International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Check for updates

Formulation of a facial serum using the seed and pulp of *Carica papaya (Caricaceae) and Persea americana (Lauraceae)*

Okorie Ogbonna, Ucheokoro Adaeze S.*, Nwaogu Onyekachi L. and Abali Sunday O.

Department of Pharmaceutics and Pharmaceutical Technology, Faculty of Pharmaceutical Sciences, University of Port Harcourt, Port Harcourt 500004, Nigeria.

International Journal of Science and Research Archive, 2026, 19(01), 900-919

Publication history: Received on 06 March 2026; revised on 15 April 2026; accepted on 17 April 2026

Article DOI: https://doi.org/10.30574/ijsra.2026.19.1.0792

Abstract

Background: The increasing demand for safe, affordable, and natural skincare products has driven interest in plant-based cosmetic formulations, particularly in regions where imported products are costly and often contain harmful synthetic additives. Tropical fruits such as *Carica papaya* (pawpaw) and *Persea americana* (avocado) are rich in bioactive compounds, including vitamins, fatty acids, and antioxidants, which offer significant dermatological benefits such as skin hydration, rejuvenation, and protection against oxidative stress.

Objectives: This study aimed to formulate and evaluate facial serums using oils derived from the seed and pulp of *Carica papaya* and *Persea americana*, and to assess their physicochemical and organoleptic properties for suitability in skincare applications.

Methods: Avocado pulp and pawpaw (seed and pulp) were processed using cold maceration in sunflower oil to obtain infused oils. These oils were blended with rosehip oil, grapeseed oil, vitamin E oil, and lemongrass essential oil to produce serum formulations at varying concentrations (60%, 65%, and 70%). The formulations were evaluated for organoleptic properties (colour, odour, texture, homogeneity, and washability), pH, viscosity, and torque using standard laboratory methods. Stability and uniformity were assessed over a 30-day period.

Results: The formulated serums exhibited desirable organoleptic properties, with the pawpaw serum showing a golden-yellow colour and the avocado serum a light green hue. Both formulations had pleasant fragrances, smooth textures, and excellent homogeneity with no phase separation. The pH ranged from 3.3 to 4.5, indicating mild acidity compatible with skin physiology. Viscosity values ranged from 5.00 to 10.00 cP, reflecting light to moderate consistency suitable for topical application, while low torque values (0.2–0.4%) confirmed good spreadability. Statistical analysis showed low variability, indicating formulation stability and reproducibility.

Conclusion: The study demonstrated that avocado and pawpaw oils can be effectively utilized to develop stable, skin-friendly facial serums with desirable physicochemical and sensory properties, offering a cost-effective and natural alternative to conventional skincare products.

Keywords: Facial serum; Carica papaya; Persea americana; Natural cosmetics; Physicochemical evaluation

1. Introduction

The skin serves as the body's first line of defense against environmental aggressors such as ultraviolet (UV) radiation, pollutants, and microbial invasion.[1] Prolonged exposure to these factors accelerates oxidative stress, premature aging,

* Corresponding author: Ucheokoro Adaeze S

and various dermatological concerns such as hyperpigmentation, dryness, and loss of elasticity.[2] As a result, skincare has become an essential aspect of daily self-care, with consumers seeking products that are effective, safe, and affordable.

In Nigeria and across Africa, the skincare industry is largely dominated by imported and chemically manufactured products, many of which contain synthetic preservatives, artificial fragrances, and petrochemical derivatives.[3,4] These products are often priced beyond the reach of the average Nigerian, creating a barrier to consistent skincare routines.[5]

Furthermore, the foreign exchange rate fluctuations and import taxes contribute to higher retail prices, making quality skincare a luxury for many households.[7]

Tropical fruits such as avocado (*Persea americana*) and pawpaw (*Carica papaya*), widely cultivated in Nigeria and other African countries, present an opportunity to develop locally sourced, natural skincare products that are both cost-effective and beneficial. Avocado oil is rich in monounsaturated fatty acids, vitamins A, D, and E, and phytosterols, which enhance skin hydration and barrier function.[7,8]

Pawpaw seed oil contains papain, oleic acid, vitamins A and C, and bioactive compounds that promote gentle exfoliation, skin renewal, and antimicrobial effects.[9,10]

By leveraging these locally available raw materials, it is possible to produce high-quality facial serums that cater to the unique climatic and economic realities of Nigerian consumers, while reducing dependence on imported formulations. The Nigerian skincare and cosmetic market is currently characterized by a paradox of high consumer demand and limited accessibility to safe, high-quality products. Despite the growing beauty consciousness among Nigerian consumers, particularly women and urban youth, access to effective and affordable skincare remains restricted due to several interlinked socioeconomic and industrial challenges.

In addition to the economic barriers, there is a growing health concern associated with the chemical composition of many main-stream and imported cosmetic products. Mass-market formulations often contain synthetic preservatives, parabens, phthalates, sulfates, and artificial fragrances, which have been linked to endocrine disruption, skin irritation, and carcinogenic effects.[11] These ingredients can cause cumulative harm, particularly when used in the tropical Nigerian climate where high humidity and sun exposure intensify chemical reactions on the skin.

Furthermore, the lack of stringent local regulation and quality assurance in Nigeria's cosmetic market allows substandard and counterfeit products to thrive. Many of these are packaged as "whitening" or "toning" creams that promise fast results but contain harmful agents like hydroquinone and mercury compounds.[3] This creates a dual public health problem, the economic inaccessibility of safe products and the health hazards of unsafe ones.

These challenges have created a pressing need for safe, affordable, and locally manufactured skincare solutions. A shift toward using indigenous plant resources offers a path toward sustainability and accessibility. Nigeria's tropical biodiversity, featuring plants such as avocado (*Persea americana*) and pawpaw (*Carica papaya*), provides an abundant source of natural oils rich in vitamins, fatty acids, and antioxidants beneficial to the skin.

Developing facial serums based on these locally sourced oils could address both the economic and health-related challenges of Nigeria's skincare market. Beyond affordability, such innovation aligns with the growing consumer preference for organic and plant-based cosmetics across Africa.[12] It also supports Nigeria's industrialization agenda by promoting local research, reducing import dependency, and fostering domestic cosmetic production.

In essence, this research is both scientifically and socioeconomically justified. It seeks to demonstrate that Nigeria's indigenous resources can serve as reliable foundations for modern skincare formulations that are affordable, safe, and sustainable. By exploring the potential of avocado and pawpaw oils, the study bridges the gap between local agricultural production and cosmetic innovation, contributing to the development of a more self-reliant, health-conscious, and eco-friendly skincare industry in Nigeria. This study aimed to formulate and evaluate a natural facial serum using locally sourced avocado and pawpaw seed oils, with complementary natural excipients, as a cost-effective and safe alternative to imported skincare products in Nigeria.

2. Methods

2.1. Primary Raw Materials

Fresh, ripe avocado fruits *Persea americana* (4 fruits ≈ 200 g pulp), and fresh, ripe pawpaw fruits *Carica papaya* (4 fruits ≈ 200 g pulp) sourced from local markets.

- Sunflower oil (600ml) — Carrier oil, cold pressed.
- Rosehip oil (*Rosa canina*) — cosmetic grade, cold-pressed.
- Grapeseed oil (*Vitis vinifera*) — cosmetic grade, cold-pressed.
- Vitamin E oil (*Tocopherol*) — antioxidant and preservative.
- Essential oil (*Lemon grass fragrance oil*) — for fragrance and antimicrobial properties.

2.2. Other Materials

- Muslin cloth or cheesecloth (for filtration)
- Amber glass bottles (for oil storage and final serum packaging

2.3. Method of Extraction

2.3.1. Avocado Oil Extraction (Cold Press Method)

Selection and Preparation of Fruits: Four ripe, undamaged avocado fruits were obtained from a local market in Nigeria. The fruits were washed under running water to remove dirt and surface contaminants. Each avocado was cut open, the seeds removed, and the pulp scooped out using a clean spoon.

2.3.2. Maceration (Infusion) Process

The avocado pulp was mashed into a smooth consistency using a clean spoon to increase surface area. Approximately 200 g of pulp was transferred into a clean glass jar. A 600 mL of sunflower oil was poured into the jar to fully submerge the pulp, maintaining a 1:3 (w/v) ratio of fruit to oil. The jar was tightly sealed and kept at room temperature (25–28 °C) for 7 days, with gentle shaking twice daily to promote the diffusion of active components into the carrier oil.

2.3.3. Filtration

After one week, the mixture was filtered through a muslin cloth to separate the oil from the pulp residue. The filtrate was collected in a clean beaker. The yield obtained was approximately 500 mL of avocado-infused oil after accounting for absorption losses.

2.3.4. Storage

The infused oil was transferred into transparent plastic bottles to protect it from light-induced oxidation. The bottles were labeled and stored in a cool, dark environment away from sunlight.

Pawpaw Oil Extraction (Cold Press Method)

Selection and Preparation of Fruits: Three to four ripe pawpaw fruits were sourced from local farms in Nigeria. The fruits were washed thoroughly with distilled water to remove surface impurities. Each fruit was peeled, and both the pulp and seeds were cut into small pieces to expose more surface area for infusion.

Maceration (Infusion) Process: Approximately 200 g of whole pawpaw fruit (pulp + seeds) was placed in a clean glass jar. A 600 mL of sunflower oil was added to completely submerge the fruit pieces, maintaining a 1:3 (w/v) ratio. The mixture was covered tightly and kept at room temperature (25–28 °C) for 7 days. During this period, the jar was shaken gently twice daily to enhance extraction and prevent microbial growth.

Filtration: After 7 days, the infused oil was sieved through a muslin cloth to remove fruit residues. The filtrate was collected into a beaker, yielding approximately 500 mL of pawpaw-infused oil after filtration.

Storage: The oil was transferred into transparent plastic bottles, sealed, labeled, and stored at in a coll, dark room away from sunglight.

2.4. Method of Formulation

Table 1 Avocado Oil Serum (% W/W)

1st Concentration (%w/w)	2nd Concentration (%w/w)	3rd Concentration (%w/w)
Avocado oil – 70%	Avocado oil – 65%	Avocado oil – 60%
Rosehip oil – 17.5%	Rosehip oil – 15%	Rosehip oil – 12.5%
Grapeseed oil – 17.5%	Grapeseed oil – 15%	Grapeseed oil – 12.5%
Vitamin E oil – 3%	Vitamin E oil – 3%	Vitamin E oil – 3%
Lemongrass fragrance oil – 2%	Lemongrass fragrance oil – 2%	Lemongrass fragrance oil – 2%

2.5. Formulation Procedure of Avocado Oil Serum

- **Preparation of Oils:** It was ensured all oils were filtered and at room temperature before blending.
- **Measuring Ingredients:** Each oil was weighed according to the formulation table using the measuring cylinder.
- **Mixing: A**vocado and rosehip oils were combined in a clean beaker and grapeseed oil was added. Then, vitamin E oil and essential oil were lastly incorporated to minimize volatilization.
- **Homogenization:** The mixture was gently stirred with a spatula between 5–10 minutes.
- **Packaging:** The formulation was transferred into sterilized amber dropper bottles into various batches.
- **Labelling and Storage: The formulation was also label by attaching each of the** batch numbers, date of production, and ingredients composition. It is being stored in a cool, dark place to prevent oxidation.

Table 2 Pawpaw Oil Serum (%w/w)

1st Concentration (%w/w)	2nd Concentration (%w/w)	3rd Concentration (%w/w)
Pawpaw oil – 70%	Paw paw oil – 65%	Paw paw oil – 60%
Rosehip oil – 17.5%	Rosehip oil – 15%	Rosehip oil – 12.5%
Grapeseed oil – 17.5%	Grapeseed oil – 15%	Grapeseed oil – 12.5%
Vitamin E oil – 3%	Vitamin E oil – 3%	Vitamin E oil – 3%
Lemongrass fragrance oil – 2%	Lemongrass fragrance oil – 2%	Lemongrass fragrance oil – 2%

2.6. Formulation Procedure of Pawpaw Oil Serum

- **Preparation of Oils:** It was ensured that all oils were filtered and at room temperature before blending.
- **Measuring Ingredients:** Each oil was weighed according to the formulation table using the measuring cylinder.
- **Mixing**: The pawpaw and rosehip oils were put together in a clean beaker, and grapeseed oil was added. Vitamin E oil and essential oil were lastly incorporated to minimize volatilization.
- **Homogenization:** The mixture was gently stirred with a spatula or use a magnetic stirrer at low speed between 5–10 minutes.
- **Packaging:** The formulation was transfer into sterilized amber dropper bottles.
- **Labelling and Storage:** The labeling was done using the various batch numbers, date of production, and ingredients. **S**torage condition includes, a cool, dark place in order to prevent oxidation.

2.6.1. Evaluation of Organoleptic Properties of the Formulated Serum

Organoleptic properties refer to the **sensory characteristics** of a formulation as perceived by the senses of sight, touch, and smell. They are vital to consumer acceptability and play a major role in determining a product's market success. The evaluated attributes include color, odor, texture, appearance, and homogeneity.

Both the avocado and pawpaw serums were evaluated immediately after formulation and during storage for 30 days to assess physical stability and possible changes in appearance.

3. Results

Table 3 Organoleptic Properties of Formulated Serums

Sample	Colour	Odour	Texture	Homogeneity	Washability
Pawpaw Serum	Golden yellow	Fragrant	Smooth, light	Uniform, no separation	Easily washable
Avocado Serum	Light green	Fragrant	Smooth, light	Uniform, no separation	Easily washable

3.1. Discussion of Organoleptic Findings

The pawpaw serum presented a golden-yellow hue, consistent with carotenoid and beta-carotene pigments naturally present in pawpaw (*Carica papaya*) fruit (Marfo et al., 1986). The characteristic fruity odor was mild and pleasant, indicating that no rancidity occurred during the infusion or storage process. The texture was light and smooth, making it suitable for daily use, especially in humid tropical climates where lighter formulations are preferred.

The avocado serum, on the other hand, exhibited a light green coloration, attributed to the presence of chlorophyll and lutein pigments found in avocado pulp.[7] Its slightly denser texture compared to pawpaw serum is due to the higher fatty acid content of avocado oil, particularly oleic and linoleic acids, which enhance emollience and provide long-lasting moisturization.[13] Both serums demonstrated excellent homogeneity and washability, indicating stable emulsification and good absorption profiles. These organoleptic outcomes are comparable to those observed in previous studies on natural oil-based serums, where formulations with similar sensory attributes were rated highly by consumers for feel, texture, and mild natural fragrance.[5]

3.2. Physicochemical Properties

3.2.1. pH Analysis

The pH of cosmetic formulations plays a critical role in determining their compatibility with the skin. The natural pH of healthy human skin lies between the pH of 4.5 and 5.5, which helps maintain the acid mantle a protective film that prevents bacterial colonization and moisture loss. Formulations with extreme pH values can lead to skin irritation, dryness, or barrier disruption.

Table 4 pH Values of Formulated Serums

Sample	Concentration (%w/w)	pH
Pawpaw Serum	60	3.7
Pawpaw Serum	65	3.8
Pawpaw Serum	70	4.5
Avocado Serum	60	3.3
Avocado Serum	65	3.5
Avocado Serum	70	3.6

3.3. Discussion of pH Results

The pH results show that all formulations were acidic, with values ranging from 3.3 to 4.5. This mild acidity is acceptable for facial serums, as slightly acidic products help maintain the natural skin barrier while improving antimicrobial protection. The pawpaw serum displayed a progressive increase in pH with concentration, reaching 4.5 at 70%. This can be attributed to the fruit's composition, which includes natural enzymes like papain and chymopapain, and organic acids such as citric and malic acid that modulate acidity.[10] The 70% formulation's pH aligns well with the skin's physiological range, indicating ideal skin compatibility. The avocado serum, with pH values between 3.3–3.6, was slightly more acidic. This could be linked to the higher concentration of free fatty acids (oleic and palmitic acids) in avocado oil, which can contribute to slight acidity. Despite being below 4.0, this pH range remains safe and beneficial for mildly exfoliating and rebalancing oily or acne-prone skin.[14] Overall, both serums maintained acceptable acidity

levels for skincare applications, confirming that the infusion and formulation processes did not significantly alter the natural chemical integrity of the oils.

3.4. Viscosity and Torque Analysis

Viscosity measures a product's resistance to flow and provides insights into texture, spreadability, and stability. A serum that is too viscous may feel greasy, while one that is too light may evaporate quickly or fail to form a protective film. Viscosity and torque were measured using a Brookfield viscometer (Spindle 62) at 25 °C. The data obtained are summarized in Table 5.

Table 5 Viscosity and Torque Values of Formulated Serums

Sample	Concentration (%)	Spindle	Viscosity (cP)	Torque (%)
Pawpaw Serum	60	62	5.00	0.2
Pawpaw Serum	65	62	10.00	0.2
Pawpaw Serum	70	62	10.00	0.4
Avocado Serum	60	62	5.00	0.2
Avocado Serum	65	62	5.00	0.2
Avocado Serum	70	62	7.50	0.3

3.5. Comparative Analysis of Pawpaw and Avocado Serums

The comparative evaluation shows that both serums possess acceptable physicochemical profiles.

- **pH:** The pawpaw serum (pH 3.7–4.5) is closer to skin pH, making it slightly more suitable for sensitive skin.
- **Viscosity:** Pawpaw serum exhibits higher viscosity, providing a richer, moisturizing feel, while avocado serum's lighter consistency makes it ideal for oily or combination skin types.
- **Torque:** Both products displayed low torque, confirming easy spreadability. This contrast suggests that the pawpaw serum is better suited as a night repair serum, offering deeper hydration, while the avocado serum functions well as a day serum due to its lightweight, fast-absorbing nature.

Table 6 Statistical Summary

Parameter	Range	Mean ± SD	Interpretation
pH	3.3–4.5	3.73 ± 0.41	Mildly acidic; suitable for facial use
Viscosity (cP)	5.00–10.00	7.25 ± 2.05	Light to moderate consistency
Torque (%)	0.2–0.4	0.27 ± 0.08	Excellent spreadability

The low standard deviation values confirm high uniformity and reproducibility across different concentrations, validating the formulation's stability and consistency.

4. Conclusion

This study demonstrated that natural tropical fruit oils, specifically avocado and pawpaw, can be effectively utilized in the formulation of facial serums suitable for cosmetic use. The two serum formulations exhibited satisfactory physicochemical properties, suggesting their potential as safe, stable, and skin-friendly alternatives to conventional facial serums. The pawpaw serum showed a higher pH (3.7–4.5) and viscosity (up to 10 cP), making it slightly more emollient and suitable for dry or mature skin. The avocado serum, with lower pH (3.3–3.6) and moderate viscosity (5–7.5 cP), provided a lighter, fast-absorbing texture suitable for oily and combination skin types. The success of this study underscores the value of indigenous resources and supports the development of sustainable skincare solutions tailored to African climates, skin types, and economic realities. By leveraging local fruits and natural processes, the research aligns with Nigeria's pursuit of self-reliance in the cosmetic industry, reducing dependence on imported raw materials. However, while this study achieved its formulation and basic evaluation goals, further research is required to establish

the toxicological, microbiological, and pharmacological safety of the formulations to ensure regulatory compliance and consumer safety.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Madison, K. C. (2003). Barrier function of the skin: "La Raison d'Être" of the epidermis. *Journal of Investigative Dermatology, 121*(2), 231–241.

[2] Kaur, C. D., & Saraf, S. (2011). In vitro sun protection factor determination of herbal oils used in cosmetics. *Pharmacognosy Research, 2*(1), 22–25.

[3] Olumide, Y. M., Akinkugbe, A. O., Altraide, D., Mohammed, T., Ahamefule, N., Ayanlowo, S., Onyekonwu, C., & Essen, N. (2008). Complications of chronic use of skin lightening cosmetics. *International Journal of Dermatology, 47*(4), 344–353.

[4] Yusuf, S. O. (2019). The Nigerian cosmetics industry: Challenges and opportunities. *Nigerian Journal of Marketing Research, 2*(1), 45–58.

[5] Akinwumi, I. O., Ogunleye, O. O., & Osoba, O. T. (2020). Evaluation of physicochemical and sensory properties of natural cosmetic oils. *Nigerian Journal of Applied Science and Technology, 38*(2), 125–134.

[6] Nwankwo, S., & Ajemunigbohun, S. S. (2013). Environmental factors and marketing performance of small-scale manufacturing firms in Lagos State, Nigeria. *Business and Management Review, 3*(3), 1–9.

[7] Dabas, A., Yadav, S., & Singh, S. (2011). A review on Avocado oil. *International Journal of Pharmaceutical Sciences and Research, 2*(5), 1080–1084.

[8] Fernández, M., Sánchez, C., & López, M. (2022). Bioactive properties of avocado oil for skin applications: A review. *Journal of Cosmetic Dermatology, 21*(2), 484–492.

[9] Marfo, E., Darko, G., & Badu-Kumi, S. (1986). Chemical constituents of pawpaw seed oil and their potential cosmetic applications. *West African Journal of Pharmacy, 3*(2), 75–79.

[10] Kanwal, S., Raza, S., Manzoor, F., & Mukhtar, I. (2015). Phytochemical and antimicrobial analysis of *Carica papaya* seed extract. *International Journal of Pharmaceutical Sciences Review and Research, 32*(1), 162–167.

[11] Darbre, P. D., & Harvey, P. W. (2014). Paraben esters: Review of recent studies of endocrine toxicity, absorption, esterase, and human exposure, and discussion of potential human health risks. *Journal of Applied Toxicology, 34*(7), 575–588.

[12] Mensah, A., Quaye, E. A., & Darko, C. (2021). Consumer preference for natural cosmetics in Sub-Saharan Africa: Trends and determinants. *African Journal of Business and Economic Research, 16*(3), 77–94.

[13] Boateng, L., & Bessman, M. (2016). Lipid composition and skin absorption of avocado oil. *Journal of Cosmetic Dermatology, 15*(4), 482–489.

[14] Lourith, N., & Kanlayavattanakul, M. (2013). Natural surfactants used in cosmetics: Glycolipids. *International Journal of Cosmetic Science, 35*(6), 579–584.