Faculty of Natural and Applied Sciences Journal of Applied Biological Sciences
Print ISSN: 3027-0685, e-ISSN: 3043-6494
www.fnasjournals.com
Volume 2; Issue 2; March 2025; Page No. 97-101.

Physicochemical Characterization of *Calliandra surinamensis* Seed Oil

***[1]Eze, P.N., [2]Irabor, E.E.I., & [3]Akanbi, M.N.**
[1]Department of Chemistry, Federal College of Education (Tech) Asaba
[2]Department of Chemistry, University of Benin, Benin-City
[3]Department of Polymer Engineering, Federal University of Technology Owerri

***Corresponding author email:** patricia.eze@fcetasaba-edu.ng

Abstract
Calliandra surinamensis seed oil is a promising non-traditional oilseed crop with potential food, cosmetic, and pharmaceutical applications. The oil from *Calliandra surinamensis* seeds was extracted using the Soxhlet extraction method with hexane as the solvent. The chemical characterisation showed that *C. surinamensis* oil registered a saponification index of 158.95 mgKOH/g oil, an Iodine index of 101.14 g 1/100 g oil, a peroxide index of 7.27 meg O_2/kg, an acid index of 10.94 mg KOH/g oil, and a free fatty acid index of 5.47 mg/g. The physical characteristics revealed that *C. surinamensis* oil has a refraction index (25) of, 1.2667, a specific gravity of 0.8973, a smoke point (°C) of 111.67, a flash point (°C) of 228.33, a fire point (°C) of above 300, a pH of 6.27, a viscosity of 5.80 and a yellow colour. The sample oil showed a moderate saponification index, suggesting a balanced fatty acid composition and good oxidative stability due to its relatively low peroxide value.

Keywords: *Calliandra Surinamensis* Seeds, oil, Physicochemical, Soxhlet Extraction, Characterization

Introduction

Seed oils are gaining recognition as a viable alternative to traditional fossil fuels and chemical-based products, driven by the increasing global demand for sustainable and renewable resources (Ameh et al., 2024). Extracted from the tiny seeds of various plants, seed oil is often regarded as "liquid gold" due to its numerous benefits for human health, sustainable energy, and environmental conservation. As a valuable natural resource, seed oils have attracted significant attention in recent years for their potential applications across multiple industries, including cosmetics, pharmaceuticals, and biofuels (Yara-Varón et al., 2017). One particular promising source of seed oil comes from *Calliandra surinamensis*, a tropical plant native to the lush rainforests of Central and South America (Irabor et al., 2023). *Calliandra surinamensis*, commonly known as Suriname, is a tree or shrub belonging to the Fabaceae family. As a member of the legume group, it plays a crucial role in nitrogen fixation, enhancing soil fertility. The plant thrives in the tropical regions of Central and South America, flourishing in well-drained soils and abundant sunlight (Eze et al., 2022). The seeds of *C. surinamensis* are housed within flat pods that initially appear green and later turn brown as they mature. When fully ripe, the pods split open, releasing brown seeds that contain a significant amount of oil. Research has highlighted that the seed oil of *Calliandra surinamensis* possesses a unique fatty acid composition, making it a valuable resource for various industrial applications (Eze et al., 2022). Though the plant is admired for its vibrant flowers and delicate foliage, its true potential lies in its nutrient-rich seeds, which yield an oil with immense benefits. This study examines the physicochemical properties of *C. surinamensis* seed oil, assessing its potential applications and advantages across different industries.

Materials and Methods

Collection, Identification, and Preparation of Samples.

The *Calliandra surinamensis* pods containing the dry seeds were collected from the Department of Plant Biology and Biotechnology, the faculty of Life Sciences, University of Benin, Benin City, and identified by a plant taxonomist in the Department of Plant Biology and Biotechnology. The pods were cracked open to release the dry seeds, which were pulverized into powder using a mechanical blender. Oil extraction was carried out in a 250 mL Soxhlet apparatus on a heating mantle. The solvent used was n-Hexane. The 300g of the ground seed powder was packed inside a muslin cloth placed in a thimble of a Soxhlet extractor. A round-bottom flask containing hexane was fixed to the end of the extractor, and a condenser was tightly fixed at the bottom end of the extractor. The extraction was carried out for three hours at 105°C. The extracted oil was poured into a beaker

and allowed to cool, and was, thereafter, separated from the solvent using a rotary evaporator. Moisture was distilled off from the extracted oil by heating (AOAC, 2005).

The percentage of oil content was calculated thus;

$$\% \text{ of oil} = grams, Total \text{ x } \frac{100}{1}$$

Characterization of Seed Oil

Physicochemical Analysis

The oil obtained was subjected to the following physicochemical analyses such as acid value, free fatty acid value, saponification value, iodine value, peroxide value, refractive index, specific gravity, and viscosity.

Determination of Acid Value

Dimethyl ether (25 mL) and ethanol (25 mL) were mixed in a 250 mL beaker. The resulting mixture was added to oil (2g) in a 250 ml conical flask, and a few drops of phenolphthalein were added. The mixture was titrated with 0.1M NaOH to the endpoint with consistent shaking, for which a dark pink colour was absorbed (AOAC, 2005). Replicate determination was carried out.

Determination Iodine Value

The oil (2g) was dissolved in carbon tetrachloride (10 ml) and Wij's solution (20 ml), and the mixture was allowed to stand in the dark for 30 minutes. 0.06M Potassium iodide solution (15ml) and water (100ml) were added and then titrated with 0.1M thiosulfate solution until the yellow colour almost disappeared. A few drops of 1% starch indicator were added, and the titration continued by adding thiosulfate drop-wise until the blue coloration disappeared after vigorous shaking. (A.O.A.C., 2005). Replicate determinations were carried out.

Determination of Saponification Value

The oil (2g) was weighed into a 250 mL round-bottom flask, and alcoholic Potassium Hydroxide solution (25 mL) was added. A reflux condenser was connected and was heated in a water bath for one hour, shaking frequently. The mixture was cooled and titrated with 0.5M hydrochloric acid solution using Phenolphthalein as an indicator. The volume of the acid used was recorded, and a blank was also conducted simultaneously (A.O.A.C., 2005). Replicate determinations were carried out.

Determination of Peroxide Value

The oil sample (1g) was poured into a clean boiling tube, followed by potassium iodide (1g) and a solvent mixture (2 vol glacial acetic acid + 1 vol chloroform) (20 ml). The tube was then placed in boiling water for thirty seconds and allowed to boil vigorously for more than thirty seconds. The hot solution was poured into a flask containing 0.03M Potassium iodide (20ml) and the tube washed with water (25ml) and then titrated with 0.22M Sodium thiosulphate ($Na_2S_2O_3$) solution using a starch indicator as outlined by AOAC (2005). Replicate determinations were carried out.

Determination of Refractive Index

A refractometer (Portable Refractometer Biotech-India) was used in the determination. The oil sample was transferred into the glass slide of the refractometer. The prism box was opened, and the ground surface of the lower prism was smeared with the oil sample. It was then closed and the box flattened again, ensuring that the oil did not flow away. The cross wires of the telescope were focused by rotating the eyepiece and adjusting the mirror to get good illumination. The light was passed through an angled mirror, and the prism box was rotated until the sharp edge was in coincidence with the intersection of the cross-wires in the telescope. The index of refraction was then read off on the scale through the eyepiece. The third decimal place in the refractive index could be read directly, and the fourth was estimated with an accuracy of about 0.0002.

Determination of Specific Gravity

The specific gravity of the oil sample was determined using a 50 mL pyrometer bottle to take the weight of the oil sample/the weight of 1.0 g of water at 30°c. (AOAC, 2005)

Cite this article as:
Eze, P. N., Irabor, E. E. I., & Akanbi, M. N. (2025). Physicochemical characterization of *calliandra surinamensis* seed oil. *FNAS Journal of Applied Biological Sciences. 2*(2), 97-101.

Results

The Result of the Physicochemical Analysis of the Seed Oil and the Seed of *Calliandra Surinamensis*

Table 1: The Physicochemical Characteristics of the *Calliandra surinamensis* Seed Oil

Parameter	Value
Saponification value (MgKOH/g)	158.95 ±15.00
Iodine value (10mg iodine/g)	101.14 ±2.71
Peroxide value (mg peroxide/kg	7.27 ±0.81
Acid value(mgKOH/g)	10.94 ±1.01
Free fatty acid (mg/g)	5.47 ±0.94
Refractive index (25)	1.2667 ±0.0378
Specific gravity	0.8973 ±0.000396
Smoke point (°C)	111.67 ±0.64
Flash point (°C)	228.33 ±6.66
Fire point (°C)	Above 300
pH	6.27 ±0.29
Viscosity	5.80 ±0.20

**Each data point is the mean of three replicates ± Standard Deviation (SD).*

Discussion

The acid value of the *C. surinamensis* seed oil (10.94) is lower than that reported for African pear (15.28) (Ikhuoria et al., 2006), *Persea gratissima* from Isiala Ngwa (11.46 mg NaOH/g) (Akubugwo et al., 2008), and other common African oils such as *kulikuli* (12.53) and palm kernel oil (25.6) (Obasi et al., 2012), all of which are consumed. However, it is higher than the value reported for chia oil from Argentinean seeds (2.05 mg KOH/g) Segura-Campos et al., 2014). It exceeds the recommended limit (4.0 mg/g) for edible oils (Codex Alimentarius Commission, 2007). The acid value indicates the free fatty acid content of the oil. The free fatty acid (FFA) value of *C. surinamensis* seed oil (5.47) is lower than that of commercially available *kulikuli* oil (6.26), palm kernel oil (12.81) (Obasi et al., 2012), and castor (*Ricinus communis*) seed oil (Nangbes et al., 2013). The FFA content reflects the level of hydrolysis and oxidative degradation, which can affect flavor and texture. Lower FFA values indicate better quality and suitability for consumption. A high FFA content suggests significant hydrolytic and lipolytic activity in the oil (Cornelio-Santiago et al., 2021). The iodine value of *C. surinamensis* seed oil is 101.14, which is higher than that of avocado pear (42.66), African pear (44.08), and African oil bean seed (57.60) (Ikhuoria et al., 2006), as well as castor seed oil (58.39) (Nangbes et al., 2013). However, it compares favorably with Nigerian market oils such as Kings Oil (94.43) and soybean oil (97.29), aligning with the iodine values of olive oils. Nevertheless, it is lower than the value reported for chia oil (193.45 mg KOH/g) (Segura-Campos et al., 2014). The iodine value, which measures the degree of unsaturation, is a key characteristic of seed oils and influences their application in the cosmetics and soap industries (Nangbes et al., 2013). A good drying oil should have an iodine value of 180 or higher (Codex Alimentarius Commission, 2007). Based on this classification, *C. surinamensis* seed oil is non-drying and unsuitable for varnishes, polishes, and alkyl resins, which may be beneficial as a plasticizer when combined with amino resins.

The saponification value of *C. surinamensis* seed oil (158.95) is comparable to values reported for Nigerian oils such as Gino oil (153.34) and *Telfairia occidentalis* oil (158.40) (Obasi et al., 2012). It is higher than values reported for African pear (143.76) (Ikhuoria et al., 2006), *Detarium microcarpum* (123.30) (Kyari, 2008), and *Persea gratissima* (106.60) (Dhellot et al., 2006). The saponification index measures the degree of unsaturation and the amount of alkali required to convert the oil into soap. The moderate saponification value of *C. surinamensis* seed oil suggests its potential for industrial applications, particularly in soap manufacturing. The peroxide value of *C. surinamensis* seed oil is 7.27 mg/kg, a key indicator of oxidative stability. According to Codex (2005), the permissible peroxide value should not exceed 10 milliequivalents of oxygen per kg of oil. Peroxide values above 10–20 mEq/kg indicate rancidity and unpleasant odor (Turner, 2010). The relatively low peroxide value suggests that *C. surinamensis* seed oil possesses good oxidative stability and antioxidant properties. Viscosity is influenced by factors such as extraction methods, age, storage conditions, saturation levels, and oxidation. The viscosity of *C. surinamensis* seed oil (5.8 Pa·s) is higher than that of castor seed oil (0.425 Pa·s) (Nangbes et al., 2013). Since increased unsaturation decreases viscosity, the moderate viscosity of this oil suggests a balance between saturated and unsaturated fatty acids. The refractive index (1.27) is lower than values reported for oil bean seed (1.46), avocado pear (1.462), and African pear (1.456) (Ikhuoria et al.,

Cite this article as:
Eze, P. N., Irabor, E. E. I., & Akanbi, M. N. (2025). Physicochemical characterization of *calliandra surinamensis* seed oil. *FNAS Journal of Applied Biological Sciences. 2*(2), 97-101.

2006), as well as *Blighia sapida* (1.449) and *Detarium microcarpum* (1.465) (Kyari, 2008). Assessing purity and monitoring hydrogenation and isomerization processes can be effectively accomplished using the refractive index (Ichu & Nwakanma, 2019). The relatively low refractive index suggests a moderate level of unsaturation in the oil. The specific gravity of *C. surinamensis* seed oil (0.897) is comparable to *Cocos nucifera* seed oil (Obasi et al., 2012) and falls within the range of 0.81–0.7 reported for common plant seed oils in Nigeria (Akubugwo et al., 2008; Akubugwo et al., 2007; Yusuf et al., 2006). Specific gravity is crucial for determining the solid-liquid ratio in commercial fats. The relatively high specific gravity suggests a moderate level of unsaturation. Thermal analysis reveals that C. surinamensis seed oil has a smoke point of 111°C, flash point of 228°C, and a fire point exceeding 300°C. The smoke point indicates the temperature threshold beyond which the fat begins to decompose and smoke on heating. It is influenced by the degree of unsaturation and the free fatty acid content (Ettefaghi et al., 2013). A lower free fatty acid content results in higher smoke, flash, and fire points, making the oil more stable for cooking (Akpan et al., 2006).

Conclusion

The physicochemical examination of *C. surinamensis* seed oil revealed its potential as a valuable oil with desirable properties. The saponification value indicates its suitability for soap manufacturing, while the iodine value indicates its potential use as a semi-drying oil. Both the peroxide and acid values fall within acceptable ranges, reflecting the oil's high oxidative stability and moderate hydrolysis. These properties suggest its suitability for industrial applications, particularly in plasticizers and soap manufacturing. The oil's relatively low smoke point limits its utility for high-heat cooking, but its high flash and fire points indicate safety in other applications. The refractive index and specific gravity measurements align well with those typical of some vegetable oils. Furthermore, the values for the smoke point, flash point, and fire point indicate the suitability of the oil for both cooking and industrial applications. The pH and viscosity measurements indicate the oil's stability and adaptability for diverse applications. In summary, the findings imply that *C. surinamensis* seed oil is a significant oil with potential uses in the food, cosmetics, and industrial fields.

Recommendations

1. *C. surinamensis* seed oil's high smoke point and stability make it ideal for culinary use.
2. *C. surinamensis* seed oil's desirable fatty acid composition and low acidity make it suitable for skincare products, such as soaps, lotions, and creams.
3. For industrial applications, *C. surinamensis* seed oil can be used as a feedstock for biodiesel generation, as a result of its high iodine value and stability.
4. Pharmaceutical industry: The oil's unique fatty acid composition and antioxidant properties make it a potential candidate for pharmaceutical applications.

However, to fully explore the potential of *C. surinamensis* seed oil, we recommend further studies on:

1. Toxicity and safety: Conduct toxicity and safety studies to ensure the oil's safe use in various applications.
2. Shelf-life and storage: Investigate the oil's shelf-life and storage conditions to ensure its quality and stability.
3. Scalability and commercialization: Conduct feasibility studies to determine the scalability and commercial viability of *C. surinamensis* seed oil production.

By exploring these recommendations and conducting further research, *C. surinamensis* seed oil can be developed into a valuable and versatile oil with various industrial, cosmetic, and pharmaceutical applications.

References

Akpan, U. G., Jimoh, A., & Mohammed, A. D. (2006). Extraction, characterization, and modification of castor seed oil. *Leonardo Journal of Sciences*, *8*, 43-52.

Akubugwo, I. E., Chinyere, G. C., & Ugbogu, A. E. (2008). Industrial qualities of rubber seed oils. Nigerian *Journal of Technical Research*, 11(1-2), 1-2.

Akubugwo, I. E., Obasi, N. A., Chinyere, G. C., & Ugbogu, A. E. (2007). Nutritional and chemical value of *Amaranthus hybridus* L. leaves from Afikpo, Nigeria. *African Journal of Biotechnology*, *6*(24), 2833-2839.

Ameh, V. I., Ayeleru, O. O., Nomngongo, P. N., & Ramatsa, I. M. (2024). Bio-oil production from waste plant seeds biomass as pyrolytic lignocellulosic feedstock and its improvement for energy potential. Waste Management Bulletin, 2(2), 32-48.

Association of Official Analytical Chemists (AOAC). (2005). Official methods of analysis (20th ed.). Washington, DC: Author.

Codex Alimentarius Commission. (2007). Codex alimentarius: cereals, pulses, legumes, and vegetable proteins. Rome: World Health Organization: Food and Agriculture Organization of the United Nations.

Cornelio-Santiago, H. P., Bodini, R. B., & Oliveira, A. L. (2021). Potential of oilseeds native to Amazon and Brazilian Cerrado biomes: Benefits, chemical and functional properties, and extraction methods. *Journal of the American Oil Chemists' Society, 98*(1), 3-20.

Dhellot, J. R., Matuoba, E., Maloumbi, M. G., Nzikou, J. M., & Dzondo, M. G. S. (2006). Extraction and nutritional properties of *Solanum nigum* L. seed oil. *African Journal of Biotechnology,* 5(11), 987-991.

Ettefaghi, E., Ahmadi, H., Rashidi, A., Mohtasebi, S. S., & Alaei, M. (2013). Experimental evaluation of engine oil properties containing copper oxide nanoparticles as nanoadditive. *International Journal of Industrial Chemistry*, 4(1), 1-9.

Eze, P. N., Obielumani, J. O., & Okotcha, E. N. (2022). Extraction of oil and fatty acid composition of *Calliandra surinamensis* seed. *Journal of Research in Science and Technical Education* (JOREST), 4(1).

Ichu, C. B., & Nwakanma, H. O. (2019). Comparative study of physicochemical characterization and quality of edible vegetable oils. *International Journal of Research in Informative Science Application and Techniques* (IJRISAT), 11.

Ikhuoria, A. E., Aiwonegbe, A., & Okoli, P. (2006). Characterization and composition of African oil bean seed (*Pentaclethra macrophylla benth*). *ChemTech Journal*, 2, 309-312.

Ikhuoria, M., Aibaugbe, A., & Maliki, M. (2006). Extraction and characterization of avocado pear (*Persea americana*) and African pear (*Dacryodes edulis*). *ChemTech Journal*, 2, 345-349.

Irabor, E. E. I., Eze P. N., Unuigbe, C. A., Imafidon, M. I., Omoruyi, U. & Emmanuel. V. (2023).'Proximate analysis and Mineral Determination of *Calliandra surinamensis* seed'. *Journal of chemical society of Nigeria, Vol. 48*, No. 1, pp 183-191.

Kyari, M. Z. (2008). Extraction and characterization of seed oils. International Agrophysics, 22, 139-142.

Nangbes, J. G., Nvau, J. B., Buba, W. M., & Zukdimma, A. N. (2013). Extraction and characterization of castor *(Ricinus communis*) seed oil. *International Journal of Engineering and Science* (IJES*), 2*(9), 105-109.

Obasi, N. A., Ukadilonu, J., Eze, E., Akubugwo, E. I., & Okorie, U. C. (2012). Extraction, characterization, and comparative assessment of coconut (Cocos nucifera) and melon (*Colocynthis citrullus*) seed. *Pakistan Journal of Biological Sciences*, *15*(1), 1-9.

Segura-Campos, M. R., Ciau-Solís, N., Rosado-Rubio, G., Chel-Guerrero, L., & Betancur-Ancona, D. (2014). Physicochemical characterization of chia (*Salvia hispanica*) seed oil from Yucatán, México. Agricultural Sciences, 5(3), 43020.

Turner, R. (2010). Fat and oils quality characteristics, extraction, and refining overview. Farm Energy Conference, Manchester. *International Journal of Engineering and Science* (IJES). www.uvm.edu/extension/cropsoil/wp-

Yara-Varón, E., Li, Y., Balcells, M., Canela-Garayoa, R., Fabiano-Tixier, A. S., & Chemat, F. (2017). Vegetable oils as alternative solvents for green oleo-extraction, purification and formulation of food and natural products. Molecules, 22(9), 1474.

Yusuf, A. A., Adewuyi, S., & Lasisi, A. A. (2006). Physicochemical composition of leaves, meals, and oil of fluted pumpkin (Telfairia occidentalis) and melon (Citrullus vulgaris).