Concentration (%)			Function
		F1	F2	F3	
1	Ginger Extract	3	3	3	Active ingredients
2	Celery Extract	0.1	0.1	0.1	Active ingredients
3	Sodium Lauryl Sulfate	10	10	10	Surfactant
4	Cocamide DEA	6	8	10	*Foam stabilizer*
5	Viscolam	6	6	6	*Thickening agent*
6	TEA	3	3	3	*Alkalizing agent*
7	Dimethicone	1	1	1	*Emollient*
8	Propylene glycol	14	14	14	Cosolvent, Humectant
9	Methylparaben	0.15	0.15	0.15	Preservative
10	Menthol	0.25	0.25	0.25	*Corigen*
11	Aquades	Ad 100	Ad 100	Ad 100	Solvent

can be calculated using the following formula (Purwati *et al.,* 2021):

$$\text{Foam stability} = \frac{\text{final foam height}}{\text{height initial foam height}} \text{ x } 100\ \%$$

Specific Weight

Carefully weigh the empty pycnometer, add distilled water to the pycnometer, and record the weights of the two pycnometer scales. Enter the shampoo preparation into the pycnometer, then insert the cover. Weigh the pycnometer containing the shampoo and record the weight. Specific gravity requirements based on SNI are a minimum of 1.01–1.10 gr /mL. They calculated specific gravity using the formula (Andriani *et al.,* 2022).

$$\text{Specific Weight} = \frac{Weight\ of\ pycnometer\ containing\ preparations - weight\ of\ empty\ pycnometer.}{volume\ pycnometer}$$

pH test

The pH test was carried out using a pH meter. Previously, the pH meter was calibrated with a pH of 6.86 or 9.18**.** Then, the electrode on the pH meter was immersed until the tip was utterly immersed in the preparation, and the reading became stable. A number indicating the pH value is recorded (Gunawan, 2020). The pH of shampoo that meets SNI requirements is 5.0–9.0 (Rashati and Eryani, 2019).

Hedonic Test

The hedonic test is carried out to know the response or impression of the five human senses to a stimulus caused by a product. Using the hedonic scale, assessment of the shampoo product, including the amount of foam, texture, color, and aroma. The hedonic test was carried out on a scale of one indicating (dislike very much, number 2 (dislike), number 3 (neutral), number 4 (like), and number 5 (very like). The test was conducted with 30 people (Anasri *et al.,* 2020).

Irritation Test

The volunteers consist of 12 volunteers. The part used is behind the ear. Clean the volunteer's skin to be tested and mark a specific area (2.5 x 2.5 cm) behind the ear, then apply shampoo using cotton buds to the place to be tested and leave it for 4 hours (Untari and Robiyanto, 2018). Observations made included the occurrence of erythema, papules, vesicles, and edema. If erythema occurs, it is marked (+); erythema and papules are marked (++)**;** erythema occurs, papules and vesicles are marked (+++); edema and vesicles are marked (++++), and if it does not occur, reactions are marked (0) (Harefa *et al.,* 2017). Requirements for volunteers are that they are 20–30 years old, physically and mentally healthy at the time the test takes place, and have no previous history of skin allergies (Untari and Robiyanto, 2018). This research has obtained ethical clearance No. 2974/UN22.9/PG/2023.

RESULTS

Standardization of Ginger Extract and Celery Extract (Table II)

Extract Qualitative Test Results (Table III and Table IV)

Test of Physical Characteristics of Ginger and Celery Extract Shampoo (Table V)

Organoleptic Test (Figire 1)

***Hedonic Test* (Table VI)**

***Irritation Test* (Figure 3)**

DISCUSSION

Standardization of Ginger Extract and Celery Extract

Table II shows that ginger and celery extracts have composed extract standardization based on the Indonesian Herbal Pharmacopoeia standards.

Table II. Results of Standardization of Ginger and Celery Extracts

Extract Standardization Test	Ginger		Celery	
	Results	Literature	Results	Literature
Organoleptic	Condensed Shape It tastes spicy brown and has a distinctive aroma.	Condensed Shape It tastes spicy brown and has a distinctive aroma.	Condensed Shape It has a distinctive taste, is dark green, and has a distinctive aroma.	Condensed Shape It has a distinctive taste, is dark green, and has a distinctive aroma.
Drying Shrinkage Test	3.56 ± 0.648	<10	3.27 ± 0.908	<10
Ethanol Soluble Juice Content Test	46.67 ± 0.0577	>5.8	76.67±15.275	>5.2

Table III. Phytochemical Screening Test Results

Screening Test	Literature	Results	
		Ginger	Celery
Alkaloids	Dragendroff: Orange, red precipitate Mayer: White precipitate Wagner: Brown precipitate	-	-
Tannins	White precipitate	+	+
Phenol	Black	+	+
Terpenoids/ Steroids	Terpenoids: Brownish-red Steroids: Blue to green	+ Terpenoids	+ Steroids
Saponins	Presence of froth min. 1 cm	+	+
Flavonoids	Yellowish black - Reddish	+	+

Table IV. TLC Test Results

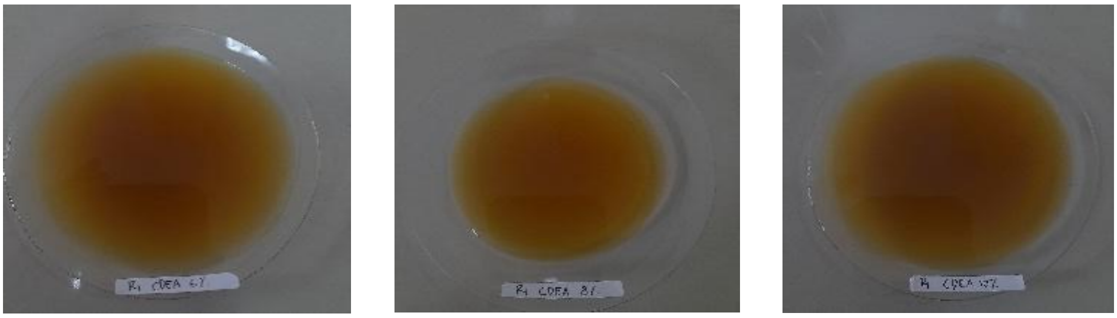
TLC test	Literature	Rf value	
		Ginger	Celery
Phenol	Blue-black spots when sprayed with $FeCl_3$	0.28;0.44;0.60 and 0.70	0.25;0.34;0.40; 0.61; and 0.83
Terpenoids	Blue-violet or red-violet spots when sprayed with Liberman Burchad and heated	0.26;0.86; and 0.56	0.67; and 0.83
Flavonoids	The spots are yellow when sprayed with $AlCl_3$.	Are not done	0.46; and 0.89

Table V. Results of Physical Characteristics Test of Ginger and Celery Extract Shampoo

Physical Characteristics Test	Average value			Condition
	Cocamide DEA 6%	Cocamide DEA 8%	Cocamide DEA 10%	
Viscosity (Cp)	523.33±13.35	873.33±20.30	1063.33±8.50	400-4000
Foam Height (cm)	10.13±0.15	10.73±0.15	11.30±0.10	1,3-22
Foam Stability (%)	81.25±0.28	83.85±0.33	85.88±0.89	>60%
Specific Weight (g/ml)	1.0461±0.0013	1.0470±0.0008	1.0480±0.0006	1.01-1.10
pH	8.55	8.60	8,62	5.0- 9.0

Extract Qualitative Test

The results of the qualitative extract tests can be seen in Table III and Table IV. Based on these results, the phytochemical screening test found that ginger and celery extract were negative for alkaloids and positive for tannins, phenols, saponins, and flavonoids. Table III also shows that in the terpenoid/steroid test, ginger extract positively contains terpenoids, and celery extract contains steroids. Fenol and terpenoid compounds can act as antifungals by disrupting the formation of fungal cell walls and can reduce membrane permeability (Rahminiwati et al., 2010) (Sutejo *et al.,* 2022). Flavonoid compounds bind to proteins



(a) (b) (c)

Description: a = Cocamide DEA 6 % Consentration Shampo Formulation; b = Cocamide DEA 8 % Consentration Shampo Formulation; c = Cocamide DEA 10 % Consentration Shampo Formulation

Figure 1. Organoleptic Test Results

(a) (b)

Description: a = Before treatment; b = After 4 hours of treatment

Figure 2. Irritation Test Results

Table VI. Hedonic Test Results for Shampoo Preparations

Parameter	F1			F2			F3		
	Amount	Average	Category	Amount	Average	Category	Amount	Average	Category
Lots of Foam	104	3.4	Enough	124	4	Like	118	3.9	Enough
Texture	97	3.2	Enough	111	3.7	Enough	111	3.7	Enough
Color	102	3.4	Enough	98	3.2	Enough	90	3	Enough
Aroma	91	3	Enough	110	3.6	Enough	97	3.2	Enough

in fungi, thus inhibiting the activity of fungal enzymes and causing disruption of their metabolic activities (Koala et al., 2021). The content of phenols, terpenoids, and flavonoids was strengthened in the TLC test, which showed that ginger and celery extracts positively contained these three active compounds.

Test of Physical Characteristics of Ginger and Celery Extract Shampoo

Based on previous research, variations in cocamide dea concentration affect the characteristics of several cleaning preparations. The preparation characteristics include viscosity, pH, specific gravity, foam height, and foam stability (Nasmety et al., 2019) (Indrawati et al., 2011) (Lailiyah et al., 2022). In addition, variations in the concentration of cocamide DEA also affect the liking of panelists in the hedonic test (Prayadnya et al., 2017). This study examined the effect of variations in the concentration of cocamide DEA on the preparation characteristics and panelists' responses to the preparation of ginger and celery extract shampoo. The concentration variations of cocamide DEA were 6%, 8% and 10%. The results obtained can be seen in Table V. The following is an explanation of this study:

***Organoleptic* Test**

Based on the observations of ginger and celery extract shampoo, there was a significant difference in the form of Formula 1, Formula 2, and

Formula 3. In Formula 1, the preparation looked a little runny; in Formula 2, the prepared formula looked thick; in Formula 3, the preparation formula may appear thick due to the higher the concentration of cocamide DEA added, the greater the viscosity, so the preparation becomes thick (Nasmety et al., 2019). Observations of shampoo preparations can be seen in Figure 1. The colors of the three formulas are brownish-orange, and the aroma parameter of the shampoo comes from the additional ginger and menthol extracts. The dominant aroma of ginger is due to the content of essential oils in ginger extract. The essential oils in ginger that cause a fragrant aroma are zingiberen and zingiberol (Handrianto, 2016). So, it is concluded that increasing the concentration of cocamide DEA did not affect the color or fragrance of the preparation.

Homogeneity Test

The homogeneity test determines the presence or absence of coarse particles in the shampoo preparation (Tee and Badia, 2019). The test showed that all three formulas were homogeneous, with no visible coarse particles or lumps. Homogeneous preparations are essential for producing high-quality shampoo because they ensure that the active ingredients are evenly dispersed (Rohmani *et al.,* 2022).

Viscosity Test

When analyzed using Oneway Anova in SPSS Var 25, the viscosity test results reveal a significant difference between the formulas with a value (p-value = 0.000) < 0.05. In Table V, it can be observed that the viscosity of the shampoo preparation increases with an increase in the concentration of cocamide DEA. The cause is because of the hydrophilic and lipophilic structure of Cocamide DEA, which enables it to reduce the surface tension between water and dirt (Lestari *et al.,* 2021).

Foam Height Test

The foam in the shampoo can prevent hair strands from sticking together, thus avoiding tangling (Lestari et al., 2020). Foam is an air-in-liquid emulsion (Rantika, 2017). The high foam test data was analyzed using the one-way ANOVA test, which resulted in (p-value = 0.000) < 0.05. This RESULT indicates a significant difference between the formulas. The foam height test data, shown in Table V, reveals that the higher the concentration of cocamide DEA, the higher the foam of the shampoo preparation. The cause is that the cocamide DEA is added to the mixture, resulting in more parts being adsorbed at the gas/liquid interface. Cocamide DEA has both hydrophilic and hydrophobic parts. The water-loving (hydrophilic) part will lead to solutions, while the other will lead to air or gas. When stirring occurs, air enters the surfactant solution. The surfactant is then adsorbed at the gas-liquid interface, trapping the gas and air to form bubbles. The more *cocamide DEA*, the more bubbles will be produced (Sari *et al.,* 2019) (Kurniawati *et al.,* 2015).

Foam Stability Test

The foam stability test result was analyzed using One-way ANOVA on SPSS Version 25 with (p-value = 0.000) < 0.05, indicating a significant difference between the formulas. The value of the foam stability test for shampoo preparations can be seen in Table V, which shows that the higher the concentration of cocamide DEA, the longer the foam in the shampoo will disappear. Foam stability is affected by the addition of cocamide DEA. The cause is that cocamide DEA is a foam stabilizer that can hold bubbles so they do not burst within a particular time. A decrease in foam stability implies that bubbles lose their main characteristics, including foam size, amount of liquid, and total foam volume (Prayadnya *et al.,* 2017). Increasing the concentration of cocamide DEA will result in a thicker bubble layer, which means it will take longer for the bubble to burst (Baranovich, 2020).

Moreover, when the viscosity of the foam is higher, it shows more excellent resistance. If the lamellae of bubble walls start leaking, the foam will lose its stability. However, if the viscosity is maintained at an optimal level, the surfactant micelles and the thickening agent combine to support the foam and keep it stable (Emmawati *et al.,* 2016).

Specific Gravity Test

The specific gravity test determines how easily shampoo flows from the packaging or can be poured (Pravitasari, 2021). When the specific gravity test results were tested and analyzed using *one-way* ANOVA, the results were *(p-value = 0.007) < 0.05,* indicating a significant difference between formulas. It can be seen in Table V that the higher the concentration of cocamide DEA, the higher the specific gravity of the preparation. With more components present in the preparation, the dosage weight also increases. Besides that, the value of specific gravity is also influenced by the composition and physical properties of the preparation (Prayadnya *et al.,* 2017).

Cycling Test

The cycling test aims to see whether phase separation occurs in shampoo preparations during the storage process (Sambodo and Salimah, 2021). The results showed that the three formulas did not experience any separation for six cycles, and no organoleptic changes occurred. These results indicate that extreme temperature changes during storage do not affect the organoleptic properties of the preparations.

PH Test

The pH test is carried out to determine the degree of acidity and alkalinity of a preparation (Nasmety et al., 2019). Data obtained when analyzed using the Walis Crustal Test on SPSS Var 25 shows a value (*p-value* = 0.001) < 0.05, indicating a significant difference between the formulas. The pH test values can be seen in Table V, which shows that the higher the concentration of cocamide DEA, the higher the pH. Cocamide DEA is alkaline, so the addition of cocamide DEA will increase the pH of the preparation (Prayadnya *et al.,* 2017). Formulations 1, 2, and 3 meet the shampoo test requirements, which fall within the 5–9 range. When the shampoo preparation is too acidic or alkaline, it can cause scalp irritation (Rohmani *et al.,* 2022) (Pravitasari *et al.,* 2021). The pH of a shampoo that is too alkaline can damage the disulfide bonds; if it is too acidic, it can damage the hydrogen bonds and salt bridges in the hair structure (Kartikasari and Yuspitasari, 2017). Loss of disulfide bonds, hydrogen bonds, and salt bridges can lead to tangled, damaged, and rough hair (Pravitasari *et al.,* 2021).

Hedonic Test

It aims to determine the response or impression of the five human senses to a product (Anasri *et al.,* 2020). From the volunteers' average rating score in Table VI, it is clear that the hedonic test parameters, such as color, aroma, and texture, received favorable responses. The hedonic test is a subjective test that depends on the preferences of each panelist. Of the three formulas, the aroma parameter of Formulation 1, which contained 6% *cocamide DEA,* had the lowest value but was still considered quite liked by the volunteers, equal to 3. The volunteers quite liked the aroma of the preparation because it smelled like ginger candy but was still too strong.

The texture parameters in formulations 2 and 3 containing cocamide DEA 8% and 10% got the same value, and the highest was 3.7 compared to a concentration of 6%. The texture of the 8% and 10% formulations is exceptionally preferred because they contain high amounts of cocamide DEA, sufficient to give a soft texture but challenging to pour. This result differs from previous studies, which say that panelists expect shampoo preparation to be easy to pour from the container and not to fall from the hand (Latirah and Nugroho, 2020). For the last parameter, namely the parameter of lots of foam, the concentration of 8% cocamide DEA is preferable to 6% and 10% cocamide *DEA*.

Irritation Test

Based on the physical characteristics test, all various cocamide DEA concentrations met the requirements of a good shampoo preparation. Thus, the best formula was determined from the hedonic test results, namely shampoo with an 8% cocamide DEA concentration. Irritation is a skin reaction to chemicals such as strong alkalis, acids, solvents, and detergents. The irritation test is a test that aims to see whether or not irritation occurs in healthy participants so that it can prove that the preparation is safe to use (Untari and Robiyanto, 2018). One of the results can be seen in Figure 2. The results of the irritation test showed that 12 volunteers showed no difference before and after 4 hours of treatment. Therefore, sampi with a concentration of 8% does not irritate.

CONCLUSION

This study concludes that variations in the concentration of cocamide DEA affect panelists' physical properties and preferences in a shampoo formulation that includes ginger and celery extracts.

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