The Chemist
Journal of the American Institute of Chemists

Characterization, Chemical Composition and Cream Formulation from the Seed Butter of *Mangifera indica* L.

Asiata Joke Aliyu[a] , Sulyman Olalekan Ibrahim[b] , Kaothar Abdulmumeen[a], Olubunmi Atolani[a]

[a]*Department of Chemistry, University of Ilorin, Ilorin, Nigeria*
[b]*Department of Industrial Chemistry, University of Ilorin, Ilorin, Nigeria*

Corresponding author: Sulyman Olalekan Ibrahim
(E-mail: ibrahim.sio@unilorin.edu.ng; Phone: +2348137279388)

Abstract: Many individuals worldwide aspire to maintain beautiful skin and hair, making the use of safe cosmetic products essential. The objective of this study was to assess the viability of utilizing mango seed butter, a byproduct of juice production, for the environmentally friendly production of cosmetic items. The study examines the composition of fatty acids and the ability of mango seed butter to reduce inflammation in a laboratory setting. We acquired the oil using solvent extraction, using n-hexane as the solvent, and then underwent transesterification via methanolysis to yield fatty acid methyl esters. The fatty acid composition was determined using gas chromatography-mass spectrometry (GC-MS). The oil contains four primary fatty acids: oleic acid (35.715%), palmitic acid (29.365%), stearic acid (25.397%), and docasadienoic acid (11.905%). Topical cream was prepared using seed butter and its ability to reduce albumin denaturation was tested. The results showed that both the seed butter and formulations had dose-dependent effects similar to the standard indomethacin, especially at lower seed butter concentrations. The findings suggest that mango seed butter, which is typically considered a waste product, shows potential in the development of both safe and cost-effective natural cosmetics.

Key Words: *Mangifera indica L*, cream, transesterification, methanolysis, anti-inflammatory, formulation

1. Introduction

Organic cosmetics that incorporate bioactive phytochemical substances provide significant beauty and pharmacological benefits while minimizing harm to users and the environment. Researchers also found that herbal cosmetics incorporate natural bioactive substances like antioxidant, anti-cancer, and antibacterial properties, which may aid in a variety of skin ailments. Phytochemicals, including vitamins, proteins, tannins, terpenoids, and other bioactive compounds, have the ability to revitalize, refresh, and safeguard the skin against different skin conditions [1,2]. On a daily basis, nearly all individuals use cosmetics, a widely-used chemical preparation [2].

Lately, there has been a shift in focus towards natural goods due to the harmful consequences of synthetic cosmetic products. The use of natural goods is steadily increasing worldwide due to their perceived enhanced safety and fewer negative side effects compared to synthetic alternatives [3]. Organic products contain potent antioxidants, vitamins, and other bioactive substances derived from natural sources, which effectively decelerate the skin aging process [4].

Mango, scientifically referred to as *Mangifera indica* L., is a highly significant tropical fruit belonging to the *Anacardiaceae* family. The increasing consumer demand led to a continuous expansion of global output, reaching its highest point to date at 47 million metric tons in 2016 [6]. People extensively grow the mango tree, a tropical fruit tree, because of its juicy and flavorful characteristics. However, beyond its well-known fruits, the mango tree offers a multitude of other components that remain largely unexplored in terms of their potential applications. An example of such a component is the seed, which makes up a substantial proportion of the fruit's weight. Traditionally, the fruit processing sector has viewed mango seeds as byproducts and disposed of them without realizing their untapped potential [6].

The chemical composition of mango seed butter suggests that it has the ability to function as an emollient, moisturizer, and enhancer of the skin's barrier. The cosmetics business is highly interested in these features as it strives to address the growing consumer demand for safer and more ecologically friendly goods. This industry is progressively seeking more natural and sustainable components [8,9]. Consumer tastes in the worldwide cosmetics and skincare sector have changed to favor products containing natural and plant-based components. Concerns about safety and the environmental effects of synthetic substances drive this movement [4].

The current trend has opened up possibilities for investigating the use of mango seed butter in skincare products, specifically creams and lotions. Nevertheless, despite the increasing interest, there is a scarcity of extensive studies that investigate the chemical makeup of mango seed butter and its potential advantages in beauty applications. Studies have demonstrated that using mango seed butter can improve skin moisturization and flexibility, both of which are essential elements in skin health preservation. Creams and lotions are essential elements of skincare routines, including moisturization, shielding, and specific therapy. The development of these goods entails meticulous consideration of chemical selection, such as emulsifiers, stabilizers, thickeners, and active substances. Attaining the appropriate equilibrium among these constituents is crucial for producing goods with favorable sensory characteristics, durability, and effectiveness [14].

Comprehending the scientific principles underlying cream composition is essential for integrating components such as mango seed butter into skincare products. This study aimed to analyze the properties of an underused mango seed oil, assess its potential for cosmetic applications, and measure its anti-inflammatory effects.

2. Materials and Methods

Sample Collection and Preparation

The mango seed (*M. indica* L.) was obtained from Ilorin, Kwara State, Nigeria, during the fruiting season in February 2022. We sent the plant sample to the herbarium of the Department of Plant Biology at the University of Ilorin in Ilorin, Nigeria, for standard identification and authentication. Mr. Bolu Ajayi assessed the sample and assigned it a voucher specimen number, UILH|001|969|2023. Following the verification process, we removed the outer shell of the seed material. We then dried the inner part, known as the endocarp, at room temperature (26-28ºC), crushed it into a powder, and stored it for future use.

Oil Extraction

The *M. indica* seed material was finely ground and then underwent many rounds of thorough Soxhlet extraction at a temperature of 60ºC using n-hexane. We condensed the consolidated extract using a vacuum rotary evaporator at a lower temperature to yield the oil.

Physicochemical characterization

The oil's physicochemical properties, including color, iodine value, and acid value, using standard methods and necessary minor adjustments, were made when needed [2,12].

GC-MS Analysis

Analyzing the fatty acid content of the trans-esterified oil was done using an Agilent Technology 7890A gas chromatograph GC-FID, which was equipped with a fused silica capillary column. We determined the fatty acid profile of the FAMEs by comparing their MS spectra with data from the National Institute of Standards and Technology (NIST, 2008) database. The relative proportions of the constituent chemicals were calculated as percentages derived from the peak regions obtained from the gas chromatography (GC) analysis, using the total ion chromatogram (TIC).

Formulation of Cream

The cream was formulated using bee wax as the emulsifier, tocopherols, water, and glycerine. Bee wax was heated with tocopherols, water, and glycerine in a beaker using a hot plate before adding the mango butter. The experiment was replicated using varying quantities of mango butter seed oil. We transferred the concoctions into various receptacles to solidify and preserve them (Table 1). The products underwent a stability test and evaluation for a duration of 70 days.

Table 1. Formulation of Cream from Mango Seed Oil

Formulations	Bee Wax (g)	Water (ml)	Tocophenols	Glycerine (ml)	Mango Butter
F1	1.0	5.0	0.2	4.0	1.0
F2	1.0	5.0	0.2	4.0	2.0
F3	1.0	5.0	0.2	4.0	3.0
F4	1.0	5.0	0.2	4.0	4.0
F5	1.0	5.0	0.2	4.0	5.0

3. Results and Discussion

The physicochemical characteristics of different formulated creams made from *Magnifera indica* seed butter are shown in Table 2. As shown in the table, the seed has a moderate oil yield of 14%. The low yield suggests blending the oil with other oils for cream production. The low saponification value of 78 mgKOH/g indicates its low ability to be used in soap making and justifies its use in cream making. The low saponification value can also be attributed to the presence of higher molecular weight fatty acids (this was confirmed in Table 4, showing the fatty acid composition of the seed oil). The presence of docasadienoic acid contributes to the obtained low saponification.

Table 2. Physicochemical Properties of *Magnifera indica* Seed

Parameters	Mango butter
Colour	Pale Yellow
% Oil Yield	14
Saponification value (MgKOH/g)	78
Acid value (MgKOH/g)	20.98
Iodine value (g of I_2/100g)	61.50
Free fatty acid (MgKOH/g)	10.49
Physical State at room temperature (26-28ºC)	Solid

A high iodine value is an indicator of a high degree of unsaturation. The fact that the oil shows a low iodine value of 61.50 g of I_2/100g was equally confirmed by instrumental analysis done using GC-MS, which confirmed the oil is highly saturated with a degree of saturation of 54.762% (Table 4). The low free fatty acid content of 10.49 mgKOH/g is a good indication of the quality of the oil and its shelf life [16]. Table 3 shows the stability test results for the prepared cream throughout the 70-day evaluation. The cream consistently displays a smooth texture and retains its pale-yellow coloration. This indicates the cream's stability, which the natural bioactive components of the seed oil may contribute to. This demonstrates that seed oil has good viability as a base oil in cream production.

Table 3. Cream Stability Test Results

Oil conc.	Production Date	Observation Date	Texture	Color
1g	June 12, 2023	14 days	Smooth	Pale yellow
2g	June 12, 2023	28 days	Smooth	Pale yellow
3g	June 12, 2023	42 days	Smooth	Pale yellow
4g	June 12, 2023	56 days	Smooth	Pale yellow
5g	June 12, 2023	70 days	Smooth	Pale yellow

Table 4 gives the fatty acid composition of the seed oil. Oleic acid accounts for a large percentage of the seed oil at 35.715%, followed by palmitic acid (29.365%) and stearic acid (25.397%). The oil shows a high degree of saturation (54.762%), which may explain why it is solid at room temperature (26-28ºC). Oleic acid, which is the most abundant fatty acid in the seed oil, has been reported for its ability to enhance smoothness and softness of the texture as well as maintain skin moisture [17,18]. The oil may have consistently demonstrated a smooth texture throughout the 70-day stability test periods due to its presence. The ability to prevent the denaturation of albumin is a good indicator of anti-inflammatory action. It is a good quality for a cream to have a mild ability to reduce inflammation on the skin. The bioactive principles in seed oil often confer the same medicinal properties on the products; research by [15] shows seed oil products often retain their pharmacologic properties, hence why the prepared oil was screened for their anti-inflammatory properties.

Table 4. Chemical Composition GC-MS Analysis of Fatty Acid in *Magnifera indica*

R.T. (min)	Fatty acid	Saturations	% Composition
18.32	Palmitic acid	16:0	29.365
20.34	Docasadienoic acid	22:2	11.905
20.45	Oleic acid	18:1	35.715
20.82	Stearic acid	18:0	25.397
	Total Saturate		**54.762**
	Total Unsaturated		**45.238**

RT: Retention Time

Table 5 shows the anti-inflammatory potentials of formulated mangoes seed oil cream and indomethacin drug used as Standard control. Figure 1 gives a better graphical illustration of the analysis.

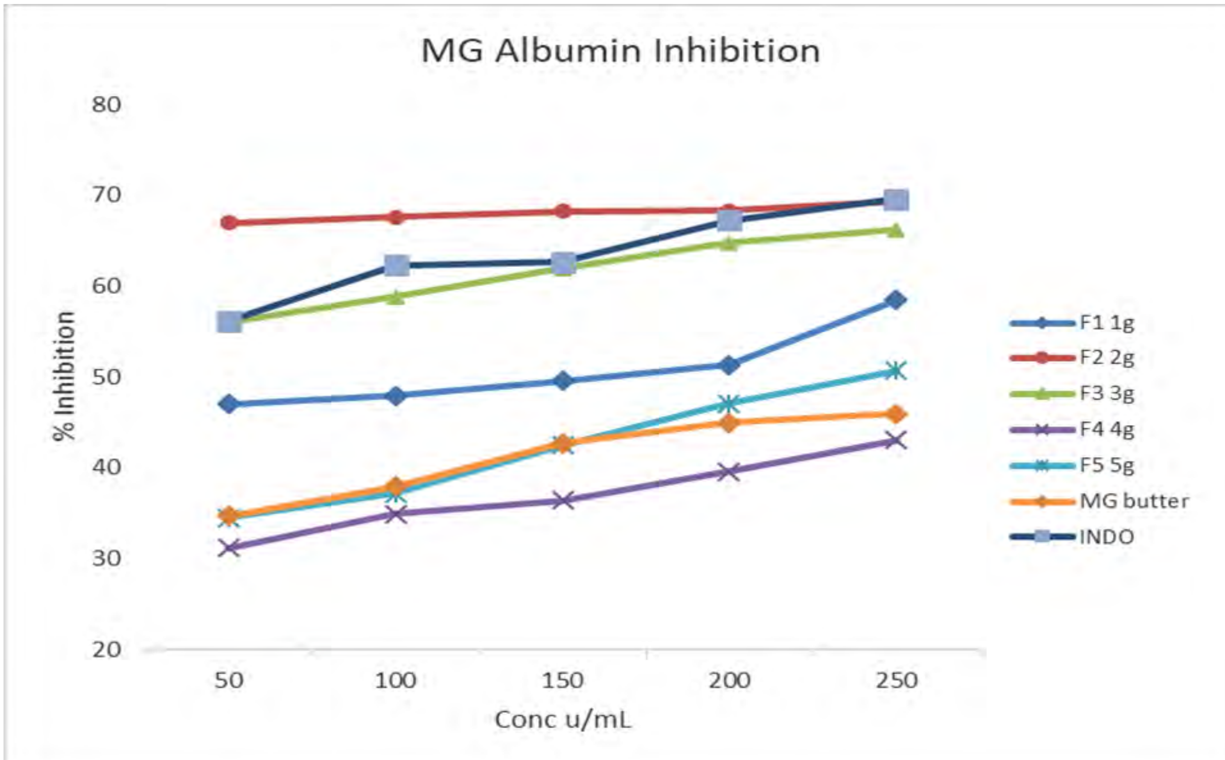

Figure 1. Percentage of Inhibition

From the results obtained, F2 cream gave the best ability to reduce skin inflammation when used as a cream, better than indomethacin used as the control, while the abilities of F3 and F1 are comparable to indomethacin used as the standard. This implies that mango seed oil works best when incorporated at a ratio of 1-3 g and that the cream has a good viability as an anti-inflammatory cream.

Table 5. Albumin-denaturation Inhibition Activity of Formulated Cream

Conc. u/mL	F1	F2	F3	F4	F5	MGB	INDSTD
50	47.02±1.79	66.10±2.02	56.05±0.39	31.14±0.91	34.53±0.69	34.70±0.52	56.15±0.41
100	47.95±0.50	67.60±1.37	58.84±0.54	34.92±0.42	37.21±0.29	37.99±1.09	62.28±0.39
150	49.59±0.53	68.25±1.62	61.96±0.14	36.39±0.14	42.40±0.77	42.75±0.57	62.67±0.39
200	51.34±0.39	68.31±0.66	64.81±1.13	39.63±0.11	47.13±0.82	44.99±1.66	67.26±0.81
250	58.51±0.71	69.29±0.74	66.17±2.67	43.08±0.21	46.25±0.14	45.97±1.07	69.56±0.14

4. Conclusion

Different variety cream blends were produced and screened from *Magnifera indica* L. seed butter for their potential to reduce skin inflammation when used as body cream from their albumin-denaturation inhibition activity. When administered as a cream, F2 cream showed superior efficacy in reducing skin inflammation compared to the control, indomethacin. The efficacy of the F3 and F1 creams was comparable to the standard indomethacin. This suggests that *Magnifera indica* L. seed butter is a viable alternative as a base oil in body cream production. Its use will reduce year-round seed waste and improve the community's economic activities with good mango tree reserves.

5. References

1. Joshi LS, Pawar HA. Herbal cosmetics and cosmeceuticals: An overview. *Nat. Prod. Chem. Res.*, 2015, 3(2), 170.
2. Atolani O, Olabiyi ET, Issa AA, Azeez HT, Onoja EG, Ibrahim SO, Zubair MF, Oguntoye, OS, Olatunji GA. Green synthesis and characterisation of natural antiseptic soaps from the oils of underutilised tropical seed. *Sustainable Chem. Pharm.*, 2016, 4, 32-39.
3. Alaiya MA, Odeniyi MA. Utilisation of *Mangifera indica* plant extracts and parts in antimicrobial formulations and as a pharmaceutical excipient: A review. *Future J. Pharm. Sci.*, 2023, 9(1), 29.
4. Khan ZU, Khan T, Mannan A, Ali A, Ni J. *In vitro* and *ex vivo* evaluation of *Mangifera indica* L. extract-loaded green nanoparticles in topical emulsion against oxidative stress and aging. *Biomedicines*, 2022, 10(9), 2266.
5. Lieb VM, Schuster LK, Kronmüller A, Schmarr H-G, Carle R, Steingass CB. Fatty acids, triacylglycerols, and thermal behaviour of various mango (*Mangifera indica* L.) kernel fats. *Food Res. Int.*, 2019, 116, 527-537.
6. Escobar LO, Landázuri A, Arroyo E, Gualle A, Andino C, Landázuri AC, "Mango (*Mangifera indica* L.) By-products for Food, Cosmetics and Water Treatment Applications: A Zero-waste and Biorefinery Approach with Classic and New Generation Solvents", 2020 Virtual AIChE Annual Meeting, 2020.
7. Nadeem M, Imran M, Iqbal Z, Abbas N, Mahmud A. Enhancement of the oxidative stability of butter oil by blending with mango (*Mangifera indica* L.) kernel oil in ambient and accelerated oxidation. *J. Food Process. Preserv.*, 2017, 41(3), e12957.
8. Wu S, Tokuda M, Kashiwagi A, Henmi A, Okada Y, Tachibana S. Evaluation of the fatty acid composition of the seeds of *Mangifera indica* L. and their application. *J. Oleo Sci.*, 2015, 64(5), 479-484.
9. Atolani O, Adamu N, Oguntoye O, Zubair M, Fabiyi O, Oyegoke R, Adeyemi OS, Areh ET, Tarigha DE,

Kambizi L, Olatunji GA. Chemical characterization, antioxidant, cytotoxicity, anti-toxoplasma gondii and antimicrobial potential of the *Citrus sinensis* seed oil for sustainable cosmeceutical production. *Heliyon*, 2020, 6, e03397-e03408.
10. Swaroop A, Bagchi M, Moriyama H, Bagchi D. Health benefits of mango (*Mangifera indica* L.) and mangiferin. *Jpn. J. Med.*, 2018, 1(2), 149-154.
11. Awolu OO, Manohar B. Quantitative and qualitative characterization of mango kernel seed oil extracted using supercritical CO_2 and solvent extraction techniques. *Heliyon*, 2019, 5(12).
12. Fahimdanesh M, Bahrami ME, eds., "Evaluation of Physicochemical Properties of Iranian Mango Seed Kernel Oil", International Conference on Nutrition and Food Sciences, 2013.
13. Zubair MF, Ibrahim OS, Atolani O, Hamid AA. Chemical composition and nutritional characterization of cotton seed as potential feed supplement. *J. Turk. Chem. Soc., Sect. A*, 2021, 8(4), 977-982.
14. Braca A, Siciliano T, D'Arrigo M, Germanò MP. Chemical composition and antimicrobial activity of *Momordica charantia* seed essential oil. *Fitoterapia*, 2008, 79(2), 123-125.
15. Zubair MF, Atolani O, Ibrahim SO, Oguntoye OS, Oyegoke RA, Olatunji GA. Fatty acids composition, antimicrobial potential and cosmeceutical utilization of *Prosopis africana* seed oil. *J. Mex. Chem. Soc.*, 2018, 62(3), 39-50.
16. Ivanova M, Hanganu A, Dumitriu R, Tociu M, Ivanov G, Stavarache C, Popescu L, Ghendov-Mosanu A, Sturza R, Deleanu C, Chira N-A. Saponification value of fats and oils as determined from 1H-NMR data: The case of dairy fats. *Foods*, 2022, 11(10), 1466.
17. Singh A, Maheshwari S. Formulation and evaluation of ferulic acid and oleic acid containing liposomal gel for skin nourishment. *Intell. Pharm.*, 2023.
18. Suryadevara V, Doppalapudi S, Reddivallam LCS, Anne R, Mudda M. Formulation and evaluation of anti-inflammatory cream by using Moringa oleifera seed oil. *Pharmacogn. Res.*, 2018, 10(2).

