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RESEARCH ARTICLE

Chemical and Nutritional Properties of Seinat (*Cucumis melo* var. *tibish*) Seeds

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Abstract

The proximate composition of seinat (*Cucumis melo* var. *tibish*) seed flour, minerals, amino acids and fatty acids were studied. Crude oil content of seinat seed flour was 31.1% while the moisture, fiber, proteins, ash and total sugar content was 4.2, 24.7, 28.5, 4.3 and 6.9% respectively. The contents of potassium, the highest mineral in seinat seed flour was 9,548.33 mg/100 g. Seinat seeds are generally considered to be a good source of amino acids which contains all the essential amino acids with isoleucine, threonine, lysine, histidine, methionine and tryptophan. The main fatty acids were linoleic, oleic, palmitic and stearic acids (61.10, 18.75, 10.37 and 9.18% respectively). The results of the present investigation showed that seinat seeds are a rich source of important nutrients that appear to have a positive effect on human health. This study is the first investigation on seinat seed which was grown in Sudan opening the way for further studies about these seeds.

Keywords: Seinat seed, crude oil content, essential amino acids, fatty acids, total sugars, Sudan.

Introduction

Seinat (*Cucumis melo* var. *tibish*), a type of melon that belongs to the Cucurbitaceae family (also commonly referred to as the cucumber, gourd, melon or pumpkin family) is a medium-sized plant family whose members are primarily found in the warmer regions of the world. It is a family of economically important species of which the fruits are used for nutrition and medicinal purposes (Jeffrey, 1990). Most species of Cucurbitaceae are oilseeds and their kernels have tremendous food value in Africa (Badifu, 2001). Many Cucurbitaceae seeds are rich in oil and protein and although none of these oils has been used on an industrial scale many are used for cooking oil in some countries in Africa and the Middle East (Al-Khalifa, 1996). Seinat grown mostly in Sudan and not well-known in neighboring countries is cultivated for an edible seed. There are five main types of melons that are grown in Sudan having different morphological characteristics and use. Each of these types has a specific local name (Mohamed and Pitrat, 1999). Types of melons that are grown in Sudan are sweet and snake melons, a wild melon known locally as Humaid, a salad melon known locally as tibish and a melon locally known as seinat. The tibish and seinat cultivars are of local origin and belong to a different melon group that is known only in Sudan (Ali, 2009). The seinat melon is a type of *Cucumis melo*. Seinat seeds are roasted and eaten. The conventional sources for vegetable oils in Sudan are limited to a few oilseeds, e.g., groundnut, sesame, sunflower and cottonseed and no longer meet the increasing demand for domestic and industrial purposes. Therefore, the need exists to look for new resources to meet this demand (Mariod *et al*., 2009). Other well-known and more investigated oilseeds, such as pumpkin and melon seeds are used directly as snacks after salting and roasting mostly in Arabian countries (El-Adawy and Taha, 2001). These seeds as well as soybeans have potential for use as functional foods, which would expand their use in the development of a wide variety of food products. Seinat seeds like pumpkin seeds can provide energy, protein, minerals and fatty acids required in the human diet (Yuan *et al*., 2009). Determination of both the physicochemical and functional properties of these seeds would contribute to increasing use and value of seinat oil in the cosmetic, pharmaceutical and food industries (Rezig *et al*., 2012). No previous reports are available on the physicochemical properties, protein concentrates or isolates of seinat seeds. Protein isolates obtained from seeds through isoelectric precipitation might be useful as a protein source for food industry applications. Against these backdrops, this study investigated the proximate composition of seinat seed flour, minerals, amino acids and fatty acids.

Materials and methods

Collection of seeds: Dried seinat fruits were brought from a local farm, Wad Medani City, Gezira State, Sudan after harvesting and transported to the Food Processing and Ingredients laboratory in Jiangnan University, China. The seeds were removed manually from the fruits and were kept dry at room temperature in desiccators.

The seeds were milled using a laboratory scale hammer mill (Debarker Co. Ltd., Beijing, China). After milling, the flour was dispersed in n-hexane using flour to n-hexane ratio of 1:5 (w/v) and stirred for 3 h at room temperature. This resulted in semi defatted flour which was fully defatted in a Soxhlet extraction apparatus using n-hexane. After defatting, the flour was spread on a plate for 2-5 h at room temperature under a laboratory fume hood to remove the excess solvent. The defatted flour was then triturated, screened through 60 mesh sizes, packed in polyethylene bags and stored in a refrigerator at 5°C until use.

Proximate composition analysis: The total protein content of seinat seed flour and defatted seinat seed flour was evaluated using a FOSS nitrogen analyzer (DK-3400 Hilleroed, Denmark) with a conversion factor of 6.25. Fat, moisture, fiber and ash contents were determined using standard AOAC methods 932.06, 925.09, 985.29 and 923.03 respectively (AOAC, 1990). Carbohydrate content was determined according to James (1996).

Mineral analysis: Mineral composition was determined in the samples from the ash which was prepared and dissolved in 6 M HCl and made up to 10 mL. Calcium content was estimated by the titrimetric method of Clark and Collip (1995). Iron content was estimated by using UV-Visible spectrophotometer (model UV-160A, Shimadzu, Shanghai, China) at 480 nm (AOAC, 1995). Magnesium was analyzed following the method of Ranganna (1986). The blue color developed was read at 650 nm in an UV-Visible spectrophotometer (model UV-160A, Shimadzu) and expressed as magnesium mg/100 g meal. Other minerals were estimated by atomic absorption spectroscopy (Shimadzu AA 6701F, atomic absorption flame emission spectrophotometer equipped with hollow cathode lamps).

Amino acids analysis: Dried samples were digested with 6 M HCl at 110°C for 24 h under nitrogen atmosphere. Reversed phase high performance liquid chromatography (RP-HPLC) analysis was carried out in an Agilent 1100 (Agilent Technologies, Palo Alto, CA, USA) assembly system after precolumn derivatization with o-phthaldialdehyde (OPA). Each sample (1 µL) was injected onto a Zorbax 80 A C18 column (i.d., 4.6 × 180 mm, Agilent Technologies) at 40°C with detection at 338 nm. Mobile phase A was 7.35 mM/L sodium acetate/triethylamine/tetrahydrofuran(500:0.12:2.5,v/v/v), adjusted to pH 7.2 with acetic acid, while mobile phase B (pH 7.2) was 7.35 mM/L sodium acetate/methanol/acetonitrile (1:2:2, v/v/v). The amino acid composition was expressed as g of amino acid per 100 g of protein.

Fatty acid composition: Fatty acids were converted to their methyl esters (FAME), following the method of He and Xia (2007) with a slight modification. In brief: 1 µL of FAME sample was injected in gas chromatograph (Series PEG30 M) equipped with a flame ionization detector. GC separation was conducted on a capillary column (PEG30 M; 30 m × 0.32 mm × 0.50 µm). The carrier gas was nitrogen and the column flow rate was 0.8 mL/min. In the beginning, oven temperature was calibrated at 190°C for 1 min, increased from 190 to 230°C at a rate of 3°C/min and then maintained at 230°C for 10 min. The temperatures of the injection port and detector were 240 and 250°C respectively. The peaks was identified on chromatogram depend on retention data from analyzed standard samples. Finally, fatty acid contents were calculated as percentage (%).

Scanning electron microscopy (SEM): Scanning electron microscopic studies were carried out using a scanning electron microscope (Quanta-200 FEI, Netherland). The samples were coated before loading to the scanning electron microscopy. The coated samples were loaded into the system and the image was viewed under 1.0 KV potential using secondary electron image. The image was captured using 11.20 mm Ricoh Camera of 600 x Mag.

Results and discussion

Proximate analysis: The proximate chemical composition of seinat seed flour was shown in Table 1. The protein content was 28.58%. This result obtained was lower than that reported by El-Adawy and Taha, (2001) for watermelon seed kernels from the same family Cucurbitaceae because; it was evaluated just from the kernel and not the whole seed. The crude fat of raw material seinat seed flour (31.13%) was slightly higher than that reported by Mariod *et al*. (2009) for *Citrullus lanatus* var. *colocynthoide*, might be because they belong to different species although they belong to the same family. High percentage of oil in the recorded sample seeds and there are variations in these levels that have been reported. The variations in the oil content can be referred to differences in plant spices, cultivation climate, ripening level and the isolation method used (Nyam *et al*., 2009). Oil content of seinat seeds indicated very clearly that the Cucurbitaceae formed a potential source of oils and fats. Further, it would be seen that in these seeds, the oil content was lower than most Sudanese conventional oil seeds namely cottonseed, sunflower, sesame and groundnut (Martin, 1984). The percentage of crude fiber of seinat seed flour was 24.75%. This result was similar to *Cucumis sativus* percentage. There is evidence that crude fiber has a number of beneficial effects related to its indigestibility in the small intestine (Aremu *et al*., 2006). The moisture content of seinat seed flour was 4.27%. The carbohydrate content for seinat seeds was 6.94% (Table 1).

Mineral content: The mineral content of seinat seed flour was presented in Table 2. Potassium and sodium were the highest whereas magnesium was the most highly concentrated trace element (Table 2).

Table 1. Proximate chemical composition of seinat seed.

Chemical composition	(%)
Moisture	4.27 ± 0.12
Crude protein	28.58 ± 0.50
Carbohydrates	6.94 ± 0.55
Crude fat	31.13 ± 0.90
Fiber	24.75 ± 0.34
Ash	4.33 ± 0.14

Values are Means ± Standard deviation of 3 determinations.

Table 2. Mineral analysis of seinat seed.

Element	(mg/100 g)
Zinc (Zn)	44.03 ± 1.53
Iron (Fe)	81.17 ± 1.52
Copper (Cu)	9.30 ± 0.72
Manganese (Mn)	15.20 ± 0.72
Potassium (K)	9,548.33 ± 1.52
Sodium (Na)	386.13 ± 0.81
Magnesium (Mg)	3,299.27 ± 0.64
Calcium (Ca)	8.34 ± 0.12

Table 3. Amino acid composition of seinat seed (g/100 g protein).

Essential amino acid (EAA)	Seinat seed flour	FAO/WHO/UNU[a]	
		Child	Adult
Histidine	5.51± 0.09	1.90	1.60
Threonine	7.93± 0.04	3.40	0.90
Valine	1.21± 0.10	3.50	1.30
Methionine	5.41± 0.10	2.70[b]	1.70[b]
Phenylalanine	1.49± 0.11	6.30[c]	1.90[c]
Isoleucine	8.80± 0.09	2.80	1.30
Leucine	1.72± 0.07	6.60	1.90
Lysine	7.47± 0.13	5.80	1.60
Tryptophan	3.34± 0.11	1.10	0.50
Non-essential amino acid			
Tyrosine	7.44 ± 0.10		
Cysteine	1.49 ± 0.14		
Aspartic acid	1.97 ± 0.04		
Glutamic acid	4.23 ± 0.12		
Serine	1.24 ± 0.12		
Glycine	1.42 ± 0.10		
Arginine	3.29 ± 0.11		
Alanine	9.78 ± 0.10		
Proline	9.24 ± 0.11		
Percentage of amino acid with different characteristics[d]			
Basic	16.26 ± 0.32		
Acidic	6.20 ± 0.16		
Hydrophobic	37.67 ± 0.67		
Uncharged polar	19.50 ± 0.50		

[a]FAO/WHO/UNU: Daily requirements for human child and adult (FAO, 2007), [b]Requirements for methionine + cysteine, [c]Requirements for phenylalanine + tyrosine, [d]Basic, acidic, hydrophobic, uncharged polar: (Lysine, arginine, histidine), (Aspartic acid, glutamic acid), (Alanine, isoleucine, leucine, methionine, phenylalanine, proline, valine), (Glycine, serine, threonine, tyrosine, cysteine), respectively.

The zinc content of the sample was 44.03 mg/100 g. This value was higher than that for pumpkin seed kernel flour and watermelon seed kernel flour and paprika seed flour (El-Adawy and Taha, 2001). Adelakun *et al*. (2012) reported that soaking, blanching, malting and roasting pre-treatments have an effect on some mineral contents of okra seed flour.

Table 4. Fatty acids composition of seinat seed oil.

Fatty acid	Composition (%)
ΣSFA	19.82
Myristic acid (C14:0)	0.05 ± 0.01
Palmitic acid (C16:0)	10.37 ± 0.02
Stearic acid (C18:0)	9.18 ± 0.04
Arachidic acid (C20:0)	0.22 ± 0.04
ΣUFA	80.18
Palmitoleic acid (C16:1)	0.08 ± 0.02
Oleic acid (C18:1)	18.75 ± 0.1
Linoleic acid (C18:2)	61.10 ± 0.08
Linolenic acid (C18:3)	0.16 ± 0.03
Eicosenoic acid (C20:1)	0.09 ± 0.02
ΣMUFA	18.92
ΣPUFA	61.26
Ratio SFA/UFA	4.01

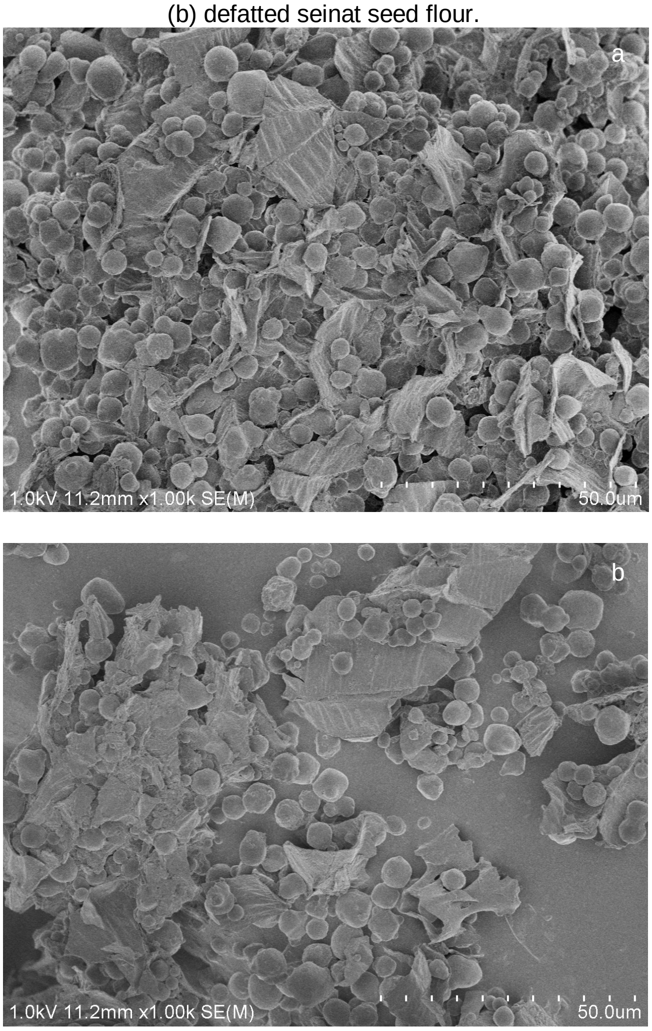
SFA: Saturated fatty acids; MUFA: Monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids; UFA: Unsaturated fatty acids.

All mineral content results were higher than that of fluted pumpkin seeds which were between 8-32 weeks after anthesis (Akwaowo *et al*., 2000). The high potassium content in these seeds makes the seinat seeds an incredible natural source of potassium supplementation for pregnant and lactating women as well as for children and the elderly. Calcium content was lower (8.34 mg/100 g), compared to whole seed, meal and dehulled-defatted seed meal of gum karaya (Galla and Dubasi, 2010).

Amino acid composition: The amino acid composition was presented in Table 3. Seinat seeds were generally considered to be a good source of amino acids. It was found that seinat seeds contained all of the essential amino acids with isoleucine, threonine, lysine, histidine, methionine and tryptophan being present at high levels compared with the FAO Pattern (FAO, 2007). Valine, leucine and phenylalanine were present in low concentration in seinat seed flour (Table 3). Most of the essential amino acids of the protein were at a higher level than the FAO/WHO reference pattern (FAO, 2007), except valine, phenylalanine and leucine which were less than the required amount. Classifications of amino acids in different groups according to chemical properties are shown in Table 3. Seinat seeds contained high amount of hydrophobic amino acids.

Fatty acid composition: The fatty acid composition of seinat seed oil is shown in Table 4. There are 9 fatty acids, 5 were unsaturated. Linoleic acid was the highest content (61.10%), followed by oleic acid (18.75%). These percentages are near to those reported by El-Adawy and Taha (2001) for watermelon seed oil. It is suggested that high level of linoleic acid makes seed oil specifically prone to oxidation. The nutritional value of linoleic acid is due to its metabolism at tissue levels which produces the hormone-like prostaglandins (Odoemelam, 2003). This fatty acid may have favorable nutritional implications and beneficial physiological effects in the prevention of diseases such as cancer and coronary heart disease (Oomah *et al*., 2000).

Fig. 1. SEM pictures of (a) whole seinat seed flour and (b) defatted seinat seed flour.



Scanning electron microscopy (SEM): Microstructural changes produced in the flour after deffating were examined by SEM (Fig. 1). The two flours were degraded into small fragments after defatting. Results showed that flour particles were clustered together and degradation of defatted flour particles take place during the defatting process. These results were similar to those reported by Radha *et al*. (2007) and Wu *et al*. (2009). Scanning electron micrographs of whole seinat seed flour and defatted seinat seed flour obtained under the same parameters (HV-1.0 kv, Mag-600 x and 50 µm) showed that defatted seinat seed flour has slightly larger particles than seinat seed flour (Fig. 1).

Conclusion

The results of the present study reveal that seinat seed is a valuable source of nutrition due to substantial amount of proteins with an adequate quantity of minerals, essential amino acids and fatty acid. The essential amino acid pattern of seinat seed suggests the possible use as a supplementary source to most legumes and that most of the essential amino acids are above the WHO/FAO/ UNU (2007) requirements for humans.

Ultimately, detailed reports on the chemical composition of seinat (*Cucumis melo* var. *tibish*) seeds have not been previously reported. The findings of the study confirm that the seeds are a rich source of many important nutrients that appear to have a very positive effect on human health.

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