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Comparative Fatty Acid Profiling and Nutritional Assessment of Groundnut and Cashew Nut Oils

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ABSTRACT

Fatty acids are vital components of biological membranes and key metabolic fuels in living organisms. Their composition influences the nutritional and functional properties of food. This study aimed to compare the fatty acid profiles of groundnut and cashew nut to determine their nutritional value. Using the AOAC in 2000 method, samples of both nuts were analysed through gas chromatography. Groundnut oil was found to contain higher concentrations of oleic acid (46.99%) and linoleic acid (9.91%), while cashew nut oil had higher levels of palmitic acid (22.88%) and lauric acid (18.98%). The total fatty acid concentration in groundnut exceeded that of cashew, indicating that groundnut is richer in fatty acids overall. This comparison highlights the superior fatty acid content of groundnut, which could inform nutritional recommendations and food formulation strategies. The findings contribute to food science literature by emphasizing the value of groundnut as a high-fatty-acid food source.

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1. INTRODUCTION

Groundnut (*Arachis hypogaea L.*), a legume originally domesticated in South America, is now widely cultivated in tropical and subtropical regions between 40°N and 40°S latitudes. Major producers, including India, China, and the United States, account for nearly 70% of global groundnut output (Sunil & Singh, 2021). It thrives in warm climates with moderate rainfall and serves as a crucial food and oil source globally. Groundnuts are consumed in various forms—boiled, roasted, ground into butter, or processed for oil—and are valued for their high protein, fat, fiber, and micronutrient content (Amoniyan *et al*., 2020; Sanni *et al*., 2024).

Cashew (*Anacardium occidentale L.*), native to northeastern Brazil, has become an economically important tree crop across tropical regions. Countries including Vietnam, India, Nigeria, and Brazil benefit from its export potential (Nguyen, 2019). The cashew nut, derived from the seed, is rich in dietary fats, protein, vitamins, and essential minerals and is widely used in confectioneries and snacks (Dantas & Costa, 2022; Das *et* al., 2014; Ogunwolu *et al*., 2009).

Both nuts are notable for their lipid content, particularly fatty acids, which are crucial for energy storage, membrane integrity, and cellular signaling (Rustan & Drevon, 2005). Fatty acids vary in type and concentration across plant species and significantly influence the nutritional and biological properties of oils. While individual fatty acid profiles of groundnut and cashew have been studied, direct comparative assessments are limited. Understanding their fatty acid composition offers valuable insight for nutritionists, food scientists, and health-conscious consumers.

This study aims to assess the fatty acid composition of groundnut and cashew nut using standardized gas chromatographic analysis. **Figures 1(a)** and **1(b)** show the photograph images of groundnut seeds and cashew nut, respectively. The novelty lies in providing a direct side-by-side evaluation of their fatty acid profiles, which contributes to nutritional science and supports informed dietary and industrial applications. The results may aid in optimizing oil use in health-focused food formulations and enhance the nutritional evaluation of plant-based lipid sources.

(a) (b)

Figure 1. Photograph image of nut: (a) groundnut seeds and (b) cashew nut.

2. LITERATURE REVIEW

Nuts are widely recognized for their nutritional density, offering an array of health-promoting components, including dietary fats, proteins, vitamins, minerals, and phytochemicals. Among these, fatty acids play a particularly vital role. As metabolic fuels and structural components of biological membranes, fatty acids influence key physiological functions such as energy transport, membrane fluidity, gene regulation, and signal transduction (Rustan & Drevon, 2005).

Groundnut (*Arachis hypogaea L.*) is a globally cultivated legume rich in protein and oil. Its nutritional composition per 100g of edible portion includes 25.8 g protein, 16.1 g carbohydrate, 6.5 g moisture, 8.5 g dietary fiber, 49.2 g total lipid, 168 mg magnesium, 376 mg phosphorus, and 4.6 mg iron (Boli *et al*., 2013). Groundnut oil is particularly rich in oleic and linoleic acids—unsaturated fatty acids associated with cardiovascular and metabolic health. Mahfoud *et al*. (2023) emphasized groundnut's versatile usage in oil extraction, snacks, and processed foods, attributing its commercial value to this robust nutritional profile.

Cashew nut (*Anacardium occidentale L.*) is equally esteemed for its nutrient content and culinary applications. Per 100g of cashew, the nutritional values include approximately 45% fats, 20% protein, 23% carbohydrate, and significant mineral contents such as calcium (504.0 mg/kg), iron (90.8 mg/kg), zinc (31.3 mg/kg), copper (16.4 mg/kg), potassium (5600 mg/kg), phosphorus (4600 mg/kg), magnesium (2400 mg/kg), and sodium (22.8 mg/kg), all on a dry weight basis (Aremu *et al*., 2006; Das *et al*., 2014). The lipid composition of cashew includes palmitic, oleic, and stearic acids, and its protein isolates are noted for their functional applications in food systems (Ogunwolu *et al*., 2009).

Understanding the diversity of fatty acids in plant oils is essential for evaluating their nutritional and industrial value. The fatty acids found in groundnut and cashew include saturated forms (e.g., palmitic, stearic, lauric acids), monounsaturated (e.g., oleic acid), and polyunsaturated types (e.g., linoleic and linolenic acids). The structural characteristics of these molecules are shown in **Figure 2**. **Figure 2(a)** presents typical fatty acids like palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2), and linolenic (18:3), all crucial to edible plant oils. These molecules differ in carbon chain length and number of double bonds, influencing their physical state and metabolic behaviour. **Figure 2(b)** illustrates less common but industrially valuable fatty acids, such as lauric (12:0), erucic (22:1), ricin oleic (hydroxy), and vernolic (epoxy) acids. These fatty acids are used in the production of lubricants, coatings, and cosmetics due to their functional side groups. **Figure 2(c)** shows a triglyceride, the principal storage form of fat composed of three fatty acid chains esterified to a glycerol molecule. **Figure 2(d)** displays a C_{44} wax ester, representing long-chain fatty acid esters used in protective barriers like plant cuticles or animal skin.

While studies have separately examined the fatty acid profiles of groundnut and cashew, direct comparative analysis remains limited. Such comparative profiling is essential to determine which nut offers higher nutritional value in terms of fatty acid concentration and quality. Previous research highlights groundnut's dominance in oleic acid and linoleic acid content, while cashew typically contains more palmitic, lauric, and myristic acids (Maestri, 2024; Rahim *et* al., 2023; Das *et al*., 2014).

This study fills an existing gap in the literature by offering a side-by-side comparison of the fatty acid composition of groundnut and cashew nut. By combining chromatographic analysis with nutritional profiling, this research contributes to food science, supports health-oriented dietary planning, and aids in value-added product development involving edible oils.

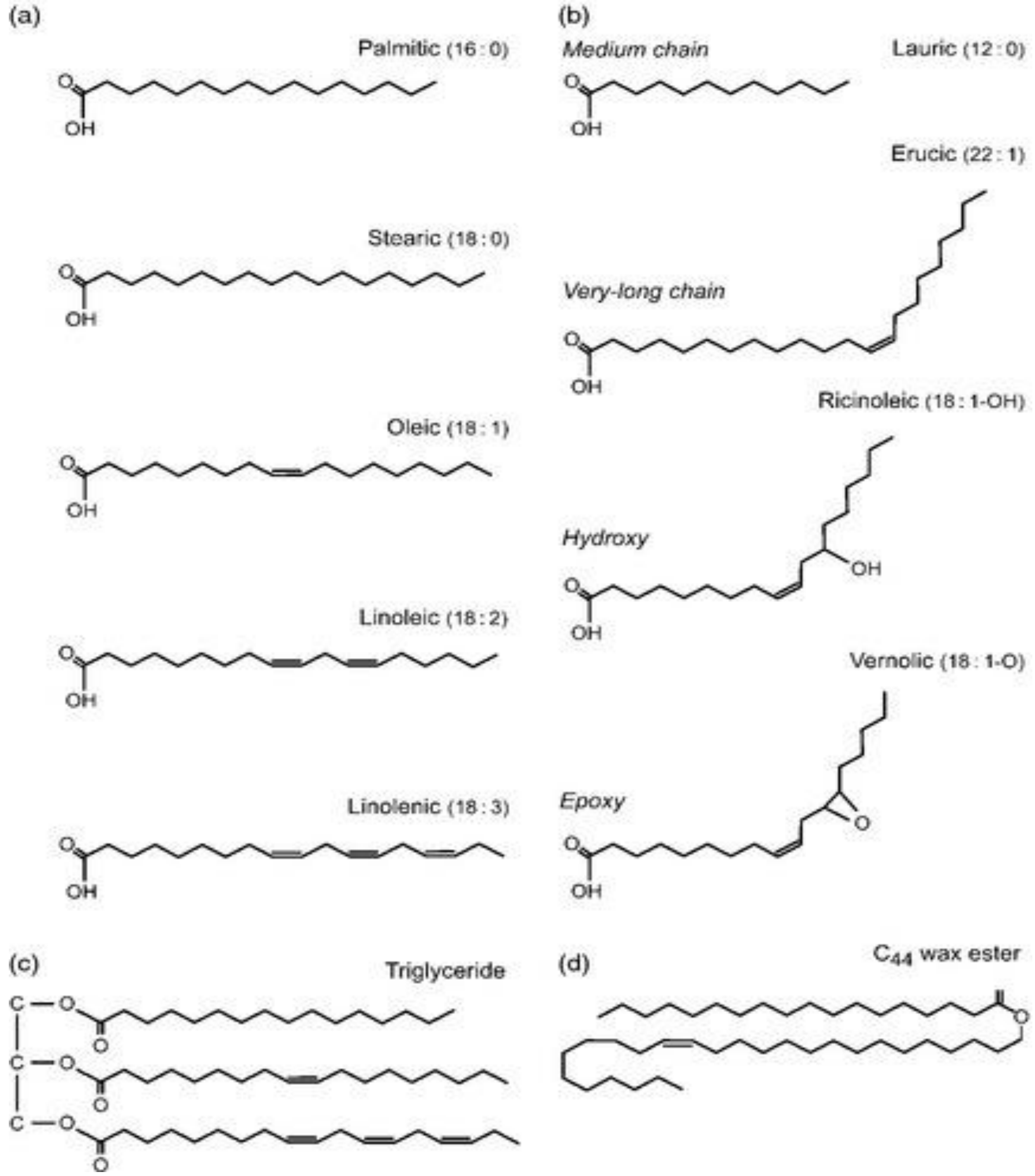

Figure 2. Representative structures of plant lipid components: (a) Common fatty acids found in edible plant oils, including saturated (palmitic, stearic) and unsaturated (oleic, linoleic, linolenic) types; (b) Unusual fatty acids of industrial relevance, such as medium-chain (lauric), very-long-chain (erucic), hydroxylated (ricinoleic), and epoxy fatty acids (vernolic); (c) Structure of a triglyceride showing three fatty acids esterified to a glycerol backbone; and (d) Structure of a C44 wax ester representing long-chain lipid compounds used in protective coatings. These molecular forms illustrate the structural diversity of fatty acids and lipid derivatives, influencing their nutritional, metabolic, and industrial functions.

3. METHODS

This study employed a comparative analytical approach to determine the fatty acid profiles of groundnut and cashew nut samples. Both nuts were procured from a local market in Owerri Metropolis, Imo State, Nigeria. The procedure for lipid extraction and fatty acid analysis followed the standardized method established by the Association of Official Analytical Chemists (AOAC) in 2000, specifically AOAC 996.01, which is widely recognized for its accuracy in determining total fatty acid content in food matrices (Zhao & Zhang, 2013).

3.1. Sample Preparation

Twenty grams (20 g) of each nut sample was separately homogenized using a mortar and pestle. The homogenates were then mixed with 60 g of anhydrous sodium sulphate to eliminate moisture. Each mixture was transferred into a 500-mL beaker for lipid extraction.

3.2. Lipid Extraction

Lipid extraction was performed by soaking the homogenized samples in 300 ml of n-hexane for 24 hours. The resulting extract was concentrated using a rotary vacuum evaporator at 40°C until dryness was achieved. The residue was then reconstituted in 1 ml of n-hexane in preparation for chromatographic analysis.

3.3. Fatty Acid Analysis

The fatty acid profiles were analysed using gas chromatography (GC), which allowed for precise identification and quantification of individual fatty acids based on retention times and peak areas. The percentage concentration of each fatty acid in both groundnut and cashew nut oils was recorded and tabulated for comparison. This method ensured the consistent extraction, isolation, and quantification of both saturated and unsaturated fatty acids present in the nut oils, enabling a reliable comparative assessment.

4. RESULTS AND DISCUSSION

Lipids are usually referred to as fats and oils. Fats are materials that are solid at ambient temperature while oils are liquids at ambient temperature. Lipids are important components of natural and many synthetic foods and compounds. By virtue of molecular composition, bioactive lipids have contributed colossally to human health. Humans require, but lack the enzymatic capability to synthesize polyunsaturated fatty acid (PUFA) such as omega-3, omega-6 and omega-9 fatty acids (Alagawany *et al*., 2022). These fatty acids and other lipid compounds such as glycolipids, phospholipids, phytosterols and phenolics have been shown to have characteristics of health-promoting properties that physiologically affect the body functions. These fatty acid compounds are dietary and essential as the body cannot synthesize them. The dietary sources of these are plants, animals, fish and microorganism and their fatty acid compositions are of varying constitution.

Fats are characteristically distinguishable from the other food substances in being soluble in non-polar solvents such as ether, chloroform, hexane, benzene, etc., and their insolubility in water. Based on the physical state of these organic solvent-soluble molecules at room temperature, they have been grouped into hard solids, soft solids and liquids as waxes, fats, and oils, respectively.

Plant lipid contents vary in composition and this is a function of plant's part and the type of plant. Their main lipids include triacylglycerols, diacylglycerols, monoacylglycerols, phospholipids, glycolipids, sterols, free fatty acids, vitamins soluble in fat (A, D, E, K), waxes and carotene and chlorophyll pigments. Storage lipids, such as oil in oil seeds contain the highest amount of triacylglycerols (95-98%), in the form of fatty acid esters with glycerol (Sagun *et al*., 2023).

Lipid extraction and analysis requires a suitable technique that can remove all lipids. In this extraction, neutral lipids such as triacyglycerides employ the use of neutral solvents and polar solvents to extract polar lipids, such as phospholipids and glycolipids (Pati *et al*., 2016; Aldana *et al*., 2020). Extraction of polar lipids in most cases requires utilization of elevated temperature and some hydrolysing agents and this could lead to extraction of non-lipid components such as sugars which appears as impurity that can be separated afterwards from lipids.

In overall, lipid analysis requires a widely used contemporary chromatographic and spectrometric technique owing to the fact that fatty acid composition has a significant impact on physical and biological properties of fat (Homayoonfar *et al*., 2021; Zotov *et al*., 2022; Mondal *et al*., 2023).

The gas chromatographic analysis of groundnut and cashew nut oils revealed notable variations in their fatty acid composition. The quantitative results are presented in **Table 1**, showing the percentage concentrations of eleven key fatty acids identified in both samples.

Table 1. Percentage composition of fatty acids in groundnut and cashew nut oils.

Fatty Acid	Cashew Nut (%)	Groundnut (%)
Arachidonic acid (20:2)	2.38	0.64
Behenic acid (22:6)	3.59	1.82
Arachidonic acid (20:3)	6.60	3.65
Myristic acid (14:0)	6.62	3.13
Linoleic acid (18:2)	4.83	9.91
Nervonic acid (24:5)	2.99	4.11
Oleic acid (18:1)	26.80	46.99
α-Linolenic acid (18:3)	3.33	3.12
Arachidonic acid (20:4)	0.98	1.47
Palmitic acid (16:0)	22.88	10.51
Lauric acid (12:0)	18.98	14.64
Total	99.99	99.99

The results show that groundnut oil contains significantly higher concentrations of oleic acid (46.99%) and linoleic acid (9.91%), both of which are unsaturated fatty acids known for their cardiovascular and anti-inflammatory benefits. In contrast, cashew nut oil exhibited a higher percentage of palmitic acid (22.88%), a saturated fatty acid, along with notable quantities of lauric acid (18.98%) and myristic acid (6.62%).

These findings suggest that groundnut oil is richer in heart-healthy unsaturated fats, particularly monounsaturated oleic acid, making it more suitable for dietary applications that emphasize lipid quality. Meanwhile, cashew oil's relatively higher saturated fat content, including medium-chain fatty acids like lauric acid, may offer unique metabolic and antimicrobial properties but should be consumed in moderation.

Interestingly, groundnut oil showed a higher total concentration of fatty acids (110 units) compared to cashew oil (61 units) in absolute values, indicating a greater lipid density. However, when normalized to percentages, both oils accounted for approximately 100% of the total identified fatty acids, validating the analytical consistency.

These results align with earlier findings that high lipid content in groundnuts and cashews. However, the present study contributes a novel comparative perspective, offering detailed insights into the fatty acid spectrum of each nut (Ogundipe *et al*., 2024; Luparelli *et al*., 2022; Bonifácio *et al*., 2023).

Overall, the data highlight that groundnut oil may be preferable for health-conscious consumers due to its higher unsaturated fatty acid content, while cashew oil remains valuable for industrial and culinary applications owing to its distinctive fatty acid profile and functional properties.

The comparative analysis of groundnut and cashew nut oils revealed distinct differences in their fatty acid profiles. Groundnut oil demonstrated a higher concentration of unsaturated fatty acids, particularly oleic acid (46.99%) and linoleic acid (9.91%), both of which are associated with positive health effects, including reduced risk of cardiovascular diseases and improved lipid metabolism. These findings align with previous studies that have emphasized groundnut's nutritional value due to its monounsaturated and polyunsaturated fat content (Toomer, 2018; Asibuo *et al*., 2008).

Conversely, cashew nut oil was richer in saturated fatty acids, with notably high levels of palmitic acid (22.88%), lauric acid (18.98%), and myristic acid (6.62%). While saturated fats have traditionally been linked to adverse health outcomes, medium-chain fatty acids such as lauric acid are known to possess antimicrobial and energy-enhancing properties, making cashew oil suitable for specific therapeutic or functional food applications (Das *et al*., 2014; Ogunwolu *et al*., 2009).

The presence of other bioactive fatty acids, such as nervonic acid and behenic acid, further underscores the diverse biochemical potential of both nut oils. Nervonic acid, in particular, plays a role in brain development and myelin sheath repair, while behenic acid contributes to texture and stability in food processing.

From a nutritional perspective, the higher total fatty acid content in groundnut oil (110 units compared to 61 units in cashew) suggests it is a more concentrated source of lipids, potentially offering greater caloric and energy yield. However, the type of fat—saturated versus unsaturated—remains a critical consideration for health outcomes.

While previous studies have examined these nuts individually, the comparative approach adopted in this study offers new insight into their relative nutritional strengths. Groundnut oil, with its high oleic acid content, may be better suited for heart-healthy diets and high-heat cooking due to its oxidative stability. Cashew oil, on the other hand, may be more appropriate for use in confectionery and processed food industries where saturated fats enhance shelf life and flavor.

In summary, this comparative assessment provides a clearer understanding of the nutritional and functional differences between groundnut and cashew nut oils. The findings may guide dietary choices, inform industrial applications, and support further research into the health impacts of specific fatty acid profiles in plant-based oils.

4. CONCLUSION

This study conducted a comparative assessment of the fatty acid profiles of groundnut and cashew nut oils using AOAC-recommended methods and gas chromatographic analysis. The results revealed that groundnut oil contains significantly higher levels of unsaturated fatty acids, particularly oleic acid and linoleic acid, while cashew nut oil is richer in saturated fatty acids, such as palmitic acid, lauric acid, and myristic acid. The total fatty acid concentration was also greater in groundnut oil, indicating its higher lipid density and nutritional potential. These findings highlight the superior health benefits of groundnut oil in promoting cardiovascular wellness and metabolic balance due to its favorable fatty acid composition. Cashew oil, while containing more saturated fats, offers unique applications in the food industry due to its functionality and stability. Overall, this comparative profiling provides valuable insights for consumers, nutritionists, and food processors, supporting informed dietary choices and guiding the selection of nut oils for health-conscious and industrial purposes.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

7. REFERENCES

Alagawany, M., Elnesr, S. S., Farag, M. R., El-Sabrout, K., Alqaisi, O., Dawood, M. A., and Abdelnour, S. A. (2022). Nutritional significance and health benefits of omega-3,-6 and-9 fatty acids in animals. *Animal Biotechnology*, *33*(7), 1678-1690.

Aldana, J., Romero-Otero, A., and Cala, M. P. (2020). Exploring the lipidome: current lipid extraction techniques for mass spectrometry analysis. *Metabolites*, *10*(6), 231.

Amoniyan, O. A., Olugbemi, S. A., Balogun, O. M., and Salako, B. O. (2020). Effect of processing methods on the proximate and mineral compositions in groundnuts for consumption. *European Journal of Nutrition and Food Safety*, *12*(9), 87-93.

Aremu, M. O., Olonisakin, A., Bako, D. A., and Madu, P. C. (2006). Compositional studies and physicochemical characteristics of cashew nut (Anarcadium occidentale) flour. *Pakistan journal of Nutrition*, *5*(4), 328-333.

Asibuo, J., Akromah, R., Adu-Dapaah, H. K., and Safo-Kantanka, O. (2008). Evaluation of nutritional quality of groundnut (Arachis hypogaea L.) from Ghana. *African Journal of Food, Agriculture, Nutrition and Development*, *8*(2), 133-150.

Boli, Z. A., Zoue, L. T., Alloue-Boraud, W. M., Kakou, C. A., and Koffi-Nevry, R. (2013). Proximate composition and mycological characterization of peanut butter sold in retail markets of Abidjan (Côte d'Ivoire). *Journal of Applied Biosciences*, *72*, 5822-5829.

Bonifácio, D. B., Caldas, A. P. S., Costa, M. A. D. C., Rocha, D. M. U. P., Hermsdorff, H. H. M., and Bressan, J. (2023). Acute effect of a beverage containing Brazil and cashew nuts on oxidative stress, lipemia, and blood pressure of women with cardiometabolic risk (Brazilian Nuts Study): a randomized clinical trial. *Applied Physiology, Nutrition, and Metabolism*, *48*(10), 789-798.

Dantas, A., and Costa, D. P. (2022). A mini-review on almonds and cashew nuts: Processing impact, phytochemical and microbiological properties, and implications on human health. *American Journal of Food Science and Technology*, *10*(5), 233-238.

Das, I., Shah, N. G., and Kumar, G. (2014). Cashew nut quality as influenced by microwave heating used for stored grain insect control. *International Journal of Food Science*, *2014*(1), 516702.

Homayoonfar, M., Roosta Azad, R., and Sardari, S. (2021). Analytical methods in fatty acid analysis for microbial applications: the recent trends. *Preparative Biochemistry & Biotechnology*, *51*(10), 937-952.

Luparelli, A., Losito, I., De Angelis, E., Pilolli, R., Lambertini, F., and Monaci, L. (2022). Tree nuts and peanuts as a source of beneficial compounds and a threat for allergic consumers: Overview on methods for their detection in complex food products. *Foods*, *11*(5), 728.

Maestri, D. (2024). Groundnut and tree nuts: a comprehensive review on their lipid components, phytochemicals, and nutraceutical properties. *Critical Reviews in Food Science and Nutrition*, *64*(21), 7426-7450.

Mahfoud, F., Assaf, J. C., Elias, R., Debs, E., and Louka, N. (2023). Defatting and defatted peanuts: a critical review on methods of oil extraction and consideration of solid matrix as a by-product or intended target. *Processes*, *11*(8), 2512.

Mondal, D. D., Chakraborty, U., Bera, M., Ghosh, S., and Kar, D. (2023). An overview of nutritional profiling in foods: Bioanalytical techniques and useful protocols. *Frontiers in Nutrition*, *10*, 1124409.

Nguyen, T. L. (2019). Strengthening export competitiveness of Vietnam cashew kernels. *Engineering and Applied Sciences*, *14*(5), 1682-1689.

Ogundipe, S. O., Usack, J. G., Pegg, R. B., and Suh, J. H. (2024). Thermal and non-thermal processing on the physical and chemical properties of tree nuts: A review. *Food and Bioprocess Technology*, *17*(7), 1727-1751.

Ogunwolu, S. O., Henshaw, F. O., Mock, H. P., Santros, A., and Awonorin, S. O. (2009). Functional properties of protein concentrates and isolates produced from cashew (Anacardium occidentale L.) nut. *Food Chemistry*, *115*(3), 852-858.

Pati, S., Nie, B., Arnold, R. D., and Cummings, B. S. (2016). Extraction, chromatographic and mass spectrometric methods for lipid analysis. *Biomedical Chromatography*, *30*(5), 695-709.

Rahim, M. A., Ayub, H., Sehrish, A., Ambreen, S., Khan, F. A., Itrat, N., and Rocha, J. M. (2023). Essential components from plant source oils: a review on extraction, detection, identification, and quantification. *Molecules*, *28*(19), 6881.

Rustan, A. C., and Drevon, C. A. (2005). Fatty acids: structures and properties. *Encyclopedia of Life Sciences*, *1*, 1-7.

Sagun, J. V., Yadav, U. P., and Alonso, A. P. (2023). Progress in understanding and improving oil content and quality in seeds. *Frontiers in plant science*, *14*, 1116894.

Sanni, J. A., Sanni, G. O., Awoniyi, R. R., Osanyinlusi, R., Richards, Y. E., Adesina, G. I., and Ekun, O. E. (2024). Effects of processing on the proximate composition, mineral content and the phytochemical analysis of groundnut seeds (Arachis hypogeae). *Biology, Medicine, & Natural Product Chemistry*, *13*(1), 63-71.

Sunil, J., and Singh, A. (2021). Structural change analysis of groundnut export markets of india: markov chain approach. *Indian Journal of Economics and Development*, *9*(1), 1-6.

Toomer, O. T. (2018). Nutritional chemistry of the peanut (Arachis hypogaea). *Critical Reviews in Food Science and Nutrition*, *58*(17), 3042-3053.

Zhao, S., and Zhang, D. (2013). Supercritical fluid extraction and characterisation of Moringa oleifera leaves oil. *Separation and Purification Technology*, *118*, 497-502.

Zotov, V. A., Bessonov, V. V., and Risnik, D. V. (2022). Methodological aspects of the analysis of fatty acids in biological samples. *Applied Biochemistry and Microbiology*, *58*(1), 83-95.