Evaluation of Chemical Properties, Amino Acid Contents and Fatty Acid Compositions of Sesame Seed Provided from Different Locations

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Abstract: In this study, chemical properties, amino acid contents, fatty acid compositions of sesame seeds dependin on growing locations of sesame plants were evaluated. Protein contents of sesame seeds changed between 20.80% (Afghanistan) and 26.01% (India). Oil contents of seeds were changed between 44.69% (Mozambique) and 55.37% (Niger-Kany). Crude fiber contents of sesame seeds ranged from 17.30% (Ethiopia-Volega) to 28.78% (Mozambique). The highest protein, crude oil and crude fiber were found in India, Niger-Kany and Mozambique sesame seed samples, respectively. In addition, while glutamic acid contents of seeds change between 3.28% (Uganda and Niger-Benje) and 4.57% (India), arginine contents of seeds ranged from 2.36% (Uganda) to 3.10% (India). The total amino acid contents of sesame seeds ranged from 18.12% (Uganda) to 23.51% (India). Palmitic acid contents of sesame oils ranged from 7.93% (Uganda) to 9.55% (Burkina Faso). While oleic acid contents of sesame seed oils are found between 35.88% (Mozambique) and 44.54% (Afghanistan), linoleic acid contents of oils ranged from 37.41% (Afghanistan) to 47.44% (Mozambique). The high amount of protein, oil contents, amino acids and unsaturated fatty acids can be positively considered from the nutritional point of view.

Key words: sesame, proximate, amino acid, fatty acid, GC

1 Introduction

Sesame (*Sesamum indicum* L.) is one of the most important plant in oil seed crop^{1,2}. Sesame is an excellent edible oil and protein^{3,4}. In general, the oil contents of the cultivars were found within the range reported for sesame seed cultivars grown in various parts of the world. Due to its high oil yield, mildness and pleasant taste sesame is named as the queen of the oilseeds crops⁴⁻⁷. Sesame seed is cultivated on a world wide basis for both oil and protein⁸. Sesame seeds are used in the making of tahin (Sesame butter) and halva, and for the preparation of rolls, crackers, cakes and pastry products in commercial bakeries. Sesame is mostly utilized as a whole seed throughout the world in condiments or as an additives on breads, biscuits and other confectionery product. Sesame is used in condiments^{2,9-11}. The variety, origin, color and size of sesame seed affect to the chemical composition of sesame

seed and its oil. Plant seeds are important sources of oils of nutritional, industrial and pharmaceutical importance. Although sesame oil contains unsaturated fatty acid, it is most resistant to oxidative rancidity among many vegetable oils^{12,13}. The fatty acid composition of oils plays an important role in determining shelf life and nutrition of food products. The main fatty acid in sesame oil is linoleic acid, followed by oleic, palmitic and stearic acid. These four fatty acids constitute a large proportion of the total fatty acid composition of sesame oil¹⁴⁻¹⁶. Therefore, the purpose of the current study was to determine chemical properties, amino acid, fatty acid compositions of sesame seeds dependin on growing locations of sesame plants.

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2 Material and Methods

2.1 Material

Sesame (*Sesamum indicum* L.) seeds belong to several countries (Afghanistan, Burkina Faso, Ethiopia-Volega, Ethiopia-Humera, Mozambique, Niger-Benje, Niger-Wadaguri, Uganda, Niger-Kany and India) were purchased from a local market in Saudi Arabia (Riyadh). They were sorted to remove any dirt or foreign material present in them. Each parameter is the mean of three replicate determinations.

2.2 Methods

2.2.1 Proximate Analysis

Determination of moisture and protein content was done according to AACC (44-15.02 and 46-30.01). Moisture was measured by heating the sample for 1 hour at 135°C in a gravity oven¹⁷⁾. The nitrogen combustion method was used for determination of crude protein. The protein determination was made in Leco combustion analyzer and 6.25 was used as the conversion factor¹⁸⁾. Total starch was measured using AACC approved method 76-13.01, using an assay kit from Megazyme (Megazyme International, Ireland). The samples were incubated with heat stable fungal α -amylase and amyloglucosidase to hydrolyze the starch to glucose. The glucose was treated with glucose oxidase/peroxidase (GOPOD) and the absorbance was read at 492 nm. The starch content was calculated based on the glucose concentration¹⁹⁾. Crude oil content was determined by ether extraction, according to AOAC Official Method 920.39(A) and crude fiber content was determined according to AOAC official method 978.10²⁰⁾.

2.2.2 Amino acid profile

The amino acid contents of seeds were determined by using AOAC Official Method 982.30 E (a,b,c)¹⁷⁾.

2.2.3 Fatty acid profile

The fatty acid methyl esters were identified by compar-

ing the retention time of the samples and appropriate fatty acids methyl esters standards according to AOAC official methods 996.06 [Analysis of methyl esters by Capillary GLC]. From the liquid phase on the top, 1 μ L the fatty acid methyl ester was injected in a gas chromatograph (GC/FID (HP-AGILENT/6890)) with a capillary column, CP-Sil 88 (100 m long, 0.25 mm ID, film thickness 0.2 μ m)²⁰⁾.

2.2.4 Statistical analysis

Analysis of variance (ANOVA) and mean $\pm$ standard deviation (MSTAT C) of results were calculated according to Püskülcü and İkiz²¹⁾.

3 Results and Discussion

Physico-chemical properties of some sesame seeds provided from several countries are given in Table 1. Moisture contents of the sesame samples ranged from 3.99% (Niger-Kany) to 4.98% (Ethiopia-Humera). In addition, while protein contents of sesame seeds change between 20.80% (Afghanistan) and 26.01% (India), ash contents of the samples varied between 4.41% (India) and 5.42% (Niger-Wadaguri) ($p < 0.05$). Oil contents of seeds were found high and changed between 44.69% (Mozambique) and 55.37% (Nigeria-Kany). Crude fiber contents of sesame seeds ranged from 17.30% (Ethiopia -Volega) to 28.78% (Mozambique) ($p < 0.05$). The highest protein, crude oil and crude fiber were found in India, Niger-Kany and Mozambique sesame seed samples, respectively. Physico-chemical properties of sesame seeds showed differences depending on several origins of sesame seeds. Our results were found similar with results (5.7% moisture, 48.5% crude oil, 20% crude protein, 9.4% crude fiber and 4.2% ash) reported by Nzikou *et al.*¹⁾. Borchani *et al.*²⁾ reported that sesame seed contained 24.63% protein, 52.67% oil

Table 1 Proximate analysis of sesame seeds (%).

	%				
	Moisture	Protein	Ash	Crude oil	Crude fiber
Afghanistan	4.03 $\pm$ 0.45*c	20.80 $\pm$ 1.17d	4.86 $\pm$ 0.21b	54.25 $\pm$ 2.33a	18.01 $\pm$ 0.56d
Burkina Faso	4.54 $\pm$ 0.38c**	22.34 $\pm$ 1.09b	5.27 $\pm$ 0.17a	53.36 $\pm$ 1.78b	17.75 $\pm$ 1.18e
India	4.68 $\pm$ 0.67b	26.01 $\pm$ 1.23a	4.41 $\pm$ 0.48b	50.18 $\pm$ 2.17c	18.18 $\pm$ 0.98d
Mozambique	4.60 $\pm$ 0.51b	22.97 $\pm$ 1.27b	5.24 $\pm$ 0.38a	44.69 $\pm$ 2.21d	28.78 $\pm$ 0.55a
Uganda	4.70 $\pm$ 0.44b	21.34 $\pm$ 0.98c	5.10 $\pm$ 0.48a	54.01 $\pm$ 1.56a	22.34 $\pm$ 1.52b
Ethiopia - Humera	4.98 $\pm$ 0.63a	22.98 $\pm$ 1.26b	4.68 $\pm$ 0.53b	52.52 $\pm$ 1.56b	22.53 $\pm$ 1.32b
Ethiopia - Volega	4.85 $\pm$ 0.47a	22.05 $\pm$ 1.11b	5.18 $\pm$ 0.47a	52.19 $\pm$ 1.38b	17.30 $\pm$ 1.45e
Niger - Benje	4.61 $\pm$ 0.33b	21.99 $\pm$ 1.34c	4.98 $\pm$ 0.41b	52.87 $\pm$ 1.48b	18.52 $\pm$ 1.28d
Niger - Kany	3.99 $\pm$ 0.36d	21.89 $\pm$ 1.42c	4.77 $\pm$ 0.38b	55.37 $\pm$ 1.67a	19.34 $\pm$ 0.87c
Niger - Wadaguri	4.20 $\pm$ 0.53c	22.46 $\pm$ 1.19b	5.42 $\pm$ 0.53a	50.88 $\pm$ 1.24c	20.58 $\pm$ 1.43c

*mean $\pm$ standard deviation; **Values within each column followed by different letters are significantly different ($p < 0.05$).

Table 2 Amino acid composition of sesame seeds (% w/w).

	Afghanistan	Burkina Faso	India	Mozambique	Uganda	Ethiopia Humera	Ethiopia Volega	Niger Benje	Niger Kany	Niger Wadaguri
Taurine	0.05 ± 0.01 ^a	0.04 ± 0.01b	0.05 ± 0.02a	0.04 ± 0.01b	0.04 ± 0.01b	0.04 ± 0.01b	0.05 ± 0.03a	0.03 ± 0.01c	0.04 ± 0.01b	0.04 ± 0.01b
Hydroxyproline	0.10 ± 0.03c ^{**}	0.08 ± 0.01c	0.13 ± 0.05a	0.09 ± 0.01d	0.11 ± 0.03b	0.09 ± 0.01d	0.08 ± 0.01c	0.09 ± 0.03d	0.09 ± 0.03d	0.10 ± 0.03c
Aspartic Acid	1.63 ± 0.09b	1.76 ± 0.11b	2.06 ± 0.17a	1.78 ± 0.13b	1.57 ± 0.09b	1.77 ± 0.03b	1.75 ± 0.21b	1.62 ± 0.13b	1.66 ± 1.22b	1.70 ± 1.17b
Threonine	0.71 ± 0.03c	0.77 ± 0.09b	0.89 ± 0.11a	0.79 ± 0.13b	0.71 ± 0.09b	0.78 ± 0.17b	0.77 ± 0.03b	0.73 ± 0.07c	0.75 ± 0.05b	0.76 ± 0.11b
Serine	0.89 ± 0.21c	0.99 ± 0.11b	1.15 ± 0.13a	0.97 ± 0.09b	0.85 ± 0.07c	0.96 ± 0.03b	0.99 ± 0.07b	0.88 ± 0.03c	0.92 ± 0.04b	0.92 ± 0.08b
Glutamic Acid	3.52 ± 0.26b	3.95 ± 0.33b	4.57 ± 0.47a	3.78 ± 0.38b	3.28 ± 0.29b	3.67 ± 0.51b	3.87 ± 0.39b	3.28 ± 0.26b	3.46 ± 0.48b	3.41 ± 0.35b
Proline	0.68 ± 0.09c	0.73 ± 0.03b	0.85 ± 0.11a	0.74 ± 0.15b	0.65 ± 0.09c	0.74 ± 0.03b	0.75 ± 0.03b	0.68 ± 0.07c	0.69 ± 0.13c	0.70 ± 0.09b
Glycine	0.98 ± 0.21b	1.06 ± 0.17a	1.22 ± 0.19a	1.09 ± 0.11a	0.96 ± 0.07b	1.07 ± 0.09a	1.05 ± 0.11a	0.99 ± 0.08a	1.02 ± 0.09a	1.03 ± 0.15a
Alanine	0.90 ± 0.07b	0.99 ± 0.09b	1.14 ± 0.05a	1.01 ± 0.11a	0.89 ± 0.07c	0.99 ± 0.03b	0.98 ± 0.09b	0.93 ± 0.13b	0.95 ± 0.18b	0.96 ± 0.21b
Cysteine	0.40 ± 0.03b	0.43 ± 0.07b	0.51 ± 0.10a	0.42 ± 0.09b	0.38 ± 0.03c	0.42 ± 0.07b	0.42 ± 0.03b	0.36 ± 0.09c	0.41 ± 0.05b	0.39 ± 0.04c
Valine	0.90 ± 0.16b	0.98 ± 0.09b	1.12 ± 0.17a	1.01 ± 0.16a	0.89 ± 0.15	1.00 ± 0.09a	0.95 ± 0.03b	0.92 ± 0.11b	0.94 ± 0.13b	0.95 ± 0.09b
Methionine	0.64 ± 0.09b	0.66 ± 0.03b	0.71 ± 0.03a	0.65 ± 0.01b	0.60 ± 0.07b	0.65 ± 0.03b	0.65 ± 0.03b	0.59 ± 0.01c	0.62 ± 0.07b	0.63 ± 0.01b
Isoleucine	0.73 ± 0.03c	0.79 ± 0.04c	0.91 ± 0.10a	0.82 ± 0.05b	0.72 ± 0.03c	0.81 ± 0.06b	0.77 ± 0.05c	0.75 ± 0.07c	0.75 ± 0.03c	0.77 ± 0.09c
Leucine	1.32 ± 0.17c	1.44 ± 0.13b	1.66 ± 0.16a	1.48 ± 0.21b	1.30 ± 0.23c	1.46 ± 0.13b	1.42 ± 0.16b	1.35 ± 0.09b	1.39 ± 0.07b	1.40 ± 0.18b
Tyrosine	0.64 ± 0.09b	0.68 ± 0.07b	0.79 ± 0.03a	0.67 ± 0.05b	0.61 ± 0.03b	0.65 ± 0.08b	0.68 ± 0.03b	0.62 ± 0.05b	0.66 ± 0.07b	0.64 ± 0.07b
Phenylalanine	0.86 ± 0.03c	0.94 ± 0.11b	1.09 ± 0.15a	0.96 ± 0.18b	0.84 ± 0.16c	0.95 ± 0.14b	0.92 ± 0.07b	0.87 ± 0.03c	0.90 ± 0.09b	0.91 ± 0.03b
Hydroxylysine	0.02 ± 0.01a	0.01 ± 0.00b	0.01 ± 0.00b	0.03 ± 0.01a	0.02 ± 0.01a	0.03 ± 0.01a	0.01 ± 0.00b	0.03 ± 0.01a	0.03 ± 0.01a	0.03 ± 0.01a
Ornithine	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00
Lysine	0.58 ± 0.03c	0.61 ± 0.07b	0.69 ± 0.05a	0.63 ± 0.03b	0.62 ± 0.07b	0.64 ± 0.03b	0.64 ± 0.01b	0.60 ± 0.03b	0.60 ± 0.05b	0.62 ± 0.07b
Histidine	0.49 ± 0.03c	0.54 ± 0.07b	0.61 ± 0.09a	0.55 ± 0.01b	0.50 ± 0.03b	0.56 ± 0.11b	0.53 ± 0.09b	0.50 ± 0.13b	0.52 ± 0.07b	0.53 ± 0.03b
Arginine	2.43 ± 0.21b	2.67 ± 0.14b	3.10 ± 0.16a	2.73 ± 0.09b	2.36 ± 0.13b	2.67 ± 0.21b	2.61 ± 0.18b	2.40 ± 0.17b	2.58 ± 0.21b	2.50 ± 0.13b
Tryptophan	0.13 ± 0.01c	0.26 ± 0.03a	0.24 ± 0.05b	0.20 ± 0.03d	0.21 ± 0.05c	0.24 ± 0.07b	0.25 ± 0.01b	0.25 ± 0.01b	0.26 ± 0.03a	0.22 ± 0.03c
Total	18.61	20.39	23.51	20.45	18.12	20.20	20.15	18.48	19.25	19.22

*mean ± standard deviation; **Values within each row followed by different letters are significantly different ($p < 0.05$).

Table 3 Fatty acid profile of sesame seed oils (%).

	Afghanistan	Burkina Faso	India	Mozambique	Uganda	Ethiopia Humera	Ethiopia Volega	Niger Benje	Niger Kany	Niger Wadaguri
Myristic	0.02 ± 0.01*	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01
Palmitic	8.92 ± 0.19b**	9.55 ± 0.27a	9.36 ± 0.13a	8.72 ± 0.21b	7.93 ± 0.27c	9.00 ± 0.28a	8.43 ± 0.56b	8.84 ± 0.44b	9.41 ± 0.39a	9.09 ± 0.51a
Palmitoleic	0.12 ± 0.03c	0.14 ± 0.03a	0.13 ± 0.01b	0.12 ± 0.01c	0.11 ± 0.01d	0.12 ± 0.03c	0.11 ± 0.01d	0.12 ± 0.01c	0.14 ± 0.03a	0.13 ± 0.01b
Margaric	0.07 ± 0.01a	0.04 ± 0.01d	0.07 ± 0.01a	0.04 ± 0.01d	0.05 ± 0.01c	0.06 ± 0.02b	0.05 ± 0.01c	0.05 ± 0.01c	0.05 ± 0.01c	0.05 ± 0.01c
Stearic	6.20 ± 0.37a	5.19 ± 0.56b	5.10 ± 0.35b	5.14 ± 0.27b	5.30 ± 0.43b	5.59 ± 0.28b	5.54 ± 0.41b	5.33 ± 0.36b	5.08 ± 0.44b	5.48 ± 0.32b
Elaidic	0.07 ± 0.01a	0.06 ± 0.01b	0.06 ± 0.01b	0.06 ± 0.03b	0.06 ± 0.02b	0.06 ± 0.01b	0.06 ± 0.01b	0.06 ± 0.03b	0.06 ± 0.01b	0.05 ± 0.01c
Oleic	44.54 ± 1.74a	37.68 ± 1.61d	40.29 ± 1.35b	35.88 ± 1.42e	38.40 ± 1.28c	37.31 ± 1.53d	37.82 ± 1.23d	38.98 ± 1.17c	37.39 ± 1.35d	38.63 ± 1.27c
Linoleic	37.41 ± 1.36c	44.94 ± 1.23c	42.56 ± 1.46d	47.44 ± 1.28a	45.67 ± 1.49b	45.38 ± 1.61b	45.52 ± 1.26b	44.14 ± 1.46c	45.44 ± 1.31b	44.06 ± 1.29c
Linolenic	0.31 ± 0.03e	0.35 ± 0.07d	0.30 ± 0.03e	0.38 ± 0.05c	0.38 ± 0.03c	0.42 ± 0.06a	0.40 ± 0.01b	0.38 ± 0.03c	0.36 ± 0.03d	0.41 ± 0.07a
Arachidic	0.68 ± 0.09a	0.59 ± 0.11c	0.58 ± 0.07c	0.61 ± 0.03b	0.57 ± 0.09e	0.60 ± 0.13b	0.61 ± 0.17b	0.58 ± 0.09d	0.58 ± 0.07d	0.59 ± 0.11c
Gonodic	0.21 ± 0.03a	0.18 ± 0.01c	0.19 ± 0.03b	0.18 ± 0.01c	0.18 ± 0.03c	0.19 ± 0.03b	0.18 ± 0.01c	0.19 ± 0.03b	0.18 ± 0.03c	0.18 ± 0.03c
Behenoic	0.16 ± 0.01b	0.16 ± 0.03b	0.15 ± 0.01c	0.18 ± 0.03a	0.16 ± 0.02b	0.16 ± 0.01b	0.16 ± 0.01b	0.15 ± 0.03c	0.15 ± 0.01c	0.14 ± 0.01d
Clupanodonic	0.06 ± 0.01e	0.03 ± 0.01e	0.17 ± 0.03a	0.17 ± 0.01a	0.17 ± 0.03a	0.15 ± 0.03b	0.15 ± 0.01b	0.14 ± 0.01c	0.14 ± 0.01c	0.13 ± 0.03d
Lignoceric	0.01 ± 0.00c	0.09 ± 0.01b	0.10 ± 0.01a	0.09 ± 0.03b	0.10 ± 0.03a	0.09 ± 0.01b	0.10 ± 0.01a	0.01 ± 0.00c	0.10 ± 0.03a	0.09 ± 0.01b

*mean ± standard deviation; **Values within each row followed by different letters are significantly different ($p < 0.05$).

and 5.44% ash. Hassan²²⁾ reported that roasted sesame seeds contained 0.20-3.06% moisture, 18.92-23.18% crude protein, 3.01-4.38% ash, 6.75-7.34% crude fiber and 56.49-59.97% crude oil. Sesame seeds contained 4.15-4.30% moisture, 18.96-22.55% protein, 3.01-3.6% fiber, 3.67-5.1% ash and 49.5-53.9% oil²³⁾. These differences in results can be probably due to growing locations, genetic factors, harvest time and analytical conditions.

Amino acid composition of sesame seeds are presented in Table 2. Generally, seeds rich in glutamic, aspartic, arginine and leucine amino acids. Amino acid contents of sesame seeds showed differences depending on growing locations of sesame seeds. The highest amino acid contents were detected in India sesame samples, followed by Mozambique, Burkina Faso, Ethiopia Humera and Ethiopia Volega in descending order. While glutamic acid contents of seeds change between 3.28% (Uganda and Nigeria-Benje) and 4.57% (India), arginine contents of seeds ranged from 2.36% (Uganda) to 3.10% (India) ($p < 0.05$). Also, leucine contents of sesame seeds changed between 1.30% (Uganda) and 1.66% (India). In addition, aspartic acid contents of sesame seeds were found between 1.57% (Uganda) and 2.06% (India). The total amino acid contents of sesame seeds ranged from 18.12% (Uganda) to 23.51% (India). As seen in Table 2, amino acid contents of sesame seeds provided from India were found higher than those of results of sesame provided from other countries.

Fatty acid compositions of sesame oils are reported in Table 3. Palmitic acid contents of sesame oils ranged from 7.93% (Uganda) to 9.55% (Burkina Faso). It was observed statistically significant differences among fatty acid compositions of sesame seeds depending on locations ($p < 0.05$). As second saturated fatty acid, stearic acid contents of sesame oils were found between 5.08% (Niger-Kany) and 6.20% (Afghanistan). In addition, while oleic acid contents of sesame seed oils were found between 35.88% (Mozambique) and 44.54% (Afghanistan), linoleic acid contents of oils ranged from 37.41% (Afghanistan) to 47.44% (Mozambique) ($p < 0.05$). Other fatty acids of the samples were found in trace amounts. The highest palmitic, oleic and linoleic acids were identified in Burkina Faso, Afghanistan and Mozambique locations, respectively. In previous study, oil contents of sesame seeds were found between 49.5 and 53.9%²⁰⁾. The percentage content of caprylic, linoleic, palmitic and stearic acids in the sesame seed oils varied between 16.9-21.8%, 4.7-12.5%, 16.0-19.3% and 13.9-21.5%, respectively²³⁾. Sesame oil contained 35.9-47.0% oleic, 35.6-47.6% linoleic, 8.7-13.8% palmitic, 2.1-6.4% stearic acids^{4, 24, 25)}. Borchani *et al.*²⁾ reported that sesame seed oil contained 12.96% palmitic, 5.76% stearic, 41.68% oleic and 38.29% linoleic acids. Linoleic (42.66-43.21% and oleic acids (39.22-41.63%) were the main unsaturated fatty acids of sesame oil²²⁾. The results obtained are in agreement with those reported by Özcan *et al.*²²⁾; Aued-Pimentel

*et al.*²⁶⁾ and Borchani *et al.*²⁾. Özcan *et al.*²⁵⁾ determined 11.2% palmitic, 12.6% stearic, 41.9% oleic, 43.9% linoleic and 0.1% linolenic acids in sesame seed oil. Our results were found generally similar to literature values. It was also considered that biochemical differences of the varieties consisted of genetic variation and different harvest time.

4 Conclusion

Crude protein, crude fibre and crude oil contents of seeds were affected mainly by variety, locations and growing conditions. It may be concluded that these seed oils are suitable for edible purposes as it contain relatively higher amounts of unsaturated fatty acid, very close to those reported for the edible oils. Sesame seed and oils are worth attention as a source of health promoting component for foods. The high amount of unsaturated fatty acids can be positively considered from the nutritional point of view.

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