Journal of Health and Medical Sciences

Salsabila, C. A., Dewi, D. A. R., Chen, S., Renate, A. R., Tjahjowiduri, L. I., Fitri, N. A., Nadhira, F., & Arkania, N. (2025), Effectiveness of Using Moisturizer with Saccharide Isomerate on Skin Hydration in Medical Student Cadets of the Republic of Indonesia Defense University. *Journal of Health and Medical Sciences*, 8(3), 23-31.

ISSN 2622-7258

DOI: 10.31014/aior.1994.08.03.236

The online version of this article can be found at:
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The Asian Institute of Research
Journal of Health and Medical Sciences
Vol.8, No.3, 2025: 23-31
ISSN 2622-7258
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DOI: 10.31014/aior.1994.08.03.236

Effectiveness of Using Moisturizer with Saccharide Isomerate on Skin Hydration in Medical Student Cadets of the Republic of Indonesia Defense University

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Abstract
The skin is a vital organ that plays an important role in maintaining the health and physiological functions of the human body. Dry and dehydrated skin can cause various health and aesthetic problems. The use of moisturizers, especially those containing saccharide isomerate, has been identified as one way to improve skin hydration. This study aims to examine the effectiveness of using moisturizers with saccharide isomerate content on skin hydration in medical students. This study used a one-group pretest-posttest design on 15 subjects who met the inclusion criteria and were treated with a moisturizer containing saccharide isomerate for seven days. The results showed the effectiveness of using a moisturizer with saccharide isomerate content on skin hydration. The mean skin hydration levels increased, especially on the right and left lower limbs, after treatment, which showed significant differences. Conclusion: A moisturiser with saccharide isomerate content greatly improved skin hydration. The results showed significant differences in the average skin hydration of the right and left lower limbs. The moisturiser also had the potential to keep skin moist after it was stopped being used.

Keywords: Dry Skin, Skin Hydration, Moisturizer, Saccharide Isomerate, Medical Students, Cadets

1. Introduction

The human body's largest organ is the skin. The skin serves multiple defense and regulatory roles, acting as a barrier against infection, regulating water levels, and minimizing the entry of allergens and irritants. The skin primarily serves as a very efficient physical barrier to prevent the leakage of electrolytes and water from the internal environment (Jansen van Rensburg et al., 2019). The integumentary system is composed of three distinct layers: the epidermis, dermis, and hypodermis. The primary function of the skin's barrier is predominantly located in the epidermis, specifically in its outermost layer, known as the stratum corneum (SK). The stratum corneum functions

as the main barrier against the transdermal absorption of chemicals and microorganisms. It plays a role in controlling the release of water from the outermost layer of the skin to the atmosphere, a process called transepidermal water loss (TEWL) (Nitiyarom et al., 2021).

If the stratum corneum is compromised, the skin can experience a variety of problems, including dryness, irritation, inflammation, and an increased risk of infection. A disrupted or poorly functioning stratum corneum can result in skin moisture loss, resulting in dry skin. In addition, disruption of the stratum corneum can also allow irritants or allergens to enter the skin more easily, causing irritation or allergic reactions. Damage to the stratum corneum can also disrupt the skin's barrier function, increasing the risk of infection by pathogenic microorganisms (Spada et al., 2018).

Signs of dry skin include roughness, redness, scaling, itching, and sometimes cracking or inflammation (Wijayadi & Kelvin, 2022). Some of the factors that affect dry skin include low ambient temperature and humidity, exposure to chemicals and microorganisms, aging and psychological stress, atopic eczema, psoriasis, and ichthyosis (Butarbutar & Chaerunisaa, 2020).

In light of these conditions, moisturizers are essential for improving skin function and physiological conditions. Moisturizers increase moisture, water content in the stratum corneum layer, and acidity. When the skin barrier is compromised, moisture content decreases. Moisturizers repair the skin barrier, increase moisture, and improve the appearance of the skin. Moisturizers can be divided into three types: humectants, occlusives, and emollients. Humectants absorb water from the environment, occlusives form a protective layer, and emollients replenish the structure of the skin's fat layer (Umborowati et al., 2022).

Saccharide isomerate is one of the natural carbohydrate complex moisturizers derived from sugar beets that has the ability to bind to the skin and retain moisture, making it effective in hydrating and moisturizing the skin (Nunes et al., 2018).

At the Republic of Indonesia Defense University, student cadets have a busy routine, such as physical training, military exercises, and intense academic activities. These conditions can cause their skin to become more susceptible to dehydration and other skin problems.

Most cadets certainly understand the importance of maintaining healthy skin, including the use of appropriate moisturizers. However, in-depth research on the effectiveness of moisturizers with saccharide isomerate content on skin hydration in the student cadet population within the Republic of Indonesia Defense University is still limited.

Therefore, this study will comprehensively discuss the effectiveness of using moisturizers with saccharide isomerate content on skin hydration in cadet medical students of the Republic of Indonesia Defense University in 2023. Through this research, it is expected to provide a better understanding of the benefits of using moisturizers with saccharide isomerate content in maintaining skin health.

2. Methods

2.1. Subject Characteristics

This study was conducted on 15 cadet medical students of the Republic of Indonesia Defense University. The demographic characteristics of the research respondents can be seen in **Table 1** below.

Table 1: Characteristics of Research Respondents

No.	Characteristics	N	%
1.	Age		
	18 years old	1	6,7
	19 years	11	73,3

	20 years	3	20,0
	Total	15	100,0
2.	Gender		
	Male	9	60,0
	Female	6	40,0
	Total	15	100,0

Based on **Table 1** above, it is known that based on age, most respondents are 19 years old, namely 11 respondents (73.3%), 3 respondents aged 20 years (20.0%), and 1 other aged 18 years (6.7%). Based on gender, most of the respondents were male, namely 9 respondents (60.0%), and 6 others were female (40.0%).

2.2. Data Normality Test

This study was conducted by measuring the average skin hydration level, which is numerical data, so a pre-analysis test in the form of a normality test is required. The mean skin hydration levels before and after treatment and the results of the data normality test in this study can be seen in **Table 2**.

Table 2: Mean Value and Normality Test Results of Skin Hydration Level Changes in Each Treatment Group

Group	Day of Treatment	Mean skin hydration level (%) ± Standard Deviation	p value (*)
Right Upper Arm	Day 0	38.67 ± 6.53	0.001
	Day 7	42.93 ± 11.67	0.003
Left Upper Arm	Day 0	37.93 ± 7.32	0.105
	Day 7	39.93 ± 12.64	0.036
Right Lower Limb	Day 0	23.67 ± 10.53	0.099
	Day 7	35.73 ± 15.20	0.110
	Day 0	22.87 ± 10.82	0.645
	Day 7	33.33 ± 16.11	0.621
Left Lower Limb			

Notes: (*) shows the results of the normality test with the Shapiro-Wilk test, the P value is significant when> 0.05
Table 2 shows the average skin hydration levels of research respondents before and after treatment. The results showed that the average skin hydration level of the right upper arm before treatment was 38.67 ± 6.53% and after treatment was 42.93 ± 11.67%, and the left arm before treatment was 37.93 ± 7.32% and after treatment 39.93 ± 12.64%, the right lower limb before treatment was 23.67 ± 10.53% and after treatment 35.73 ± 15.20%, and the left lower limb before treatment was 22.87 ± 10.82% and after treatment was 33.33 ± 16.11%. Based on the table above, it is also known that the measurement variables of the right lower limb on day 0 and day 7 and the left lower limb on day 0 and day 7 are normally distributed, while the right and left upper arm variables on both day 0 and day 7 measurements are not normally distributed.

2.3. Analysis of Significance with T-test Dependent and Wilxocon

The results of the test for differences in skin hydration levels before and after the use of moisturizers with saccharide isomerate content can be seen in **Table 3** below.

Table 3: Significance Test of Differences in Skin Hydration Levels Before and After Treatment

Group Day 0	Group Day 7	Mean difference in skin hydration (%) ± Standard Deviation	p value
Right Upper Arm	Right Upper Arm	4.27±13.20	0.271[b]

Left Upper Arm	Left Upper Arm	2.00±15.13	0.363[b]
Right Lower Limb	Right Lower Limb	12.07±14.87	0.007[a]
Left Lower Limb	Left Lower Limb	10.47±18.58	0.047[a]

Notes: ([a]) shows the result of dependent T test; ([b]) shows the result of Wilxocon test. P value is significant if <0.05

Table 3 shows that the right and left lower limbs have the greatest difference in mean skin hydration before and after treatment, namely 12.07 ± 14.87% and 10.47 ± 18.58%, respectively. The results of this study showed that there was a significant difference in the mean skin hydration of the right lower limb and left lower limb before and after treatment (p values = 0.007 and 0.047), but the level of skin hydration of the right and left upper arms before and after treatment did not have a significant difference.

3. Results and Discussion

The skin plays a crucial role. The primary purpose of the skin is to ensure the survival of the individual. Additionally, the skin holds significance in terms of aesthetics, race, and systemic markers. The skin is composed of three distinct layers: the epidermis, dermis, and subcutaneous layer. The epidermis mostly comprises keratinocytes, with a minority of melanocytes and dendritic cells, including Langerhans cells. The epidermal layer of the skin contains nucleated cells that house nerve fibers responsible for transmitting impulses. It has five separate layers: the basal layer, the stratum spinosum (sweat layer), the stratum granulosum, and the stratum corneum (Voegeli et al., 2019). Intermediary cells are called temporary reinforcement cells. An optimal state of skin health and normalcy is characterized by the presence of over 10% water in the outer layer of the skin. This is a result of the management of fluid equilibrium in the skin. An optimal skin profile and function necessitate a water content in the stratum corneum exceeding 10%. Disruption of the fluid equilibrium in the skin can render dry skin susceptible to a range of physical and chemical stimuli. Dry skin is a condition characterized by a deficiency of fluid or oil in the skin, leading to a decrease in surface wetness. Transepidermal water loss (TEWL), also known as the loss of water by diffusion in the epidermis, is what causes the decrease in skin hydration and the stratum corneum's reduced barrier function. (Vlorensia et al., 2020; Gougeon et al., 2023). Saccharide isomerate is a naturally occurring, biologically active, and environmentally friendly technology that converts sugars by isomerization. This substance is created by transforming edible corn sugar, which is primarily composed of glucose, into a distinct carbohydrate complex that closely resembles skin. It shares similarities with the natural moisturizing components found in the outermost layer of human skin, known as the stratum corneum. It has the ability to attract and retain water, and past studies have demonstrated its positive impact on the skin's protective barrier, moisture levels, and the microorganisms that inhabit the skin (Martin et al., 2023).

A moisturizer is a therapy that can enhance skin moisture. Moisturizer is an essential element of everyday skincare, particularly when there are alterations in the outermost layer of the skin and a decrease in the amount of water in the outermost layer of the skin. Ensuring healthy skin and addressing skin conditions that coincide with dryness and are linked to compromised skin barrier function, such as atopic disorders and various forms of dermatitis, are integral components of a dermatologist's approach. Moisturizers enhance the restoration of the skin's protective barrier, preserving the health and visual appeal of the skin through their functions as humectants, emollients, and occlusives, each having distinct modes of action. Moisturizers enhance skin hydration and augment the water content of the outermost layer of the skin by directly supplying water to the skin from its aqueous phase. They also enhance occlusion to minimize the loss of water through the skin while simultaneously covering minor skin fissures, creating a comforting protective barrier, and safeguarding the skin against friction. Furthermore, the utilization of moisturizer enhances the texture of the skin by filling the gaps between partially shed skin flakes and reinstating the intercellular lipid bilayer's capacity to soak up, retain, and transport water. Afterward, the mechanics of the skin change as enhanced moisture promotes the breakdown of corneodesmosomes and prevents the buildup of corneocytes (Purnamawati et al., 2017)

This study was conducted to determine the effectiveness of using moisturizers with saccharide isomerate content on skin hydration. The moisturizer in this research treatment was given for 7 days and then measured for the

difference in skin hydration before and after treatment. A skin hydration examination was carried out using a precision digital skin analyzer.

The study findings revealed that the majority of respondents, including 73.3%, were 19 years old. Additionally, 20.0% of the respondents were 20 years old, while 6.7% were 18 years old. Multiple studies have documented that these skin biophysical characteristics exhibit variations based on age, gender, anatomical area, and season within diverse ethnic communities. The inflection point of this curve becomes apparent at the age of thirty, indicating a more uniform and luminous complexion, enhanced hydration, and a reduced pH level. The skin serves as the primary protective layer, rendering it susceptible to the harmful effects of sunlight, air pollution, and climatic variations. These environmental variables expedite the manifestation of aging in the skin, particularly photoaging induced by ultraviolet (UV) radiation. The advancement of technology has led to the availability of numerous non-invasive instruments for assessing the physiological characteristics of the skin. The commonly utilized parameters include the hydration level of the outermost layer of the skin (stratum corneum), the amount of water lost through the skin (transdermal water loss), the content of sebum (an oily substance produced by the skin), the level of melanin (a pigment responsible for skin color), the level of erythema (redness of the skin), the color system of the skin, and the pH value of the skin surface. Research (Pan et al., 2020) indicates that the cheeks exhibit the highest level of brightness and lightness, with the lowest concentration of sebum. In contrast, the chin has a significantly deeper shade, while the forehead tends to have a yellowish hue. The skin parameters of TEWL, sebum content, and melanin and erythema indices have a direct correlation with age, displaying a linear relationship. On the other hand, the skin hydration value, ITA, and pH demonstrate a non-monotonic relationship with age. Conversely, as age increases, the expression of aquaporin decreases. Aquaporins, also known as AQPs, are a group of water channels that facilitate the movement of water and tiny molecules to maintain fluid balance in the body. Aquaporins (AQPs) are found in a wide range of species, such as bacteria and humans. Thirteen members of the AQP family have been discovered in humans (AQP0-12), and they are found in different organs. Recently, it has been acknowledged that deviations in the levels of AQPs expression can lead to a range of illnesses (Pan et al., 2020; Ikarashi et al., 2017). In this study, the study population and sample were young adults with a small age gap. This can minimize the occurrence of bias and control the age variable as a confounding variable.

The study findings indicated that the majority of respondents were male, specifically 9 respondents (60.0%), whereas 6 respondents were female (40.0%). The variation in population size can be attributed to the factors of hydration, transepidermal water loss, sebum production, microcirculation, pigmentation, and skin thickness. These factors tend to be higher in men, whereas women generally have higher skin pH levels. Understanding the disparities in skin characteristics associated with gender can aid in the strategic design and creation of gender-specific goods, enabling more tailored dermatological treatments and cosmetic interventions. Sex-related disparities exist in the anatomical, physiological, epidemiological, and symptomatic aspects of certain diseases. Regarding skin illnesses, there is a higher incidence of infectious diseases in men, whereas psychological issues, pigmentation abnormalities, specific hair conditions, and autoimmune and allergy diseases are more commonly observed in women. Conversely, women experience a higher prevalence of sex-related skin illnesses, and the occurrence and outcome of some skin cancers are linked to sex-related disparities. The precise mechanisms responsible for the disparities in skin diseases between sexes remain mostly unidentified. These variances may be influenced by sex hormones, behavioral characteristics, ethnicity, and environmental variations (Rahrovan et al., 2018). Circulating hormones have a significant impact on the disparities between male and female facial skin. Oestrogen mostly affects the skin of women, while androgens, such as testosterone and 5α-dihydrotestosterone (DHT), primarily influence the skin of men. Oestrogen has advantageous protective effects on the skin by promoting the synthesis of collagen and the creation of elastic fibers and hyaluronic acid. Oestrogen has been demonstrated to enhance the skin's ability to bind water and regulate local inflammation, granulation, and re-epithelialization processes. As a result, it improves the integrity of the skin barrier and enhances its capacity to heal wounds. Testosterone increases the thickness of the tissue that surrounds the dermal and epidermal layers of the skin, which helps in the creation of collagen. While both males and females generate sebum, the elevated amounts of testosterone in males lead to a more substantial production, resulting in generally consistent sebum production levels as they grow older. Both positive and negative effects are on men's skin. Heightened sebum production aids in the assimilation of oils for skin hydration, but it also exacerbates acne and imparts a sticky or

oily sensation to the skin while causing the pores to appear enlarged and more prominent (Sikora et al., 2021; Wang et al., 2017).

The results showed the average skin hydration levels of the right upper arm before treatment was 38.67 ± 6.53% and after treatment was 42.93 ± 11.67%, the left arm before treatment was 37.93 ± 7.32% and after treatment 39.93 ± 12.64%, the right lower limb before treatment was 23.67 ± 10.53% and after treatment 35.73 ± 15.20%, and the left lower limb before treatment was 22.87 ± 10.82% and after treatment was 33.33 ± 16.11%. The results of this study show that the right and left lower limbs have the greatest difference in mean skin hydration before and after treatment, namely 12.07 ± 14.87% and 10.47 ± 18.58%, respectively. The results of this study are in accordance with research (Dewi & Pangkahila, 2022), which shows the mean skin hydration before and after treatment of the upper arm 28.47±4.80 to 71.30±10.79; the forearm 26.63±2.68 to 63.93±9.24; the upper limb 24.20±5.72 to 60.60±14.71; and the lower limb 22.00±2.13 to 41.57±6.95%, respectively (Dewi & Pangkahila, 2022).

The results of this study showed that there was a significant difference in the mean skin hydration of the right lower limb and left lower limb before and after treatment (p values = 0.007 and 0.047), but the level of skin hydration of the right and left upper arms before and after treatment did not have a significant difference. The results of this study are in accordance with research (Vlorensia et al., 2020), which shows that moisturizing creams containing saccharide isomerate and ceramide effectively increase skin hydration. The average skin hydration after treatment was 24.46%, with a standard deviation of 3.83 (Vlorensia et al., 2020). The results of this study are in accordance with research (Gougeon et al., 2023) that showed that, compared to the control area, the application of creams, but especially creams containing saccharide isomerate, significantly improved the hydration and glossy properties of the skin on average after 30 minutes. This significant increase ranged from 1.7-fold in the placebo group to 4.6-fold in the cream containing urea (Gougeon et al., 2023). The results of this study are in accordance with research (Dewi & Pangkahila, 2022) showing that using a moisturizer containing saccharide isomerate led to a significant improvement in skin hydration within a 2-week period ($p<0.05$). Following the discontinuation of the moisturizer, all four sites exhibited notable variations in skin moisture ($p<0.05$). The study findings indicate that incorporating SI 5% into the moisturizer formulation leads to a significant increase in skin hydration. Furthermore, this enhanced hydration is sustained even after discontinuing the use of the moisturizer, surpassing the effects of standard moisturizers (Dewi & Pangkahila, 2022).

Saccharide isomerate is a naturally occurring, biologically active, and environmentally friendly sugar isomerization agent. This product is created by transforming the sugars found in the edible part of maize, which are primarily glucose, into a distinct combination of carbohydrates that closely resemble the skin. These carbohydrates are similar to the natural moisturizing substances present in the outermost layer of human skin, known as the stratum corneum. Saccharide isomerate is a fully plant-derived compound consisting of complex carbohydrates that closely resemble those naturally present in human skin. This vegan hyaluronic acid booster has demonstrated its capacity to deliver sustained skin hydration by effectively adhering to the skin and limiting the loss of water via the epidermis. Clinical evidence supports the efficacy of saccharide isomerate 1% in delivering both immediate and prolonged hydration. It has the ability to attract and retain water and has previously demonstrated positive effects on the skin's protective barrier, moisture levels, and the microorganisms present on the skin (Martin et al., 2023; Hon et al., 2018). Saccharide isomerate has humectant properties that improve skin hydration (Peltier et al., 2022).

Reduced humidity (reduced water content in the outermost layer of the skin) leads to a decrease in the breakdown of desmosomes. The desmosomes present in the SK sheet undergo digestion, resulting in the separation of the sheet into individual cells when placed in a buffer solution. On the other hand, protease inhibitors added to the buffer solution or heating the sheet stops the desmosomes from breaking down and cells from separating. Leupeptin, or chymostatin, exhibited a cell dissociation slowdown that was only around half as efficient as aprotinin. But when the two substances were mixed together, they stopped the breakdown of the stratum corneum layer just as well as aprotinin did alone. he results support the idea that desmosomes are very important for SK cells to stick together, and that these two types of serine proteases break down desmosomes, which leads to SK desquamation. A decline in trypsin-type protease activity associated with aging was seen in individuals without any health conditions. The amount of moisture in the stratum corneum affects the proteases' ability to break down

desmosomes there. According to studies, there are two factors that affect desquamation. The water content of the stratum corneum is one factor to consider. Insufficient water levels impede the optimal functioning of enzymes, regardless of their normal enzyme content. Humectant therapy effectively hydrates the stratum corneum by providing it with water. Another contributing element is a reduction in the enzymatic activity of the protease. This phenomenon is observable in skin that is afflicted with illness or undergoing the natural process of aging (Koyama et al., 1999).

Saccaride isomerate (SI) is a complex carbohydrate mucopolysaccharide (glycan) that closely resembles the one present in the outermost layer of human skin, known as the stratum corneum. Therefore, hyaluronan, or hyaluronic acid, will be produced in the epidermis. In the same way that hyaluronan does, SI can raise the water content of the stratum corneum, which keeps the epidermis moist even when the humidity level is low. SI has the ability to adhere to the skin even in extremely acidic environments (Dewi & Pangkahila, 2022).

The difference in significance between hands and feet may be attributed to differences in anatomical location and exposure to environments that can compromise skin hydration. Research (Mayrovitz et al., 2017) skin hydration, as measured by the tissue dielectric constant (TDC) tool, resulted in values in the forearm proving to be greater than in the leg or foot. In the forearm, there was a monotonous decrease in TDC values ($P < 0.001$) as depth increased, with TDC values at 0.5 mm being 38.4 ± 5.5 and 25.8 ± 4.1 at 5.0 mm depth. At the foot site, a similar decrease in TDC values was observed from 0.5 mm to 2.5 mm ($P < 0.001$), but the values at 2.5 and 5.0 mm (34.1 ± 6.3 vs. 33.0 ± 12.1) were not significantly different from each other (Mayrovitz et al., 2017).

4. Conclusions

This study demonstrates that the application of a moisturizer containing saccharide isomerate leads to a substantial enhancement in skin hydration among students enrolled in the Faculty of Medicine and Health Sciences at the Republic of Indonesia Defense University. The findings demonstrated a notable disparity in the average skin moisture levels between the right and left lower limbs following the intervention, therefore confirming the efficacy of the moisturizer in augmenting the water content of the outermost layer of the skin, known as the stratum corneum. Furthermore, the research also discovered that incorporating saccharide isomerate into the moisturizer formulation can significantly enhance skin moisture and sustain it even after the cessation of usage, surpassing the effects of conventional moisturizers. This demonstrates the efficacy of including saccharide isomerate in moisturizer formulations to greatly enhance skin hydration. This can be advantageous in addressing dry skin and prolonging skin moisture retention.

Given the results of this study, it is advisable to extend the observation period to a longer duration beyond the current 7-day timeframe in order to further investigate the topic. Extending the study term is anticipated to yield a more comprehensive understanding of the dynamics or alterations that may transpire over an extended timeframe. To enhance the representativeness of the findings, it is imperative to broaden the pool of respondents by incorporating volunteers who mirror the diversity and variability within the community being examined. Therefore, it is anticipated to generate more precise and pertinent results.

Author Contributions: All authors contributed to this research.

Funding: Not applicable.

Conflict of Interest: The authors declare no conflict of interest.

Informed Consent Statement/Ethics Approval: Not applicable.

Declaration of Generative AI and AI-assisted Technologies: This study has not used any generative AI tools or technologies in the preparation of this manuscript.

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