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Chemical Composition and *in vitro* Antioxidant Properties of Hexane and Methanol Extract of *Sesamum indicum* Seeds Obtained from Kogi State, Nigeria

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ABSTRACT: The chemical composition and *in vitro* properties of hexane and methanol extract of *Sesamum indicum seeds* (SIS) obtained from Kogi State, Nigeria were evaluated**.** The proximate analysis of the ground seed showed the presence of moisture content (8.56 ± 0.02%), dry matter (91.44 ± 0.02%), ash content (5.70 ± 0.01%), crude protein (19.37 ± 0.08%), crude fiber (6.34 ± 0.03%), fat (52.77 ± 0.02%) and carbohydrates (7.26 ± 0.14%). Phytochemical analysis of both extracts showed the presence of oxalate, hydro cyanide, alkaloids, tannins, total flavonoids, phenol, steroids and terpenes. Flavonoids and phenol contents were higher in both extracts. The flavonoid and phenol concentrations of hexane and methanol extracts were 24.79 ± 0.01 and 25.27 ± 0.02 mg/100 g, 24.32 ± 0.02 mg/100 g and 18.66 ± 0.04 mg/100g, respectively. Hydrogen cyanide was found in lowest concentration in both extracts. Vitamins analysis showed that vitamin E had the highest composite for hexane and methanol extract. Vitamin E concentration was 3.44 ± 0.01 mg/100g and 2.95± 0.02mg/100g respectively while vitamin B6 (0.01 ± 0.00 mg/100g) and vitamin B1 (0.03 ± 0.00 mg/100g) were found in lowest concentration respectively. The mineral analysis showed that potassium (43.33 ± 0.04 and 27.46 ± 0.02 mg/100g) had the highest concentration for methanol and hexane extract, respectively. The results of the DPPH activity of methanol and hexane extract of *S. indicum* seeds indicated that the activity of the extract were all significantly ($p<0.05$) lower than the values for ascorbic acid (standard) across all concentrations. However, the DPPH activity of hexane extract indicated that there was no activity in the tested concentrations below100 µg/mL. The result of the FRAP of methanol and hexane extract of SIS showed that there was no activity at the concentrations of 100 µg/ml and 400 µg/ml respectively. However, the activity observed at concentrations above 100 µg/ml and 400 µg/ml were all significantly ($p<0.05$) lower than the same concentration in ascorbic acid. This result implies that hexane and methanol extract of *S. indicum* seeds possess nutritional and pharmacological value and can be a rich source of minerals, vitamins and antioxidative supplement.

Keywords: *Sesamum indicum* seeds, proximate analysis, phytochemicals, minerals, vitamins and antioxidants

Introduction

Some substances derived from plants are known for their antioxidant activity and their consumption is connected with reduced risks of cancer, cardiovascular disease, diabetes and other diseases associated with aging (Sakina *et al*., 2015). They are the richest source of drugs of folk systems of medicine, modern medicines, nutraceuticals, food supplements, folk medicines, pharmaceutical intermediates and chemical entities for synthetic drugs (Sathisha, 2013). Plant parts like root, leaves, fruit, flowers, and seeds are usually used in traditional preparations or as pure active principles formulated in to a suitable preparation. Medicines derived from plants are used in all nations and cultures and, thus, plants have always played a key role in health care systems worldwide. According to the World Health Organization, in spite of the wide use of medicinal plants, their efficacies and contents have rarely been tested (WHO, 2008) , therefore it is necessary to evaluate the comprehensive nutritional and pharmacological potentials of plants used in the management of diseases because even with the promising potential of plants and their high global demand, there are still concerns about their safety and the contents that may contribute to their pharmacological potential (Obidike and Salawu, 2013).

There is need to search for phytochemicals of native and naturalized plants for pharmacological and nutritional purposes because plant derived products have great potential as sources of pharmaceuticals. The medicinal properties of plants have been examine in recent scientific developments throughout the world, due to their potential antioxidant activities, with reduced side effects and economic viability (Auudy *et al.*, 2003). In recent times, there has been a rise of interest in the healing potentials of medicinal plants and some fruits as antioxidants in reducing free radical induced tissue injury (Schuler, 1990). Free radicals are chemically destructive molecules which react with different types of macromolecules in the body to cause damage to vital cell constituents such as DNA, proteins and lipids (Harman, 1981). Medicinal plants are important sources of antioxidants (Rice-Evans, 2004) and it has been reported that the use of fruits and vegetables containing antioxidant agents and some minerals and vitamins diminish the possibility of chronic diseases such as diabetes, cancer and cardiovascular diseases (Myojin *et al.*, 2008; Semiz and Sen, 2007). Plants contain many phytochemicals that are useful sources of natural antioxidants, such as phenolic diterpenes, flavonoids, tannins, phenolic acids (Lee *et al*., 2004), and Polyphenols (Bernardi *et al*., 2008). Some of the compounds obtained from food, such as vitamin E, Vitamin A, and Vitamin C, and some micronutrient elements such as zinc and selenium have been reported for its pharmacological importance in fighting free radicals (Farrukh *et al.,* 2006). Several synthetic antioxidants and vitamins and minerals supplements are in use, but have however been reported that they have several side effects such as risk of liver damage, and carcinogenesis in laboratory animals (Gao *et al*., 1999). In order to avoid these effects, more effective, less toxic and cost effective antioxidants, minerals and vitamins need to be developed. Medicinal plants appear to have these desired comparative advantages, hence the growing interest in natural antioxidants, minerals and vitamins from plants.

Sesamum indicum is an annualplant that belong to pedaliaceae family (Bedigian, 2015). It is a herbaceous plant cultivated for its edible seed, oil and flavorsome value (Bedigian, 2010). It is commonly refer to as "Queen of Oilseeds" due to its high degree of resistance to oxidation and rancidity. Sesame seeds have different colours including white, buff, tan, gold, brown, reddish, gray, and black. The seeds are small, their size, form, and colors vary with the thousands of varieties and the seed coat may be smooth or ribbed (Devarajan *et al*., 2016). It is consumed directly as sweetmeat, a "peanut butter-like" product, a candy ingredient, bread condiments, and snack foods. Sesame oil has been used in the treatment of hepatitis and other chronic diseases including diabetes and migraine. Sesame flower extract has been shown in studies to possess tumor arresting property (Bhaskaran *et al*., 2006). Sesame plant is known as one of the richest food source of lignans, a major type of phytoestrogens known to man since the dawn of civilization (Shittu *et al.,* 2007) and is increasingly being incorporated into human diets because of its reported health benefits. Sesame oil, extracted from *S. indicum* L. seed has been used in the food and pharmaceutical industries due its high lipids and protein content and its distinctive flavour (Abou-Gharbia *et al*., 2000).

However, there is no comprehensive report on the composition of the phytochemical, proximate, minerals vitamins and *in vitro* properties of different extracts of *S. indicum* seeds grown in Kogi State have being carried out probably because it is one of the commonest seed in the aforementioned state, thus the potentials was neglected and such information is necessary for the potential use of this plant in disease therapeutic & prevention and also it will provide an idea on the pharmacological, dietary and toxic potentials of the plant. Therefore, this study is aimed at assessing the chemical composition and *in vitro* antioxidant properties of methanol and hexane extracts of *S. indicum* seeds obtained in Kogi State.

Materials and methods

Collection and identification of plant: *Sesamum indicum* seeds were purchased from an Inye farmer at Engenma Ward 3 in Ankpa Local Government Area of Kogi State. The plant was identified by Mr. Ibeh Ndukwe of the Department of Forestry and Environmental Management, Michael Okpara University of Agriculture Umudike (MOUAU). A voucher specimen was kept at the Herbarium Unit in the Department of Physiology and Pharmacology, College of Veterinary Medicine, MOUAU with a voucher number of MOUAU/CVM/VPP/2021/1.

Preparation of crude extract: The *S. indicum* seeds were thoroughly washed, air-dried at room temperature and the dried seeds pulverized by the use of a miller. The pulverized sample seed was introduced into the extraction chamber of a Soxhlet extractor and extraction was carried out using hexane and methanol separately with temperature maintained at 60 °C. At the end of the extraction, the extract was concentrated to dryness with rotary evaporator which was maintained at 40 °C.

Phytochemical analysis of hexane and methanol extract of S. indicum seeds: Alkaloid content of *S. indicum* seeds was determined by the method described by Santhi and Sengottuvel (2016). Flavonoid content was determined by the method of Harbon (1980). The total phenol content was determined according to the method of Singleton *et al.* (1999), Content of tannins in the extract was determined by Folin Denis method (Polshettiwar *et al*. (2007). The method employed by Harland and Oberlease (1978) was used in the determination of phytate content of sesame seeds. Oxalate and hydrogen cyanide were determined by the method described by Onwuka (2005).

Proximate analysis of ground S. indicum seed: Moisture and total ash content were determined by method as described by AOAC (1990). Fat content of the sample was determined by the continuous solvent extraction method using a Soxhlex apparatus as described by Pearson (1976). Crude fibre, carbohydrates and dry matter contents were determined by the method described by James (1995). Protein content was determined by Kjeldahl digestion method described by AOAC (2010).

Determination of vitamin content: The method as described by Onwuka (2005) was employed for the determination of vitamin content of extracts of *S. indicum* seed

Determination of mineral elements content: The method described by AOAC (1995) was employed for the determination of mineral content of extracts of *S. indicum* seed.

Determination of in vitro antioxidants: 2, 2-diphenyl-1-picrylhydrazyl (DPPH) photometric assay was assessed by the method described by Mensor *et al.* (2001). The ferric reducing antioxidant power (FRAP) was carried out as described by Benzie and Strain, (1999).

Statistical analysis: Results were expressed as the Mean ± S.D. One way analysis of variance (ANOVA) was used to separate means with post-hoc multiple comparison (option - LSD). Significance was accepted at ($p \leq 0.05$). Data analysis was done using Statistical Package for Social Scientists (SPSS), version 16.

Results

Proximate composition of Sesamum indicum ground seed: The result of the proximate composition of *S. indicum* methanol seed extract as shown in Table 1 indicated that the seed has high dry matter (91.44 ± 0.02) followed by high fat content (52.77 ± 0.02) and crude protein (19.37 ± 0.08). However, ash content was the least components in sesame seeds (5.70 ± 0.01).

Table 1: Proximate composition of *Sesamum indicum* ground seeds

Proximate (%)	**Composition**
Moisture content	8.56 ± 0.02
Dry matter	91.44 ± 0.02
Ash content	5.70 ± 0.01
Crude protein	19.37 ± 0.08
Crude fibre	6.34 ± 0.03
Fat	52.77 ± 0.02
Carbohydrates	7.26 ± 0.14

Values are mean ± standard deviation

Phytochemical composition of methanol and hexane extracts of S. indicum seeds: Result of the phytochemical composition of the methanol extract of *S. indicum* seeds as shown in Table 2. Total flavonoid (24.32 ± 0.02mg/100 g) was the highest composite of the extract followed by total phenol (18.66 ± 0.04 mg/100g) while the composition of hexane extract showed that total phenol (25.27 ± 0.02 mg/100g) was the highest composite of the extract followed by total flavonoid (24.79 ± 0.01 mg/100g). However, the methanol and hexane extract have hydrogen cyanide (0.03 ± 0.00 mg/100g) and (0.04 ± 0.00 mg/100g) respectively as the lowest phytochemical composite.

Table 2: Phytochemical composition of methanol and hexane extracts of *S. indicum* seeds

Phytochemicals	Hexane Extract	Methanol Extract
Oxalate (mg/100 g)	0.19 ± 0.00	0.15 ± 0.01
Hydro cyanide (mg/100 g)	0.04 ± 0.00	0.03 ± 0.00
Alkaloids (mg/100 g)	1.47 ± 0.01	0.55 ± 0.01
Tannins (mg/100 g)	0.77 ± 0.01	0.19 ± 0.00
Total flavonoids (mg/100 g)	24.79 ± 0.01	24.32 ± 0.02
Total phenol (mg/100 g)	25.27 ± 0.02	18.66 ± 0.04
Steroids (mg/100 g)	0.45 ± 0.00	0.13 ± 0.00
Terpenes (mg/100 g)	1.26 ± 0.00	0.79 ± 0.00

Values are mean ± standard deviations

Vitamin contents of methanol and hexane extracts of Sesamum indicum seeds: The vitamin content of the methanol extract of sesame seeds showed that vitamin E (2.95± 0.02 mg/100g) was the highest composite followed by vitamin A (1.96 ± 0.29 µg/mL) while vitamin B1 (0.03 ± 0.00 mg/100g) was the lowest composite. Meanwhile, analysis of the hexane extract showed that vitamin E (3.44 ± 0.01 mg/100g) was the highest composite followed by vitamin A (1.98 ± 0.01 µg/mL) while vitamin B6 and B12 (0.01 ± 0.00 mg/100g) were the lowest composite as shown in Table 3.

Table 3: Vitamin contents of methanol and hexane extracts of *Sesamum indicum* seeds

Vitamins(µg/mL)	Methanol Extract	Hexane Extract
A	1.96 ± 0.29	1.98 ± 0.01
B1	0.03 ± 0.00	0.03 ± 0.00
B2	0.08 ± 0.00	0.04 ± 0.00
B3	0.04 ± 0.00	0.05 ± 0.00
B5	0.04 ± 0.00	0.03 ± 0.00
B6	0.06 ± 0.00	0.01 ± 0.00
B12	0.04 ± 0.00	0.01 ± 0.00
C	1.75 ± 0.01	0.05 ± 0.00
E	2.95± 0.02	3.44 ± 0.01

Values are mean ± standard deviations

Mineral contents of methanol and hexane extracts of Sesamum indicum seeds: The results presented in Table 4 showed that the highest mineral content in methanol and hexane extracts of *S. indicum* seeds was potassium (43.33 ± 0.04 and 27.46 ± 0.02 mg/100 g, respectively), followed by calcium (31.56 ± 0.02 and 24.80 ± 0.01 mg/100 g, respectively) while the lowest content was copper (0.089 ± 0.00 and 0.08 ± 0.00 ppm respectively).

Table 4: Mineral contents of methanol and hexane extracts of *Sesamum indicum* seeds

Minerals	Methanol Extract	Hexane Extract
Calcium (mg/100 g)	31.56 ± 0.02	24.80 ± 0.01
Phosphorus (mg/100 g)	11.84 ± 0.01	13.34 ± 0.03
Magnesium (mg/100 g)	28.68 ± 0.04	19.53 ± 0.04
Potassium (mg/100 g)	43.33 ± 0.04	27.46 ± 0.02
Sodium (mg/100 g)	23.85 ± 0.00	16.36 ± 0.02
Copper (ppm	0.089 ± 0.00	0.08 ± 0.00
Selenium (ppm)	1.16 ± 0.00	3.29 ± 0.00
Zinc (ppm)	0.53 ± 0.01	0.90 ± 0.00
Iron (ppm)	1.31 ± 0.01	1.55 ± 0.00

Values are mean ± standard deviations

DPPH activity of methanol and hexane extract of Sesamum indicum seed: The results of the DPPH activity of methanol extract of *S. indicum* seeds as shown in Table 5 indicate that the activity of the extract were all significantly ($p<0.05$) lower than the values for ascorbic acid across all concentrations meanwhile the DPPH activity of hexane extract indicate that there was no activity in the tested concentrations below 100µg/mL. However, the concentrations above 200µg/mL showed activity but were all significantly (p<0.05) lower than those of the values for ascorbic acid across all concentrations. However, the activity of the both extracts increased with increase in concentration.

Table 5: DPPH activity of methanol and hexane extract of *Sesamum indicum* seeds

Concentration (µg/mL)	Methanol extract (%)	Hexane extract (%)	Ascorbic acid (%)
25	0.51 ± 0.43*	NA	95.51 ± 0.10
50	3.46 ± 0.07*	NA	96.45 ± 0.08
100	7.31 ± 0.47*	NA	96.49 ± 0.05
200	15.42 ± 0.25*	2.47 ± 0.54*	96.69 ± 0.11
400	27.35 ± 0.23*	3.00 ± 0.77*	96.78 ± 0.53
800	46.77 ± 0.49	7.20 ± 1.26	NT

Values are mean ± standard deviation. Values marked (*) are statistically different from the control (Ascorbic acid). NA = no activity, NT = not tested

Ferric reducing antioxidant power (FRAP) of methanol and hexane extract of Sesamum indicum seeds: The result of the FRAP of methanol extract of *S. indicum* seeds as represented in Table 6 showed that there was no activity at the concentrations of 100 µg/mL and below. However, the activity observed at concentrations above 100 µg/mL were all significantly (p<0.05) lower than those of the same concentration of ascorbic acid which served as the standard. Moreover, the result of the FRAP activity of hexane extract of *S. indicum* seeds indicated activity only at the concentration of 800 ug/ml which was also significantly lower than the FRAP values observed for ascorbic acid of same concentration.

Table 5: Ferric reducing antioxidant power (FRAP) of methanol and hexane extract of *Sesamum indicum* seeds

Concentration (µg/mL)	Methanol extract (µM)	Hexane extract (µM)	Ascorbic acid (µM)
25	NA	NA	0.16 ± 0.00
50	NA	NA	0.37 ± 0.00
100	NA	NA	0.78 ± 0.01
200	0.01 ± 0.00*	NA	1.38 ± 0.01
400	0.02 ± 0.00*	NA	1.67 ± 0.00
800	0.05 ± 0.00*	0.02±0.00*	1.96±0.00

Values are mean ± standard deviation. Values marked (*) are statistically different from the control. NA = no activity.

Discussion

The proximate composition of *Sesamum indicum* seeds showed that the moisture content of *S. indicum* seeds was 8.56 ± 0.02%. This value was higher than the results reported in other similar works of Christian *et al*. (2019), who reported the moisture content of sesame seeds as 6.21±2.41% but lower than the moisture content values of *Chrysophyllum albidum* seed endosperms (30.3%) by Egbuonu *et al*. (2020). High amount of moisture in crops exposed them to microbial attack (Desai and Salunkhe, 1991) thereby reducing the durability or storage capability of the seed, hence spoilage (Enyoh *et al.*, 2017). The value of dry matter in this study was 91.44 ± 0.02%, which was similar to that of *Helianthus annus* L. seeds ((94.18 ± 0.74) reported by Devshree *et al*. (2017) and also lower than that of the seed endosperm of *Chrysophyllum albidum* reported by Egbuonu *et al*. (2020).

The quantity ash content was a reflection of the mineral contents present in the food materials (Nnamani *et al*., 2009). The ash content value of this seed was 5.70 ± 0.01% and is in accordance with the value (1.44–5.93%) reported by Unal and Yalcin (2008) but lower than the value (8.94 ± 0.96%) recorded by Mbaebie *et al*. (2010). This suggested that the seed will be a rich source of mineral since the ash content of any material is a measure of the total amount of minerals present within the food. Crude fibre is necessary for proper functioning in the intestinal tract (Christian *et al.*, 2019) and has been known to reduce cholesterol level of the body and helps in the maintenance of human health (Bello *et al*., 2008). However, the value was lower than the value (8.22 ± 0.18) recorded by Dravie *et al*. (2020) and higher than the values (1.30% - 3.30%) of Dimitrov *et al*. (2023).

According to Bowmen and Russell (2001), values of ash and crude fibre content are paramount in terms of food digestibility and suitability thus fiber content of this seed may help to manage constipation problems and also protect the body against cancer and digestive disorders (Onyeabor *et al*., 2017). The crude protein value of the present study was 19.37 ± 0.08 and was higher than the value (14.73±6.39%) reported by Christian *et al*. (2019) but they were almost comparable with the value (18.1 ± 1.25) reported by Yusuf *et al*. (2008). Ali (2010) and Effiong *et al*. (2009) stated that any plant food that provide about 12% of their caloric value from protein are considered good sources of protein. Thus, *S. indicum* seeds could be a good source of protein.

The fat content (FC) of the sesame samples was found to be 52.77 ± 0.02 and was almost similar with value (56.56±0.62) reported by Dravie *et al*. (2020) but higher than the value (36.10%) reported by Yusuf *et al.* (2008). The presence of high lipid content in sesame seeds is suggestive of its nutritional value because lipids provide an excellent source of energy that enhances the transport of fat-soluble vitamins and protects internal organs. The carbohydrate content of the seeds was obtained to be 7.26 ± 0.14, which was almost similar with result (8.34–8.80%) reported by Tamene *et al*. (2022). However, it was below the value given by FAO/WHO RDA (55%). Hence, sesame seed is not a good source of carbohydrates.

The antinutrient content (mg/100 g) in the seed for oxalate (0.19± 0.00 and 0.15 ± 0.0 mg/100 g) and hydrocyanide (0.04 ± 0.00 and 0.03 ± 0.00 mg/100 g) were almost similar in hexane extract and methanol extracts respectively. The results of oxalate revealed in both seeds extract were comparably lower than the values reported by Amaechi (2009) in *Buccholzia coricea* seeds (1.06 mg/100 g). However, it was higher than the value reported by Egbonu (2015) in *Citrullus lanatus* seeds (0.09± 0.00). The alkaloid content in the hexane extract of sesame seeds (1.47 ± 0.01 mg/100 g) was higher than the content in the methanol extract of same seeds (0.55±0.01 mg/100g). They are comparably higher than the value (0.36±1.03 mg/100g) of alkaloid in water melon (*Citrullus lanatus*) rind reported by Egbonu (2015) but the methanol extract of sesame seeds was almost similar with the value (1.39±0.00 mg/100g) reported by Egbonu (2015) in water melon (*C. lanatus)* seeds. The presence of alkaloids in this seed indicates its use for medicinal purposes such as analgesic, anti-cancer and antibacterial (Saxena *et al.*, 2013). Tannins are plant polyphenols which have the ability to form complexes with metals ions and with macro-molecules such as proteins and polysaccharides (Dei *et al.*, 2007). The tannin content of hexane extract (0.77±0.01 mg/100g) of this seed was higher than its methanol extract (0.19 ±0.00 mg/100g). However, the values of both seed extract were lower than the value (2.04±1.37%) reported by Mbaebie *et al*. (2010). According to Emijiugha and Agebede (2000), tannin usually forms insoluble complexes with proteins, thereby interfering with their bioavailability. Poor palatability is generally attributed to high tannin diets (Bolanle *et al.*, 2014) so the quantity in this seed may not affect protein availability. Flavonoids have been reported to have antioxidant, antiprotozoal, antibacterial and antiviral actions (Sridhar *et al*., 2014). The flavonoid content in the hexane extract (24.97±0.01 mg/100g) was almost similar with the value of the methanol extract (24±0.02 mg/100g) but they are comparably higher than the values (16.12±10.7%) reported by Mbaebie *et al*. (2010) in sesame seeds. Thus, the availability of flavonoid in this seed suggests that their use may offer protection against diseases related to free radicals, bacterial and fungal activities (Adeolu and Enesi, 2013).

The phenol content in the hexane extract of the seed (25.27±0.01 mg/100g) was higher than the one in methanol extract (18.66±0.04 mg/100g), however, they are comparably higher than the values (0.45±0.02 - 0.82±0.00%) recorded by Ijeh *et al*. (2010) for processed and unprocessed *Treculia africana* seed. Phenol functions as antimicrobial compound and protects plants from pathogens (Okwu and Okwu, 2004). Hence, the phenol in this sample could indicate their apparent antimicrobial potential, which could be considered in the treatment of typhoid fever and other bacterial infections (Adeolu and Enesi, 2013). It has also been stipulated that the antioxidant activity of plants might be due to their phenolic compounds (Aberoumand, 2012).

The steroids and terpenes content of hexane extract (0.45 ± 0.00 and 1.26 ± 0.00 respectively) of the seed were higher than that of methanol extract (0.13 ± 0.00 and 0.79 ± 0.00 respectively). Rangarajan and Ambilly (2012) reported the presence of steroids and terpenes in *Sesamum indicum* seeds. Steroids found in *S. indicum* seeds could be beneficial for humans because their presence in the form of phytosterols could decrease the cholesterol concentrations in the blood (Sadava *et al.,* 2011) and also the presence of terpenes in *S. indicum* seed could account for its use as an anti-diabetic agent (Ramesh *et al*., 2005) and antibiotics (Aliyu *et al.,* 2008).

The vitamin content of methanol and hexane extract of sesame indicum seeds was shown in Table 3. Vitamin A and E were slightly higher in hexane extract than in methanol extract while vitamin C was higher in methanol extract than in hexane extract. Vitamin A, C and E were 1.96 ± 0.29, 1.75 ± 0.01 and 2.95 ± 0.02 µg/mL respectively in methanol extract while that of hexane extract were 1.98 ± 0.01, 0.05 ± 0.00 and 3.44 ± 0.01 µg/ml. This was lower than the value (vitamin A, vitamins C and E (5.89 µg/100g, 3.94 mg/100g, and 2.77 mg/100g, respectively) reported by Okudu *et al*. (2016) in sesame flour. The presence of Vitamin A, C and E in sesame seeds is an indication of its health benefits; as these vitamins acts as antioxidants (Bello *et al*., 2008).

The result of the mineral composition of methanol and hexane extract of *Sesamum indicum* seeds as shown in Table 4 shows the presence of calcium, magnesium, potassium, phosphorus and sodium, copper, selenium, zinc and iron. It further attests to the nutritional value of *sesame* seed and suggests its possible role in the maintenance of muscle tone and body electrolytes. The role of these mineral elements in health maintenance has also been highlighted (Olusanya, 2008). The sodium and potassium contents of methanol extract of *Sesamum indicum* seed are 23.85 ± 0.00 and 43.33 ± 0.04 mg/100 g respectively and 16.36 ± 0.02 and 27.46 ± 0.02 respectively for hexane extract. These values were quite higher than the sodium and potassium values (2.00±0.01 mg/100 g and 4.00±0.01 mg/100g respectively) reported by Sani *et al*. (2013) for *Sesamum indicum* seed oil but these values were comparatively far lower than the values of sodium and potassium (235.74 mg/100g and 184.12 mg/100g respectively) reported by Okudu *et al*. (2016) for ground sesame seed. This suggested that *S. indicum* seed extract may be a good source of sodium and potassium, and could serve as nutritional supplement for these elements. The concentration of copper in this sesame seed was almost the same in both extracts. The values were 0.09 and 0.08 ppm in methanol and hexane extract respectively. These results were almost similar to the concentration (0.1988 - 1.1002 mg/kg) of copper in sesame reported by Abu-Almaaly (2019) in Iraq. However, these results are comparatively lower than the value (4.9 - 5.0 mg/kg) of copper in sesame seed reported by Tamene *et al*. (2011) in Ethopia. Excessive consumption of copper can cause oxidative stress and damage the immune system (Malede *et al*., 2020). The result suggests that the concentration of copper in sesame seed in the present study may not be enough to cause any oxidative stress and damage to the immune system. The concentrations of Zn in sesame seed samples were 0.53 ± 0.01and 0.90 ± 0.00 ppm for methanol and hexane extracts respectively. These results were almost similar to the value (0.82 ± 0.21) reported by Christain *et al*. (2019) but lower than the values (7.89 and 6.77 ppm) reported by Njoku *et al*. (2010) in sesame seed flour and sesame oil respectively. This result differences may be as a result of varietal difference and handling processes during seed storage (Gupta *et al*., 2015).

Iron is an essential trace element for haemoglobin formation, normal functioning of central nervous system and in the oxidation of carbohydrate, protein and fats (Asaolu *et al*., 1997). The reference dose values (RFD) of iron is 0.7 mg/day (Javed *et al*., 2016). The concentration of iron in the methanol and hexane extract of sesame seeds were 1.31 ± 0.01 and 1.55 ± 0.00 ppm respectively. However, this disagrees with values (55.26 ppm and 53.48 ppm) reported by Njoku *et al.* (2010) in sesame seed flour and oil respectively but the values are slightly above the recommended dose per day. Such variations might be attributed to the difference in varieties, growth environment, pretreatment and analytical methods used.

DPPH is the most simple and effective method for antioxidant capacity evaluation and antioxidant with scavenging activities (Syed *et al*., 2018). The methanol extract exhibited a better free radical scavenging activity than hexane extract at all concentrations tested. The results of both extracts tested were 46.77% and 7.20% for methanol and hexane extracts respectively at 800 µg/mL (highest concentration). The results of methanol extract was almost similar with the work of Dravie *et al.* (2018) who reported that the DPPH activity of methanol extract of same seed was 51.26% but the DPPH activity of the hexane extract (7.20%) was not in accordance with the work of Dravie *et al*. (2018). This difference may be as a result of the variation in solvent used for the extraction, pretreatment and analytical methods used as their seeds were gotten in Ghana. However the results of both extracts were significantly lower than that of ascorbic acid (serves as standard) which agreed with the work of Dravie *et al*. (2018) and Ruslan *et al*. (2018). The results of the DPPH free radical scavenging assay suggested that the components in the sesame seed extract were capable of scavenging free radicals via electron and hydrogen donating mechanisms and act as an antioxidant. This potential could be attributed to the high flavonoid and phenol composition of sesame seeds since antioxidant properties has been attributed to high phytochemical composition of plants which play massive roles in the treatment and management of disease conditions. The FRAP assay is used to determine the ability of a compound to reduce Fe 3^+ to Fe 2^+ blue coloured form in the presence of antioxidants (Wong *et al.,* 2006). In this present study, The FRAP values for 800 µg/mL concentration were 0.05 µM and 0.02 µM for methanol and hexane extract respectively which were significantly lower than the FRAP value of ascorbic acid. This result is in accordance with the work of Dravie *et al*. (2018) but disagreed with the work of Ruslan *et al*. (2018) who reported a non- significant change in FRAP values of sesame seeds (from China and India respectively) relative to that of ascorbic acid. From the result of this *in vitro* antioxidant studies, the antioxidant activity of this sesame seed grown in Kogi, Nigeria may be based mainly by the availability of bioactive compounds that favour hydrogen atom or single electron donation rather than ferric reduction.

Conclusion

In conclusion, hexane and methanol extract of *Sesamum indicum* seeds possess nutritional and pharmacological value and can be a rich source of minerals, vitamins and antioxidative supplement with very low anti-nutrient contents (oxalate, hydrogen cyanide and tannin) and carbohydrates content.

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Conflict of Interest

No conflict of interest was reported by the authors

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