Upcycled moringa seeds for skin recovery

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ABSTRACT

The Moringa tree, Moringa oleifera, has been an integral part of African traditional medicine for centuries and is now recognized as a valuable source of natural compounds for skincare. Here we explore the potential of a moringa seed extract (tradename MorinGuard®) as a cosmetic active ingredient for skin protection and recovery. The extract is derived from upcycled moringa seed cake, a byproduct of moringa oil production, transforming an unused natural resource into a valuable ingredient. Additionally, we partner with a supplier committed to sustainability and social responsibility, creating a positive impact by supporting over 1,500 smallholder farmers in Rwanda. In our studies, the moringa seed extract shows strong anti-inflammatory and skin protecting properties. The extract lowers key markers of inflammation and decreases the synthesis of matrix metalloproteinases in vitro. Clinical tests confirmed its effectiveness in speeding up skin recovery after microneedle treatment, with improvements in blood flow and skin barrier. When combined with Lipoid Kosmetik's Skin Lipid Matrix SLM (tradename SLM Eco®), the extract is even more effective. Overall, the moringa seed extract is a cosmetic ingredient that soothes, repairs, and protects challenged skin. It bridges traditional African knowledge with modern cosmetic science, supports the sustainable use of natural resources, and is ethically sourced – making it a responsible choice for skincare.

Africa is a continent of rich cultural diversity and medical traditions that offers rich natural resources. Plants like the moringa tree, neem, baobab, aloe vera, or rooibos offer exciting potential for cosmetic applications. By combining traditional wisdom with modern science, innovative cosmetic concepts can be created that reflect Africa's medical heritage while meeting today's demand for natural and effective beauty care products.

The Moringa tree (Moringa oleifera) is one great example. In traditional African medicine, every part of the tree – including its oil, leaves, and seeds – has been used to treat inflammation, wounds, pain, and skin conditions, despite limited knowledge of its underlying biochemistry. Recent research has identified moringin and its glycosylated derivative, glucomoringin, as key secondary metabolites abundant in moringa.

These unique isothiocyanates, found exclusively in Moringa oleifera, have attracted interest in cosmetics for their antioxidant, anti-inflammatory, and protective benefits for the skin.[1]

From upcycled moringa seed cake to cosmetic actives

Although the moringa tree's oil is the primary commercial product (REF [2]), the seed cake (ca. 85% of biomass) that is left after oil extraction is largely undervalued and of limited use despite being rich in proteins and valuable phytochemicals like moringin. To address this, Lipoid Kosmetik has created a cosmetic extract from Moringa seed cake, preserving and enhancing the value of these unused bioactive components.

We source moringa seed cake from a supplier with a sustainable and socially responsible supply chain, linking over 1,500 smallholder farmers in Rwanda to the global cosmetic market. This partnership supports their livelihoods through economic growth, sustainable development, and creates a positive social impact.

Moringin – Key component of the moringa seed extract

We characterized the phytochemical profile of the moringa seed extract and identified

its key components using dereplication analysis and High-Performance Thin Layer Chromatography (HPTLC). As a result, moringin and its glycosylated form glucomoringin were identified as key active components together with a rich polyphenol and flavonoid profile (Figure 2).

The scientific literature (REF [1], [2], [3], [4], [5]) characterizes moringin, the active compound in the moringa seed extract, as an anti-inflammatory and antioxidant compound that inhibits the inflammatory NF-κB pathway while activating the antioxidative Nrf2 pathway.

Based on this dual action, the moringa seed extract has the potential to reduce levels of inflammatory markers, matrix-metalloproteinases (MMPs) and nitric oxide (NO), making it a promising ingredient for skin recovery and skin protection.

The moringa seed extract reduces inflammatory responses *in vitro*

Skin inflammation is typically related to: (i) high levels of inflammatory markers; (ii) the synthesis of matrix-metalloproteinases (MMP); and (iii) elevated levels of nitric oxide (NO). Therefore, we examined the inhibitory effect of the moringa seed extract on (i) the release of inflammatory markers, (ii) the synthesis of MMPs and (iii) the release of NO (not shown) upon inflammation.

Inflammatory markers like cytokines, chemokines, enzymes, and other molecules mediate, regulate, and participate in the inflammatory processes. They contribute to clinical symptoms of inflammation, such as redness, heat, swelling, and pain. Common cytokines involved in skin inflammation help in recruiting and activating immune cells to the site of inflammation.

To study the effect of moringa seed extract on inflammatory markers, normal human dermal fibroblasts (NHDF) were treated with Interleukin-1β (IL-1β) to induce the release of inflammatory markers (8-isoprostane, prostaglandin E_2 (PGE_2), IL-8 and IL-6). The release of inflammatory markers was measured by an Enzyme-Linked Immunosorbent Assay (ELISA) upon co-incubation with different concentrations of the moringa seed extract.

As a result, the moringa seed extract displays anti-inflammatory activity by reducing the levels of the inflammatory markers IL-6, IL-8,MMPs modulate inflammation by processing and activating cytokines and chemokines. For example, some MMPs can activate IL-1β, a potent inflammatory cytokine, thereby amplifying the inflammatory response. Furthermore, MMPs degrade components of the extracellular matrix such as collagen, thereby facilitating the migration of immune cells to the site of inflammation, amplifying the immune response.

To study the effect of the moringa seed extract on MMP synthesis, immortalized human keratinocytes (HaCaT) were first stimulated with polyinosinic-polycytidylic acid (Poly I:C), a synthetic double-stranded RNA molecule that mimics viral infection and triggers an inflammatory response, including

Figure 1: Sourcing Moringa seed cake supports an ethical and sustainable supply chain. One moringa tree can produce about 15,000 seeds annually and cold pressing yields ca. 15% precious moringa oil. Lipoid Kosmetik upcycles the remaining seed cake, a by-product of oil production, thereby promoting sustainability and economic opportunities for farming families in Rwanda

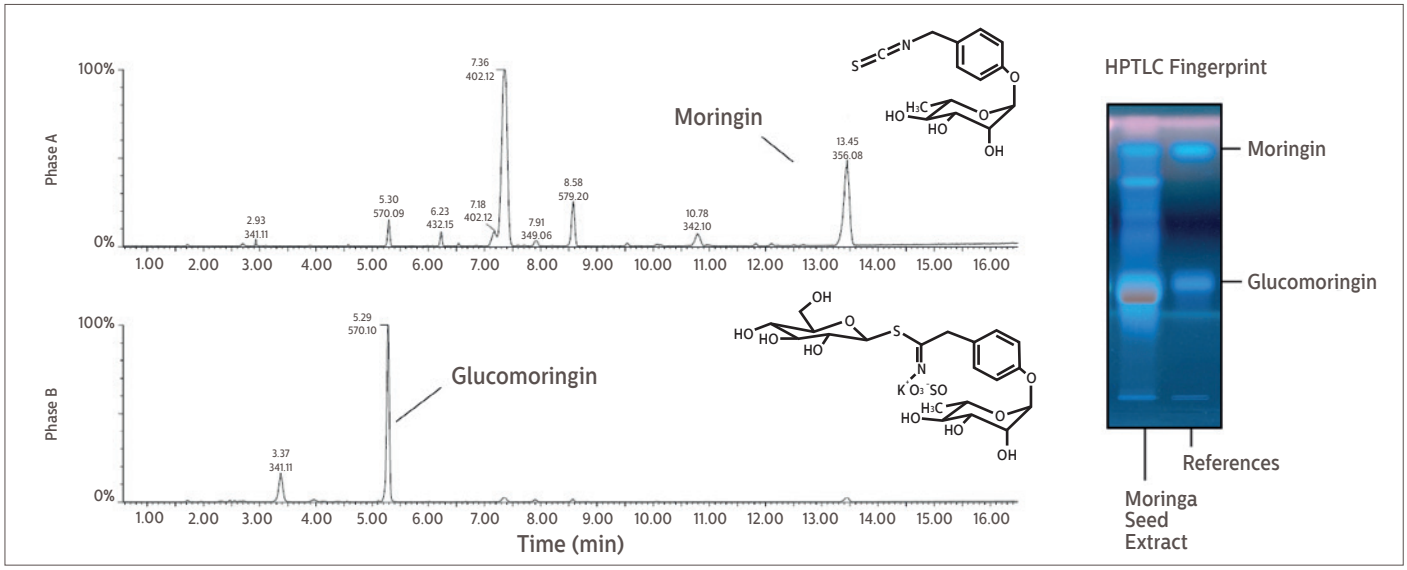

Figure 2: the moringa seed extract contains moringin and glucomoringin as main active constituents. (A) Dereplication analysis: A preliminary liquid-liquid extraction was conducted to separate the extract's metabolites from a glycerol matrix, resulting in two distinct phases. Both phases were analyzed using high-resolution liquid chromatography-mass spectrometry (LC-MS). (B) HPTLC fingerprint: The polyphenol and flavonoid profiles of the moringa seed extract (left lane) were compared to moringin and glucomoringin as pure external standards (right lane)

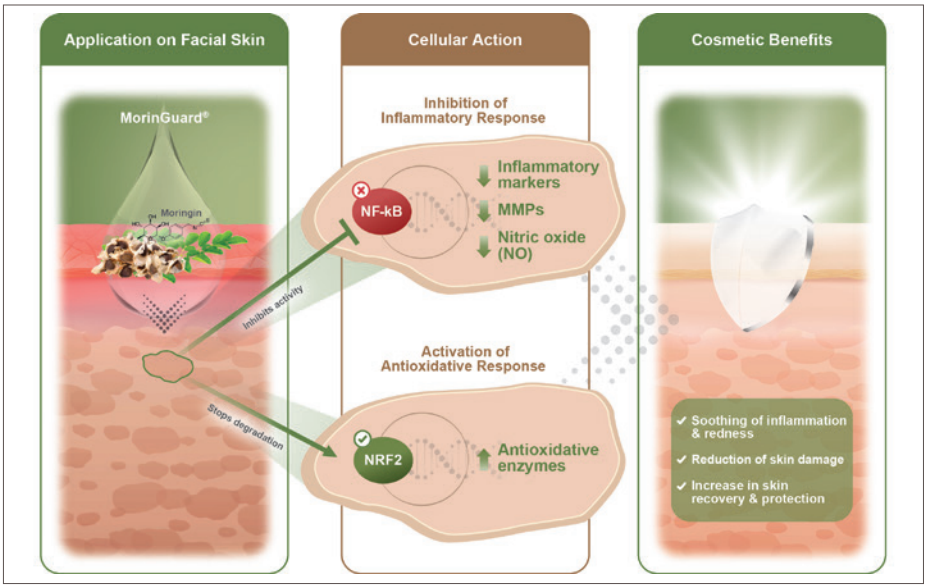

Figure 3: The moringa seed extract soothes inflammation and provides skin protection and recovery

the synthesis of matrix-metalloproteinases (MMPs). After stimulation with Poly I:C, the cells were co-incubated with increasing concentrations of the moringa seed extract and MMP levels were quantified using the ELISA assay.

As a result, the moringa seed extract displays anti-inflammatory activity by reducing MMP-1 and MMP-9 levels *in vitro*.

The moringa seed extract supports and accelerates skin recovery from irritation

The objective of this study was to investigate the effect of the moringa seed extract on skin protection and recovery after irritation *in vivo*, while also examining the complementary benefit of Lipoid Kosmetik's Skin Lipid Matrix SLM as an additional ingredient alongside the moringa seed extract (the moringa seed extract + SLM).

Skin Lipid Matrix SLM is a biomimetic formulation composed of essential skin lipids that create a unique three-dimensional lamellar lipid structure that replicates the natural lipid matrix of the stratum corneum. It complements the action of moringin by effectively restoring the skin's natural protective barrier.

In the study, 15 women underwent dermaroller needling using a micro-needle device (Figure 6A) with a maximum

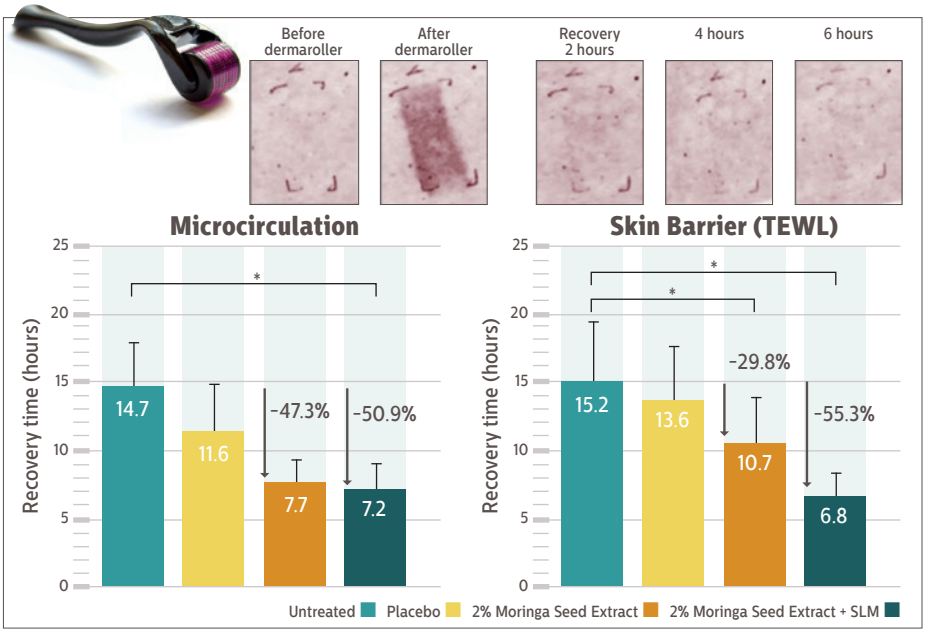

Figure 6: The moringa seed extract accelerates skin recovery after irritation. In a double-blind, placebo-controlled clinical study, volunteers' skin was irritated using a dermaroller. The treated areas were either left untreated or treated with creams containing: 0% moringa seed extract + 0% SLM (placebo), 2% moringa seed extract, or 2% moringa seed extract + 20% SLM. A: Representative images of the forearm skin before and after dermaroller treatment illustrate the recovery process. B: The time required for complete recovery of microcirculation and TEWL after skin irritation. Mean + SEM. Statistical analysis Wilcoxon test comparing 'treated vs. 'untreated'. * = p < 0.05. N = 15

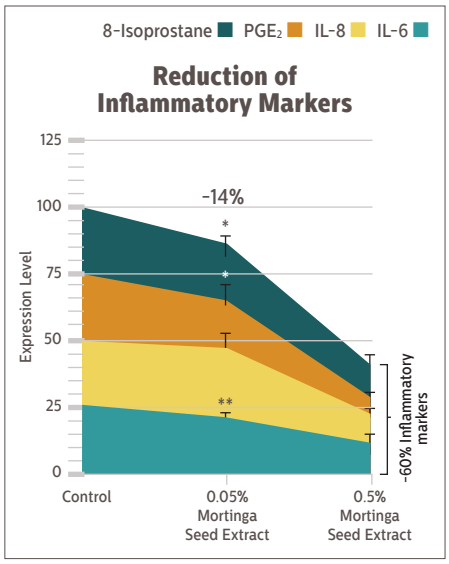

Figure 4: The moringa seed extract reduces inflammatory markers in a skin cell model. Normal human dermal fibroblasts were seeded in 24 well plates and incubated with IL-1β in the absence (control) and presence of the moringa seed extract (0.05% and 0.5%) for 24 hours. Unstimulated cells served as negative control. 24 hours after cell stimulation, supernatants were removed, centrifuged, and investigated for 8-isoprostane, PGE2, IL-8 and IL-6 concentrations by ELISA. Shown is the cumulated data normalized to 100%. Mean + SEM. Student's T-test between 'stimulated control' and 'treated'. * = p < 0.05; ** = p < 0.01; *** = p < 0.001. N=3

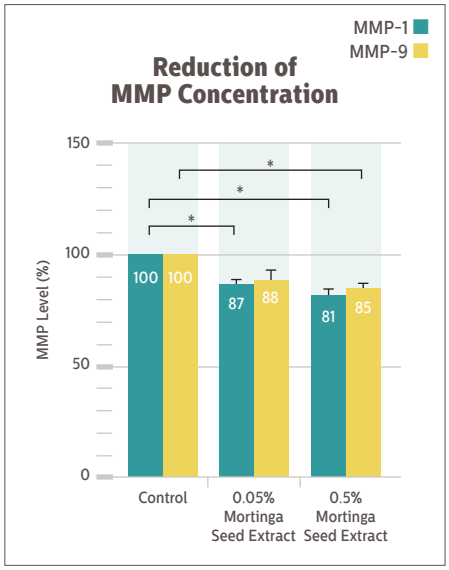

Figure 5: The moringa seed extract reduces the synthesis of matrix metalloproteinases (MMPs) in a skin cell model. HaCaT keratinocytes were seeded in 24 well plates and incubated with Poly I:C in the absence (control) and presence of the moringa seed extract (0.05% and 0.5%) for 24 hours. Unstimulated cells served as negative control. 24 hours after cell stimulation, supernatants were removed, centrifuged, and investigated for MMP-1 and MMP-9 concentrations by ELISA. Data is normalized to control (100%). Mean + SEM. Student's T-test between 'stimulated control' and 'treated'. * = p < 0.05. N=3

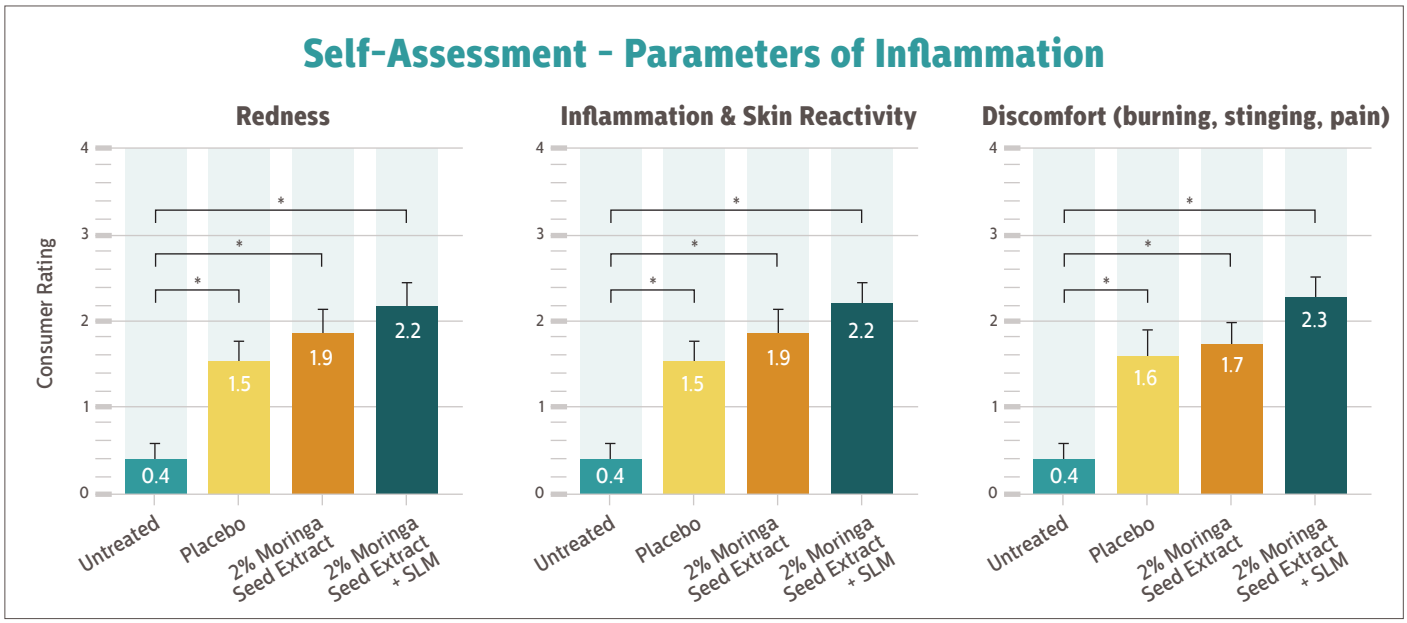

Figure 7: The moringa seed extract improves skin redness, inflammation, and discomfort. In a double-blind placebo-controlled clinical study, volunteers' skin was irritated using a dermaroller and then either left untreated or treated with creams containing: 0% the moringa seed extract + 0% SLM (placebo), 2% moringa seed extract, or 2% moringa seed extract + 20% SLM. At the end of the treatment, participants ranked improvements in skin redness, inflammation and reactivity, and discomfort using a scale: 'best treatment (3 points), 'second best treatment (2 points), 'third best treatment (1 point), worst treatment (0 points). Results are shown as average scores. Data is presented as mean + SEM. Statistical analysis was performed using the Wilcoxon test to compare treated versus untreated areas. * = $p < 0.05$. N = 15

penetration depth of 0.3 mm. The device was applied to four randomized areas on the forearm, which induced increased blood flow and barrier irritation, as evidenced by elevated microcirculation and transepidermal water loss (TEWL).

After this initial damage, a repair phase began, during which each area was treated with either a test cream, a placebo cream, or left untreated. The time for complete recovery of microcirculation was monitored via the Periflux PF5000 and the time for complete recovery of the skin barrier (TEWL) was measured with a Tewameter® TM 300.

Photographs were captured using IntelliStudio®. In addition, participants completed a questionnaire after the first application and after complete recovery to share their experience with the product and opinion about possible applications for the moringa seed extract.

Self-assessment – parameters of inflammation

As a result, instrumental analysis revealed that the time needed for complete recovery of dermaroller-treated skin is significantly shortened by the moringa seed extract alone, and even more in combination with Skin Lipid Matrix SLM. Microcirculation normalized 47% faster with a 2% moringa seed extract treatment alone and 51% faster when combined with SLM, as compared to untreated skin. In parallel, TEWL reached normal levels 30% faster with the the moringa seed extract and 55% faster in combination with SLM, relative to the control (Figure 6).

Furthermore, the people who tested the treatments rated the 2% moringa seed extract + SLM combination as the best, followed by 2% moringa seed extract alone. Thus, combining the moringa seed extract with SLM works even better for skin recovery and protection (Figure 7).

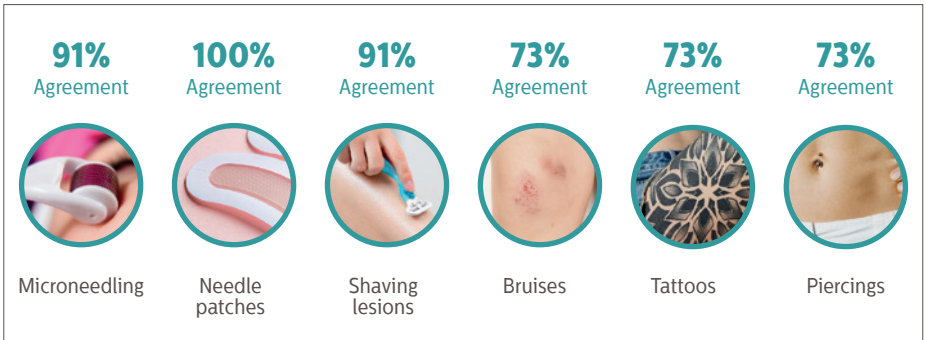

Figure 8: The moringa seed extract is regarded by consumers as a suitable and effective ingredient for various cosmetic applications. After having used the moringa seed extract test cream, users expressed their opinion about its suitability for various applications by responding to the question: 'Do you think this cream is effective for the following applications?' with the options: 'Yes, definitely', 'Rather yes', 'Rather no', and 'No, not at all'. Results are presented as the percentage of positive responses (Yes, definitely' and 'Rather yes'). N=15

Participants also said that the moringa seed extract would also be effective in soothing shaved skin, reducing bruising, and caring for tattoos or piercings (Figure 8), highlighting its broad potential for cosmetic applications.

Conclusion

The moringa seed extract is an effective, ethical, and eco-friendly active ingredient. Derived from upcycled moringa seed cake (*Moringa oleifera*) of traceable origin, this preservative-free, self-preserving glycerinic-aqueous extract combines traditional African knowledge with modern cosmetic science. It significantly accelerates the recovery of irritated skin, especially in combination with Skin Lipid Matrix SLM, making it a great choice for skin recovery and protection. **PC**

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