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CHEMICAL COMPOSITIONS AND THE PHYTOCHEMICAL CONSTITUENTS OF THE SEED OF *SESAMUM INDICUM* GROWN AT KATSINA STATE, NORTHERN NIGERIA

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ABSTRACT
The seeds of *Sesamum indicum* (sesame) are one of the oldest sauce, relish and spice known to man. This study determines the chemical composition (both proximate and the mineral contents), as well as the phytochemical constituent of the variety of sesame seed available in Katsina State, Nigeria. The proximate and phytochemical analyses were carried out using standard procedures, while the mineral content was determined by atomic absorption spectrophotometry. The results for the proximate content of the analysed sesame seeds are moisture 7.63%; crude protein 21.34%; crude fibre 9.54%; crude lipid 41.84%; ash 9.01% and carbohydrate 10.64%. The seeds were also found to contain some minerals including Na 0.37%; K 1.69%; Mg 0.32%; Ca 1.12%; P 0.76%; Zn 0.0073%; Cu 0.038%; Mn 0.0026 and Fe 0.021%. The results for the phytochemical screening revealed the presence of alkaloids, carbohydrates, flavonoids, phytosterols, proteins, saponins and terpenoids, while tannins were found to be absent. The present findings suggest that sesame seeds can be a good source of nutrients in the diet and may have health and economic benefits due to its fibre and minerals content, as well as its phytochemical contents.

Keywords: *Sesamum indicum*, phytochemicals, proximate analysis, mineral content

INTRODUCTION
Man cannot live independently without interacting with plants, for his life and survival would be impossible without plants and plant products (Emmanuel *et al.,* 2015). The plant kingdom is considered as the treasure house for food, potential drugs, other materials and to some extent shelter (Trivedi, 2009). The use of traditional medicines based on the compounds derived and/or isolated from plants is a common activity throughout the world, and according to World Health Organisation medicinal plants would be the best source to obtain variety of drugs (Thite *et al.,* 2013). Recent reports have revealed that quite a large number of indigenous plant species are high in nutrients value (Lalas and Tsaknis, 2002). However, despite the identification of many of such plants with potentials of serving as food and drugs, there is very little information about their chemical compositions (Blessing *et al.,* 2010). One of such plants that has played a major role in human/livestock food and drugs since ancient times is the sesame (Olaleye *et al.,* 2015), and it has been recommended as a potential source to solve the problem of micronutrients deficiencies in modern day nutrition (Blessing *et al.,* 2010).
Widely distributed across India and Africa, *Sesamum indicum* L. (Pedaliaceae), also known as sesame is reputed for its folk medicine (Jefferson, 2003). Incidently, sesame seeds are the oldest sauce, relish and spice known to man, dating back to as early as 1600 BC (Nagendra *et al.,* 2012). The concoction or infusion from the roots, leaves or seeds of sesame have been recommended by traditional health practitioners in Nigeria for the treatment of various ailments including bruised, catarrh, eye pains, inflamed membranes of the mouth, chicken pox, measles and as a hair shampoo against *Taenia capitis* (Gill, 1992). Several studies have been conducted on different species of sesamum grown in the Western part of Nigeria, however there is scanty scientific information on *S.indicum* grown in the northern part of Nigeria. At the beginning of this study there was very few reports on the phytochemical, proximate and mineral composition of the seeds or other parts (leaves and root) of *S. indicum* grown in the study area. It is in view of that the present study was aimed to provide information on the mineral compositions, proximate composition and phytochemical constituents of the seed of *Sesamum indicum* produced in Katsina, North-Western Nigeria.

MATERIALS AND METHODS
Sample Collection and Preparation
Dried sesame seed were obtained from three different farms in Dutsin-Ma Local Government of Katsina State, Nigeria. The seeds were milled with pestle and mortar and then packed in an air tight container and stored in a dessicator (containing silica gel) ready for further analysis.
All the chemicals used were of analytical grade.
Determination of Mineral Content
Mineral analysis was determined using 10 g of the milled sesame seed and subjected to dry ashing for 5 hr in well cleaned porcelain crucibles at 550°C. The residue ash was dissolved in 5 ml of HNO_3/HCl (1:2) and heated gently on a hot plate until brown fumes disappeared and white coloration was formed. The solution on each crucible was filtered into 100 ml volumetric flask and the volume made up to 100 ml with deionized water.
The cations (Na, K, Mg, Ca, P, Zn, Cu, Mn and Fe) were determined using flame atomic absorption spectrophotometer (Shahid *et al.,* 1999).
Determination of Proximate Composition
The proximate compositions of the milled sesame seed were determined using standard analytical methods. All measurements were done in triplicates and values presented in percentage.

Moisture Content
Two grams of the milled sesame seed was oven-dried in a crucible at 105 °C overnight. The dried sample was then cooled in desiccator for 1 hr and weighed to a constant weight and the percentage loss in weight was expressed as percentage moisture content (AOAC, 1999).
Ash Content
The residue remaining was weighed after the ashing of 2 g dried milled sesame seed in a crucible. The ashing was done in a muffle furnace of temperature 550 °C for 6 hr. The ashed sample was cooled in a desiccator and weighed. The percentage residual weighed was expressed as ash content (AOAC, 1999).
Crude Lipid Content
Continuous extraction of lipid was done for 5 hr with petroleum ether in a soxhlet extractor with 2.00 g of the sample used to determine the crude lipid content (Udo and Oguwele, 1986).
Crude Protein Content
Kjeldahl method was used to determined total protein. Here 1 g of the sample was put into a filter paper and put into a Kjedahl flask, 10 cm^3 of concentrated H_2SO_4 were added and digested in a fume cupboard until the solution becomes colourless. The distillation was carried out with 15 mL of 50% of NaOH. The tip of the condenser was dipped into a conical flask containing 6 cm^3 of 4% boric acid in a mixed indicator until a green coloration was observed. Titration was done in the receiver flask with 0.01 M HCl until the solution turned red (Gabriel *et al.,* 2018).
Crude Fibre Content
Estimation of the crude fibre was done by acid and alkaline digestion methods, 2.00 g of each sample were used with 20% H_2SO_4 and NaOH solution (Gabriel *et al.,* 2018).
Carbohydrate Content
The carbohydrate content of the test sample was determined by estimation using the arithmetic difference method (De Conto *et al.,* 2011; James, 1995).

%CHO = 100 - (% Moisture + % Fat + % Ash + % Fibre + % Protein)

Phytochemical Screening
The qualitative phytochemical screening of the sesame seed extracts was carried out according to different standard procedures to ascertain the phytochemical composition of the seed.
Test for Alkaloids
Mayer's Test: Two drops of Mayer's reagent were added to 2 ml of the milled sesame seed extract along the sides of test tube (Evans, 1997).
Test for Carbohydrates
Benedict's Test: Benedict's reagent (0.5 ml) was added to 0.5 ml of the milled sesame seed filtrate. The mixture was heated on a boiling water bath for 2 minutes (Benedict, 1908).
Test for Oils and Fats
Spot Test: A small quantity of extract was pressed between two filter papers (Sahira and Cathrine 2015).
Test for Flavonoids
Alkaline Reagent Test: A measure of 2 ml of 2% NaOH was mixed with aqueous milled sesame seed extract, a concentrated yellow colour was produced which became colourless when 2 drops of the diluted acid was added (Sofowora 1993).
Test for Phytosterols
Libermann-Burchard's Test: The milled sesame seed extract (50 mg) was dissolved in of 2 ml acetic anhydride, and to this 2 drops of concentrated sulphuric acid were slowly added along the sides of the test tube (Finar, 1986).
Test for Proteins
The extract (10 mg) was dissolved in 5 ml of distilled water and filtered through Whatmann No. 1 filter paper and the filtrate was subjected to Biuret test for proteins. Here 2 ml of the filtrate was treated with 1 drop of 2% copper sulphate solution, and 1 ml of (95%) ethanol was added, followed by excess of potassium hydroxide pellets (Gahan, 1984).
Test for Saponins
The milled sesame seed extract (50 mg) was diluted with distilled water and made up to 10 ml. The suspension was shaken in a graduated cylinder for 15 minutes (Kokate, 1999).
Test for Terpenoids
Noller's Test: The milled sesame seed extract (2 mg) was taken in a dry test tube and was treated with a bit of tin foil and 0.5 ml of thionyl chloride, followed by gentle heating (Sourabh *et al.,* 2014).

RESULTS AND DISCUSSION
Results
The results for the different proximate composition (the sample of the milled sesame seed) including moisture content, ash content, crude lipid content, crude protein content, crude fibre content and carbohydrate contentwere determined using different standard techniques as presented in Table 1. Again the sample of the milled sesame seed was tested for the presence of some mineral elements including Na, K, Mg, Ca, P, Zn, Cu, Mn and Fe, and the result is presented in Table 2. Lastly, the sample was also tested for different phytochemical composition including alkaloids, carbohydrates, oils and fats, flavonoids, phytosterols, proteins, saponins and terpenes and the results are presented in Table 3.

Table 1: Proximate Composition (%) of *Sesamum indicum* Seed

S/NO	Component	Mean Value (%)
1.	Moisture	7.63
2.	Crude Protein	21.34
3.	Crude Fibre	9.54
4.	Crude Lipid	41.84
5.	Ash	9.01
6.	Carbohydrate	10.64

Table 2: Mineral Content (%) of the Seed of *Sesamum indicum*

Mineral	Na	K	Mg	Ca	P	Zn	Cu	Mn	Fe
Concentration	0.37	1.69	0.32	1.12	0.76	0.0073	0.038	0.0026	0.021

Table 3: Qualitative Analysis of the *Sesamum indicum* Seed Extract

S/NO	Phytochemical Constituents	Watermelon Seed Extract
1.	Alkaloids	+
2.	Carbohydrates	+
3.	Flavonoids	+
4.	Phytosterols	+
5.	Proteins	+
6.	Saponins	+
7.	Terpenoids	+
8.	Tannins	-

+ Present - Absent

DISCUSSION

Result for the proximate constituent analysis of sesame *(Sesamum indicum)* seeds is presented in Table 1, while that of the minerals composition is presented in Table 2. Reports by different researches reveal the proximate compositions of sesame seeds. The moisture content of the sesame analysed was found to be 7.63% and this was found to be within the range of results (4.11%-10.91%) reported by different researchers (Blessing *et al.,* 2010 (10.91%); Nagendra *et al.,* 2012 (6.61%); Makinde and Akinoso, 2013 (5.41%); Haftom *et al.,* 2015 (4.11%). Therefore the values obtained in this study were found to be within the acceptable limits. The low moisture contents observed in the whole plant may enable this plant to possess a long storage capability. Similarly, the percentage protein in the sesame seed was found to be 21.34% and this is supported by reports from Makinde and Akinoso (2013) and Haftom *et al.,* (2015) who reported a percentage protein content of 26.79% and 22.58% respectively. This means that sesame seed can serve as a good source of this important nutrient, since protein is an essential component of the diet needed for survival of both humans and animals (Pugalenthi *et al.,* 2004).

The sesame seed analyzed was found to contain 9.54% of crude fibre, and this was found to be within the range of 3.2% - 10.0% reported by Obianjunwa *et al.,* (2005) and El-Khier *et al.,* (2008). Fiber in the diet is important as it helps to maintain human health by reducing blood cholesterol and glucose level in the body Bello *et al.,* (2008). The presence of an appreciable amount of fibre in sesame seed makes it a possible remedy for lowering of cholesterol levels in the blood and reduce risk of various cancers (Gabriel *et al.,* 2018). It is also known to expand the inside walls of the colon, easing the passage of waste, thus making it effective against constipation (Betty *et al.*, 2016).

The crude lipid or oil content of the seed extracted from the sesame seed was found to be 41.84% and this was found to be a little below (but still within) that reported by Haftom *et al.,* (2015) who reported a range of 47.18%-58.52%, with Tashiro *et al.,* (1990) reporting the oil content in the range of 43.4% to 58.8% for 42 strains of sesame with the highest oil content found in white-seeded strain, while Bahkali *et al.,* (1998) reported oil content in Saudi and Indian sesame seeds ranging from 43.2% to 54.0%. The variation in the oil content may be due to variation in variety, soil type, climatic, maturity of plant, the harvesting time of the seeds and the extraction method used (Egbekun and Ehieze 1997; Rahman *et al.,* 2007). Oil provides concentrated energy in diet and enhanced palatability (Hassan *et al.*, 2008).

The carbohydrate content in the sesame seed analyzed in this study was found to be 10.64% and this is supported by reports from other researchers (Blessing *et al.,* (2010); Nagendra *et al.,* (2012); Alege *et al.,* (2013); Makinde and Akinoso (2013) and Haftom *et al.,* (2015), who reported a near similar results. However, this value is less than the RDA by FAO/WHO (55%), thus a diet of sesame seeds should be taken along-side another food with a much higher carbohydrate in order to have the daily required carbohydrate intake carbohydrates not only provide the most easily accessible energy source for our body, but also play an important role in many physiological processes.

The ash content of the sample analyzed was found to be 9.01%. This result is similar to the results reported by Blessing *et al.,* (2010) who reported 9.62%; Makinde and Akinoso, (2013) who reported 7.31% and Haftom *et al.,* (2015) who reported 9.00%. Sample with appreciable ash content is expected to have high concentration of various mineral elements, which are expected to speed up metabolic processes, improve growth and development (Betty *et al.*, 2016).

The mineral content of the sesame seed analyzed is presented in Table 2, with potassium (K) having the highest value of 1.69%, followed by calcium (Ca) with 1.12%, then phosporous (P), sodium (Na) and magnessium (Mg) with values of 0.76%, 0.37% and 0.32% respectively, while iron (Fe), copper (Cu), manganese (Mn) and zinc (Zn) had 0.021%, 0.038%, 0.0026% and 0.0073% respectively. This result is supported by the findings reported by Blessing *et al.,* (2010); Nagendra *et al.,* (2012); Alege *et al.,* (2013); Makinde and Akinoso (2013) and Haftom *et al.,* (2015).Copper helps the body form collagen and absorbs iron, and plays a role in energy production. Zinc plays role in wound healing as well as treatment to diarrhea. Iron is a mineral that serves several important functions, its main function being to carry oxygen throughout our bodies and making red blood cells (Beard and Dawson, 1997). Due to the reasonable concentrations of calcium, magnesium and zinc in the sesame seed, it should be recommended as an element of bone and teeth strengthening, and also as a potential ingredient in cosmetics for stimulation and revitalization. Potassium and sodium help in regulating the water balance and the acid-base balance in the blood and tissues. Therefore sesame seed can easily be used to supplement some of these minerals in the human body.

The phytochemical analysis/screening of the sesame seeds showed the presence of alkaloids, carbohydrates, flavonoids, phytosterols, proteins saponins and terpenoids, while tannins were absent. This result resembles that reported by Blessing *et al.,* (2010) and Nwobasi and Attamah, (2017). However presence of tannins was reported by both the group of reseachers which contradicts the findings of this study. Saponins have been reported to be effective and responsible for the treatment of many conditions such as inflammation, pre-and post-menopausal symptoms (Bombardelli and Gabetta, 2001), cardiovascular and hypertension (Yao *et al.,* 2005). Some alkaloids from plant sources are reported to have medicinal actions such as analgesics, antispasmodics, anti-cholinergics and anaesthetic properties (Okwu, 2004). Antimicrobial activity of some alkaloids have also been reported (Olaleye, 2007). Flavonoids are used as natural antioxidants in foods and pharmaceutical drugs due to their ability to scavenge reactive oxygen species (Bombardelli and Gabetta, 2001).

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