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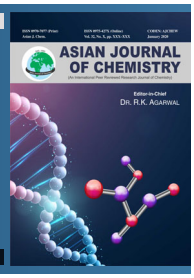

Formulation of an Essential Oil-Based Body Wash: Selection of Components and their Effects on Product Foamability and Emulsion Durability

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To meetout the growing consumer demand for cosmetic preparations that incorporate biologically active and natural ingredients, this study utilized lemongrass essential oil to create the main scent for body wash products in place of artificial fragrances on the market. Lemongrass essential oil is distilled by the method of hydrodistillation with the optimum yield of 0.29%. The process of developing a body wash formula is based on the survey of parameters affecting the product qualities. Multiple parameters including detergent, humectants, skin emollient, foaming agent, preservative, essential oil content were investigated. The product was evaluated based on the criteria of the foamability, the durability of the emulsion and the storage of samples in different storage conditions (room temperature, heat shock, acceleration). The results indicate that lemongrass essential oil body wash formulae are on par with some other shower gel products on the market, opening up the development trend for new research products to enter the market.

Keywords: Lemongrass essential oil, Body wash, Foamability, Durability of the emulsion.

INTRODUCTION

The rapid growth of the cosmetics industry in the world is associated to the rising aesthetic needs of people for cleaning products. In Vietnam, a large number of cosmetics is labeled with "Fragrance" in the ingredient list on the packaging, implying that flavourings are added to skincare products to overwhelm the uncomfortable natural smell of the other ingredients that make up the product [1,2]. However, it has been suggested that certain sensitive skins are unable to absorb these fragrance ingredients well and that the ingredients may persist for a long time after use in human body [3,4]. Although being sometimes termed as "natural fragrance," they may some-times contain chemical ingredients that enhance the product's properties and allow the fragrance to dissolve easily with the product. In addition, when used long-term, artificial aromas may destroy collagen, reduce the ability of the skin to heal itself and easily induce dry skin and wrinkle formation. Aromas can also sometimes come from natural extracts of fruits, herbs and plants [5-7] and sometimes cause mild irritation. On the other hand, daily exposure to environmental pollutants and increasing awareness to the role of hygiene and the risk of infection have risen the need for cleansing and body care products with potent bactericidal properties [8,9]. As a result, cleaning the skin is one of the most important measures to help prevent infections that cause disease in the body. However, the use of artificial antibacterial agents could promote itching fungus on the body [10-14].

In this study, a body wash product was formulated incorporating essential oils instead of flavouring. Lemongrass (*Cymbopogon citratus*) essential oil is the secondary metabolite that is extracted from the parts of citronella such as citronella leaves, citronella root. The essential oil accumulates in the leaves with the content varying from 0.4 to 2.0% depending

on the variety, ecological conditions and growing habitat. *Cymbopogon* family currently has about 55 species [15]. Lemongrass essential oil possesses a myriad of useful aromatic compounds that can reduce pain, exhibit anticancer activities (myrcene and limonene) and strong deodorant, antibacterial properties (citral and geraniol). Applications of lemongrass essential oil ranges from food, pharmaceuticals and to cosmetic industries. Lemongrass essential oil has pale yellow colour, strong lemon odor and is often extracted by direct distillation with water solvent. The main components of citronella essential oils include citral, geraniol, citronellol, nerol, limonene, geranyl, acetate and linalool [16-19]. One notable component of lemongrass essential oil is citral, which is responsible for fresh, citrus-scented aroma of the oil and due to the citral ingredient. In particular, lemongrass essential oil has the composition of citral is responsible for antibacterial properties against the development of many planktons such *Desulfovibrio alaskensis* (Gram-negative bacteria), *Ampylobacter jejuni* (causing intestinal inflammation and food poisoning), *Escherichia coli* (bacteria that cause diarrhea), *Listeria monocytogenes* (causing fever, muscle aches and nausea and diarrhea) and *Bacillus cereus* (food poisoning bacteria). The spread of those bacteria into the nervous system may cause headaches, stiff neck, dizziness, loss of balance and convulsions [20-23]. Although lemongrass essential oil may contribute to the prevention of those diseases, studies that utilize lemongrass essential oil sources to personal care products have been inadequate. Therefore, in this study, the possibility of using lemongrass essential oil as an alternative source for aromatherapy in formulation of body wash products was investigated. Quality measures including physical appearance and properties, sensory properties and durability of the products (tracking the product parameters when stored under normal conditions, thermal shock conditions and accelerated aging conditions) were investigated. The results are expected to contribute to expand the potentiality of citronella and lemongrass essential oils and to devise new product lines for application in the field of cosmetics.

EXPERIMENTAL

In this study, lemongrass essential oils were extracted using a hydrodistillation process. The distillation system is an industry-scale apparatus for steam distillation. The extraction process was carried out using about 300 to 750 kg of material per batch. Lemongrass leaves used in this study were collected from Tan Phu Dong District, Tien Giang Province, Vietnam. Lemongrass leaves (710 kg) were hydrodistilled for 3 h to afford mixture containing essential oils and water, which was then filtered to remove the water in the mixture. The essential oil is then dried on anhydrous sodium sulfate and stored in a sealed container. The achieved distillation yield was approximately 0.29%.

Used chemicals included sodium lauryl ether sulphate (SLES), EDTA, PEG-7 glycerol cocoate (PEG-7), disodium cocoamphodiacetate (minocol), coco amido propyl betaine (CAPB), cocodiethanolamide (CDE), carbopol thickener, glycerol, sodium lactate, polyquaternium-10 and D-panthanol. Chemical were purchased at Nguyen Ba Trading Production Co., Ltd, Tan Binh District, Ho Chi Minh City, Vietnam.

Formulation of body wash product: The experimental process is carried out as follows. First, the main detergent, co-detergent, humectants, preservative and a part of water were dissolved together and stirred gently, followed by heating (if necessary). The thickener was then dispersed in water, lightly heated and mixed with the mixture. Foam agent and opaque substance were added continuously to the product. Following that, lemongrass essential oil, emulsifier and antioxidant were emulsified with water, then added to the mixture. Also, add electrolyte and dissolved pH adjustment solution to the mixture. Finally, the body wash is cooled and poured into a bottle to evaluate the parameters and quality of the body wash.

Foamability: Foamability determines the sense of use of the product. This study uses the shaking test to measure foaming. The liquid is diluted 100 times and then 2 mL of solution was put into a stoppered tube, followed by shaking with a moderate force until the amount of foam generated reached maximum level, *i.e.* constant foam volume.

Foamability is calculated by the formula:

$$\varepsilon_f \frac{V_{foam} - V_{liquid}}{V_{foam}}$$

where ε_f: foaming level; V_{foam}: foam volume after shaking; V_{liquid}: original volume of liquid.

Durability of the emulsion: The cleaning effect is expressed through the time of emulsification, that is, the emulsifying ability of the product with selected paraffin oil, which was used for simulating dirt. A volume of 2 mL of diluent is added to 2 g of paraffin oil, followed by shaking to produce an emulsion. The use of a stopwatch is used to determine the lifetime of the system, which started when a 1 mL volume of oil is clearly separated.

A number of influencing factors during storage and transportation of products are also simulated for evaluation. During the storage process, it is inevitable that the denaturation of the product is under the influence of environmental agents, so it is necessary to find the best solution to preserve the product. Products were packed in sealed bottles and stored in different conditions: room temperature, temperature 45 °C and conditions of thermal shock. Then observation of the state, colour and smell was carried out.

RESULTS AND DISCUSSION

Effect of detergent and detergent content: The influence of detergent and content on foaming and durability of the emulsion of shower gel products from citronella oil is shown in Fig. 1. Among detergents (SLES, SLS and lauric acid), SLES seemed to have better foamability (0.4382) than that of SLS (0.3671) and of lauric acid (0.2754). When compared with the sample on the market, the foam content in the SLES sample is also slightly higher than that of the market sample (0.4048). SLES is an anionic surfactant that is widely used in cosmetics and personal care products because of its cleansing and emulsifying properties. SLES is less irritating to eyes and skin and

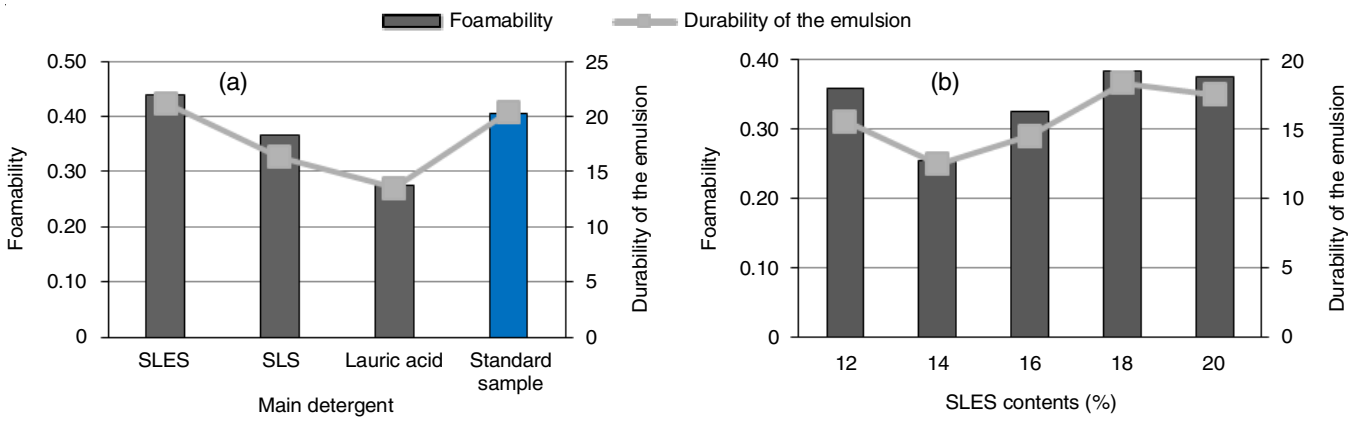

Fig. 1. Influence of detergent on foamability and durability of the emulsion: (a) main detergent, (b) SLES contents %

causes pouring of product to be smoother and lighter because SLES has more ethoxy group than SLS. On the other hand, SLS is also an anion activating agent, cleaning agent, emulsifier and foaming agent, which breaks surface tension and allows better interaction between skin and product. However, SLS causes abrasion, dry skin, irritation of sensitive skin and eye irritation. Therefore, SLES should be used and is further elaborated in the next experiment.

The content of EDTA is further investigated with respect to foamability to assess the capability to isolate heavy metal ions of EDTA, creating stability and preventing the product from being affected by chemical reactions between metals and other active substances. Fig. 2a showed that foamability of the sample treated with EDTA (0.4118) was higher than that of other samples treated with other detergents and was comparable with that of the standard sample. On the other hand, the durability of the emulsion of SLES (21.22 min) and EDTA (20.56 min) in Figs. 1a and 2a is also longer than the remaining samples and the market sample. From the results in Figs. 1a and 2a, SLES and EDTA at 18% and 0.15%, respectively were selec-ted for optimal best froth (0.3827 and 0.4048) and emulsion stability (18.32 and 21.12 min) and were used for subsequent investigations.

Effect of detergent adjuvant and detergent adjuvant content: Fig. 3 shows the effect of the agent and the amount of detergent adjuvant on the foamability and durability of the emulsion of the wash products. Based on the graph results in Fig. 3a, foamability level (0.333 and 0.3902) and durable foam time (17.24 and 20.35 min) observed at two products individually treated with PEG-7 and minocol are different and lower than the sample containing both PEG-7 and minocol. Meanwhile, when comparing foamability and foam durability of the sample containing PEG-7 and minocol (0.4382 and 24.11 min, respectively) with those of a commercial sample on the market (0.4048 and 20.45 min), the foaming and durability of PEG-7 and minocol still prevailed.

PEG 7 is a commonly-used fat enhancer-foaming in cleansing preparations. PEG 7 also acts as a surfactant and soluble stimulant for essential oils and active substances that softens the skin and moisturizes the skin. Minocol is an extremely light, non-peeling, amphoteric surfactant. The agent is a moderate foaming agent and is recommended for sensitive, stable skin over a wide pH range and to improve foam stability formula.

The formulation of the product was further elaborated by investigating the effect of PEG-7 and minocol content on foamability and foam durability. It is indicated that both PEG-7 and minocol gave optimal foamability and foaming duration at concentration of 2.5% and 2% corresponding. Therefore, PEG-7 2.5 and minocol 2% concentration were selected for investigating the next factors of body wash formulation.

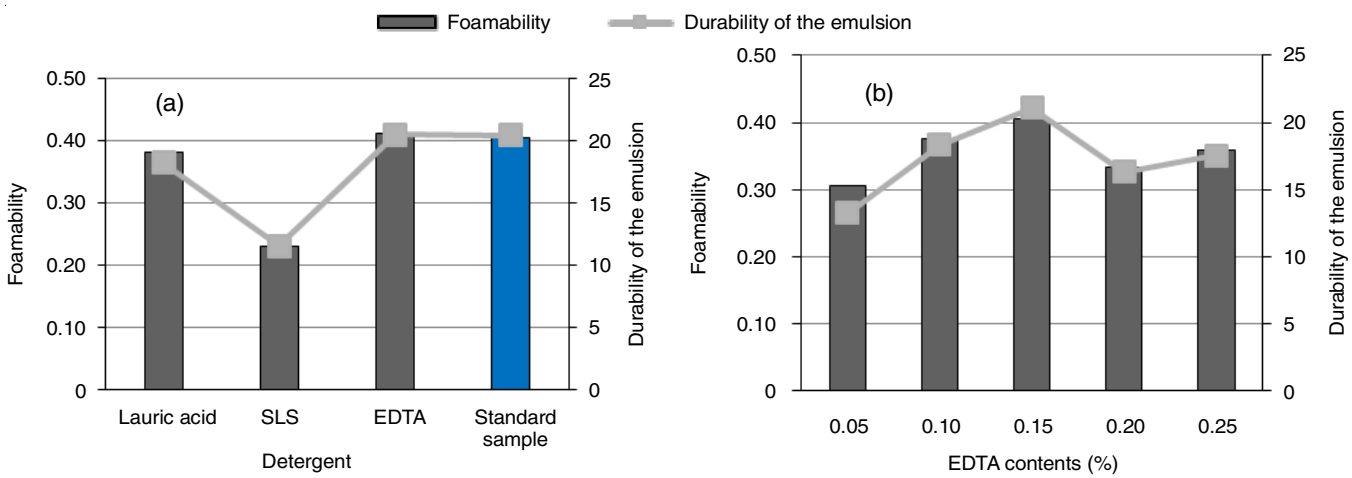

Fig. 2. Influence of detergent on foamability and durability of the emulsion: (a) detergent, (b) EDTA contents %

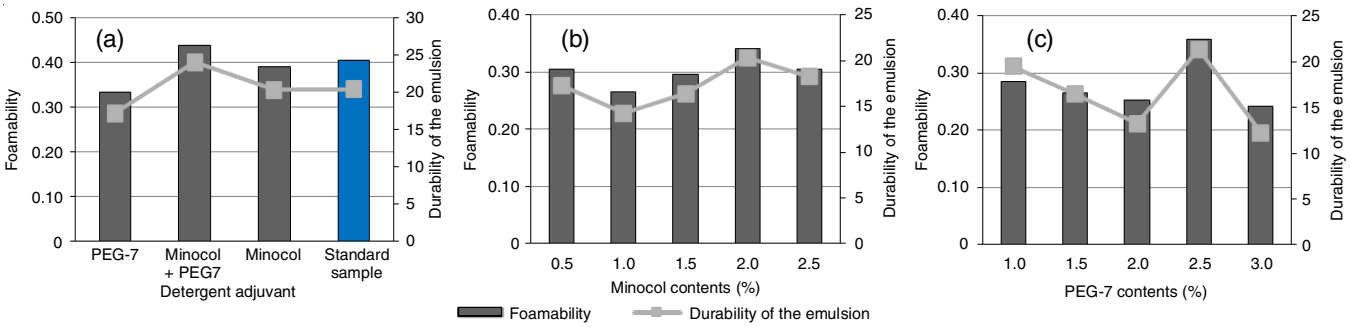

Fig. 3. Influence of detergent on foamability and durability of the emulsion: (a) detergent adjuvant, (b) minocol contents %, (c) PEG-7 contents %

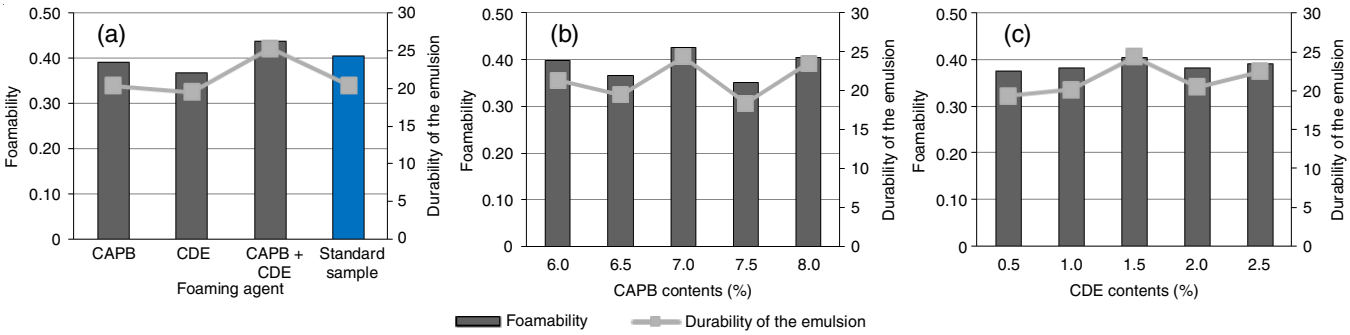

Fig. 4. Influence of foaming on foamability and durability of the emulsion: (a) foaming agent, (b) CAPB contents %, (c) CDE contents %

Effect of foaming agent and foaming content: Fig. 4a shows the effect of different foaming agents on the foamability and foam durability of the body wash products. The combination of CAPB and CDE gave the highest foam content (0.4382) and durability of the emulsion (25.36 min), significantly higher than those of the commercial sample.

The optimum concentration of CAPB and CDE was then investigated. Fig. 4b and 4c indicated the highest foaming level and durability was achieved at CAPB content of 7% and of CDE content of 1.5%. Considering the long durability of foam 24.39 and 24.38 min, respectively for CDE and CAPB agent), CAPB (7%) and CDE (1.5%) were selected to investigate the impact of next substances.

The addition of CocoBetaine (cocamidopropyl betaine) to these surfactants will help improve foam performance, reduce irritation caused by anionic surfactants, increase the cleaning ability of non-ionic surfactants and allows the use of a combination of cationic and non-ions for advanced cleaning formulas. In addition, CocoBetaine is also used as an emulsifier, thickener and antistatic agent that does not irritate the skin or mucous membranes. In addition, the combination of CDE to increase stability and thicken fluids and reduce skin irritation may be compatible with other surfactants.

Effect of thickener and thickener content: Effect of different thickeners including xanthan gum, HEC, carbopol and CMC was investigated with respect to foamability and foam durability of the product. Due to specific characteristics of each substance, the foaming among examined samples showed drastic differences in which the peak value (0.4382) was achieved when using carbopol, followed by HEC (0.4182), xanthan gum (0.3671), CMC (0.3902) and the commercial sample (0.4048).

Carbopol is a very effective thickener that is often used in very small amounts to prevent sedimentation. Carbopol is also durable at a wide temperature range, compatible with all other materials and favourable in cosmetics applications due to its low oiliness, viscosity and ease of washing. Meanwhile, the dissolution of HEC and Xanthan gum in water may cause clumping if the dissolution is incompleteleading to a longer time to dissolve completely and may be separated. In addition, the use of CMC in the formula necessitates auxiliary dispersants such as sugar and fructose syrup.

Impact of carbopol content was investigated afterwards. Fig. 5b shows that at 18% of carbopol content, foaming (0.4186) and durability of the emulsion (22.48 min) were higher than those obtained at other concentrations. Therefore, the content of 18% carbopol was selected for the next substance survey.

Effect of humectants and humectant content: The influence of moisturizers on foaming and emulsifying properties of lemongrass essential oil body wash products is shown in Fig. 6a. The experiments were conducted around the humectants (glycerol, sodium lactate, dipropylene glycol) and their combinations. The foaming (0.4186) and the durability of the emulsion (22.57 min) were higher than the rest of the samples and the commercial sample on the market. Meanwhile, two samples containing dipropylene glycol and sodium lactate + dipropylene glycol have showed the lowest foaming and durability of the emulsion.

Glycerol tends to rapidly absorb moisture from the air, enabling its application in moisturizing the skin, creating a special barrier on the surface of the skin and limiting evaporation. The use of glycerol can disrupt this peeling process and allow skin cells to have a better finishing time. At the same time, glycerol in combination with sodium lactate could improve

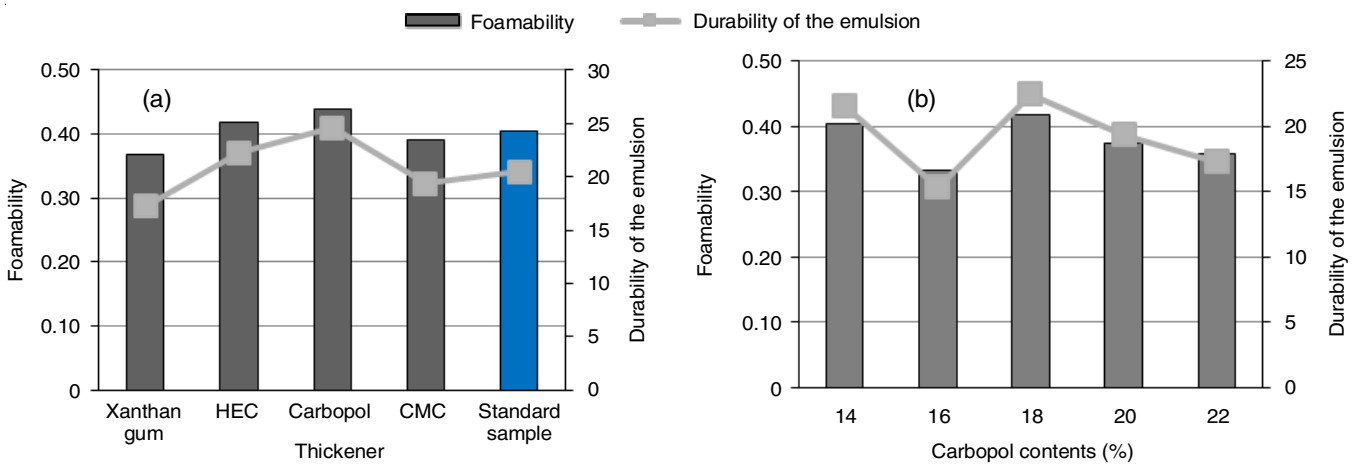

Fig. 5. Influence of thickener on foamability and durability of the emulsion: (a) thickener, (b) carbopol contents %

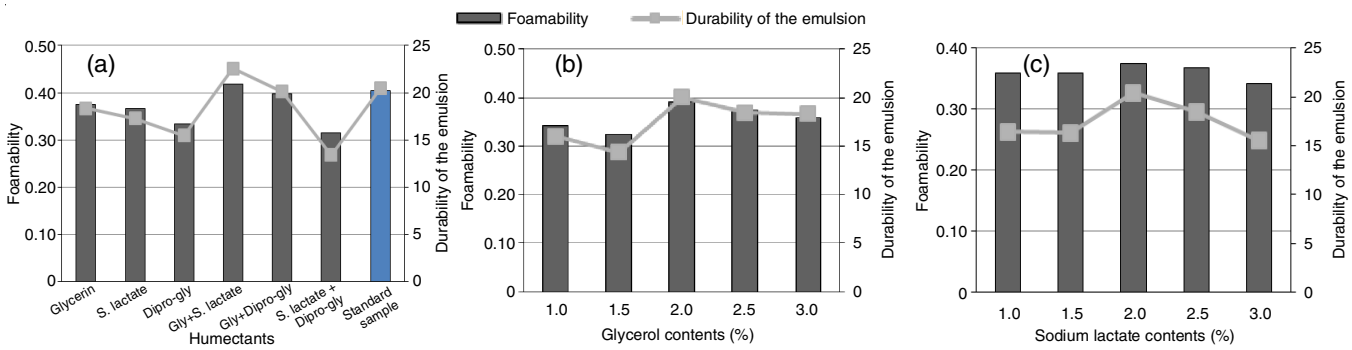

Fig. 6. Influence of humectants on foamability and durability of the emulsion: (a) humectants, (b) glycerin contents %, (c) sodium lactate contents %

its capability to moisturize the skin and play the role as a preservative for the product. Considering the higher cost of dipropylene glycol, glycerol and sodium lactate combination is selected in the following survey.

Fig. 6b and 6c illustrated the variation in foamability and foam durability with respect to glycerol content and sodium lactate content. Both humectants gave the highest foaming and durability at the concentration of 2% with high statistical confidence. Therefore, glycerol and sodium lactate content of 2% were selected for the next survey.

Effect of skin emollient and skin emollient content: The influence of skin emollient agents on the foaming and durability of the emulsion properties of lemongrass essential oil body wash products is shown in Fig. 7. Three skin emollients including polyquaternium 10, D-panthenol and vitamin B3 were considered. It seemed that vitamin B3 gave the lowest foamability (0.333) in comparison with that of other emollients. On the other hand, when combining the two substances, polyquaternium 10 and D-panthenol, the foaming and foam durability of the emulsion was 0.4253 and 24.47 min, respectively. These figures were greater than those of remaining samples, including a commercial sample (Dove brand) (0.4048 and 20,445 min) on the market.

Polyquaternium-10 is an important nourishing ingredient for skin emollient products, creating a film on the skin and moisturizing. This compound is non-irritating and compatible with a large amount of active substance, allowing a transparent product to be produced. In addition, the addition of D-pan-

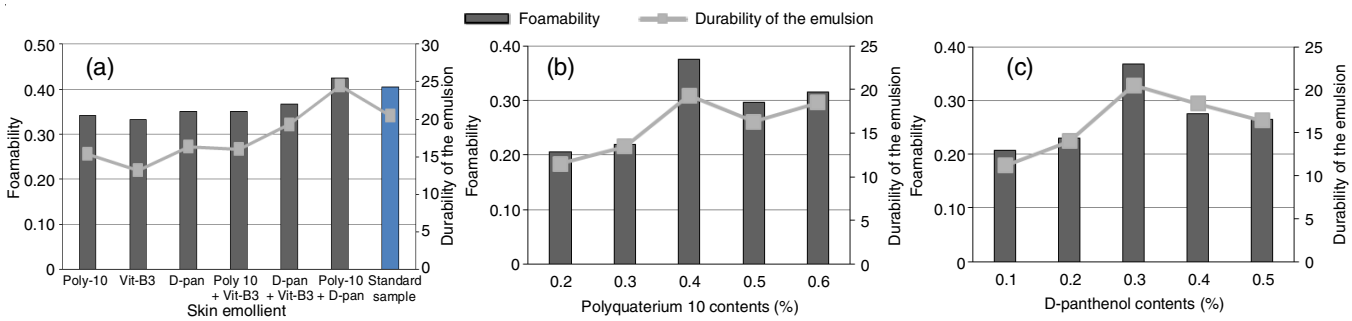

Fig. 7. Influence of skin emollient on foamability and durability of the emulsion: (a) skin emollient, (b) polyquaterium 10 contents %, (c) D-panthenol contents %

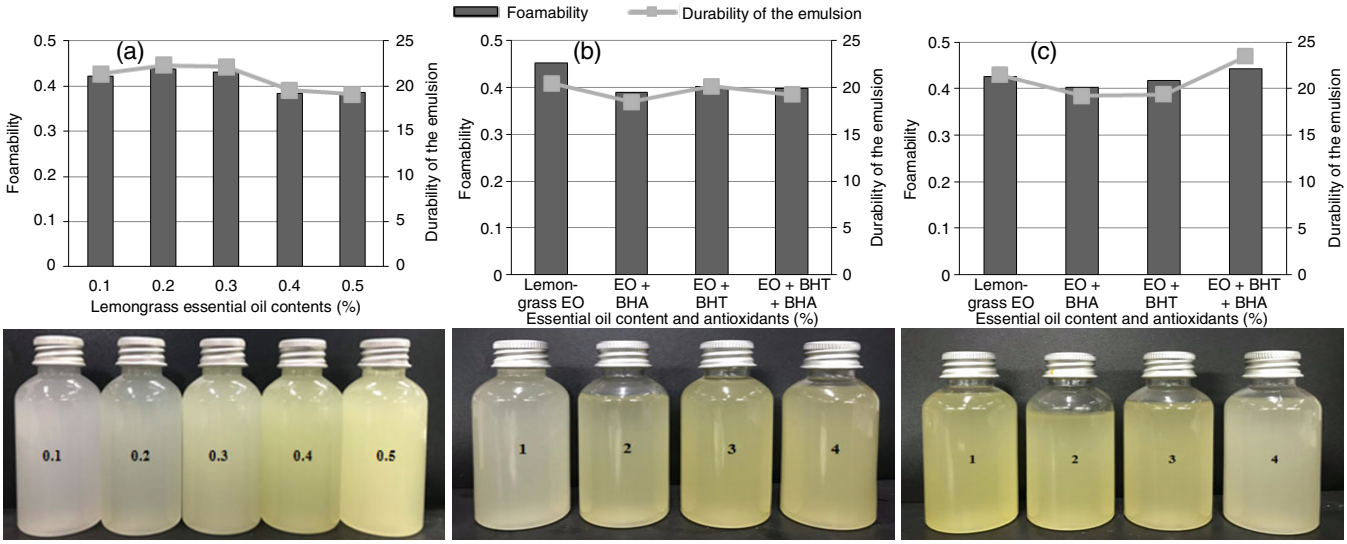

Fig. 8. Influence of lemongrass essential oil and antioxidants on foamability and durability of the emulsion: (a) lemongrass essential oil contents, (b) normal condition, (c) nano condition

thenol helps restore moisture and protect the skin from harmful agents that cause dry skin. On the other hand, D-panthenol also enhances the regeneration of the outermost protective layer of the skin, thus significantly reducing dehydration. In particular, when D-panthenol is converted into vitamin B5, it will increase the skin's hydration, improve the softness and elasticity of the skin, making it an ideal substance to treat dry, scaly skin.

After determining the skin emollient in the base formula, we conducted a survey of the content of polyquaternium 10 and D-panthenol. Regarding the foaming and durability of the emulsion resulted by polyquaternium 10 (0.3750-1928 min) and D-panthenol (0.3671-20.48 min), as shown in Fig. 7b and 7c, the optimal content of polyquaternium 10 was 0.4% and of D-panthenol was 0.3%. These values were selected to investigate next factors.

Effect of lemongrass essential oil and antioxidants: The influence of the citronella essential oil content is the most important factor affecting the whole body wash formula. The most abundant compound in lemongrass essential oil is citral, accounting for more than 80% of the citronella oil content. Citral is unstable and could be easily oxidized and denatured by external conditions such as light, temperature and pH [23,24]. Fig. 8a illustrated the influence of lemongrass essential oil content. Generally, as the content of lemongrass essential oil increases, the scent of the product as well as the persistent scent on the hand is improved.

However, the disadvantage of increased essential oil content is that the colour of the product becomes more yellow, which is indicative of higher denaturation and shorter shelf life. Inspection of body wash products shows that the product that solely incorporated lemongrass essential oils exhibited negligible visual changes compared to other samples after 1 week of storage at 45 °C.

In contrast, in the nanoization condition, the sample containing essential oil + BHT + BHA is the least colour-denatured sample. In terms of foaming and durability of the emulsion, described in Fig. 8b and 8c, the sample that only contains lemongrass essential oil showed higher foaming (0.4536) and durability of the emulsion (22.45), compared to the other models under normal conditions. In nano conditions, the citronella essential oil + BHT + BHA samples showed superior foaming (0.4417) and durability of the emulsion (23.45). The denaturation of lemongrass essential oil in the product may be partly due to the citral content and specific characteristics of each active ingredient in the formulation. Therefore, the product that incorporates lemongrass essential oil + BHT + BHA is the most favourable formulation.

Evaluation of the effect of storage conditions on body wash products: The influence of storage conditions on foamability and durability of the emulsion of floor cleaning products is shown in Fig. 9. The results indicated that, the heat shock and heated storage conditions did not significantly affect the foaming and foam durability of the product, compared to the sample in normal conditions. However, in terms of appearance, the sample stored at accelerated condition had a slight yellowing after storage time. However, this did not significantly impair visual quality of the product. Foamability and foam durability of samples stored under thermal shock conditions showed no significant changes. However, the colour of this sample exhibited a change into pale yellow due to oxidation.

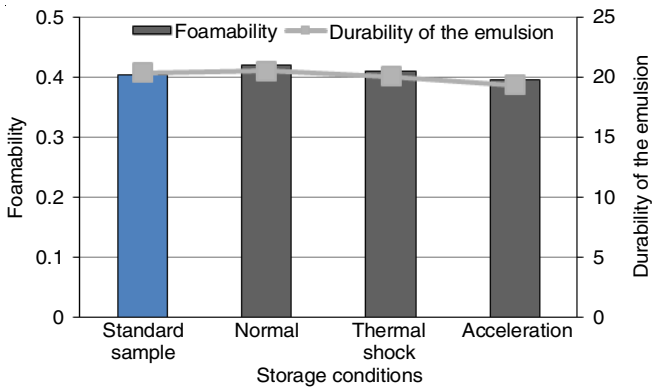

Fig. 9. Influence of storage conditions on foamability and durability of the emulsion

Conclusion

This study has successfully devised a basic formulation of a body wash that incorporated lemongrass essential oil. A study of parameters affecting the foamability and foam durability of the body wash product indicated following optimal parameters: Detergent SLES 18%, EDTA 0.15%, detergent adjuvant PEG-7 2.5%, minocol 2%, foaming agent CAPB 7%, CDE 1.5%, thickener poly gel 18%, humectants glycerol 2%, sodium lactate 2%, skin emollient polyquaternium-10 0.4%, D-panthenol 0.3%, 0.2% lemongrass essential oil. Current results demonstrate the potential in manufacturing cosmetic products using lemongrass essential oil as an aromatherapy substitute for fragrance commercial products in the market to improve user safety and utility.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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