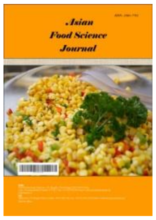

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Proximate Composition, Mineral Bioavailability and Functional Properties of Defatted and Undefatted Avocado Pear (*Persia americana*) Seed Flours

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Authors' contributions

This work was carried out in collaboration among all authors. Author NJTE designed the study. Author AEU performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author SCA approved the final manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The aim of this study was to investigate the proximate composition, mineral bioavailability and functional properties of defatted and undefatted avocado pear seed flours. Avocado pear seed was processed into flour and thereafter defatted using n-hexane. The proximate composition, total and extractable minerals and functional properties of the seed flours were determined using standard methods. Proximate analysis revealed that the defatted seed flour contained significantly ($p<0.05$) higher protein (11.90%) and ash (2.60%) than the undefatted sample (7.24% and 2.12%, respectively). The undefatted seed flour recorded higher values of moisture (4.84%), fat (3.28%), crude fibre (7.99%), carbohydrate (74.71%) and energy (406.08 kcal) than the defatted sample. Mineral composition of the seed flours also showed that undefatted sample contained significantly ($p<0.05$) higher contents of sodium (24.56 mg/100 g) and iron (9.05 mg/100 g) than the defatted while defatted sample was significantly ($p<0.05$) higher in potassium (103.15 mg/100 g), phosphorus (7.80 mg/100 g) and calcium (56.50 mg/100 g). Defatted seed flour gave the highest bioavailable sodium (53.88%), potassium (51.69%), iron (26.07%), phosphorus (47.12%) and calcium (43.47%) while undefatted seed flour had the lowest bioavailable sodium (51.41%),

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potassium (50.49%), iron (17.45%), phosphorus (45.35%) and calcium (36.35%). There were significant differences ($p<0.05$) among these values. Results of the functional properties of the seed flours showed that the defatted seed flours were high in water and oil absorption capacities (1.87 g/g and 1.87 g/g, respectively), bulk density (0.85 g/ml) and swelling power (6.75 g/g). However, these values were significantly ($p<0.05$) similar except for bulk density. Least gelation concentration was 4% for both flours while solubilities were 14.57% and 14.63% for defatted and undefatted seed flour, respectively. The result from this study indicates that avocado pear seed flours may be useful in some food formulations. Defatted avocado pear seed is a good source of protein and can be incorporated into existing food products to provide a protein rich diet.

Keywords: Avocado pear seed; defatted; undefatted; proximate; functional; mineral bioavailability.

1. INTRODUCTION

Avocado pear (*Persia americana*) is an edible fruit belonging to the family Lauraceae. It has its origin from Mexico and Central and South America but it is now cultivated worldwide [1]. The fruit is a large fleshy berry which is 5-15 cm long, ovate to spherical containing a single, hard nut shaped seed [2]. The fruit is known as 'eben mbakara' among the Ibiobio/Efik and 'ube oyibo' in Ojoto and neighbouring Igbo speaking communities of South East Nigeria. The fruit pulp is thick pale yellow having high oil content and rich in vitamins A, B and E [3,4]. It is also reported to be rich in fatty acids such as linoleic, oleic, stearic, capric and myristic acids [5].

The avocado pear seed is a by-product representing 13-18% of the fruit [2]. It is often discarded as agro-food wastes during processing of the pulp thereby representing a severe ecological problem. In Nigeria, the seed is utilized for the treatment of hypertension, diabetes and high blood pressure by incorporating the seed flour into existing food products such as soups, pap and puddings [6]. Ifesan et al. [7] developed acceptable candies from avocado pear seed and reported that sample with 85% avocado pear seed was most preferred. Emelike et al. [8] also developed moi-moi (steamed cowpea pudding) from blends of cowpea and avocado pear seed flour and reported that avocado pear seed flour can be substituted at 10% level with cowpea for the production of acceptable and nutritious moi-moi. Reports have shown that the seed contains more antioxidant constituents than the fruit pulp [9]. Ejiofor et al. [2] investigated the proximate composition of avocado pear seed and reported it to contain 49.03 g carbohydrate, 17.90 g lipid, 15.5 g protein, 15.10g moisture and 2.26 g ash.

Industrial processing and utilization of avocado pear seed have not been fully developed in Nigeria and other countries where it is cultivated as its utilization is hindered by the presence of anti-nutritional factors. Lack of knowledge of the nutritional qualities of this lesser known plant seed is also responsible for the poor utilization in different food formulations. Talabi et al. [1] reported avocado pear seed to contain high concentration of anti-nutritional factors such as phytate, oxalate, tannin, alkaloids and cyanogenic glycosides which makes the seed to be potentially toxic and useless for human and animal nutrition. The presence of these anti-nutritional factors can affect the bioavailability of minerals in avocado pear seed [10]. Mineral bioavailability is the maximum amount of mineral released from the matrix during gastro-intestinal digestion that becomes available for intestinal absorption [11]. Anti-nutritional factors chelate metals such as iron and zinc and reduce the absorption of these nutrients, but they also inhibit digestive enzymes and precipitate proteins [12]. Phytates for example has been reported to bind calcium, magnesium, iron, copper and zinc and inhibit their absorption by the small intestine [13] while oxalate forms complex with dietary calcium, thus rendering it unavailable for absorption and assimilation [14]. Although numerous studies on the nutrient and anti-nutrient characteristics of avocado pear seed exists, there is paucity of information on the mineral bioavailability of these nutrients and the effects of defatting on the nutrient composition of the seed.

The nutritional value of foods depends on their nutrient content and the bioavailability of these nutrients [10]. Improvement of the nutritional quality of avocado pear seeds for possible use in food formulations can be successfully carried out through processing. Various processing methods and treatments have been successfully used in transforming food ingredients into healthier products with maximum nutritional value to ensure nutrient security of the population in developed countries [15,16]. Previous research works on defatting of plant seeds reported defatting to be responsible for providing nutritionally better products than the raw seeds [17,18,19]. Emelike et al. [20] also reported that delipidation of cashew kernel resulted to an increase in minerals, protein and crude fibre contents. Thus, the removal or reduction of certain unwanted components in avocado pear seed flour through defatting is required in order to enhance its nutritional quality for further use in food product development. Therefore, the objective of the study was to determine the proximate composition, mineral bioavailability and functional properties of defatted and undefatted avocado pear seed flours.

2. MATERIALS AND METHODS

2.1 Procurement of Materials

Avocado pear (*Persea americana*) was purchased from Bori Market in Khana Local Government Area of Rivers State. All reagents used were of analytical grade.

2.2 Processing of Avocado Pear Seed Flour

Avocado pear seed was processed into flour using the method of Ejiofor et al. [2] with some modifications. The succulent fleshy part of the fruit was removed to obtain the seed. The seeds (2 kg) were washed and grated into 0.2% sodium metabisulfite in 3 liters of water. This was done to control the browning reaction of the Avocado pear seed. The grated sample was dried in a hot air oven (DHG-9140 A, England) at 60°C for 12 hrs. The dried avocado pear seeds were grinded with hammer mill and sieved into a fine powder (500 μm) to obtain the fine flour. The Avocado pear seed flour was then stored in an air-tight cellophane bag at room temperature (37°C) until required for further use.

2.3 Defatting of Avocado Pear Seed Flour

Avocado pear seed flour was defatted using the method described by the Association of Official Analytical Chemists [21]. Hundred grams (100 g) of avocado pear seed flour was weighed into a beaker; 200 ml of n-hexane was poured into it and was stirred properly. The beaker containing the mixture was allowed to stand for 3 hrs while shaking on an orbital shaker. The oil solvent mixture was decanted and the residue which is the defatted sample was dried in a hot air oven (DHG-9140 A, England) for 12 hrs at 60°C.

2.4 Proximate Analysis

Moisture, crude protein, crude fat, crude fibre and ash contents of the defatted and undefatted avocado pear seed flours were determined by standard methods of the Association of Official Analytical Chemists [21] while Nitrogen free extract was determined by difference using the formula;

% Nitrogen free extract= 100-(% Moisture + % crude protein + % crude fat + % ash + % crude fibre).

2.5 Energy Content Determination

The energy content (E) of the avocado pear seed flours were calculated using Atwater factor method as described by Adegunwa et al. [22].

E = (9 x Protein) + (4 x Fat) + (4 x Carbohydrate)

2.6 Mineral Analysis

Mineral elements of defatted and undefatted avocado pear seed flours were analyzed for calcium, sodium, phosphorus, potassium and iron using an Atomic Absorption Spectrophotometer, AAS (Model 372, Perkin-Elmer, Beaconsfield, U.K.) according to the procedure of AOAC [21] method.

2.7 HCL-Extractability of Mineral Bioavailability (*In vitro* Bioavailability)

Mineral in the seed flours were extracted using the method described by Chauhan and Mahjan [23]. One gram (1 g) of the sample was extracted using 10ml of 0.03N HCL with shaking at 37°C for 3 hrs. Thereafter the extract was filtered and the clear filtrate obtained was dried at 100°Cand then place on a muffle furnace at 550°C for 4 hrs. Then the samples were cooled and about 5 ml of 5N HCL was added and boiled gently for 10 min and then cooled and diluted to 100 ml with distilled water.

Mineral extractability (%) =

$$\frac{Mineral\ extractable\ in\ 0.03N\ HCL\ (\frac{mg}{100g})}{Total\ mineral\ (\frac{mg}{100g})} \times 100$$

2.8 Determination of Functional Properties

Bulk density of the avocado pear seed flours was determined using the method of Narayana and Narasinga-Rao [24], water and oil absorption capacities by Okoye and Onyekwelu [25] and swelling power by Tharise et al. [26]. Solubility was determined using the method of Takashi and Sieb [27] while least gelation concentration by Akin-Osanaiye et al. [18].

2.9 Statistical Analysis

The results were subjected to a one-sided paired sample t-test and significant differences between mean values were calculated at 5% level of probability using the Statistical Product for Service Solution (SPSS) version 23.0.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Defatted and Undefatted Avocado Pear Seed Flours

The proximate composition of defatted and undefatted avocado pear seed flours is presented in Table 1. Moisture content of undefatted and defatted seed flours were 4.84% and 4.60%, respectively. There was a decrease in the moisture content after defatting of the seed flour. Kumari et al. [28] also reported similar decrease in moisture contents of rice bran after defatting with values of 4.18% and 4.80% for defatted and undefatted flours, respectively. Moisture content of the flours was low when compared with 11.70% and 10.35% for raw and defatted sesame flours reported by Ogungbenle and Onoge [29]. The low moisture contents in the flour samples would enhance their shelf stability by preventing the growth of microorganisms during storage.

The defatted seed flour contained high quantity of ash (2.60%) than undefatted sample (2.12%). The defatting process resulted to a significant ($p<0.05$) increase in ash content, which implies that the defatted avocado pear seed flour contains more minerals than undefatted seed flour. Kumari et al. [28] also observed the ash content of defatted rice bran (11.60%) to be significantly higher than the full fat rice bran (9.20%). Pomeranz and Clifton [30] have recommended that ash contents of nuts, seed and tubers should fall within the range of 1.5-2.2% in order to be suitable for animal feed. Ash content of the defatted flour was higher than this range which makes it suitable for human consumption as well as animal feed.

The defatted seed flour contained higher crude protein (11.90%) when compared to the undefatted sample (7.24%). This shows that defatting significantly ($p<0.05$) increased the protein content of avocado pear seed flour. This same trend was also reported by Emelike et al. [20] for cashew kernels after defatting. This implies that the defatted avocado pear seed flour can be used as a source of dietary protein. The incorporation of defatted avocado pear seed flour in existing food products will also provide a protein rich diet thereby solving the problem of energy-protein malnutrition in areas where protein rich foods are scarce.

The crude fat content of 1.03% obtained for defatted seed flour is significantly ($p<0.05$) low compared to that of undefatted sample (3.28%). The decrease in the fat content of the flour is attributed to the reduction of the fat content of the seed due to defatting. The fat content of defatted seed flour is high when compared to defatted *Telfariria occidentalis* (0.85%) reported by Alozie et al. [31]. Dietary fat increases the palatability of food by absorbing and retaining the flavours. The fat content of the seed flour samples is within 1-2% which said to be sufficient to human beings as excess fat consumption is implicated in certain cardiovascular disorders such as atherosclerosis and aging [32]. Crude fat determines the free fatty lipids of flour. This property can be used as the basis in determining processing temperatures as well as auto-oxidation which can lead to rancidity and can also affect flavor of food. The low fat content obtained from defatted avocado seed flour may mean that it will not easily get rancid when stored.

The crude fibre contents were considerably low in defatted seed flour (6.25%) when compared to the undefatted sample (7.99%). The study showed that defatting significantly ($p<0.05$) decreases the fibre content of avocado pear seed. The crude fibre content of the defatted seed flour sample was comparable with the value of 6.20% for defatted cashew kernel flour [20] and higher than 3.3% for defatted *Moringa oleifera* seed flour [33]. A diet low in fibre is undesirable as it could cause constipation. This is an indication that avocado pear seed flour can be incorporated in the formulation of snack products to increase the fibre contents.

The levels of carbohydrate were appreciable in defatted (73.54%) and undefatted (74.71%) seed flours. This makes avocado pear seed flour a rich energy source. The carbohydrate content of avocado pear seed flour samples from this study was higher than 21.50% for defatted cashew kernel flour reported by Emelike et al. [20], 42.27% for full fat *Telfariria occidentalis* reported by Alozie et al. [30] and 57.77% for defatted *Moringa oleifera* reported by Olagbemide and Philip [33]. High carbohydrate content of the avocado seed flour shows that the flour can be a best energy-giving food and capable of supplying the daily energy requirement of the body if incorporated in food items.

Energy content of the defatted seed flour (374.65 kcal) was significantly (p<0.05) lower than that of undefatted seed flour (406.08 kcal). The variation in energy values from this study might probably be due to the presence of fat in undefatted seed flour.

Table 1. Proximate composition of defatted and undefatted avocado pear seed flours

Parameters	Undefatted	Defatted
Moisture (%)	4.84±0.94[a]	4.60±0.39[a]
Protein (%)	7.24±0.51[b]	11.90±0.00[a]
Fat (%)	3.28±0.00[a]	1.03±0.23[b]
Crude fibre (%)	7.99±0.50[a]	6.25±0.13[b]
Ash (%)	2.12±0.08[b]	2.60±0.15[a]
Carbohydrate (%)	74.71±1.86[a]	73.54±0.58[a]
Energy (kcal)	406.08±1.33[a]	374.65±4.53[b]

Values are averages of duplicate readings (mean ±standard deviation). Means followed by different superscripts within the same column indicate significant difference (p<0.05)

3.2 Total Mineral Content (mg/100g) of Defatted and Undefatted Avocado Pear Seed Flours

The total mineral composition of defatted and undefatted avocado pear seed flours is presented in Table 2. The results showed that calcium content of defatted avocado pear seed flour (56.50 mg/100 g) was significantly (p<0.05) high as compared to 50.55 mg/100 g for undefatted flour. These values were low when compared with 75.3mg/100g and 59.0 mg/100 g for defatted and undefatted cashew kernel reported by Emelike et al. [20]. It was however higher when compared with 2.29 mg/100 g and 3.30 mg/100 g for undefatted and defatted kargo seed reported by Akin-Osanaiye et al. [18]. The presence of calcium in foods is essential for disease prevention. Calcium is a constituent of bones and helps for contraction and blood clotting [34].

Phosphorus content of the defatted flours (7.80 mg/100 g) was also significantly (p<0.05) high when compared to undefatted flour (5.79 mg/100 g). The low content of phosphorus in undefatted seed flour could be due to the presence of phytic acids which are the principal form of phosphorus in many seeds; 60–90% of phosphorus in seeds is present as phytic acid [35] and this lowers the total phosphorus value in avocado seed flour. However, defatting was observed to significantly (p<0.05) increase its phosphorus content. This observation is similar with the report of Emelike et al. [20] who reported that phosphorus content of defatted cashew kernel (24.7 mg/100 g) was higher that the undefatted sample (8.3 mg/100 g). Jacob et al. [34] reported 5.77 mg/100 g for melon seeds which is lower than that obtained from this study for defatted avocado pear seed flour but comparable with undefatted sample.

Sodium content was observed to be high in undefatted seed flour (24.56 mg/100 g) as compared to defatted sample (22.15 mg/100 g). Jacob et al. [34] reported 0.21 mg/100 g for melon seed flour which is lower than that obtained from this study. It is also higher when compared with the values of 7.8 mg/100 g and 5.0 mg/100 g for defatted and undefatted cashew kernel flour reported by Emelike et al. [20]. The value of sodium from this study is also higher than that of some legume seeds such as bambara nuts (0.05 mg/100 g), Jack bean (0.07 mg/100 g) and pigeon pea (0.05 mg/100 g) as reported by Apata and Ologhobo [36]. Sodium is a vital mineral that regulates fluid balance in the body and also in the proper functioning of muscles and nerves [37]. High sodium content in the body has been associated with high blood pressure in the body [38]. However, sodium content from this study is low and may not cause adverse health problems.

Iron content was 8.11 mg/100 g and 9.05 mg/100 g for defatted and undefatted avocado pear seed flour, respectively. There was a significant (p<0.05) difference observed for these values. The value of iron from this study is low when compared to that of melon seed (144.70 mg/ 100 g) reported by Jacob *et al*. [34]. Emelike et al. [20] reported 11.8 mg/100 g and 9.0 mg/100 g for defatted and undefatted cashew kernel which is lower than that obtained from this study for defatted avocado pear seed flour. The low values of iron obtained from this study could be attributed to the presence of phytates which have been reported to bind iron [13]. Iron plays a vital role in the respiratory pigments haemoglobin and myoglobin [39].

Potassium was the highest to other minerals investigated in the present study. This was found to be significantly (p<0.05) higher in the defatted sample (103.15 mg/100) as compared to the undefatted sample (95.42 mg/100 g). Similar observation was also reported by Emelike et al. [20] for defatted (52.0 mg/100 g) and undefatted (6.8 mg/100 g) cashew kernel flour. Potassium is necessary for electrolyte balance, controls high pressure, etc. This could also be the reason why avocado pear seed is utilized for the treatment of high blood pressure in traditional medicine. The increase in potassium content on defatting as observed from this study is attributed to the removal of fat which resulted in a relative increase in the amount of these minerals.

Table 2. Total mineral content (mg/100 g) of defatted and undefatted avocado pear seed flours

Parameters	Defatted	Undefatted
Sodium	22.15^b	24.56^a
Potassium	103.15^a	95.42^b
Iron	8.11^b	9.05^a
Phosphorus	7.80^a	5.79^b
Calcium	56.50^a	50.55^b

Means followed by different superscripts within the same column indicate significant difference (p<0.05)

3.3 Mineral Bioavailability (%) of Defatted and Undefatted Avocado Pear Seed Flours

The percentage mineral bioavailability of defatted and undefatted avocado pear seed flours is presented in Table 3. Defatted seed flour gave the highest bioavailable sodium (53.88%), potassium (51.69%), iron (26.07%), phosphorus (47.12%) and calcium (43.47%) while undefatted seed flour had the lowest bioavailable sodium (51.41%), potassium (50.49%), iron (17.45%), phosphorus (45.35%) and calcium (36.35%). There were significant differences (p<0.05) among these values. These differences could be attributed to the defatting process which assisted in the reduction of anti-nutrients such as phytates and oxalates in avocado pear seed flour thereby enhancing its bioavailable minerals. According to Kiin-Kabari and Agoha [40], availability could be enhanced with processing methods that reduces the effect of phytic acid, which binds metals such as calcium, zinc and iron, thus increasing the bioavailability of such minerals. This study therefore showed that defatting helps to increase the bioavailability of minerals in avocado pear seed flour. The use of defatted avocado pear seed in food product development will result to products with enhanced nutritional quality than undefatted seed flour.

Table 3. Mineral bioavailability (%) of defatted and undefatted avocado pear seed flours

Parameters	Defatted	Undefatted
Sodium	53.88^a	51.41^b
Potassium	51.69^a	50.49^b
Iron	26.07^a	17.45^b
Phosphorus	47.12^a	45.35^b
Calcium	43.47^a	36.57^b

Means followed by different superscripts within the same column indicate significant difference (p<0.05)

3.4 Functional Properties of Defatted and Undefatted Avocado Pear Seed Flours

Functional properties of defatted and undefatted avocado pear seed flours are presented in Table 4. The results indicated that the solubility of defatted avocado pear seed flour was 14.57% while that of undefatted flour was 14.63%. Solubility is the ability of solids to disperse in an aqueous solution (mostly water). These values were higher when compared to 13.80% and 3.67% for cassava flour and purple sweet potato flour, respectively as reported by Kusumayanti et al. [41]. According to Baafi and Safo-Kantanka [42], solubility is an indicator of quality. The high solubility of the seed flours suggests it is digestible and therefore could be suitable for infant food formulations.

The swelling power of the undefatted and defatted avocado pear seed flours are 6.69 g/g and 6.75 g/g respectively. There was no significant (p>0.05) difference in the swelling power of the flour samples, however the defatted sample exhibited lower swelling power than undefatted flour. Swelling power is the ability to increase in volume when foamed e.g. flour is mixed with water. Solubility of the seed flours from this study is lower when compared with that of cassava pulp flour (17.16-20.08%) as reported by Baafi and Safo-Kantanka [42]. It is however higher than that of bread fruit flour (7.02-8.72%) reported by Appiah et al. [43]. High swelling power is an important criterion for good quality flour. Since the swelling power of the seed flours of avocado pear is high, it suggests it may find application in noodle production [44].

Table 4. Functional properties of defatted and undefatted Avocado pear seed flour

Parameters	Defatted	Undefatted
Bulk density (g/ml)	0.85±0.17[a]	0.73±0.19[b]
Water absorption (g/g)	1.87±0.05	1.85±0.05
Oil absorption (g/g)	1.50±0.00	1.43±0.08
Swelling power (g/g)	6.75±0.52	6.69±0.55
Solubility (%)	14.57±0.50	14.63±0.43
Least gelation Concentration (%)	4.00±0.00	4.00±0.00

Values are expressed as mean ± standard deviation of triplicate determination. Means with the different letters along the same column are significantly different (p>0.05)

Results for bulk density revealed significant (p<0.05) differences between defatted (0.85 ml/g) and undefatted avocado pear seed flour (0.73 ml/g). From the results, it is obvious that defatting Avocado pear seed flour increases its bulk density. This observation is in agreement with the results of Adebowale et al. [45] who reported increase in bulk density of mucuna specie after defatting from 0.51-0.80 g/ml. Bulk density plays an important role in packaging, transportation of food products and decreases porosity of materials due to surface properties [46]. Bulk density of the seed flour was high when compared to that of defatted cashew kernel flour (0.1g/g) as reported by Emelike et al. [20]. High bulk density of the seed flours indicates that they would serve as good thickeners in food products.

The water absorption capacity of defatted avocado pear seed flour (1.87 g/g) was higher than that of undefatted seed flour (1.85 g/g), however, no significant (p>0.05) differences existed between the flour samples. Water absorption for defatted seed flour was higher when compared to the values of 1.30 g/g and 1.00 g/g for soybean and cowpea flours, respectively as reported by Lin et al. [47]. According to Osundahunsi et al. [48], higher water absorption capacity could improve yield and consistency and also give body to food. This is an indication that defatted and undefatted avocado pear seed flours could be useful in baked and other products that require hydration to improve handling characteristics.

The oil absorption capacity of defatted avocado pear seed flour (1.50 g/g) was significantly (p<0.05) different from undefatted flour (1.43 g/g). The value reported from this study is higher than the values of full fat and roasted defatted (1.31 and 1.27 g/g, respectively) flax seed flours as reported by Hussain et al. [49] and defatted cashew kernel flour (0.20 g/g) reported by Emelike et al. [20]. Adebowale et al. [45] reported high oil absorption capacity of mucuna specie (2.25 g/g) compared with full fat sample (2.60 g/g). Liquid retention is an index of the ability of proteins to absorb and retain oil which in turn influences the texture and mouth feel characteristics of foods and food products like comminuted meats [50]. Defatted avocado pear seed flour would therefore be useful as a flavour retainer in certain food products.

The least gelation concentration for undefatted avocado pear seed flour and defatted seed flour was 4%. This value was lower than that reported for Bambara groundnut flour (8%). The least gelation concentration is defined as the lowest protein concentration at which gel remained in the inverted tube. Akintayo [51] reported that the lower the least gelation concentration, the better the gelating ability of the protein ingredient. Udensi et al. [52] indicated that gelation is a quality indicator influencing the texture of food such as moi-moi, agidi and soup. Flours with least gelation concentration are not suitable for infant formulation since they require more dilution and would result in reduced energy density in relation to volume [53]. Since the flours gelled at 4%, it indicates that the flours could be used in infant formulation to enhance nutrient density [54]. The results also show that the seed flours would be a good gel-forming or firming agent, and would be useful in food systems such as pudding and snacks which require thickening and gelling.

4. CONCLUSION

The defatting of avocado pear seed flour resulted to a significant (p<0.05) increase in protein and ash content indicating that defatted avocado pear seed flour is a good source of ash and protein which can be used to improve the nutrient content of existing food products thereby providing a protein rich diet. Mineral contents (potassium, phosphorus and calcium) of the seed flour was also significantly ($p<0.05$) improved after defatting. Defatting also gave higher bioavailable sodium, potassium, iron, phosphorus and calcium. Functional properties of the defatted and undefatted seed flours were significantly similar except for bulk density. However, the seed flours showed good functionalities which has the potential for food formulation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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