

The Study of the Ratio between Virgin Coconut Oil and Shea Butter on the Physicochemical Properties of Skin Care Lotion Formulation

Thanit Metheenukul¹, Jukkrint Srivilai^{*2} Nattanan Sanggew³ and Sirilak Duangsuwan³

¹Department of Chemistry, Faculty of Science and Technology, Uttaradit Rajabhat University, Uttaradit, 53000, Thailand

^{2*}School of Pharmaceutical Sciences, Faculty of Pharmacy, University of Phayao, Phayao, 56000, Thailand

³Department of Chemistry, Faculty of Education, Uttaradit Rajabhat University, Uttaradit, 53000, Thailand

*Corresponding author. E-mail: jukkarint@hotmail.com

ABSTRACT

Tropical climate of Thailand is abundant for coconut planting. Coconut oil has been used in Thai folk medicine for skin condition and widely used in cosmetic purpose for skin moisturizing. This study aimed to use natural extract virgin coconut oil as functional ingredient of o/w emulsion dosage form for skin care lotion products. The coconut oil was extracted by developed expressed machine to yield with 20 – 30 % by weight of coconut meat. In the lotion formulation, the common moisturizer in cosmetic use, shea butter was studied with difference ratio with extracted virgin coconut oil of 5:1, 4:2, 3:3, 2:4 and 1:5 by weight. The emulsion formulations were characterized by pH, viscosity, stability and droplet size. All of lotion formulas showed the pH values in between 6.38-6.93, which is close to neutral pH and can be used on human skin. Emulsion viscosity increased with virgin coconut oil content increasing, resulting in better coated on skin. These might be from lauric acid, which is the main constituent in virgin coconut oil. The lotion stability of phase separation form shaking stability was tested by 5,000 rpm speed centrifugation for 30 mins, it showed that no phase separation for all of emulsion formulas. These implied that the developed product were stable under high centrifugation force. Developed lotion products particle size was 64–180 nm. Interestingly, the weight ratio of 1:5 for shea butter and coconut oil provided the smallest particle size about 64.66 nm, resulting in good texture and might be better skin absorption. Therefore, virgin coconut oil content increasing can make the smaller particle size in lotion for better absorb in human skin. This work points that coconut oil is good property ingredient for skin care cosmetic and essentially further study in industrial scale.

Keywords: skin care lotion, emulsion, virgin coconut oil, shea butter, properties of lotion

INTRODUCTION

Coconut is an economic crop of Thailand that is prominent in being used in cosmetics to enhance the beauty of body. It commonly used in form of cold pressed

Article history:

Received 11 August 2023; Received in revised from 20 December 2023;

Accepted 28 December 2023; Available online 30 December 2023

oil or virgin coconut oil (VCO) which are valuable in pharmaceutical and cosmetic utilization. VCO was extracted by natural process (Meharban & Vardhanan, 2018). VCO has the anti-inflammatory properties for human skin from UVB, increase collagen content and reduce the chances of skin cancer (Kim et al., 2017). VCO has an anti-inflammatory effect on the skin because it helps retain skin moisture and help for relaxing (Varma et al., 2019). Traditional production of VCO relies on microorganisms attached to coconut meat to help the separation. In the industry the extraction is necessary to select microorganisms to improve the production. *Leuconostoc* bacteria are effective microorganisms in coconut milk fermentation into VCO which will proceed according to the bacteria maturity Maini & Lopez, 2022). Natural extracted coconut oil had been produced by grated coconut meat mixed with warm or room temperature water and squeezed to make coconut milk. After 1-2 days fermentation, coconut oil will separate without the means of chemical and heating. It can retain the essential substances in the oil and suitable to be used as a cosmetic ingredient for skin nourishing. VCO inhibits the growth of *Staphylococcus aureus* or *S. aureus* bacteria by destroying the bacterial cell wall mechanism and increase the potential for phagocytic immune cells of human body (Widianingrum et al., 2019). VCO with *Candida kefyr* or *C. kefyr* effective for agent *E. coli* and *S. epidermidis* (de Oliveira et al., 2018). Coconut oil with a surfactant will allow to combine with water to form an emulsion. Emulsions with smaller in particle size and more stability for utilization in the compositions of food cosmetic and pharmaceutical (Pengon et al., 2018).

Because coconut is an important economic crop of Thailand and has been used for food, medicine and skin care products for a long time. Therefore, the research was interested in studying the effect of virgin coconut oil on the properties of skin care lotion products.

RESEARCH METHODOLOGY

1. Plant material and coconut oil extraction.

The mature coconut fruits were collected from Uttaradit province, Mueang. The kernel of coconut fruit was separated and grinded to provide coconut milk. Coconut milk will then be taken to fermented by natural process in closed container for 1 – 2 days for virgin coconut oil separate in layer from coconut cream, then lap and filter to yield the clear virgin coconut oil (VCO) of 20 – 30 % w/w.

2. Lotion preparation

The base lotion was prepared in emulsion dosage form using hot-hot process to get the suitable formula before varying the ratio of natural oils, virgin coconut oil and shea butter. More than 20 formulas were evaluated and developed, and the suitable formula was shown in the **Table 1**. The lotion preparation was started from heating up of oil phase (Phase A) to 70 °C and water phase (Phase B) to 75 °C with separately vessels. Then both phases were gently mixed with homogenizing at 3000 rpm under temperature monitoring until it cooled down around 30°C. At 50 °C phase C was added and homogenized continuously to avoid temperature degradation.

In this experiment, the effect of weight ratio between VCO and shea butter on the skin care lotion characteristic has been studied. Therefore, the weight ratio

between shea butter and virgin coconut oil has been established in five formulations for skin care lotion as in table 2.

Table 1 Ingredients of skin care lotion products

Phase of lotion	Ingredients	Weight percentage
Phase A (Oil phase)	White petrolatum	2.0
	Virgin coconut oil (VCO) and shea butter	6.0
	Cetyl alcohol	2.0
	Glyceryl stearate (and) PEG-100 stearate	2.0
	Mineral oil	1.0
	Glyceryl monostearate	4.0
	Isopropyl myristate	1.0
Phase B (Water phase)	Propylene glycol	4.0
	Glycerine	2.0
	Butylene glycol	2.0
	Water	73.05
Phase C (Flavoring substances and vitamin)	Phenoxy ethanol	0.8
	Flavoring substances (Perfume)	0.05
	Vitamin E	0.1

Table 2 Weight ratio between shea butter and VCO in skin care lotion formulas

Skin care lotion products formulas	Weight ratio	
	Shea Butter	VCO
1	5	1
2	4	2
3	3	3
4	2	4
5	1	5

3. Characterization and stability of developed lotion

Developed lotions were characterized as follows;

- (a) Acidity–alkalinity or pH of lotion products had determined by pH meter model S-20K as in figure 1. Sample with the weight of 5 gram at room temperature test for 3 times and calculated the mean value. pH meter will be calibrated with the standard buffer solution by the pH of 4, 7 and 10.
- (b) Viscosity and rheology of lotion were determined at the room temperature by Viscometer Brookfield model DVI+CP as in figure 2. Evaluation method used the pin size CPE-41 speed of 100 rpm. Sample with the weight of 0.5 gram was put into the analytical plate of instrument and test for 3 times for calculate the mean value.
- (c) Stability of lotion products was evaluated by centrifuge testing with Microcentrifuge/refrigerated centrifuge model Z326K as in figure 3 with

speed of 5000 rpm for 30 min. In the experiment, sample of 5 gram was taken into centrifuge tube with the volume of 15 ml. Then phase separation parameter was observed. The experiment was tested for 3 times.

- (d) Particle size of lotion was evaluated by particle size analyzer ZETASIZER model Nano-ZS90 in figure 4. Lotion was diluted by DI water in the ratio of 1 :1 00 by volume with the volume of 5 ml of DI water. Then put it into the cuvette at temperature control by 25 °C and tested for 3 time to calculate the mean value.



Figure 1 pH meter



Figure 2 Viscometer Brookfield



Figure 3 Microcentrifuge/refrigerated centrifuge model Z326K



Figure 4 Particle size analyzer ZETASIZER model Nano-ZS90

RESULTS AND DISCUSSION

Acidity and Alkalinity or pH values for the products of lotion have the values of pH 6.38-6.93 which close to the neutral value as in table 3.

Table 3 Acidity and Alkalinity or pH values for the skin care lotion from the experiments

Skin care lotion recipe formulas	Weight ratio of plant natural oil		pH	SD.
	Shea Butter	Virgin coconut oil (VCO)		
1	5	1	6.42	± 0.02
2	4	2	6.75	± 0.01
3	3	3	6.73	± 0.08
4	2	4	6.86	± 0.06
5	1	5	6.38	± 0.06

Acidity and Alkalinity or pH for all of product lotion formulas determined by pH meter (S-20K) had the value between 6.38-6.93 which were closed to the neutral value. The results show that all of lotion products from the experiment can be used for human body skin. All of 5 formulas, that containing of VCO had the pH value close to human body skin of 4.5 0–5 .75. This implied that VCO and other ingredient were less effect on pH change from nutral pH of water in formula. Moreover, coconut oil can customize the pH value of skin care lotion products close to the pH value of human skin by adjusting pH. The pH of cosmetic products must be within the acceptable skin pH of 4.5–7.5 (Fransiska et al., 2021). Human body skin is the largest organ in the human body with a surface area of 1.5–2 square meters has a pH between 4.0 and 6.0 [9].

Rheology evaluation for the skin care lotion products in centipoise (cP) unit found that increasing coconut oil in formulas cause the increasing in viscosity of products as table 4.

Table 4 Viscosity of skin care lotion products

Skin care lotion recipe formulas	Weight ratio of plant natural oil (% in total)		Viscosity (cP)	SD.
	Shea Butter	Virgin coconut oil (VCO)		
1	5 (83.33)	1 (16.67)	404.50	± 157.35
2	4 (66.66)	2 (33.34)	16.53	± 5.08
3	3 (50.00)	3 (50.00)	53.60	± 12.66
4	2 (33.34)	4 (66.66)	519.26	± 14.40
5	1 (16.67)	5 (83.33)	419.53	± 37.80

From the result of table 4, the product recipe with high content of shea butter to 83.33% of total plant natural oil trend to increase in viscosity of lotion. Increase in viscosity from two factors of 1) smaller in particle size as observe in formula 5 and 2) solid content in the recipe as observe in formula 1. Because the main chemical composition in shea butter were triglyceride and oleic acids, while in coconut oil can be found lauric acid as the main composition. The difference of main composition causes the difference in melting point for shea butter of 40-48 °C which higher than the coconut oil melting point of 23-26 °C. In room temperature, coconut oil is liquid phase while shea butter has the characteristic between solid and liquid.

It is particularly interesting when shea butter content in lotion recipe less than 17% of total vegetable oils affect to particle size of lotion recipe reducing which can observe in formula 5 (table 5). Decreasing in particle size causes the higher the viscosity as well (Yoshihara et al., 2022). Proper viscosity of a cosmetic formulation allows for better diffusion and influences the product quality (Yeo & Kim, 2018). When applying lotion on the skin, user will pour on the palm before spreading and rubbing on the skin. A good lotion should spread well while applying, which causes shearing. However, lotion must not flow or drip from the hands when takes out of the packaging and apply or rub on the skin (Yao & Patel, 2001).

Stability of lotion recipe formulas had been tested by centrifuge by rotation speed of 5,000 rpm there was no phase separation found for every lotion recipe formula. The results show the stability of products for consumer acceptance. Stability study of cosmetic is important to setting criteria for quality, safety and efficacy (Deuschle et al., 2015). In the case of sunscreen lotion, rheological properties due to the viscosity and the type of emulsifier mixed in the lotion affected on lotion stability (Addor et al., 2022). Lotion stability was the important property which must be considered before spreading to the consumers. Storage conditions recommended by the operator were 15–30 °C. When the temperature was raised to 46°C for some period, there was no effect on the chemical stability of the lotion product (Bogan et al., 2018).

Stability test for lotion products by centrifuge with round speed of 5,000 rpm found the texture of products were homogeneous with no segregation. Show

that lotion recipe formulas from this experiment could be produced for commercial with the acceptance in the markets.

Particles size of lotion products has been tested by particle size analyzer ZETASIZER model Nano-ZS9 0. The results of particle size analyzer were as in table 5.

Table 5 Particle size in the texture of skin care lotion recipe lotion

Skin care lotion recipe formulas	Weight ratio of plant natural oil (% in total)		Particle size (nm)	(SD)
	Shea Butter	Virgin coconut oil (VCO)		
1	5 (83.33)	1 (16.67)	181.34	± 16.61
2	4 (66.66)	2 (33.34)	154.17	± 16.31
3	3 (50.00)	3 (50.00)	184.72	± 13.44
4	2 (33.34)	4 (66.66)	147.56	± 6.04
5	1 (16.67)	5 (83.33)	64.66	± 2.28

The results from particle size analyzer in table 5 for lotion recipe formulas had particle size between 64–180 nm. The recipe with the most coconut oil content of 83.33 % in total of plant natural oil had the smallest size of 64.66 nm showed that coconut oil rendered the lotion texture finer and better absorb into the human skin.

Skin absorption of drugs or active substances was often the main factor for the ability to coat the skin or occlusive effect. Smaller particle size increases diffusion efficiency. The experimental results found that high viscosity lotion recipe tended to affect adhesion and skin coating better than low viscosity recipe. Smaller in particle size of lotion resulting in better skin permeability. Therefore, lotion recipe formula 5 proper for the future development from the efficiency for takes the drug or importance substances into the skin. Smaller size of the lotion particles affects the penetration and retention of moisture to the skin (Moribe et al., 2010). The nanometer size of particles in lotion was excellent property for use in cosmetics cause the active ingredients in the lotion well penetrate the skin and provides long-lasting skin care value (Guzmán et al., 2022). Lotions with nanoemulsion size particles were able to maintain the physical properties during retention and permeability more than non-nanoemulsion lotions (Hanifah & Jufri, 2018). When the weight ratio of virgin coconut oil was increased, the particle size tended to become smaller. Therefore, increasing the weight ratio of virgin coconut oil in body lotions cause the better in the skin penetration and provides long-lasting skin care value.

CONCLUSIONS

The skin care lotion production experiment studied the ratio between virgin coconut oil and shea butter on the properties of skin care lotion products from the experiments in terms of pH, viscosity, centrifuged stability test and particle size measurement. virgin coconut oil used in this study was produced by natural processes to preserve the essence of coconut oil. All of skin care lotion recipe was in

the range of pH 6.38-6.93, which close to neutral pH. As the total percentage of coconut oil increased, the viscosity of the lotion recipe tended to increase. Stability of skin care lotion recipe test by skin care lotion recipe centrifuge by the speed of 5,000 rpm not cause the lotion sample separate. Therefore, all of skin care lotion recipe from this experiment had the stability property for the acceptance of the commercial. The skin care lotion recipe from the experiment had the particle size between 64-180 nm. The lotion recipe which contents the most percentage of coconut oil had the smallest particle size of 64.66 nm. The result show that virgin coconut oil caused the finer texture and easier to absorb for better skin care into the human skin.

ACKNOWLEDGMENTS

Study on physical properties of lotion products from the ratio between virgin coconut oil and shea butter. The research team would like to thank Mr. Noppadol Bunyarattaphan for facilitates laboratory and research equipment. Miss Kanokwan Hansuk research and innovation center in cosmetics and natural products faculty of pharmaceutical Science Univesity of Phayao for lotion recipe properties analyzer. Granfather Kaew, granmother Kum, Mr. San Sookying, Miss Premjit Rojanapanich and Mr. Pormchai Sakornsatiankul support coconut fruit for virgin oil production. Miss Arunee Rodmun assisted in grated coconut meat to be squeezed into coconut milk for oil production. Faculty of science and technology, Uttaradit Rajabhat University for the research laboratory.

REFERENCES

- Addor, F.A.N., Barcaui, C.B., Gomes, E.E., Lupi, O., Marçon, C.R., & Miot, H.A. (2022). Sunscreen lotions in the dermatological prescription: review of concepts and controversies. *Anais Brasileiros de Dermatologia*, 97(2), 204-222.
- Bogan, R., Maas, H.J., & Zimmermann, T. (2018). Chemical stability of reactive skin decontamination lotion (RSDL®). *Toxicology Letters*, 293, 264-268.
- Colorimetric sensors. *Sensing and Bio-Sensing Research*, 35,100473.
- De Oliveira, S.F., Lôbo, I.P., da Cruz, R.S., Andrioli, J.L., da Mata, C.P.S.M., Soares, G.A., Santos, E.C., Aguiar-Oliveira, E., Franco, M., & da Conceição A.O. (2018). Antimicrobial activity of coconut oil-in-water emulsion on *Staphylococcus epidermidis* and *Escherichia coli* EPEC associated to *Candida kefyr*. *Heliyon*, 4(11): e00924.
- Deuschle, V.C.K.N., Deuschle, R.A.N., Bortoluzzi, M.R., & Athayde, M.L. (2015). Physical chemistry evaluation of stability, spreadability, in vitro antioxidant, and photo-protective capacities of topical formulations containing *Calendula officinalis* L. leaf extract. *Brazilian Journal of Pharmaceutical Sciences*, 51 (1), 63–75.

- Fransiska, D., Darmawan, M., Sinurat, E., Sedayu, B.B., Wardhana, Y.W., Herdiana, Y., & Setiana, G.P. (2021). Characteristics of Oil in Water (o/w) Type Lotions Incorporated with Kappa/ Iota Carrageenan. The 2 nd International Conference on Agriculture and Rural Development, 7 1 5 : 012050. Serang City, Banten, Indonesia.
- Finnegan, M., Duffy, E., & Morrin, A. (2022). The determination of skin surface pH via the skin volatile emission using wearable Kim, S., Jang, J.E., Kim, J., Lee, Y.I., Lee, D.W., Song, S.Y., & Lee, J.H. (2017). Enhanced barrier functions and anti-inflammatory effect of cultured coconut extract on human skin. *Food and Chemical Toxicology*, 106 (A), 367-375.
- Guzmán, E., Ortega, F., & Rubio, R.G. (2022). Pickering Emulsions: A Novel Tool for Cosmetic Formulators. *Cosmetics*, 9, 9040068.
- Hanifah M., & Jufri, M. (2018) Formulation and Stability Testing of Nanoemulsion Lotion Containing Centella asiatica Extract. *Journal of Young Pharmacists*, 10(4), 404-408.
- Meharban, M.P., & Vardhanan, Y.S. (2018). Extraction of virgin coconut oil from the Testa-free Albuminous endosperm through yeast mediated aqueous fermentation system: Fourier transform–Infrared Spectra (FT-IR). *International Journal for Research in Applied Science and Technology*, 6(3), 1620-1627.
- Maini, Z.A., & Lopez, C.M. (2022). Transitions in bacterial communities across two fermentation-based virgin coconut oil (VCO) production processes. *Heliyon*, 8(8), e10154.
- Moribe, K., Shibata, M., Furuishi, T., Higashi, K., Tomono, K., & Yamamoto, K. (2010). Effect of Particle Size on Skin Permeation and Retention of Piroxicam in Aqueous Suspension. *Chemical and Pharmaceutical Bulletin*, 58(8), 1096-1099.
- Pengon, S., Chinatangkul, N., Limmatvapirat, C., & Limmatvapirat, S. (2018). The effect of surfactant on the physical properties of coconut oil nanoemulsions. *Asian Journal of Pharmaceutical Sciences*, 13 (5), 409-414.
- Varma, S.R., Sivaprakasam, T.O., Arumugam, I., Dilip, N., Raghuraman, M., Pavan, K.B., Rafiq, M., & Parames. R. (2019). In vitro anti-inflammatory and skin protective properties of Virgin coconut oil. *Journal of Traditional and Complementary Medicine*, 9(1), 5-14.
- Widianingrum, D.C., Noviandi, C.T., & Salasia, S.I.O. (2019). Antibacterial and immunomodulator activities of virgin coconut oil (VCO) against *Staphylococcus aureus*. *Heliyon*, 5(10), e02612.
- Yoshihara, H. Koshizaki, N.Yamauchi, Y., & Ishikawa, Y. (2022). Size distribution evolution and viscosity effect on spherical submicrometer particle generation process by pulsed laser melting in liquid. *Powder Technology*, 404, 117445.

- Yeo, H.Y., & Kim, J.H. (2018). Stability Determination of the Various Cosmetic Formulations containing Glycolic Acid. *Journal of Fashion Business*, 22(3), 30–38.
- Yao, M.L., & Patel, J.C. (2001). Rheological Characterization of Body Lotions. *Applied Rheology*, 11(2), 83–88.