

## Formulation and Effectiveness Testing of A Virgin Coconut Oil (VCO) Moisturizing Cream For Treating Heel Xerosis

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### Abstract.

Xerosis of the heel of the foot is first shown by symptoms of dryness with the skin surface becoming scaly, hard, and uncomfortable. Continuous conditions will cause the surface of the skin to crack and crack which results in irritation and inflammation. Pure coconut oil is a fatty oil that can be used as a cream base and is able to prevent tissue damage and provide protection to the skin. To formulate a pure coconut oil moisturizing cream preparation and find out its effectiveness in treating xerosis on the heels of the feet. This study was conducted experimentally which included making cream preparations by adding virgin coconut oil, each with a concentration of F1 (2%), F2 (4%), F3 (6%) and F4 (8%) into the cream base moisturizer. As a blank, a moisturizing cream base without pure coconut oil (F0) is used. Tests on the virgin coconut oil moisturizing cream preparation included homogeneity test, emulsion type determination, pH determination, observation of the stability of the preparation after 12 weeks of storage, skin irritation test, test of the ability of the cream preparation to treat xerosis on the heels using 15 volunteers for one months of administration by applying moisturizing cream twice a day, by seeing a decrease in the xerosis level scale. Pure coconut oil can be formulated into a moisturizing cream preparation that is homogeneous and remains stable in storage for 4 weeks at room temperature with a w/m emulsion type. cream preparations show pH results that are in accordance with the physiological pH of the skin (6) and do not irritate the skin. Pure coconut oil cream preparations have the effect of curing xerosis on the heels of the feet in 15 volunteers for 4 weeks of use, preparations with a concentration of 8% are more effective than concentrations of 2%, 4% and 6%. Pure coconut oil (virgin coconut oil) can be formulated in the preparation of a moisturizing cream with a water/o emulsion type, the cream that is most effective in curing xerosis is produced from a concentration of 8% virgin coconut oil.

**Keywords:** Xerosis, Virgin Coconut Oil and Moisturizing Cream.

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### I. INTRODUCTION

Cracked heels are a clinical condition characterized by the presence of fissures on the heel. These fissures result from dry skin—or xerosis—which reduces skin elasticity, causing the skin layers to harden and crack (Presilia et al., 2017).

The term "xerosis" describes dryness of the epidermal skin layer. It is a common condition that can lead to peeling and itching. Risk factors for xerosis include sun exposure, friction, low humidity, and soap use (Parker et al., 2017).

Xerosis of the heel is a condition of severe dryness that leads to cracking. It is caused by a reduction in moisture resulting from the loss of lipids and natural moisturizing factors in the stratum corneum. Initial symptoms include dryness, with the skin surface becoming scaly and hard, accompanied by discomfort. If the condition persists, the skin surface cracks and splits, resulting in irritation and inflammation. Xerosis can lead to serious problems if not treated early. If the cracks are deep enough to reach the dermis, bleeding may occur, potentially triggering fungal or bacterial infections. Heel xerosis can be caused by exposure to chemicals such as detergents (which can dissolve skin lipids), environmental temperatures, age, and genetic abnormalities (Aryani, 2019).

Xerosis can be managed using moisturizing creams, which serve to increase and maintain skin moisture in various conditions, whether hot or cold. Moisturizing creams contain ingredients capable of retaining water within skin tissues, particularly the epidermis. One of the main ingredients in moisturizing cream is plant oil which is considered to mix more easily with skin fat and is better able to penetrate skin cells (Dewi Muliawan, 2013).

Moisturizers are composed of occlusives, humectants, and emollients. Occlusives inhibit evaporation from the skin's surface. Humectants function by drawing water from the dermis toward the stratum corneum.

Meanwhile, emollients work by filling the spaces between corneocytes to enhance hydration, though they can act as occlusives if applied in excess. Naturally, the skin attempts to protect itself against dryness through a lipid barrier derived from sebaceous glands and, to a lesser extent, sweat glands, as well as an outer layer that serves as a skin barrier. However, under certain conditions, these natural protective mechanisms are insufficient. Consequently, additional non-natural protection is required in the form of moisturizers—such as virgin coconut oil (VCO), which was used in this study—to maintain the skin's structure and function (Presilia et al., 2017).

In addition to VCO, other ingredients such as aloe vera and olive oil can be used to moisturize the skin. Aloe vera improves skin hydration and stimulates the production of collagen and elastin fibers, thereby reducing wrinkles and increasing skin elasticity. Olive oil acts as a protective or occlusive agent and softens the skin (Presilia et al., 2017).

Virgin coconut oil (VCO)—pure coconut oil extracted from fresh, mature coconuts via a specialized process that preserves its natural constituents—contains fatty acids, notably lauric acid and oleic acid. These components serve to soften the skin, enhance penetration, provide moisture, and accelerate skin healing. Furthermore, VCO is safe for topical use as it is non-irritating. Regarding its biological activity, VCO also exhibits antibacterial, antiviral, and antifungal properties. When used in moisturizers, VCO functions as an emollient and can even act as an occlusive agent if applied at the appropriate concentration (Presilia et al., 2017). Virgin Coconut Oil (VCO) is utilized in cream formulations due to its beneficial skin properties; specifically, it acts as an emollient and moisturizer that softens and hydrates the skin, thereby reducing its diffusion resistance. Short- and medium-chain fatty acids—such as lauric acid and oleic acid—are easily absorbed through the skin, which can enhance the penetration rate of active ingredients from VCO-based creams (Setiawan, 2019).

Virgin Coconut Oil (VCO) is an Indonesian product that is increasingly being used to improve public health. VCO contains 92% saturated fatty acids, comprising 48–53% lauric acid (C12), 1.5–2.5% oleic acid, and other fatty acids such as 8% caprylic acid (C8) and 7% capric acid (C10). The fatty acid content (particularly lauric and oleic acids) in VCO offers benefits such as skin softening, penetration enhancement, moisturization, and accelerated skin healing (Fatonah et al., 2013).

Research findings (Presilia et al., 2017) indicate that among 29 respondents using the study product—virgin coconut oil extract—and assessed before (pre) and after (post) use, 12 respondents (41.4%) showed significant results, specifically a decrease in scores on the Xerosis Severity Scale (XSS). Meanwhile, 17 respondents (58.6%) showed no decrease (scores remained unchanged), and no respondents (0%) exhibited an increase in XSS scores during the study.

## II. METHOD

This research was conducted at the Pharmaceutics Laboratory of the Faculty of Health Sciences, Cut Nyak Dhien Langsa Science University, in November 2022.

The study population consisted of women aged 20–50 years suffering from xerosis (dry skin) on their heels. The research involved villagers from the Syamtalira Aron District.

The sample comprised 15 female volunteers selected via purposive sampling. Specifically, the group included 6 volunteers aged 20–30 years and 9 volunteers aged 30–50 years. Purposive sampling is a technique for selecting data sources based on specific criteria (Sugiyono, 2017); thus, the researchers selected a total of 15 volunteers.

This study employed an experimental design involving the formulation of a moisturizing cream using virgin coconut oil. Evaluations of the preparation included homogeneity testing, emulsion type determination, stability assessment, and pH measurement. These were followed by skin irritation testing, an assessment of the cream's ability to treat heel xerosis using the 15 volunteers, and an evaluation of its effectiveness.

The study utilized a Completely Randomized Design (CRD) featuring five treatments based on varying concentrations of virgin coconut oil: F0 (blank/control), F1 (2%), F2 (4%), F3 (6%), and F4 (8%). The number of replications was determined based on the calculation formula by Hanafiah (2016), as follows:

**Legend:**

tc = Treatment combination

n = Number of replications

There are 5 treatments in this study; therefore, the required number of replications is calculated as follows:

$$tc(n-1) \geq 15$$

$$5(n-1) \geq 15$$

$$5n - 5 \geq 15$$

$$5n \geq 15 + 5$$

$$n \geq 20/5$$

$$n \geq 4$$

Thus, each treatment was replicated 4 (four) times.

The equipment used in this study included an electronic balance (Mettler Toledo), pH meter (Hanna), porcelain dish, mortar, pestle, test tube clamp, glass slide, plastic pot, water bath, and laboratory glassware. The materials used in this study were virgin coconut oil, cera alba, liquid paraffin, nipagin, borax, BHT, and distilled water.

**III. ANALYSIS RESULTS**

The preparation of the moisturizing cream in this study was conducted in two stages: the first stage involved formulating the moisturizing cream using virgin coconut oil (VCO), and the second stage involved evaluating the prepared cream. The moisturizing cream formulations were prepared using varying concentrations of virgin coconut oil: F0 (blank), F1 (2%), F2 (4%), F3 (6%), and F4 (8%). Physical quality evaluations of the virgin coconut oil moisturizing cream included tests for homogeneity, emulsion type, pH, and stability. Meanwhile, evaluations of the cream's effectiveness included irritation testing on volunteers and an assessment of its ability to treat heel xerosis.

**Results of the product homogeneity test**

The results of the homogeneity test for the virgin coconut oil moisturizing cream are presented in Table 4.1.

Table 4.1 Observation Data from the Product Homogeneity Test

| test | Observation of the spreadability test |             |             |             |             |
|------|---------------------------------------|-------------|-------------|-------------|-------------|
|      | F0                                    | F1          | F2          | F3          | F4          |
| 1    | Homogeneous                           | Homogeneous | Homogeneous | Homogeneous | Homogeneous |
| 2    | Homogeneous                           | Homogeneous | Homogeneous | Homogeneous | Homogeneous |
| 3    | Homogeneous                           | Homogeneous | Homogeneous | Homogeneous | Homogeneous |
| 4    | Homogeneous                           | Homogeneous | Homogeneous | Homogeneous | Homogeneous |

Homogeneity test observations indicate that all formulations of the virgin coconut oil moisturizing cream possess a homogeneous consistency, evidenced by the absence of coarse particles when the product is spread onto a transparent glass surface.

**Results of the W/O emulsion type test for the cream formulation**

Experimental results regarding the emulsion type test for the virgin coconut oil moisturizing cream, using methylene blue staining, are presented in Table 2.

**Table 2 Emulsion type test results for the formulation using methylene blue**

| No | Formula | Solubility of methylene blue in the formulation |    |
|----|---------|-------------------------------------------------|----|
|    |         | Yes                                             | No |
| 1  | F0      | -                                               | ✓  |
| 2  | F1      | -                                               | ✓  |
| 3  | F2      | -                                               | ✓  |
| 4  | F3      | -                                               | ✓  |
| 5  | F4      | -                                               | ✓  |

Notes:

F0 : Blank (oil-free cream base)

F1 : 2% virgin coconut oil concentration

F2 : 4% virgin coconut oil concentration

F3 : 6% virgin coconut oil concentration

F4 : 8% virgin coconut oil concentration

Testing was conducted by adding a methylene blue solution to the test preparations. If the emulsion turned blue, it was classified as an o/w (oil-in-water) type; conversely, if the resulting color was uneven or the methylene blue did not dissolve, it was classified as a w/o (water-in-oil) type. Based on the test results, formulas F0, F1, F2, F3, and F4 were identified as w/o type emulsions because the methylene blue did not dissolve and produced a non-homogeneous color.

Preparation pH test results

The pH of the cream preparations was measured using universal pH strips. The pH measurement results for the virgin coconut oil moisturizing cream preparations are as follows:

**Table 3 pH Test Observation Data**

| Test | pH Value |    |    |    |    |
|------|----------|----|----|----|----|
|      | F0       | F1 | F2 | F3 | F4 |
| 1    | 6        | 6  | 6  | 6  | 6  |
| 2    | 6        | 6  | 6  | 6  | 6  |
| 3    | 6        | 6  | 6  | 6  | 6  |
| 4    | 6        | 6  | 6  | 6  | 6  |

The test results for the pH value of pure coconut oil moisturizing cream preparations for F0, F1, F2, F3 and F4 were the same, namely 6, and did not change before and after storage.

Preparation stability test results

Based on the stability test results on the preparation for 4 weeks at room temperature, the results were obtained in Table

**Table 4 Data from Stability Test Observations**

| Formula | Observations during storage |   |   |        |   |   |             |   |   |             |   |   |              |   |   |
|---------|-----------------------------|---|---|--------|---|---|-------------|---|---|-------------|---|---|--------------|---|---|
|         | Week-0                      |   |   | Week-1 |   |   | Minggu ke-4 |   |   | Minggu ke-8 |   |   | Minggu ke-12 |   |   |
|         | X                           | Y | Z | X      | Y | Z | X           | Y | Z | X           | Y | Z | X            | Y | Z |
| F0      | -                           | - | - | -      | - | - | -           | - | - | -           | - | - | -            | - | - |
| F1      | -                           | - | - | -      | - | - | -           | - | - | -           | - | - | -            | - | - |
| F2      | -                           | - | - | -      | - | - | -           | - | - | -           | - | - | -            | - | - |
| F3      | -                           | - | - | -      | - | - | -           | - | - | -           | - | - | -            | - | - |
| F4      | -                           | - | - | -      | - | - | -           | - | - | -           | - | - | -            | - | - |

Legend:

F0 : Blank (cream base without oil)

F1 : Virgin coconut oil concentration 2%

F2 : Virgin coconut oil concentration 4%

F3 : Virgin coconut oil concentration 6%

F4 : Virgin coconut oil concentration 8%

X : Color change

Y : Odor change

Z : Phase separation

√ : Change occurred

- : No change occurred

The stability evaluation of the preparations was conducted over a 4-week storage period, with observations made at weeks 1, 2, 3, and 4. The cream preparations were stored at room temperature and monitored for changes in odor, color, and phase separation. The results of the 4-week stability test, presented in Table 4, indicate that none of the preparations across the various formulations or concentrations underwent color changes (remaining white), developed a distinct odor, or exhibited phase separation. These results held true for observations made at weeks 1, 2, 3, and 4 during storage at room temperature. This indicates that the preparations are physically stable.

#### Evaluation Results of Moisturizing Cream Effectiveness

##### Irritation test results on test animals

The results of the irritation test on test animals for the virgin coconut oil moisturizing cream are presented in Table 5.

**Table 5 Irritation Test Data for the Cream on Test Animals**

| Kelompok uji | Observation time |       |            |       |            |       |
|--------------|------------------|-------|------------|-------|------------|-------|
|              | Before treatment |       | 24 O'clock |       | 72 O'clock |       |
|              | Erythema         | Udema | Erythema   | Udema | Erythema   | Udema |
| F0 (blanko)  | 0                | 0     | 0          | 0     | 0          | 0     |
| F1 (2%)      | 0                | 0     | 0          | 0     | 0          | 0     |
| F2 (4%)      | 0                | 0     | 0          | 0     | 0          | 0     |
| F3 (6%)      | 0                | 0     | 0          | 0     | 0          | 0     |
| F4 (8%)      | 0                | 0     | 0          | 0     | 0          | 0     |

##### Criteria:

##### 1. Erythema

- No erythema = 0
- Very slight erythema = 1
- Mild erythema = 2
- Moderate erythema = 3
- Severe erythema = 4

##### 2. Edema

- No edema = 0
- Very slight edema = 1
- Mild edema = 2
- Moderate edema = 3
- Severe edema = 4

Observations regarding irritation in white test rats were conducted on virgin coconut oil moisturizing cream formulations at the following concentrations: F0 (blank), F1 (2%), F2 (4%), F3 (6%), and F4 (8%). The results indicated that none of the treatments over the 3-day period caused irritation, such as the appearance of erythema or edema.

##### Results of the formulation's efficacy in treating heel xerosis

The results regarding the efficacy of the virgin coconut oil moisturizing cream in treating heel xerosis, based on the obtained scale, are as follows:

**Table 6 Changes in Heel Xerosis Scale in Volunteers Over 4 Weeks**

| Formula     | Age | Volunteer | Initial Condition | Week-2 | Week-4 | Change Scale (%) |
|-------------|-----|-----------|-------------------|--------|--------|------------------|
| F0 (Blanko) |     | I         | 1                 | 1      | 0      | 28,32            |
|             |     | II        | 2                 | 2      | 2      |                  |

|            |               |         |      |      |      |       |
|------------|---------------|---------|------|------|------|-------|
|            | 20-30<br>year | III     | 4    | 4    | 3    | 33,33 |
| F1<br>(2%) |               | Average | 2,33 | 2,33 | 1,67 |       |
|            |               | IV      | 3    | 3    | 2    |       |
|            |               | V       | 3    | 2    | 2    |       |
|            |               | VI      | 3    | 3    | 2    |       |
|            |               | Average | 3    | 2,67 | 2    |       |
| F2<br>(4%) | 30-50<br>year | VII     | 4    | 3    | 2    | 41,75 |
|            |               | VIII    | 4    | 3    | 2    |       |
|            |               | IX      | 4    | 4    | 3    |       |
|            |               | Average | 4    | 3,33 | 2,33 |       |
| F3<br>(6%) |               | X       | 4    | 3    | 1    | 58,25 |
|            |               | XI      | 4    | 3    | 2    |       |
|            |               | XII     | 4    | 3    | 2    |       |
|            |               | Average | 4    | 3    | 1,67 |       |
| F4<br>(8%) |               | XIII    | 4    | 3    | 0    | 78,58 |
|            |               | XIV     | 5    | 3    | 0    |       |
|            |               | XV      | 5    | 3    | 3    |       |
|            |               | Average | 4,67 | 3    | 1    |       |

Legend:

- 0 : normal skin
- 1 : scaly appearance with slight skin flaking
- 2 : scaly appearance with significant skin flaking
- 3 : fine, flat lines
- 4 : thick, raised lines with shallow fissures
- 5 : large, deep fissures
- 6 : large, deep fissures accompanied by erythema
- F0 : Blank (cream base)
- F1 : 2% virgin coconut oil concentration
- F2 : 4% virgin coconut oil concentration
- F3 : 6% virgin coconut oil concentration
- F4 : 8% virgin coconut oil concentration

The severity scale for heel xerosis is shown in Table 7.

**Table 7 Xerosis grading scale for the heels**

| Level     | Scale | Description                                          |
|-----------|-------|------------------------------------------------------|
| Light     | 0     | Normal skin                                          |
|           | 1     | Scaly appearance with slight skin flaking            |
|           | 2     | Scaly appearance with many skin flakes               |
| Currently | 3     | Thin, flat lines                                     |
|           | 4     | Thick lines that rise, broken not deep               |
| Critical  | 5     | Deep large cracks                                    |
|           | 6     | Large, deep fissures accompanied by slight erythema. |

Data in Table 7 indicate that over the four-week treatment period, there was an improvement in heel xerosis among the volunteers, particularly with formula F4. Higher concentrations of added virgin coconut oil (VCO) resulted in enhanced efficacy in treating heel xerosis and a reduction in the severity of the condition.

#### Research Discussion

##### Homogeneity Test

The homogeneity test aims to assess the uniformity of the mixture of ingredients in the cream formulation. In this evaluation, homogeneity was assessed visually by observing the cream's color and checking for any poorly mixed components. The results indicate that the cream formulation with a water-in-oil (w/o) base met homogeneity requirements, as no coarse particles were visible. This aligns with research by Setiawan (2019), which found that all prepared VCO-based creams were homogeneous, as no granules

were detected when the product was rubbed onto the hands. A standard requirement for creams is that, when applied to a glass slide, there should be no separation of the emulsion's constituent components (Azkiya et al., 2017).

### **Emulsion Type Testing in Cream Preparations**

Emulsion type determination is performed to determine whether a cream preparation is W/O or O/W. The results of the cream emulsion type test indicate that F0, F1, F2, F3, and F4 have a W/O emulsion type, using a methylene blue dye test. This is because the volume of the dispersed phase (water phase) used in the cream is smaller than that of the dispersing phase (oil phase), resulting in the water globules being dispersed into the oil phase, forming a W/O emulsion. According to research by Febia, S, in 2022, the results of the emulsion type test with phase dilution, as can be seen in formulas F0-F5, cannot be diluted with the addition of water, thus proving that the cream preparation is a W/O emulsion type (Pratasik et al., 2019).

#### **Preparation pH Test**

The pH test aims to determine the safety of the cream preparation when used and to ensure it does not irritate the skin. A low or acidic pH can irritate the skin, and conversely, if the pH is too high, it can dry out the skin upon application. Topical formulations must meet these requirements. If the pH is too alkaline, it can cause scaly skin, while if the skin's pH is too acidic, it can trigger skin irritation. The pH test results for each cream formulation showed that F0, F1, F2, F3, and F4 were the same, at 6. According to research by Febia, S., in 2022, the pH test results showed that formulas F1-F5 had pH values within the skin's pH range (4.5-6.5). These results are considered good (Azkiya et al., 2017).

#### **Preparation Stability Test**

The stability of the virgin coconut oil moisturizing cream formulation was tested by observing changes in color, aroma, and phase separation during storage at room temperature. These changes were observed in weeks 1, 2, 3, and 4 (Vijayalakshmi et al., 2018).

Based on the results of stability tests on the preparations over 4 weeks, the results in Table 4.4 indicate that all preparations of each formulation or concentration remained unchanged from their initial white color, had no distinctive odor, and no phase separation occurred. This was observed during weeks 1, 2, 3, and 4 during storage at room temperature. This indicates that the preparations are physically stable. According to research by Setiawan A in 2019, VCO cream preparations showed similar test results. Color observations showed that Formula 1 was white, while Formulas 2 and 3 were white, with no distinctive odor for all three preparations.

#### **Irritation Test on Test Animals**

Irritation tests were conducted to determine the potential for skin irritation after application of the moisturizing cream preparations, thereby determining the safety of the resulting moisturizing cream preparations. Prior to the irritation test on virgin coconut oil-based moisturizing creams, the concentration of the moisturizing cream to be tested on white mice was first determined. This concentration was determined by testing several concentrations of moisturizing cream: 2%, 4%, 6%, 8%, and a blank.

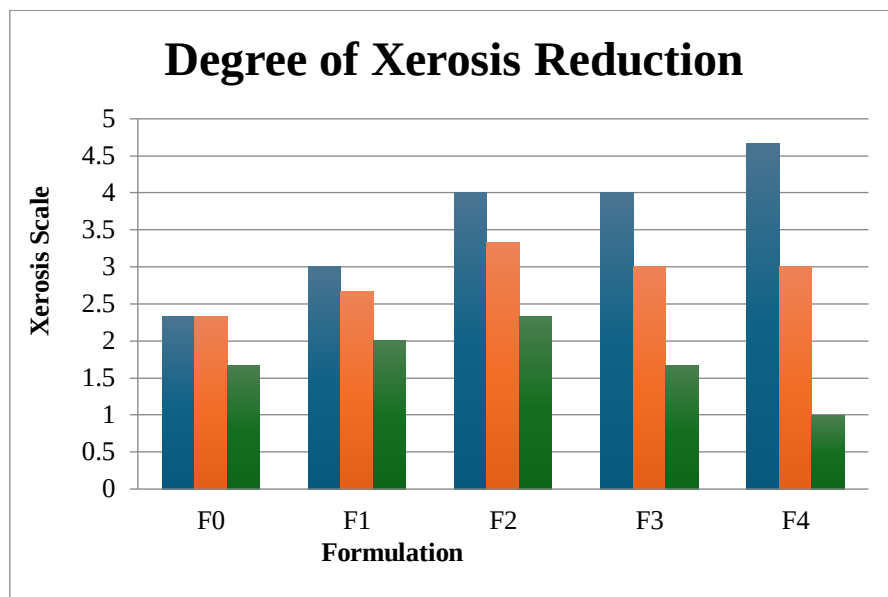
The irritation test was conducted on five white mice. The hair on the backs of the mice was shaved to a length of 2–2.5 cm until clean. Observations for the irritation test were conducted 24 and 72 hours after administration of the test preparation. The skin reaction was observed using two main parameters: the level of erythema (redness or swelling). ...grated) and the degree of edema (swelling) that developed; these observations were then scored from 0 to 4 based on severity (Pratimasari et al., 2015).

Based on the irritation test results, it was observed that moisturizing cream formulations based on virgin coconut oil—at concentrations of 2%, 4%, 6%, and 8%, as well as a blank control—did not induce erythema or edema in the test areas on the white rats used as test subjects.

#### **Test of Formulation Efficacy for Healing Heel Xerosis**

Advanced age and female gender are significant risk factors associated with dry skin. Therefore, this study recruited female volunteers aged 20–50 years from the Syamtalira Aron District. Volunteers 1–6 were aged 20–30 years, while volunteers 7–15 were aged 30–50 years; their daily activities included washing, sweeping, mopping, and other household chores. Risk factors for xerosis include sun exposure, friction, low humidity, and soap use (Parker et al., 2017; Sinulingga et al., 2018).





**Fig. 1 Diagram of the reduction level of heel xerosis.**

Legend:

F0: Blank (cream base)

F1: 2% virgin coconut oil cream

F2: 4% virgin coconut oil cream

F3: 6% virgin coconut oil cream

F4: 8% virgin coconut oil cream

Based on the severity scale by Rogers et al. (Figure 1), volunteers were assigned formula F0 (the blank cream preparation). Volunteer I presented with an initial condition of mild xerosis—characterized by a scaly appearance with slight skin flaking; by week 2, the heel showed no change in xerosis type, but by week 4, the condition improved to normal skin. Volunteer II presented with an initial condition of mild xerosis—characterized by a scaly appearance with significant skin flaking; at weeks 2 and 4, the heel showed no change in xerosis type. Volunteer III presented with an initial condition of moderate xerosis—characterized by thin, flat lines; at weeks 2 and 4, the heel showed no change in xerosis type.

Volunteers were assigned formula F1 (2% virgin coconut oil cream). Volunteers IV and VI presented with an initial condition of moderate xerosis—characterized by thin, flat lines; at week 2, the heel showed no change in xerosis type, but by week 4, the condition improved to mild xerosis—characterized by a scaly appearance with significant skin flaking. Volunteer V presented with an initial condition of moderate xerosis—characterized by thin, flat lines; at week 2, the condition improved to mild xerosis—characterized by a scaly appearance with significant skin flaking—and by week 4, no further change in xerosis type was observed.

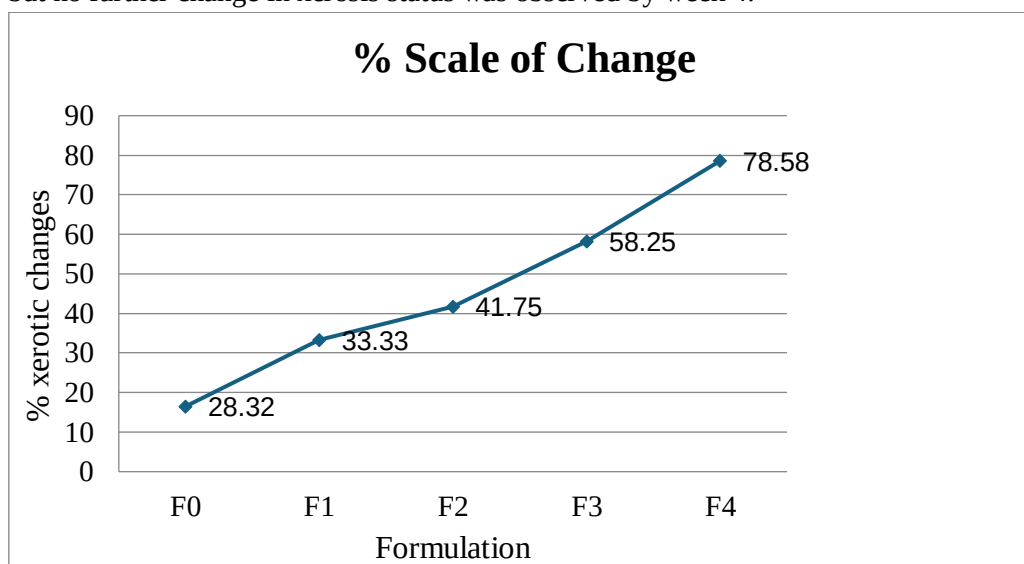
Volunteers were assigned formula F2 (4% virgin coconut oil cream). Volunteers VII and VIII presented with an initial condition of moderate xerosis—characterized by raised, thick lines and shallow cracks; by week 2, they showed improvement to a milder form of moderate xerosis (thin, flat lines), and by week 4, the condition had improved to mild xerosis (scaly appearance with numerous skin flakes). Volunteer IX presented with an initial condition of moderate xerosis (raised, thick lines and shallow cracks); by week 2, there was no improvement in the xerosis type, but by week 4, the condition had improved to a milder form of moderate xerosis (thin, flat lines).

Volunteers were treated with formula F3, a virgin coconut oil cream with a 6% concentration. Volunteer X presented with an initial condition of moderate xerosis (raised, thick lines and shallow cracks); by week 2, they showed improvement to a milder form of moderate xerosis (thin, flat lines), and by week 4, the condition had improved to mild xerosis (scaly appearance with few skin flakes). Volunteers XI and XII presented with an initial condition of moderate xerosis (raised, thick lines and shallow cracks); by week 2,



they showed improvement to a milder form of moderate xerosis (thin, flat lines), and by week 4, the condition had improved to mild xerosis (scaly appearance with numerous skin flakes).

Volunteers were treated with formula F4, a virgin coconut oil cream with an 8% concentration. Volunteer XIII presented with an initial condition of moderate xerosis (raised, thick lines and shallow cracks); by week 2, they showed improvement to a milder form of moderate xerosis (thin, flat lines), and by week 4, the skin condition had returned to normal. Volunteer XIV presented with severe xerosis—characterized by large, deep cracks—at baseline; by week 2, the condition improved to moderate xerosis (thin, flat lines), and by week 4, the skin had returned to a normal state. Volunteer XV also presented with severe xerosis (large, deep cracks) at baseline; by week 2, the condition improved to moderate xerosis (thin, flat lines), but no further change in xerosis status was observed by week 4.



**Fig. 2: Diagram of the percentage change in xerosis scale on the heels.**

Based on Figure 4.2 above regarding the percentage change in the xerosis scale on the heels, volunteers treated with formula F0 showed an average scale change of 28.22%. Formula F1 showed an average scale change of 33.33%, while formula F2 showed 41.75%. Formula F3 showed an average scale change of 58.25%, and formula F4 showed 78.58%.

From Figure 4.2, it can be concluded that the Virgin Coconut Oil (VCO) moisturizing cream preparations for treating heel xerosis showed an increase in percentage improvement from formula F0 to F4; this indicates that higher concentrations led to a higher percentage of xerosis healing on the heels.

In general, each formula demonstrated improved recovery from heel xerosis—assessed at baseline, week 2, and week 4 of cream usage—with the extent of recovery increasing over time. This trend is evident in the recovery percentages, which rose from the blank formulation through formulas 1 to 4. The reduction in xerosis severity varied by formula; a higher concentration of virgin coconut oil in the cream resulted in a greater percentage reduction in xerosis. Consequently, the highest concentration (8%) accelerated the recovery of heel xerosis the most effectively.

Research conducted by Besti Wika Presilia in 2017 indicated that VCO is capable of treating heel xerosis. Among the 29 respondents who used the test product and were evaluated before (pre) and after (post) treatment, 12 respondents (41.4%) showed significant results, specifically a reduction in scores based on the Xerosis Severity Scale (XSS). Meanwhile, 17 respondents (58.6%) showed no decrease or remained unchanged. No respondents (0%) exhibited an increase in XSS scores during the study.

Ideally, a moisturizing formula contains occlusive, humectant, and emollient ingredients to provide optimal results in treating dry skin. Skin must be able to retain moisture to maintain its function as healthy skin. If moisture levels drop drastically, the skin is deprived of necessary nutrients, leading to dryness, roughness, cracking, and peeling (Febia Sari et al., 2022).

In moisturizers, VCO acts as an emollient and even as an occlusive agent when used at appropriate, high concentrations. Virgin coconut oil (VCO)—containing fatty acids such as lauric acid and oleic acid—can soften the skin, enhance penetration, provide moisture, and accelerate skin healing. Furthermore, VCO is safe for skin use as it is non-irritating. Regarding its biological activity, VCO also exhibits antibacterial, antiviral, and antifungal properties (Presilia et al., 2017).

The study results indicate that using the cream for one month can reduce heel cracking to a normal state, provided it is applied routinely every day. Several volunteers noted that the morning and evening application schedule was appropriate. Variations in the degree of change were influenced by the level of adherence and the severity of the xerosis.

#### IV. CONCLUSION

Based on the research conducted, it can be concluded that:

- a. Virgin coconut oil can be formulated into a moisturizing cream (water-in-oil emulsion type) at concentrations of 2%, 4%, 6%, and 8%; the cream formulations meet quality requirements and remain stable during four weeks of storage.
- b. A cream containing virgin coconut oil is effective in treating heel xerosis; a formulation with an 8% concentration performs better than those with 2%, 4%, or 6% concentrations in reducing heel cracking over the four-week study period.

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