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Formulation and Evaluation of Herbal Shower Gel using Various Malaysian Plant and Herbal Extracts

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ABSTRACT

This study addresses concerns over synthetic additives in commercial personal care products, such as triclosan, known for adverse effects on skin and endocrine health. Focusing on herbal shower gels, natural alternatives from local Malaysian plants and herbs—Azadirachta indica, Aloe barbadensis miller, Propolis, Ginger, Papaya, Pomegranate, Piper betle, Centella asiatica, and Camellia sinensis—were formulated to provide effective cleansing while minimizing adverse reactions. Physicochemical parameters including organoleptic evaluation, pH, foaming ability and stability, viscosity, solubility, antibacterial activity, and sensory analysis were assessed. The formulations exhibited promising antibacterial efficacy against Staphylococcus aureus and Escherichia coli, with no observed skin irritation among consumers during sensory analysis. These findings underscore the importance of exploring natural alternatives in personal care product formulations to address health and environmental concerns associated with synthetic additives.

1. Introduction

Personal hygiene products formulated with herbal extracts have gained prominence for their potential in addressing various dermatological concerns. Utilizing botanical ingredients for therapeutic purposes dates back to ancient civilizations, representing a longstanding tradition preceding modern germ theory [1]. Among these products, shower gel serves as a fundamental component of daily skincare routines, tasked with effectively removing impurities accumulated on the skin surface throughout the day. This aspect of hygiene maintenance not only fosters a healthy and luminous complexion but also plays a pivotal role in preventing common dermatological issues such as acne, dryness, and premature aging. However, the widespread adoption of synthetic additives, including triclosan—a common antibacterial agent in commercial formulations—has raised concerns regarding their potential adverse effects on skin health and endocrine function [2]. In

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response, there is a growing interest in formulating personal care products with natural alternatives, leveraging the therapeutic properties of botanical extracts while minimizing the risk of adverse reactions.

This study aims to capitalize on the rich botanical diversity indigenous to Malaysia by incorporating locally sourced plant and herbal extracts into the formulation of shower gels. Despite Malaysia's abundance of medicinal plant species, their integration into commercial skincare products remains relatively underexplored. Peninsular Malaysia alone boasts approximately 1300 identified medicinal plant species, presenting a promising yet underutilized resource for innovative product development [3]. The specific herbs selected for this study including Azadirachta indica, Aloe barbadensis miller, and others were chosen based on their documented traditional uses in Malaysian medicine and their potential antimicrobial properties. Central to this endeavour is the commitment to formulating shower gels with minimal reliance on synthetic ingredients, thereby reducing the risk of skin irritation and long-term health implications associated with their use.

Natural antibacterial agents such as Neem leaves, Betel leaves, and Ginger extracts are employed as substitutes for synthetic additives, offering effective cleansing properties without compromising skin integrity [4]. Moreover, this study addresses the escalating concern surrounding skin disorders exacerbated by prolonged exposure to ultraviolet (UV) radiation—a prevalent issue in Malaysia's tropical climate characterized by intense sunlight and high humidity levels. Indigenous herbs selected for inclusion in the formulation exhibit may inherent photoprotective properties, providing anti-aging, brightening, and anti-inflammatory benefits crucial for mitigating UV-induced skin damage and promoting skin resilience [5].

In summary, this project endeavours to develop herbal-based shower gels utilizing a diverse array of local plant and herbal extracts and subject them to comprehensive evaluation to assess their safety, efficacy, and suitability for human use. By harnessing the therapeutic potential of natural ingredients, this research seeks to contribute to the advancement of sustainable and skin-friendly skincare formulations tailored to the needs of diverse consumer demographics.

2. Methodology

2.1 Materials

Media for growing bacterial strains; Mueller-Hinton (MH) agar and broth powders (analytical grade) were purchased from Essen-Haus Sdn. Bhd. Methyl Propanediol (99% purity), Acrylates copolymer, Triethanolamine 99% (TEA), Sodium Lauryl Ether Sulfate (SLES), Cocamidopropyl Betaine, Iscaguard PEG, opacifying agent, fragrance and all plant and herbal extracts were procured from Bio Tajmeel Cosmeceutical Sdn. Bhd. Two bacterial strains namely Staphylococcus aureus (ATCC 25923) and Escherichia coli (ATCC 25922) were obtained from the central laboratory of Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA). All experiments were performed in triplicate unless otherwise stated. Control samples, Lifebuoy, Watermelon and Johnson & Johnson shower gels were bought from a nearby pharmaceutical store.

2.2 Formulation of Herbal Shower Gel

Three formulations (denoted as F1, F2 and F3) of herbal shower gel were formulated by using various plants and herbal extracts as summarized in Table 1. The formulation was prepared by adding 2 mL of Methyl propanediol (LS Diol) to a 250 mL beaker containing 60 mL of deionized water. The solution was homogenized using a homogenizer for 2 minutes at room temperature. About 8 mL of Acrylates copolymer (Repoly 100) was added to the mixture and gently homogenized. Then, 1.50 mL

of Triethanolamine (TEA 99%) was added to the mixture and homogenized. Next, 15 g of Sodium Lauryl Ether Sulphate (SLES) and 8 mL Cocamidopropyl Betaine (Mitaine CAS) were added and homogenized into the mixture. The combination of extracts containing 1 mL of the main active ingredients and 0.50 mL of other extracts was added to each formulation and was continuously mixed. After that, approximately 1.5 mL of Silk and Pear fragrance was added to each formulation and homogenized. Two millilitres of opacifying agent were later added as the last ingredient and homogenized for about 3 minutes until it became homogeneous. Each complete formulation was transferred into a 250 mL Schott bottle and stored at room temperature.

Table 1
Plant and herbal extract contents in each formulation

Plant and herbal extracts	In 100ml shower gel formulation		
	F1	F2	F3
Propolis	1 ml	-	-
Azadirachta indica (neem leaves)	0.25 ml	-	-
Aloe barbadensis miller (aloe vera)	0.25 ml	-	-
Carica papaya (papaya)	-	1 ml	-
Zingiber officinale (ginger)	-	0.25 ml	-
Punica granatum (pomegranate)	-	0.25 ml	-
Camellia sinensis (black tea)	-	-	1 ml
Piper betle	-	-	0.25 ml
Centella asiatica	-	-	0.25 ml

2.3 Physicochemical Evaluation of Prepared Herbal Shower Gel Formulations

The prepared herbal shower gel formulations were evaluated to establish their quality based on various parameters, as mentioned below.

2.3.1 Organoleptic study

The herbal shower gel formulations and Lifebuoy were observed in terms of color, odor, state, transparency, and texture of the shower gel.

2.3.2 Determination of pH

A pH meter was used to measure the pH of the formulated shower gels at room temperature (25°C). To obtain accurate results, the pH meter was frequently calibrated using buffer solutions. After calibration, the pH level of 10% v/v formulated herbal shower gel solution was measured and recorded using the pH meter [6]. The steps were repeated for the commercial shower gel Lifebuoy.

2.3.3 Viscosity

A viscometer was used to measure the viscosity of each shower gel formulation. The viscosity was measured and recorded by using the R6 spindle at different speeds of 10, 20, 30, 50 and 100 rpm for 30 sec. The steps were repeated for selected commercial shower gels, Lifebuoy, Watermelon and Johnson & Johnson. The three formulations' dynamic viscosity, η, was calculated based on Eq. (1) [7].

$$\eta = \nu \times \rho \quad (1)$$

2.3.4 Solubility

About 2 mL of each formulation was dissolved in a 150 mL beaker containing 100 mL deionized water using a magnetic stirrer at 100 rpm. The time taken for F1, F2, and F3 to dissolve completely in water was recorded [8]. The steps were repeated for Lifebuoy shower gel.

2.3.5 Percentage of solid content

Two clean dry evaporating dishes were weighed, and 4 g of each formulation was added to it. The exact weight of the shower gel was measured. The evaporating dish with shower gel was placed on a hot plate until the liquid portion evaporated. The weight of the shower gel (solids) was calculated after drying using Eq. (2).

$$\% \text{ solid content} = \left(\frac{\text{Net weight of the dry specimen}}{\text{Net weight of the original specimen}} \right) \times 100\% \quad (2)$$

2.3.6 Foam ability and stability

The cylinder shake method was used to test the foaming ability of each formulation. One percent from the formulated shower gel was poured into a 250 mL graduated cylinder and shaken ten times by covering it with one hand. The foaming ability was evaluated based on the foam volume produced after the 10 s shake test [9]. The height of foam volume produced was recorded after 1 and 10 min. The sustainability ratio was calculated by using Eq. (3) [8]. The steps were repeated by using Lifebuoy.

$$X = \left(\frac{V_2}{V_1} \right) \times 100\% \quad (3)$$

2.4 Stability Study of Formulated Herbal Shower Gel Formulations

The stability of the formulated herbal shower gels was carried out by pouring 100 mL of each shower gel into a 250 mL Schott bottle and placing them in a stability chamber at 45 °C with relative dampness of 75% and at a room temperature, 25 °C. The thermal stability was evaluated after 0, 4, and 8 weeks of storage. The appearances and other qualities were reviewed for two months [9].

2.5 Antibacterial Assessment

The prepared formulations were subjected to antibacterial testing by agar well diffusion method.

2.5.1 Preparation of Mueller-Hinton (MH) broth and agar plates

Mueller-Hinton (MH) agar was made by mixing 38 g agar with 1 liter of distilled water in a 1-liter Schott bottle [10]. In order to make Mueller-Hinton (MH) broth, 21 g of broth powder was dissolved in 1 liter of distilled water using a 1-liter Schott bottle. The broth and agar mediums were autoclaved at 121°C for 15 minutes before being chilled to 40-45°C. The cooled agar was poured onto the sterilized petri dish and was allowed to cool at room temperature. The broth and agar were stored in a refrigerator at 2-8°C until used.

2.5.2 Preparation of inoculum

The microorganisms, S. aureus and E. coli, were sub cultured approximately one day before the assay to ensure that they will be in their log phase of growth during the assay. Two to ten colonies of each microbe were inoculated into 50 mL of Mueller-Hinton (MH) broth and cultured for 30 minutes in an incubator shaker that was to shake at 170 rpm and 37°C. Using a UV-Vis spectrophotometer, the turbidity of the suspension was determined at 600 nm. The 0.5 McFarland standard, which has an absorbance value between 0.08 and 0.10, was used to compare the turbidity of the suspension of both microorganisms [9]. If the absorbance of the tested microbe culture was lower than the specified range, it was adjusted by extending the incubation time by 30 minutes. The suspension was prepared before inoculating the microorganisms on the agar plate.

2.5.3 Inoculation of the MH plate

The MH agar plates were used after a 24-hour incubation period at 37°C. A sterile micropipette was used for pipetting 100 µL of the S. aureus suspension, which was then streaked across the surface of the agar plates using the sterile hockey stick to inoculate the MH agar plate. The plate was rotated approximately 60 degrees to ensure an even distribution of the inoculum. This process was repeated for the suspension of E. coli. The plates were allowed to dry at room temperature for 15 minutes before use [11].

2.5.4 Controls

The negative control is the inoculated MH plate with no formulated shower gels applied to it; hence, it does not produce any inhibition zone.

2.5.5 Agar well diffusion assay

The agar well diffusion assay was carried out using the dried, inoculated MH agar plates that were previously prepared. A sterile cork borer was used to create the wells by poking holes into the four portions of the divided MH agar plates. Each plate featured four five mm-diameter wells, and a sterile needle was used to remove the agar cutout from each well [10]. Four different concentrations of each shower gel were prepared, which were the undiluted and 1:2, 1:3, and 1:4 (shower gel to distilled water ratio) dilutions. The three dilutions were made to study their bactericidal effects after being diluted with distilled water. Undiluted and 1:2 dilutions were considered as high concentrations, while 1:3 and 1:4 dilutions were considered low. Two to four drops of the formulated shower gel of each dilution were placed into each well. The agar plates were incubated for 24 hours at 37°C. A ruler was used to measure the observed inhibitory zones to the closest millimeter. To reduce test error, every test was run three times. The antibacterial activities of the formulated shower gels against S. aureus and E. coli were compared to the commercial product, Lifebuoy shower gel.

2.6 Sensory Analysis

Forty volunteers from Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA) were involved in the evaluation of the sensory properties of all herbal shower gel formulations. The protocol was explained, and the volunteers' informed consent was obtained.

An arm-wash method was employed in this analysis to determine the skin irritancy, moisture, preferences, and overall satisfaction after using the shower gels [12]. A survey and a small amount of shower gels were distributed among the volunteers to be applied on their both forearms for 2 minutes and rinsed off with water twice a day. This step was repeated for two days, and the skin reaction was observed and evaluated on the third day of the trial. The sensory analysis of shower gels was rated based on a five-point scale, for example, 5 = very good, 4 = good, 3 = satisfactory, 2 = unsatisfactory, and 1 = bad [8]. The data was collected, and a comparison was made between herbal shower gel and Lifebuoy.

3. Results

3.1 Physicochemical Evaluation

3.1.1 Organoleptic study

Table 2 presents the visual inspection of the formulated herbal shower gels and the commercial product, Lifebuoy. The herbal shower gel formulations F1, F2 and F3 were visually inspected based on their colour, odour, state, transparency, and texture. F1 and F3 are white in colour, while F2 is dark brown due to Black tea powder extract. All three formulations have a long-lasting, luxurious aroma with opaque transparency. Compared to Lifebuoy shower gel, it has a pink colour with a long-lasting and strong aroma and smooth and shiny texture. Based on this evaluation, the organoleptic properties of the formulated herbal shower were physically stable and accepted to be use by consumers.

Table 2
Organoleptic evaluation of the three formulated herbal shower gels and Lifebuoy

Parameters	Types of shower gels			
	F1	F2	F3	Lifebuoy
Colour	White	Dark Brown	White	Pink
Odour	Long-lasting, luxurious aroma	Long-lasting, luxurious aroma	Long-lasting luxurious aroma	Long-lasting, strong aroma
State	Semi-solid	Semi-solid	Semi-solid	Semi-solid
Transparency	Milky opaque	Opaque	Milky opaque	Opaque
Texture	Smooth	Smooth	Shiny	Smooth and shiny

3.1.2 Determination of pH

Shower gel pH level is responsible for enhancing and improving skin quality. Healthy skin has a pH of 5.4 to 5.9 [13], which is slightly acidic and gives the concept of the acid mantle. Mild acidity helps to protect the skin against the overgrowth of pathogens and protects it from ageing. Thus, shower gels or body wash with a pH of about 5.5 is the most relevant in preventing and treating skin disease. Based on the result of the pH analysis in Table 3, the pH range of the herbal shower gels was 6.6 to 6.8, which is slightly acidic compared to the more alkaline Lifebuoy that has pH range of 9.3 to 9.4. Adding Triethanolamine (TEA) 99%, which acts as the pH adjuster, may affect the pH value of the formulated shower gels. TEA 99% can be used to raise the pH if necessary because it is a strong base and is very alkaline.

According to cosmetic law regulations, the acceptable pH range of body wash or bath products is 2.0 to 10.5 [14]. However, most commercial shower gels have pH ranging from 7 to 9. Slightly acidic shower gel products can afford to maintain healthy skin with those having pH of 6 and 6.7 were known as highly suitable for sensitive skin [15]. Moreover, a product that is too acidic will irritate the skin, and if it is too alkaline, it can make the skin scaly and itch [16]. As shown in Table 3, F1, F2 and

F3 showed similar pHs with no significant differences between undiluted, 1:2, 1:3 and 1:4 dilutions. The formulated shower gels were slightly acidic and will not cause irritation or sensitization to the skin.

Table 3
Average pH of the three formulated herbal shower gels and Lifebuoy at different concentrations

Strengths	Average pH			
	F1	F2	F3	Lifebuoy
Undiluted	6.642	6.638	6.637	9.352
1:2	6.687	6.686	6.679	9.315
1:3	6.752	6.753	6.748	9.376
1:4	6.793	6.793	6.792	9.396

3.1.3 Viscosity

A fluid's thickness or stickiness is called viscosity. The number of particles in a shower gel affects its viscosity, at least to some extent. The viscosity of a product plays a key role in defining and regulating a variety of characteristics, including shelf-life stability and product aesthetics, clarity, flowability, spread ability, and consistency [9,17]. The viscosity data in Table 4 revealed that as revolutions per minute (rpm) increased, the viscosity of the created herbal shower gels gradually changed, indicating that the herbal shower gels were time dependent. The result shows that the herbal shower gels are a good viscous product because their viscosity almost reaches the range of marketed products of Watermelon.

F2, which used black tea extract, showed higher viscosities among the formulated herbal shower gel as the extract used was in solid form. Even though F2 has the highest viscosity among the formulated herbal shower gel, its viscosity is still less than the commercial products tested. In addition, the acceptable range of viscosity for body wash products is between 36 to 60 Poise (P). The outcomes indicated that the formulated herbal shower gels' viscosity falls within an acceptable range. The formulated herbal shower gels also showed high viscosity at low rpm, and their viscosity decreased when the shear rate was increased. It indicates that the viscosity decreases as the rpm increases, indicating the nature of the shampoo compositions was pseudo-plastic [9]. It is a desirable quality in shower gel as it will ease the spreading of the shower gel on the skin.

Table 4
Dynamic viscosity of the three formulated herbal shower gels and commercial products at different spindle speeds (P)

Types of shower gel	Dynamic viscosity (P) of shower gel at different spindle speeds (rpm)				
	10	20	30	50	100
F1	39.80	37.87	35.91	33.96	29.39
F2	46.32	45.79	39.62	36.74	30.63
F3	42.26	39.74	37.43	34.77	26.47
Lifebuoy	50.50	48.79	46.48	40.60	38.43
Watermelon	44.77	44.32	41.20	34.38	22.02
Johnson & Johnson	48.68	45.20	42.35	39.20	34.17

3.1.4 Solubility

Solubility of the shower gel is very important because rinsing it with water is the last stage of the washing process. Table 5 shows that the duration of herbal shower gels to dissolve in water is shorter than the commercial product Lifebuoy. F2 has the highest time taken for it to dissolve in the water

among the formulated herbal shower gel, while F1 has the lowest duration. These results corresponded with the result obtained for the viscosity value, as the solubility of shower gels was related to their viscosity. The higher the viscosity of the shower gel, the worse its solubility in water.

Table 5
Average time taken for shower gels to dissolve completely (s)

Types of shower gel	F1	F2	F3	Lifebuoy
Time taken to dissolve (s)	26.32	33.84	29.00	43.73

3.1.5 Percentage of solid content

Percentage of solid content: The term "solids content" refers to the coating's non-solvent, non-water components, such as pigments and binders, which do not evaporate and can form a cured (dry) film. The results presented in Table 6 showed that Lifebuoy's percentage of solid content is the highest, followed by F2, F3 and F1. F2 has the highest percentage of solid content among other herbal shower gels due to one of the active ingredients used in the formulation; Camellia sinensis is in the form of solid. The percentage of solid content for all the shower gel is within the acceptable range of 20%-30% [18]. Thus, the shower gel must have a percentage within the acceptable range. If the shower gel has an excessive amount of solid, it will be harder to rinse off.

Table 6
Percentage of the solid content of the three formulated herbal shower gels and Lifebuoy

Parameter	Types of shower gels			
	F1	F2	F3	Lifebuoy
Weight of crucible (g)	29.67	24.78	23.35	29.67
Weight of shower gel (g)	4.00	4.01	4.01	4.00
Net weight of the dry specimen	0.81	0.87	0.82	30.70
Solid content (%)	20.30	21.73	20.52	25.69

3.1.6 Foam ability and stability

The volume of the foam produced (foaming ability) and its stability are crucial factors in determining how well-made a washing preparation is. The primary function of foam is to give contact time on a dirty surface so that wetting agents, detergents, and degreasers have adequate time to work. Customers frequently equate thick, continuous foam with good washing results [8]. Table 7 shows that Lifebuoy has the highest foaming ability, followed by F3, F1 and F2.

Table 7
Height of the foam formed (cm)

Parameter	Height of the foam formed (cm)			
	F1	F2	F3	Lifebuoy
After 10 s	147.00	146.33	153.67	186.33
After 1 min	146.67	146.00	153.00	181.00
After 10 min	143.33	142.33	151.00	175.00
Sustainability ratio (%)	98.02	96.95	98.19	96.43

However, based on the sustainability ratio, Lifebuoy's foam is the least stable out of F1, F2, and F3, though it is still in a good range. Foam sustainability is the ability of the foam to be sustained. It is important as high sustainability means that the foam is stable. The sustainability of herbal shower gel and Lifebuoy is 96.43%-99.03, indicating a good sustainability ratio.

3.2 Stability Study

The most crucial aspect of a shower gel's stability study is its storage environment. After eight weeks of storage, the thermal stability of herbal shower gels was evaluated. The reactivity of the components can be affected by a wide range of factors, including temperature, pH, and light [19]. Figures 1 and 2 show that all three herbal shower formulations had good viscosity, pH and no phase separation after eight weeks of observation in the stability chamber and at room temperature. This evaluation demonstrates that the product is stable because it maintains its quality and has a longer shelf life.

(a) (b) (c)

Fig. 1. Condition of formulation placed in stability chamber (a) F1 (b) F2 (c) F3

Fig. 2. F1, F2, and F3 at room temperature

3.3 Antibacterial Activity Evaluation

The antibacterial activity of the three shower gel formulations F1, F2, and F3, were evaluated against S. aureus and E. coli using the agar-well diffusion technique. Tables 8 and 9 present the zone of inhibition results for the commercial and formulated shower gels against both bacterial strains. The herbal shower gel formulations had effective inhibition zones ranging from 10.34 to 16.32 mm against S. aureus. Similar observations were obtained for zone of inhibition against E. coli that ranged from 11.26 to 18.32 mm. Increasing the dilution ratio for all shower gel formulations decreased the size of the inhibition zones on both tested bacteria.

Table 8
Zone of inhibition of formulated and commercial shower gels against S. aureus (mm)

Strengths	Zone of inhibition against S. aureus (mm)			
	F1	F2	F3	Lifebuoy
Undiluted	16.32 ± 0.1	15.34 ± 0.2	16.16 ± 0.4	0
1:2	15.22 ± 0.3	14.36 ± 0.5	13.46 ± 0.2	0
1:3	14.54 ± 0.3	13.24 ± 0.1	11.28 ± 0.2	0
1:4	11.26 ± 0.2	12.30 ± 0.3	10.34 ± 0.6	0

Table 9
Zone of inhibition of formulated and commercial shower gels against E. coli (mm)

Strengths	Zone of inhibition against E. coli (mm)			
	F1	F2	F3	Lifebuoy
Undiluted	18.32 ± 0.5	16.54 ± 0.5	16.55 ± 0.1	0
1:2	15.64 ± 0.2	15.34 ± 0.1	13.35 ± 0.3	0
1:3	14.32 ± 0.3	14.22 ± 0.2	12.33 ± 0.2	0
1:4	13.26 ± 0.3	13.14 ± 0.4	11.26 ± 0.4	0

Figures 3 and 4 show that all agar plates containing shower gel formulations had zones of inhibition against S. aureus and E. coli. Further, it was also evident that the self-prepared formulations have greater bactericidal effect on Gram negative bacteria than in Gram positive bacteria. The bacteriostatic and bactericidal properties of these shower gels may be contributed by alkaloids, tannins, and phenolic components in the plant and herbal extracts which were added in the formulation [20,21].

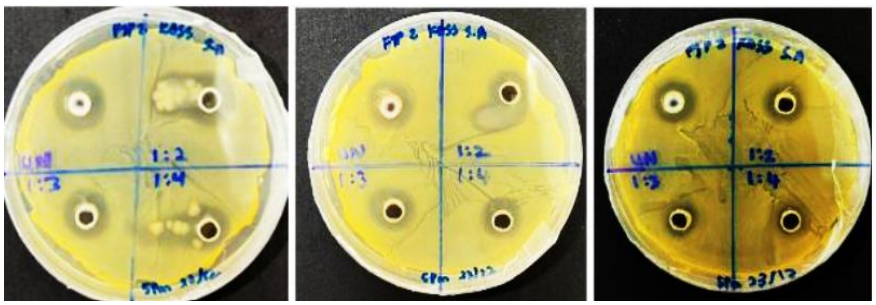

Fig. 3. Antibacterial study of F1, F2, and F3 against S. aureus

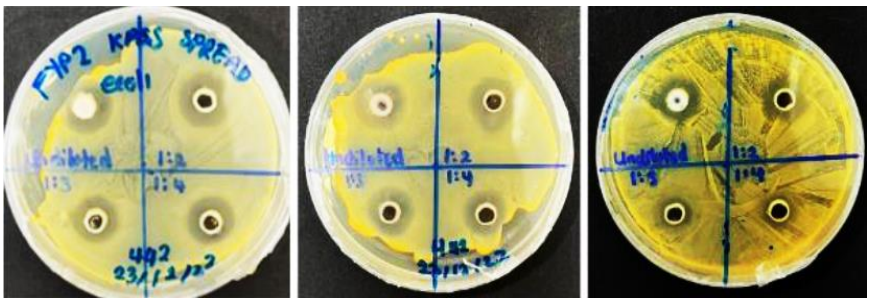

Fig. 4. Antibacterial study of F1, F2, and F3 against E. coli

Figure 5 displays that the commercial shower gel, Lifebuoy, did not exhibit any zone of inhibition against either of the bacteria isolates. This finding was supported by previous findings where Lifebuoy was demonstrated as unable to inhibit the growth of *S*. aureus and E. coli at various concentrations; 1:1, 1:2, 1:4, and 1:8 [22]. Therefore, the formulated herbal shower gels are assumed to have greater antibacterial properties than Lifebuoy shower gel at all concentrations.

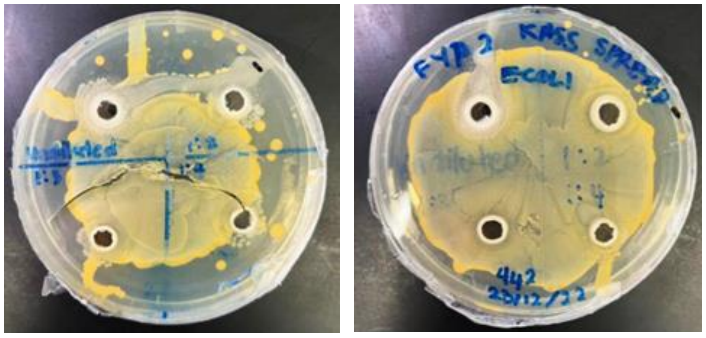

Fig. 5. Antibacterial study of Lifebuoy against S. aureus and E. coli

3.4 Sensory Analysis

This sensory assessment involved 40 volunteers (aged 20-40 years) from Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA), selected through random sampling. Prior to participation, all volunteers were screened for skin allergies and sensitivities. The protocol was explained, and written informed consent was obtained from all participants.

An arm-wash method was employed using a double-blind procedure where neither the volunteers nor the immediate investigators knew which formulation was being tested. The analysis determined skin irritancy, moisture retention, user preferences, and overall satisfaction after using the shower gels. A standardized survey instrument using a validated five-point Likert scale (5 = very good, 4 = good, 3 = satisfactory, 2 = unsatisfactory, and 1 = bad) was used to collect responses. Statistical analysis was performed using SPSS version 25.0, with significance set at $p < 0.05$. Tables 10, 11 and 12 show the volunteers' response to the formulated herbal shower gel and Lifebuoy.

Table 10
Volunteers' response to sensory analysis of F1

Parameter	Percentage of participants (%)	
	F1	Lifebuoy
Colour	80	20
Texture	77.5	22.5
Fragrance	82.5	17.5
Moisture	90	10
Skin irritancy	0	0
Overall satisfaction	92.5	7.5

Table 11
Volunteers' response to sensory analysis of F2

Parameter	Percentage of participants (%)	
	F1	Lifebuoy
Colour	47.5	52.5
Texture	67.5	32.5
Fragrance	100	0
Moisture	97.5	2.5
Skin irritancy	0	0
Overall satisfaction	100	0

Table 12
Volunteers' response to sensory analysis of F3

Parameter	Percentage of participants (%)	
	F1	Lifebuoy
Colour	82.5	17.5
Texture	90	10
Fragrance	97.5	2.5
Moisture	90	10
Skin irritancy	0	0
Overall satisfaction	100	0

The results showed that most volunteers favour herbal shower gel over Lifebuoy. Most volunteers preferred the formulated herbal shower gels, and most rated the products higher than three marks based on the five-point scale. However, in terms of colour, it was found that 52.5% of respondents chose Lifebuoy above the formulation F2. F2 contains black tea extract that renders the shower gel to be brownish in colour, which many found as unappealing. The herbal shower gel may appear as less enticing than Lifebuoy because it contains no synthetic dyes or pearling agents. Nevertheless, there have been no reports of skin irritation feedback for all three formulations. Overall, most volunteers were satisfied with all herbal shower gel formulations as they claimed them to be very fragrant, moisturizing, and gentle to the skin.

4. Conclusions

Three different shower gel formulations containing three different local plant and herb extracts were successfully developed and evaluated using numerous assays. Findings show that all formulations have antibacterial effects against the two most common bacterial strains in the environment, namely, S. aureus and E. coli. Further, through sensory analysis, it was revealed that most volunteers favour the formulated shower gels compared to the commercial shower gel sample. The study demonstrates that local plants and herbs have high potential to be developed as commercial body care products offering various benefits.

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