

Ceramide is More Effective than Shea Butter in Maintaining Skin Acidity

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ABSTRACT

Background: Skin is the largest organ that functions as a physical barrier. Stable skin pH can maximize its function. Ceramide and shea butter cream have components that maintain the skin pH in the stratum corneum. **Purpose:** The aim is to compare ceramide and shea butter cream effects on skin pH. **Methods:** The experimental analytic study was performed on 30 respondents. The skin pH measurement was done before applying creams and 30 days after applying ceramide cream and shea butter cream. Ceramide cream was applied on the right volar and shea butter cream on the left volar. Comparative analysis with a paired t-test was used with a significant value of $p < 0.05$. **Results:** The average skin pH after applying ceramide cream was $4,61 \pm 1,19$, while shea butter cream was $5,30 \pm 1,07$. The derivation of skin pH after ceramide cream application was $1,57 \pm 1,26$, and that of shea butter cream was $0,88 \pm 1,14$. The application of ceramide cream showed a lower pH than shea butter cream significantly, with $p = 0.025$. **Conclusion:** The intervention using ceramide and shea butter cream for 30 days could lower the skin pH level. The derivation of skin pH with ceramide is more significant than using shea butter cream. Ceramide can be considered to maintain skin homeostasis and skin pH.

Keywords: *ceramide, shea butter, skin pH, stratum corneum.*

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BACKGROUND

Skin is the largest organ that covers all parts of the body and acts as a physical barrier to the environment. The skin functions as a temperature regulator, a barrier against exposure to ultraviolet (UV) light, trauma, pathogenic microorganisms, and toxic materials. The skin becomes acidic when the pH is below its normal value, caused by many factors such as skin care products, cigarettes, air, water, sun, and pollution. Intrinsic factors that can affect the acidity of the skin are genetic factors, age, sex, and hormones.^{1,2}

In 1991, Chapman *et al* stated that the skin acidity in men is higher than in women because men have a higher rate of sebum production. Age can also affect the occurrence of skin acidity. Infants in the first week of life, for example, have a higher pH between 5.5 and 6.5 because the acid layer as a protective skin has not yet fully formed. Skin acidity can occur at any age and is associated with hormonal changes such as puberty, pregnancy, and menopause.^{2,3}

The level of acidity (pH) in the stratum corneum is the most important factor for skin protection. Normal pH levels in the stratum corneum are 4.1 to 5.8, which serve to maintain the integrity of the corneocytes, epidermal barriers, stratum corneum, and defense against antimicrobials. A mechanism that can

affect the pH levels of the stratum corneum includes the production of free fatty acids, the breakdown of filaggrin, and the secretion of the lamellar body. The lipid matrix in the stratum corneum is composed of cholesterol, free fatty acids, and ceramide where the composition is influenced by the pH levels of the skin, which plays an important role in mechanical and cohesive processes in the stratum corneum.¹⁻³

The increase in skin pH levels is caused by several things, such as decreased fat metabolism, impaired integrity in the lipid layer, and increased activity of protease enzymes.^{3,4} The process can cause disruption to homeostasis, stratum corneum cohesion, and decreased antimicrobial activity so that the skin becomes dry and infection becomes easy.^{5,6} Some studies explain that moisturizing creams containing ceramide can improve moisture and skin barriers and restore the skin's pH levels to normal.⁷

Shea butter is an extract from the Sheu tree (*Vitellaria paradoxa*) consisting of triglycerides, oleic fatty acids, stearic, linoleic, and palmitic acids as well as some non-sponsorable compounds. Shea butter cream is widely used in the cosmetic industry because it contains non-sponsorable compounds (such as tripteren, tocopherol, phenol, and sterol). These compounds are anti-inflammatory agents and powerful antioxidants. Studies of atopic dermatitis patients with the use of shea butter cream show the

same effectiveness as other products to improve ceramide levels in the skin.^{8,9}

Because this related research is still not widely published, the goal of this study was to assess the use of ceramide cream and shea butter cream against improvements in skin pH levels that can be utilized in the application of skincare products to skin diseases with impaired pH levels.

METHODS

This is an experimental study with pre and post-test design. The inclusion criteria of this study are people who have been briefed on research procedures and the side effects that can occur and are willing to fill out an informed consent form. We excluded respondents who had skin diseases in the intervention area, used topical medications within 5 days before the intervention, took antibiotics within 2 weeks before the intervention, and used immunosuppressive drugs or antihistamines within 7 days before the intervention started. We divided the respondents into 4 observation groups. First by measuring pH, second by giving ceramide cream, third by giving shea butter cream, and the fourth by measuring skin pH levels after treatment.

Consecutive sampling was used based on predetermined inclusion and exclusion criteria. Federer formula was used to determine the number of samples: $(t-1)(r-1) > 15$, t is number of groups and r is number of subjects per group. The number of samples obtained was 24. Proportion of missing-value was added to calculate samples. Our sample consisted of 30 respondents consisting of 15 men and 15 women, with an age range of 20-25 years.

The preparation of ceramide cream and the shea butter cream was obtained from the Laboratory of Pharmaceutical Technology of Setia Budi University, Surakarta City. The cream bases of this research are ceramide cream and shea butter cream which are vanishing cream bases with 150 g stearic acid formulation, 20 g white night, 80 g white vaseline, 15 g triethanolamine, 80 g propylene glycol, and 655 g aquadest.

All of our respondents took skin pH measurements using the *ExstikpH meter tool*® waterproof pH meter. Measurements are carried out in the volar area on the right and left hands with an area of 4 cm x 4 cm. The pH measurement of the skin is carried out at a room temperature of 21 ± 1 °C with a humidity of $50 \pm 5\%$. Ceramide cream is applied to the volar area of the right hand, while shea butter cream is applied to the volar area of the left hand. Both creams are used twice daily for 30 days. The pH measurement of the skin was done at the time before the intervention and on the 30th day after getting the intervention at both intervention sites.

All data are statistically analyzed using the Kolmogorov-Smirnov test to determine the normality of the data distribution. Descriptive statistical analysis was conducted for several variables, including gender, average age, average skin pH level, and an average decrease in skin pH levels. A paired t-test comparison was used to find out the difference in skin pH levels before and after using ceramide cream and shea butter cream. SPSS application version 24 (IBM Corp., Chicago, USA) was used to analyze the data, with a significance rate of $p < 0.05$. This research has been reviewed by the Health Research Ethics Committee at Dr. Moewardi General Hospital, Surakarta.

RESULT

The average age of our study respondents was 22.57 ± 1.59 with the age range of 20 to 25. The average pH in the volar area of the right hand before intervention was 6.17 ± 0.28 while the left hand volar area was 6.20 ± 0.30 . A paired t-test that compares the right and left volar pH yields a value of $p = 0.149$ in the comparative test. This value indicates that there is no statistically significant difference. The average pH after the administration of ceramide cream is 4.61 ± 1.19 while the average pH after giving shea butter cream is 5.30 ± 1.07 . There was a decrease in skin pH after the intervention; where the average decrease in pH after the administration of ceramide cream was 1.57 ± 1.26 and the average decrease in pH after the administration of shea butter cream was 0.88 ± 1.14 (Table 1).

Table 1. Research characteristics data

Variable	Sum (n, average, and standard score)
Gender	
Man	15
Woman	15
Average age of respondents	22.57 ± 1.59
Average decrease in pH	
Ceramide cream	1.57 ± 1.26
Shea butter cream	0.88 ± 1.14

The paired t-test of the skin pH before and after applying ceramide cream and shea butter cream showed a value of $p=0.00$. The values show a statistically significant difference between pH before and after the administration of ceramide cream and

shea butter cream. The paired t-test of the skin pH after administration of ceramide cream and shea butter cream showed a statistically significant $p=0.01$ value (Table 2).

Table 2. Comparison of the skin pH levels after the use of ceramide and shea butter cream

Material	pH before	pH after	pH before and after	Value ^{p1}
Ceramide	6.17±0.28	4.61±1.19	1.57±1.26 p=0.00	0,01
Shea butter	6.20±0.30	5.30±1.07	0.88±1.14 p=0.00	

Value^{p1}: comparative test between pH after application of ceramide cream and *shea butter* cream

DISCUSSION

Based on the results, there was a difference in the average value of pH before and after the administration of ceramide cream that was 6.17±0.28 and 4.61±1.19 ($p = 0.00$) with an average value of a decrease in pH of 1.57±1.26. Our results are in accordance with research conducted by Meck Fessel *et al.* in 2014 that claims topical administration of ceramide cream can increase ceramide levels and improve skin pH levels. The decrease in skin pH levels after administration of ceramide cream may be due to the substitution of ceramide directly in the lipid matrix, thereby restoring ceramide levels in the skin can improve the lipid matrix and affect the repair of pH and skin transepidermal water loss (TEWL).

The skin is the largest organ in the body, covering all parts of the body and serving to regulate body temperature, protect against UV exposure, trauma, pathogenic microorganisms, and toxic materials.^{1,2} The pH level of the stratum corneum is affected by several things such as the production of free fatty acids, the breakdown of filaggrin, and the secretion of the lamellar body. The lipid matrix has an important function in the skin's barrier layers and it is also affected by the pH levels of the skin. The lipid matrix in the stratum corneum is composed of cholesterol, free fatty acids, and ceramides. The composition plays an important role in maintaining the physiological processes of the stratum corneum.^{2,10,11}

The acidity (pH) level of the skin serves to maintain homeostasis, epidermal permeability, integrity, cohesion, and stratum corneum, as well as the activation of proinflammatory cytokines as a defense against pathogenic microbes. Decreased filaggrin production, infection, decreased sodium-protein antiporter type 1 (NHE1) and secretory phospholipase (sPLA2) may also lead to increased pH levels in the stratum corneum. Changes in pH levels

will activate and increase calcitriol, which can cause inflammation of the skin. Calcitriol can reduce the corneodesmosomes of the stratum corneum, thereby interfering with the cohesive function of the stratum corneum. It can also reduce the enzymes that play a role in the formation of a lipid matrix, thereby destroying the permeability of the skin.¹² The process can cause disruptions in the homeostatic function of the skin so that the skin becomes dry and easily infected.^{11,13}

In our study, we found an average pH value before and after the administration of shea butter cream of 6.20±0.30 and 5.30±1.07 ($p=0.00$) with an average pH decrease of 0.88 ± 1.14 . The results are the same as research conducted by Lin *et al* in 2018. Studies have found that the application of shea butter cream can fix the integrity of the stratum corneum, which is characterized by improving pH and TEWL. The decrease in skin pH after using shea butter cream is caused by a variety of mechanisms, such as blocking the inflammatory cascade by inhibiting the NF- κ B pathway, and regulating ROS through the triploid content of shea butter. The process can prevent damage and improve skin integrity.^{8,10,14}

Ceramide plays an important role in the function of the skin barrier. Decreased ceramide levels can cause the skin to become dry in the cases of xerosis and atopic dermatitis. In 2014, Meck, Fessel *et al* pointed out that exogenous administration of ceramide can increase the level of ceramide in the skin, improve barrier function, and reduce transdermal water loss (TEWL). Lower skin pH will result in lower ceramide levels and disrupt the homeostatic process. The pH level can be one of the indicators of a decrease in the ceramide level in the stratum corneum.¹⁵⁻¹⁷ Ceramide is also widely used as a therapeutic agent, such as hydroxypalmitoyl dihydrosphingosine, whose hydroxy fatty acid content is assimilated into dihydrosphingosine. It was reported in 2013 that the

use of hydroxypalmitoyl dihydrosphingosine in human skin reconstruction cultures increased ceramide levels. The reason for the increase is the conversion of hydroxypalmitoyl dihydrosphingosine into ceramide. In vitro studies have shown that hydroxypalmitoyl dihydrosphingosine can also induce endogenous ceramide production. Maximized endogenous ceramides and improved stratum corneum integrity will cause the skin's pH levels to be normal.^{7,18}

Shea butter is the result of an extract of *Vitellaria paradoxa* that is widely used in the cosmetics industry. Shea butter contains triglycerides with oleic acid, linoleic acid, and palmitic fatty acids, as well as triterpenoids, tocopherols, phenols, and sterols. These ingredients have anti-inflammatory and antioxidant effects, so they can reduce the levels of pro-inflammatory cytokines.^{8,10,14} Shea butter has anti-inflammatory effects through resistance to *inducible nitric oxide synthase* (iNOS), *cyclooxygenase-2* (COX-2) and cytokines through *the nuclear factor kappa beta* pathway (NF-κB). These anti-inflammatory effects can prevent damage to skin integrity and maintain normal skin pH levels.^{8,19} Tripteren contained in shea butter cream can repair damaged skin tissue by speeding up wound closure and modulating the production of reactive oxygen species (ROS).^{20,21} Shea butter has the same effect as ceramide precursor products.⁸

In this study, a comparative test was conducted to compare the average pH of the skin after the application of ceramide cream and shea butter cream. Based on the t-test value between the pH of the skin after the administration of ceramide cream and shea butter cream, the p-value is 0.01, which indicates that there is a significant and statistically significant difference ($p < 0.05$). Table 2 also shows an average decrease in skin pH levels higher after the administration of ceramide cream than shea butter cream, which is 1.57 ± 1.26 after the administration of ceramide cream and 0.88 ± 1.14 after the administration of shea butter cream. It can be concluded that ceramide cream has better efficacy against the decrease in skin pH than shea butter cream. This is because ceramide creams can repair the damaged lipid matrix directly by replacing the levels of broken ceramides, so that the pH levels of the skin return to normal more quickly. Shea butter cream indirectly repairs the damaged lipid matrix by regulating the production of ROS and reducing pro-inflammatory cytokines. Therefore, the drop in skin pH after using shea butter cream is not as large and fast as ceramide cream.^{4,8}

This study's limitations include the number of respondents, which was limited to 30 respondents. A greater number of respondents is needed for future research of the potential effects of ceramide and shea butter cream on skin pH improvement. Respondents' activities such as the type of bath soap used that can affect the results of the pH measurement could not be controlled.

The use of ceramide and shea butter can improve the pH level of the skin, where ceramide cream shows a greater reduction in pH levels compared to shea buttercream. Ceramide cream has a direct effect on repairing the damaged lipid matrix, while shea butter has an indirect effect on the repair of the lipid matrix through ROS regulation and reducing the production of pro-inflammatory cytokines. The result obtained from this study is that ceramide cream is more considered to improve skin PH levels and skin integrity disorders, such as atopic dermatitis or dry skin.

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