



From Nature To Nurture: How *Simmondsia Chinensis* Enhanced With Neem And Turmeric To Formulate Biocompatible Cleansing Agents.

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Abstract

The present study explores the potential of *Simmondsia chinensis*, more often known as jojoba oil, as an all-natural alternative to conventional skin-washing biocompatible treatments. Strong synthetic surfactants in many conventional cleansers interrupt the delicate balance of the skin and lead to dryness and irritation. This paper investigates the feasibility of producing effective cleaning agents from naturally existing moisturizing and non-comedogenic components, such as jojoba oil. The antioxidant, anti-inflammatory, and antibacterial characteristics of neem and turmeric make them a powerful tool in the fight against acne, alleviating inflammation, and promoting natural healing. Their active compounds aid in hydrating skin, balancing its tone, and fortifying it from within. Two formulations were developed and assessed: soap and a hand wash. Prioritizing skin compatibility drove the formulations to exclude powerful synthetic surfactants and preservatives. Analyzed were the pH, lathering capability, and stability of the compositions. First, skin compatibility was also assessed using volunteer assessments and side effect observation. According to the results, both jojoba oil-based formulations had excellent features. Though with very alkaline pH, the soap produced a constant lather and was well tolerated. The handwash, created in a skin-compatible acidic pH range, also exhibited excellent lathering properties and stability without aggravating skin. This paper highlights the potential of jojoba oil as a component for biocompatible skin cleansing solutions. The findings suggest that while jojoba oil may effectively cleanse the skin and lower the risk of irritation, it offers a milder replacement for conventional cleansers. More research will help to maximize formulations for different skin types and specialized uses and to negotiate long-term effects.

Keywords:

Jojoba oil is biocompatible, Skin cleansing, a Natural alternative, and has no Harsh synthetic surfactants, Irritation, Dryness, Effective cleansing agents, Moisturizing, Non-comedogenic, Soap, Handwash, pH, Lathering ability, Stability, Volunteer assessments, and Adverse reactions.

1. Introduction

The demand for biocompatible and sustainable personal care products is experiencing unprecedented growth in an era marked by heightened health consciousness and increased awareness of the environmental impact of synthetic chemicals (Ajayi et al., 2024). Although traditional cleansing products are effective at maintaining hygiene, they frequently contain harsh surfactants, artificial perfumes, and preservatives that can damage the skin's natural barrier and cause dryness, irritation, and possibly long-term health issues. There is also a pressing demand for greener alternatives because the manufacture and disposal of these traditional products pollute the environment.

The skin, the largest organ of the human body, acts as a crucial interface between the internal environment and the external world, providing a vital protective barrier against pathogens, toxins, and environmental stressors (Proksch et al., 2018). Maintaining the integrity of this barrier is paramount for overall health and well-being. The frequent use of harsh cleansing agents can strip away the skin's natural lipids and disrupt its delicate microbiome, compromising its protective function and potentially leading to various dermatological issues (Lemery et al., 2015).

Because of this greater awareness, there is a lot of interest in researching natural materials to develop biocompatible cleaning products that are not only effective at eliminating dirt and germs but also gentle on the skin and environmentally friendly. Plant-derived oils, with their natural cleansing qualities and skin-nourishing ingredients, have shown enormous promise in this endeavor. Jojoba oil, which is derived from *Simmondsia chinensis* seeds, is notable among them because of its distinct chemical makeup and exceptional skin compatibility.

Jojoba oil is a liquid wax ester that closely resembles human sebum rather than a triglyceride like the majority of plant oils. This structural similarity confers several advantages, including excellent emollience, non-comedogenicity (it doesn't clog pores), and the ability to regulate sebum production, making it suitable for a wide range of skin types (Pazyar et al., 2013). Furthermore, jojoba oil possesses inherent moisturizing, anti-inflammatory, and antioxidant properties, contributing to skin health and protection.

Considering these beneficial attributes, jojoba oil presents a compelling natural alternative for the formulation of biocompatible cleansing agents such as soap and hand wash. In contrast to conventional soaps, which often contain harsh alkaline salts of fatty acids that strip the skin of its natural oils, soaps made with jojoba oil may have a gentler cleansing effect in addition to emollient and moisturizing qualities. (Lin et al., 2017). When added to hand wash recipes, jojoba oil can help create a richer lather that conditions the skin and leaves it feeling supple and moisturized. However, when natural oils like jojoba oil are directly added to conventional cleansing formulas, issues may arise with foaming qualities, cleaning effectiveness against a wide range of bacteria, and general product stability. Therefore, innovative approaches and optimized formulations are required to harness the full potential of jojoba oil in creating effective and biocompatible cleansing agents. This research aims to address these challenges by investigating the feasibility of utilizing jojoba oil as a key ingredient in the development of soap and hand wash formulations that prioritize both cleansing efficacy and skin biocompatibility.

This study will investigate several ways to include jojoba oil into formulations and then look at how it affects the physicochemical attributes, such as antibacterial activity, viscosity, pH, and lather quality, of the finished goods. In addition, the research will assess the dermatological compatibility of the formulations through in vitro and maybe in vivo testing to make sure they are mild and won't harm the skin or interfere with its barrier function. To meet the increasing need for biocompatible alternatives, this research aims to provide scientific evidence supporting the use of jojoba oil in cleansing agent compositions. The ultimate goal is to aid in the creation of personal hygiene products that are more sustainable, gentler on the skin, and effective. The results

of this study could lead to a more eco-conscious personal care sector and better options for cleansing for consumers who are looking for kinder and more nutritious products.

2. Materials & Methodology

Mature jojoba seeds (*Simmondsia chinensis*) were handpicked from the arid Kolayat region of Bikaner, Rajasthan, known for high-quality yield. Seeds were thoroughly cleansed, air-dried, and stored in airtight containers at room temperature to protect their quality; along with that, they were also kept away from sunlight and humidity. Before cold-press extraction, seeds were cleaned again and mechanically crushed to enhance oil yield. The crushed seeds were immediately processed.

"The oil extraction process involved a cold-pressed method. To maintain the nutritional value and avoid any external substances, the temperature was carefully kept between 25 to 30 degrees Celsius. 250g of prepared seeds were used, yielding approximately 99 mL of extracted oil. Following this, a filtration process was employed to remove impurities and sediments, often relying on gravity for the separation of the remaining. We then stored the obtained oil in small black glass bottles to shield it from direct sunlight."

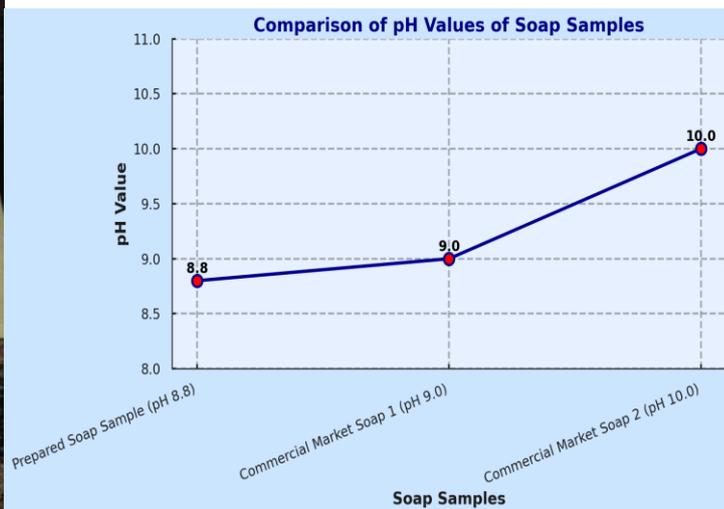
The soap-making started by gently melting a premade soap base, which already had a good amount of glycerin. We added a small amount of distilled water to achieve the desired consistency. Then came the star, our very own 100% natural jojoba essential oil, with quantities of 3 ml, 4 ml, and 5 ml used in three separate batches. For a lovely, vibrant yellowish-orange color and its natural germ-fighting powers, 1 gram of turmeric powder was mixed in. We also made another intriguing soap. This time, along with 3 ml of our jojoba oil, we added 0.5 ml of raw neem leaf extract. Neem is known for keeping things clean and fighting off bacteria and fungus, and it gives the soap a lovely green color. All the mixtures were stirred well until everything was evenly mixed, then poured into molds and left to harden. Then the soap is stored properly for testing and observation.

For Hand Wash

For hand wash preparation, a premade soap base was melted, followed by the addition of distilled water and a small amount of citric acid to achieve a skin-friendly pH range of 5 to 7. Glycerin was also incorporated to enhance skin moisturization. The ratio of soap base to the water mixture was maintained at approximately 7:1. Subsequently, varying concentrations of jojoba essential oil (2 ml, 3 ml, 4 ml, and 5 ml) was added to separate batches. To impart antimicrobial properties and natural color, a small quantity of turmeric powder was added to two batches, while neem leaf extract was added to the remaining two batches. All mixtures were thoroughly stirred to ensure homogeneity and then stored in closed containers.

3. OBSERVATION FROM SOAP TESTING PROCEDURES

3.1: pH test: To determine the mildness and skin-friendliness of the formulated jojoba oil-based soap, the pH of a 1% (w/v) solution was measured using universal indicator pH strips. The approximate recorded pH of the solution was observed to be 8.



3.2: Foaming Test: For the lathering test, a small piece of soap in 8 mL of water was agitated. The resulting foam height reached 2 cm and persisted for approximately 28 to 35 minutes. Qualitative aspects like foam texture were also noted.



3.3: Stability Test: To assess the soap's stability, samples were subjected to various environmental extremes for 15-20 days. These conditions included extreme cold (-2°C), high temperatures ($40-60^{\circ}\text{C}$), humid environments, and direct sunlight exposure. Upon thorough examination after this period, no visible signs of physical degradation were observed in any of the soap samples. Specifically, there were no instances of cracking, the development of spots, or the appearance of patches on the soap surfaces across all tested conditions, indicating excellent physical stability.



3.4: Skin Sensitivity Test: For the skin sensitivity test, five volunteers of varying ages used the jojoba oil-based soap on their hands. The test areas on their hands were checked for any negative reactions after each wash and water rinse. Throughout the testing period, none of the participants reported or exhibited any signs of skin irritation, itching, swelling, rashes, or hives. Instead, a mild and pleasant aroma, characteristic of jojoba oil and glycerine, was noted on the skin after washing. This suggests good initial skin compatibility for the formulated soap among the tested individuals.

HAND WASH

The formulated jojoba oil-based hand wash also underwent a series of tests to evaluate its properties and initial compatibility. The observations of these tests are presented below:



3.5 Stability Test:

Samples of the jojoba oil-based hand wash were stored at 50°C and -1°C for 10-15 days. Upon examination, no significant changes in color or the development of any foul odor were observed in the handwash samples under either temperature condition.

3.6 Lathering Ability:

A 1% (v/v) solution of the jojoba oil-based hand wash (10 mL of solution) produced a foam height of 3 cm upon agitation. The lather was described as nice and satisfactory for the intended use of a hand wash.

3.7 pH Assessment:

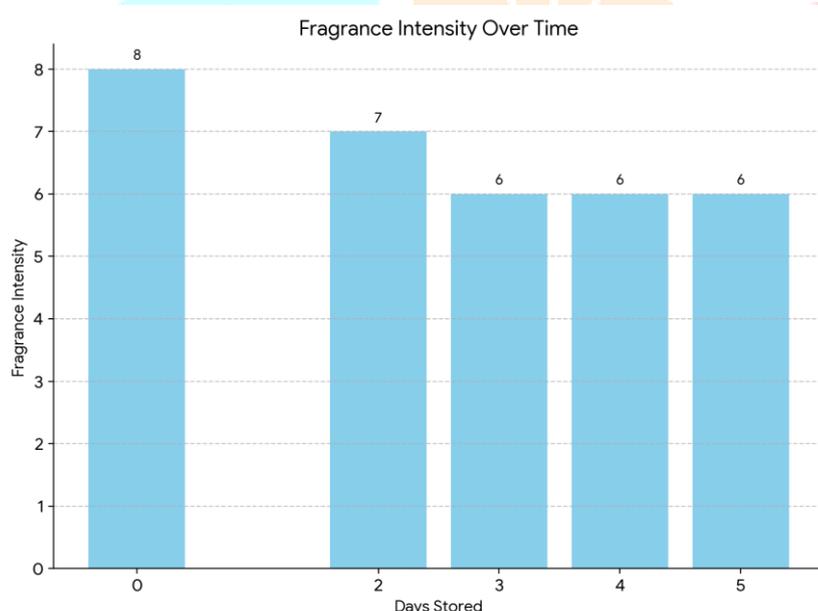
The pH of the jojoba oil-based hand wash was found to be between 4 and 5, as determined using pH indicator strips.

3.8 Skin Safety Test:

Five volunteers participated in the skin safety assessment of the jojoba oil-based hand wash. Following repeated use, none of the participants reported or exhibited any adverse skin reactions, such as rashes, itching, redness, swelling, or irritation.

3.9 Fragrance Stability Test:

Hand Wash samples stored for several weeks retained a noticeable fragrance. While a slight decrease in intensity might have occurred over the extended storage period, the overall fragrance remained intact and perceptible.



4. Results

The contemporary landscape of cleansing products is often characterized by formulations laden with harsh synthetic chemicals that, while effectively removing impurities, can inadvertently strip the skin of its vital moisture and disrupt its delicate protective barrier. This pervasive issue underscores a significant consumer need for gentler, nature-inspired alternatives that cleanse without compromising skin health. This research was passionately undertaken with the core objective of exploring the potential of natural, skin-friendly ingredients, with a particular focus on jojoba oil (*Simmondsia chinensis*), in the development of effective cleansing agents that consciously exclude aggressive components such as sodium lauryl sulfate (SLS), sodium dodecyl sulfate (SDS), and parabens, all known contributors to skin irritation and dryness.

The selection of jojoba oil as the cornerstone of our formulations was predicated on its remarkable affinity with human skin. Its unique chemical structure bears a striking resemblance to sebum, the skin's naturally produced oil, a characteristic that bestows upon it exceptional biocompatibility and the potential to bolster the skin's inherent moisture barrier (Aura Cacia, n.d.; NIVEA India, n.d.). This structural mimicry facilitates seamless integration into the skin's lipid matrix, delivering essential hydration without the heavy, greasy after-

feel often associated with other occlusive oils (Aura Cacia, n.d.; NIVEA India, n.d.). Its emollient properties further enhance its moisturizing capabilities by attracting and retaining water, thereby alleviating dryness, preventing flakiness, and improving overall skin suppleness (KNESKO, n.d.; WebMD, n.d.). This inherent moisturizing action is particularly crucial in cleansing formulations, where the very act of removing dirt and oil can inadvertently lead to dehydration.

Beyond its exceptional moisturizing attributes, jojoba oil presents a compellingly healthier profile. Its non-comedogenic nature ensures that it does not clog pores, rendering it suitable even for individuals with acne-prone skin (Aura Cacia, n.d.; NIVEA India, n.d.; Soulflower, n.d.). Furthermore, its non-allergenic properties significantly reduce the risk of skin irritation or adverse reactions, making it a well-tolerated ingredient across a spectrum of skin types, including sensitive skin (Soulflower, n.d.; Three Ships Beauty, n.d.; WebMD, n.d.). Jojoba oil is also a rich reservoir of vital nutrients, including vitamins A, B, and E, essential minerals like chromium, copper, and zinc, and a potent array of antioxidants (Fleur & Bee, n.d.; Ogee, n.d.; Soulflower, n.d.; Three Ships Beauty, n.d.). These bioactive compounds contribute to the nourishment and protection of the skin at a cellular level, promoting healthy skin function and overall radiance (Fleur & Bee, n.d.; Ogee, n.d.; Three Ships Beauty, n.d.).

The potential therapeutic applications of jojoba oil extend to the management of various skin conditions. Its inherent moisturizing and anti-inflammatory properties may offer soothing relief and help mitigate the symptoms associated with conditions such as eczema and psoriasis (Ogee, n.d.; WebMD, n.d.). Moreover, its antioxidant profile may contribute to the acceleration of wound healing processes and potentially reduce the formation of unsightly scars (Healthline, 2023; WebMD, n.d.).

An intriguing aspect of jojoba oil's interaction with the skin is its potential to regulate the skin's own sebum production (Healthline, 2023; Holland & Barrett, n.d.). Due to its remarkable similarity to natural sebum, the topical application of jojoba oil can send a signal to the skin that adequate oil levels are present, thereby potentially reducing the overactivity of the sebaceous glands, a key factor in the development of acne (Healthline, 2023; Holland & Barrett, n.d.).

In our experimental endeavor, the cold-pressed extraction of jojoba oil yielded a pure, golden liquid that served as the foundation for both our soap and handwash formulations. The resulting jojoba oil-based soap exhibited a pH of 8, a value consistent with many traditional, naturally derived soaps, and importantly, demonstrated excellent skin tolerance with no reports of irritation or adverse reactions from our panel of five volunteers across different age groups. Its lathering ability was deemed satisfactory for cleansing purposes, producing a stable foam that persisted for a significant duration (28-35 minutes). Furthermore, the soap maintained its physical integrity and appearance under a range of environmental stressors, exhibiting no cracking, spotting, or discoloration.

Similarly, the jojoba oil-based hand wash was meticulously formulated to achieve a skin-compatible pH range of 4 to 5, further emphasizing its gentle nature. This formulation also exhibited a satisfactory lathering profile, producing a foam height of 3 cm from a 1% solution. Crucially, the handwash demonstrated excellent skin safety, with none of the five volunteers reporting any adverse reactions such as rashes, itching, redness, swelling, or irritation. The stability tests conducted on the handwash revealed no significant changes in color or the development of any unpleasant odors, even when subjected to temperature extremes. Notably, the subtle, natural fragrance of jojoba oil remained discernible in the hand wash samples even after several weeks of storage, indicating a degree of fragrance stability.

These encouraging observations strongly support the initial premise of this research: that jojoba oil, with its unique biocompatibility and inherent skin-loving properties, can serve as a cornerstone ingredient in the development of effective and, more importantly, skin-friendly cleansing agents. By consciously excluding harsh synthetic surfactants and preservatives, these formulations represent a tangible step towards providing

consumers with alternatives that cleanse without compromising the skin's natural balance and comfort. While these initial findings are promising, they underscore the need for further, more comprehensive studies, including long-term usage trials and quantitative assessments of skin hydration levels and barrier function, to fully elucidate the skin-conditioning benefits of these naturally derived cleansing products. Ultimately, this research contributes to a growing body of evidence that suggests a harmonious path forward in personal care, where effective cleansing and genuine skin health can coexist.

5. Discussion

A. Interpretation of Findings

1. Biocompatibility and efficacy:

Both jojoba oil soap and handwash showed promise. The soap, despite slight alkalinity, was well-tolerated, likely due to jojoba oil's sebum-like properties, and produced stable lather. The handwash, formulated at a skin-compatible acidic pH, also demonstrated good lathering, stability across temperatures, and no irritation, crucial for barrier function and preventing microorganism growth. The persistence of jojoba oil's fragrance suggests stable, beneficial components.

2. Comparison with existing literature:

Our findings align with jojoba oil's known skin-friendly properties. Its non-comedogenic nature (Aura Cacia, n.d.; NIVEA India, n.d.) suits acne-prone skin, and its moisturizing and emollient effects (KNESKO, n.d.; WebMD, n.d.) likely explain the lack of irritation. The acidic pH of our handwash aligns with the industry trend towards biocompatible cleansers that maintain the skin's natural defenses.

B. Implications of the Research

1. Potential of jojoba oil in biocompatible cleansers:

Jojoba oil shows significant potential for a new generation of biocompatible cleansers. Its moisturizing, non-comedogenic, and non-allergenic properties make it a strong alternative to harsh synthetics like SLS and SDS, offering effective cleansing in solid and liquid formulations without adverse effects.

2. Implications for industry and consumers:

This research provides a rationale for the personal care industry to adopt jojoba oil, meeting rising consumer demand for natural, sustainable products. It also empowers consumers to make informed choices, seeking products that prioritize skin health.

3. Benefits for sensitive skin and environmental concerns:

Jojoba oil cleansers offer particular benefits for sensitive skin, minimizing the irritation and dryness often caused by conventional products. Their natural, plant-derived nature also aligns with the growing preference for eco-friendly and sustainable options.

C. Limitations of the Study

1. Limitations:

The small volunteer panel limits the generalizability of our skin compatibility findings. The study's short duration means long-term effects on skin health remain unassessed. We also did not quantitatively analyze the antimicrobial properties of components like turmeric and neem.

6. Suggestions for Future Research Aspects

Building on our findings and acknowledging the study's limitations, several key research directions emerge. A fascinating avenue would be to explore how different sources of jojoba oil – perhaps varying by geographical origin or extraction method – might influence the final product's characteristics and its interaction with the skin.

Formulation optimization also holds great promise. Investigating synergistic combinations of jojoba oil with other natural ingredients, celebrated for their skin-soothing or antimicrobial properties, could lead to enhanced efficacy and broader benefits.

To truly understand the long-term impact on skin health, rigorous clinical studies are essential. These should involve larger, more diverse participant groups and extend over longer periods to assess sustained effects on skin hydration, barrier function, and overall skin well-being.

Finally, delving deeper into the antimicrobial potential of our formulations, particularly those enriched with turmeric and neem, would be valuable. Quantitatively analyzing their effectiveness in reducing skin bacteria could further validate their use in promoting skin health. Exploring the potential of jojoba oil-based cleansers for specific skin conditions, like eczema or psoriasis, through targeted clinical trials, could also be transformative.

7. Conclusion

This research embarked on a journey to explore the potential of jojoba oil as a cornerstone for skin-friendly cleansing agents, seeking to move away from the harsh synthetic chemicals that often dominate the personal care landscape. Our investigation has yielded several key findings that illuminate this potential, suggesting a promising path forward for biocompatible cleansing formulations.

A. Summary of Key Findings

1. Briefly restate the main findings of our research.

Our study demonstrated that both a jojoba oil-based soap and handwash can be formulated successfully, exhibiting favorable characteristics in terms of pH, lathering ability, and stability. Importantly, these formulations showed excellent skin compatibility in our initial volunteer assessments, with no significant adverse reactions observed. This suggests that jojoba oil can effectively cleanse the skin without causing the irritation or dryness often associated with conventional cleansing products.

B. Achievement of Research Objectives

1. Discussion on whether our research objectives were met.

We believe that the research objectives, as initially defined, have been substantially met. We set out to investigate the feasibility of developing cleansing agents using jojoba oil, consciously excluding harsh synthetic surfactants and preservatives. The successful formulation and preliminary evaluation of both a soap and a hand wash that meet these criteria indicate that our primary objective has been achieved. The positive skin compatibility results further support the potential of jojoba oil as a biocompatible cleansing agent.

C. Final Remarks

1. Offering concluding thoughts on the significance of our work and the potential of jojoba oil in biocompatible cleansing formulations.

In conclusion, this research offers a compelling glimpse into the potential of jojoba oil to revolutionize the way we approach cleansing. By prioritizing biocompatibility and harnessing the inherent skin-loving properties of this natural oil, we have demonstrated the feasibility of creating effective cleansing agents that are both gentle and sustainable. This work carries significant implications for the personal care industry, suggesting a move towards formulations that respect the skin's delicate balance while minimizing environmental impact.

The positive results from our initial evaluations pave the way for further exploration and development of jojoba oil-based cleansers, potentially offering a welcome alternative for individuals with sensitive skin and those seeking more natural and eco-conscious personal care choices. As we continue to deepen our understanding of this remarkable natural ingredient, the future of cleansing may well lie in the gentle, nourishing power of jojoba oil.

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