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Nutrient and Antinutrient Compositions of Sesame (*Sesamum indicum* L.), and their Fungal Pathogens in Port Harcourt Metropolis

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Abstract

Sesame (Sesamum indicum L.) is one of the oldest cultivated oilseed crops in the world and is widely grown in tropical and subtropical regions. It is valued for its high oil content, nutritional quality, and health-promoting phytochemicals, but prone to fungal pathogens. This research was carried out in the Department of Plant Science and Biotechnology, and Food Science and Technology of Rivers State University. Dried seeds of S. indicum were purchased from mile 3 market, Port Harcourt. Mycological, nutrient and antinutrient compositions evaluation were done in triplicates using standard methods. Statistical analysis was done using one-way analysis of variance (ANOVA). Nutrient compositions revealed carbohydrate (38.30±0.17%) with the highest value while ash (3.26±0.05%) the least. For minerals, phosphorus had the highest value (220.33±0.57mg/100g) while iron the least (0.27±0.57mg/100g). Vitamin C and A were present. Antinutrient composition revealed polyphenol (14.23±0.05%) as the highest, while oxalate (0.01±0.00) the least. Mycological studies revealed the presence of Aspergillus niger, and flavus. These pathogens affect both the quantity and quality of sesame seeds by lowering oil content and leading to mycotoxin contamination. In conclusion, S. indicum is rich in nutrients but prone to fungal contaminations. Therefore, effective postharvest management including moisture control, proper drying and hygienic storage practices is essential for minimizing fungal contamination and preserving seed quality.

Keyword: Nutrient, Antinutrient composition, Sesame and Fungal contaminants

Introduction: Sesame (*Sesamum indicum* L.) is one of the oldest cultivated oilseed crops and is widely grown in tropical and subtropical regions of the world. It belongs to the family Pedaliaceae (Zech-Matterne,Tengberg and Van-Andringa, 2015) and is highly valued for its nutritional, medicinal, and economic importance (Wei, Zhao, Wang, Wang, Chai, Hou, and Meng, 2022). Sesame seeds are consumed directly as food ingredients and are processed into oil, flour, confectioneries, and other value-added products (Bedigian, 2010; Majdalawieh, Massri, and Nasrallah, 2017). The nutritional quality of sesame seeds has attracted significant scientific interest because they contain substantial amounts of oil, protein, dietary fiber, vitamins, minerals, and phytochemicals (Bohn, Meyer and Rasmussen, 2008; Rout, Yadava, Mukhopadhyay, Gupta, Pental and Pradhan, 2018; Haixia and Lu, 2015; Milder, Arts, Betty, Venema and Hollman 2005; Khan, Ahmad, Ali, and Hussain, 2025). Apart from their nutritional constituents, sesame seeds contain several bioactive compounds including sesamin, sesamolin, sesamol, tocopherols, phytosterols, and phenolic compounds. These phytochemicals exhibit antioxidant, anti-inflammatory, antihypertensive, cholesterol-lowering, and anticancer properties (Yousefi, Bahadoran, and Azizi, 2025; Oboulbiga, Douamba, Compaoré-Sérémé, Semporé, Dabo, Semde, Tapsoba, and Hama-Ba, 2023). The presence of these compounds has contributed to the increasing utilization of sesame as a functional food with potential therapeutic benefits (Wei et al., 2022; (Xu and Zhang, 2018; Bohn, Meyer and Rasmussen, 2008). Despite its high nutritional value, sesame contains certain antinutritional factors that may reduce the bioavailability of nutrients. Antinutrients are naturally occurring compounds that interfere with the digestion, absorption, and utilization of nutrients in humans and animals (Oplinger, Putnam, Kaminski, Hanson, Oelke, Schulte and Doll, 2016; Adatia, Clarke, Yanishevsky and Ben-Shoshan, 2017). The major antinutritional compounds identified in sesame seeds include phytic acid, oxalic acid, and tannins. Phytic acid is capable of chelating essential minerals such as calcium, iron, zinc, and magnesium, thereby reducing their absorption in the digestive tract. Similarly, oxalic acid binds calcium to form insoluble calcium oxalate complexes, while tannins can decrease protein digestibility through the formation of protein-tannin complexes. These antinutritional factors may negatively affect the nutritional quality of sesame, particularly when consumed in large quantities without adequate processing (Wei et al., 2022).

Several processing methods, including soaking, fermentation, roasting, germination, and dehulling, have been reported to reduce the levels of antinutritional compounds in sesame seeds and improve nutrient availability. Such processing techniques enhance mineral absorption and protein digestibility, thereby increasing the overall nutritional benefits of sesame-based products (Wei *et al*., 2022; Gebregergis, Baraki, and Fiseseha, 2024). In addition to nutritional and antinutritional concerns, sesame cultivation is constrained by several fungal pathogens that affect seed quality, crop productivity, and storage stability. Fungal diseases are among the major factors responsible for economic losses in sesame production worldwide (Gong, Song, and Zhang, 2024). Important fungal pathogens associated with sesame include *Aspergillus* spp., *Fusarium* spp., *Macrophomina phaseolina*, *Rhizoctonia solani*, *Alternaria* spp., and *Cercospora* spp. These pathogens cause diseases such as root rot, wilt, damping-off, charcoal rot, and leaf spot, resulting in reduced plant growth, yield loss, and poor seed quality (Abraham, Natarajan and Murugaesam, 2012; McCoy, Caudwell, Chang, Chen, Chiykowski, Cousin, Dale, Deleeune, Golino, Hackett, Kirkpatrick, Marwitz, Petzold, Sinha, Sugiura, Whitcomb, Yany, Zhu and Seemuller, 2010; Nakashima, Chaleepprom, Wongkaew, Sirithorn and Kato, 2011; Nakashima, Hayashi, Chaleeprom, Wongkaew, and Sirithorn, 2007; Akhtar, Sengupta and Chowdhury, 2008). Environmental conditions such as high humidity, elevated temperature, poor storage practices, and mechanical seed damage favor fungal growth and mycotoxin production in stored sesame seeds (Chandra, Kumar, Singh, Sharma, and Gupta, 2025). Sesame seeds have gained increasing attention as a valuable food resource for addressing nutritional deficiencies and enhancing food security. The antinutritional factors can interfere with the absorption and utilization of essential minerals. Therefore, there is need to evaluate the nutrient and antinutrient compositions and identify the fungal pathogens associated with them.

Collection of Samples: Dry seeds of *Sesamum indicum L* were purchased from Mile 3 Market in Port Harcourt. The seeds were taken to Food Science and Technology Laboratory for nutrient and phytochemical analysis while mycological studies were carried out in plant pathology laboratory of Plant Science and Biotechnology Department.

Proximate Composition Determination: Standard Analytical Method AOAC, (2005) was the method used to determine the proximate composition comprising; Moisture, Ash, Crude Fiber, Lipid, Protein, and Carbohydrate.

Determination of Minerals: Mineral analysis was carried out after wet digestion with a digestion mixture containing concentrated nitric acid and concentrated tetraoxosulphate (VI) acid in a ratio of 3:1. (ASTM, 2004). A digestion mixture containing concentrated nitric acid and concentrated tetraoxosulphate (vi) acid (H_2SO4) in a ratio of 3:1 was used as wet digestion to be able to carry out mineral analysis. 0.2 gram of lentil samples in powdered forms were weighed and put into a conical flask and 5cm3 of digestion mixture was added and placed in a fume cupboard for digestion at a temperature of 150ºC-200ºC for 2 hours; the mixture became digested and was allowed to cool. Distilled water (30cm3) was added to the digest, shaken vigorously, and filtered. In a volumetric flask, the filtrate is marked up into 100 cm^3. In the digest, the Flame photometer was used to determine sodium (Na), Potassium (K), Calcium (Ca), Iron (Fe), Magnesium (mg), and Phosphorous (P), but when EDTA complexometric fixation (ASTM, 2004) is used in the digest, it determines calcium.

Determination of Vitamins: The vitamins in the species studied were determined by the official methods of the Association of Official Analytical Chemists (AOAC, 2005).

Determination of Phytochemicals: Antinutrients can also be referred to as phytochemicals. Some anti-nutrients determined in the sample of Sesame include glycoside, oxalates, saponin, tannins, carotenoids, polyphenols, flavonoids, and lignans. Standard Analytical Method, AOAC, (2005) was used in the determination of the anti-nutrients of Sesame.

Mycological Study:Sterilization of Glassware and Preparation of Mycological Medium

Sterilization of conical flasks, slides, Petri dishes and all the equipment was carried out in the laboratory. The glassware was sterilized in the oven at 120°C for an hour after washing with soap, while the other equipment's were surfaced sterilized with 70% ethanol to reduce Microbial contamination (Chuku, 2009). Inoculating loops and scalpels were sterilized by dipping for 20 seconds in 70% ethanol and heated to red hot. Potato Dextrose Agar was prepared in conical flasks using the standard method. The mouth of the flask was plugged with non-absorbent cotton wool and wrapped with aluminum foil. The conical flasks containing the mycological Medium were autoclaved at 121°C and pressure of 1.1kg cm^{-3} for 15 minutes. The molten agar was allowed to cool to about 40°C and dispensed into Petri dishes at 15mls per plate and allowed to further cool and solidify.

Isolation of fungi from *Sesamum indicum L.* A tenfold serial dilution was used in accordance with the method of Obire, Wekhe and Steve, (2016) where 1g of the diseased sample was transferred into the first test tube containing 9mls of normal saline. 1ml of the solution was transferred to the second test tube and finally from the second to the third. 0.1ml aliquots from the second and third dilutions were plated onto Sabouraud Dextrose Agar in Petri dishes containing ampicillin to hinder the growth of bacteria and this was done in triplicate. The inoculated plates were incubated for 5 days at ambient temperature of 25ºC ± 3°C (Wekhe *et al*., 2020). The entire set up was observed for 7 days to ensure full grown organisms. Pure cultures of isolates were obtained after a series of isolations.

Identification of fungal organisms of *S. indicum*: Microscopic examination of fungal isolates was carried out by the needle mount method (Cheesebrough, 2000). The fungal spores were properly teased apart to ensure proper visibility. The well spread spores were stained with cotton blue in lactophenol and examined microscopically using both the low and high-power objective. The fungi were identified based on their spore and colonial morphology, mycelia structure and other associated structures using the keys of (Barnett & Hunter, 1998).

Results: Proximate Composition of *S. indicum*: The proximate composition of *S. indicum* is seen in Table 4.1. The moisture content recorded 14.23 ± 0.05%. The moisture content of this study is higher than that reported by Fuad and Buwketu (2020) which varied in the range of 5.43-5.81%. Christian, Stanley, and Emmanuel, (2019) recorded 50.60±3.74%, for seed of *S. indicum* L. grown in southern Nigeria and moisture reported by Wobasi and Attamah (2017) which was less than 5%. The moisture content of this study is also higher than Nzikou, Matos and Bouanga-Kalou (2009), and Kanu, (2011). According to Enyoh, Ihionu, Verla and Ehosie (2017) and Enyoh, Verla, Enyoh and Verla, (2018), the moisture contents observed in the seed may enhance rapid deterioration thereby reducing long storage capability. Ashes are the organic residue remaining after either ignition or complete oxidation of organic matter in the food sample. The ash content of this study recorded 3.26±0.05. The ash content of this study is lower than that of Christien *et al*., (2019), 8.46±0.24% Fuad and Bewketu (2020) which recorded 4.27%. Lipid in this study recorded 15.03±0.05. High Lipid (15.03±0.05%) and protein (25.43±0.05%) Content of this study agree with Wobasi and Attamah (2017); Nzikou *et al*., (2009), (48.5% and 20%) Shah, 2013 (43.3 and 18.3%), and Dashak and Fali, 1993 (43.6±0.11% and 20.8±0.14%) respectively. This research's proximate analysis showed that carbohydrate content has the highest value 38.30± 0.17%. Fibre content recorded 3.53±0.05%. The crude fibre of this research (6.12 ± 4.10%) is lower than that recorded by Christian *et al*., (2019).

Mineral and vitamin composition of *S. indicum*: The mineral and vitamin composition of *S. indicum* are seen in Table 4.2. The result revealed the presence of calcium (18.15± 0.05mg/100g), iron (0.27±0.21mg/100g), magnesium 30.62±0.57mg/100g), Phosphorus (220.33±0.57mg/100g), potassium (103.00±1.73mg/100g), sodium (24.90±1.73mg/100g), Vitamin C (105.33±0.57mg/100g) and Vitamin A (21.33±0.57mg/100g) respectively. The mineral result revealed that phosphorus recorded the highest 220.33±0.57mg/100g; while the least was iron 0.27±0.21mg/100g. *S. indicum* has been reported to be a source of several minerals (Elleuch, Besbes, Roiseux, Blecker, Attia, 2007). The vitamin C content was 105.33±0.57 while vitamin A recorded 21.33±0.57mg/100g. Other researchers such as Mili *et al*., (2021) and Eskandari *et al*., (2015) identified these vitamins in their study.

Antinutrient Composition of *S. indicum:* Antinutrient composition of *S. indicum* is shown in Table 4.4. The result revealed high polyphenol 14.23±0.05%, flavonoid 13.60±0.00 and lignan 12.60±0.17% content respectively. Antinutrient are substances that disrupt or prevent the digestion and absorption of nutrients, negatively affecting the health and growth of animals (Farran, Uwayjan, Miski, Akhdar, and Ashkarian, (2000).

Fungi contamination of *S. Indicum:* This research identified *Aspergillus niger* and *A. flavus* to be associated with *S. indicum* seed spoilage. Other researchers such as , Ghosh, Biswas and Aikat, (2018), Riba, Bouras, Mokrane, Mathieu, Lebrihi and Sabao, (2010), Rostami, Naddafi, Aghamohamadi, Najafi, Fazizadeh, (2009) and Mimoune, Ribar, Verheecke, Mathieu and Sabao,(2016), Wekhe, Agbagwa, and Shedrach (2026) have also identified these organisms to be frequent fungal contaminants found worldwide on various substrates such as cereals, grapes, coffee bean, nuts and other food products.

Conclusion: Sesame seeds are nutritionally rich oilseeds containing high levels of oil, protein, essential fatty acids, minerals, vitamins, and some antinutrients (such as polyphenol, flavonoid and lignan) and bioactive compounds. The high value of moisture content makes it ideal for weight watching but may enhance rapid deterioration thereby reducing long storage capability. The presence of *Aspergillus species* can make it mycotoxigenic to health. Therefore, effective postharvest management including moisture control, proper drying and hygienic storage practices is essential for minimizing fungal contamination and preserving seed quality.

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Table 4.1: Proximate composition of *S. indicum* seed

Parameter	Composition (%)
Moisture	14.23±0.05
Ash	3.26±0.05
Lipid	15.03±0.05
Fibre	3.53±0.05
Carbohydrate	38.30±0.17
Protein	25.43±0.05

Table 4.2: Mineral and Vitamin Composition of *S. indicum* seed

Parameter	Composition (mg/100g)
Calcium	18.16±0.05
Iron	0.27±0.21
Magnesium	30.67±0.57
Phosphorus	220.33±0.57
Potassium	103.00±1.73
Sodium	24.90±1.73
Vitamin C	105.33±0.57
Vitamin A	21.33±0.57

Table 4.3: Anti-nutrient Composition of Sesame

Parameter	Composition (%)
Oxalate	0.01±0.00
Saponin	0.03±0.00
Tannin	0.02±0.00
Carotenoid	0.05±0.00
Polyphenol	14.23±0.05
Flavonoid	13.60±0.00
Lignan	12.60±0.17

Fungal Characterization

Table 4.4: Shows the fungal characterization of *Sesamum indicum* seeds isolates

S/N	**Type of Hyphae**	**Color of Hyphae**	**Spore Color**	**Spore shape**	**Colony Color**	**Fungus**
1	Septate/ Biseriate	White to pale yellow	pale yellow Brown to black conidia	Round, obscures vesicle	Initially white, then Yellow to gray	*Aspergillus niger*
2	Septate	Yellow brown or hyaline	Brown	Conidia are round, globose to subglobose	Granular, velvety, yellow brown	*Aspergillus flavus*