

# Characteristics of Sesame (*Sesamum Indicum L.*) Seed Meal Grown in the Northern Region of Bangladesh

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## ABSTRACT

Oil was extracted from sesame seed by hydraulic press and the physico-chemical characteristics such as moisture content, density, specific gravity, Refractive index, free fatty acid, acid value, iodine value, peroxide value and unsaponifiable matters were determined. Proximate analysis of defatted seed meal were done. The residual oil was extracted by organic solvents as the residual oil deteriorates and degrades the quality of seed meal during the storage. The carbohydrate content in defatted meal was found to be the highest (56.7%) and protein was 22.5%. The major minerals such as Ca, Mg, Na K, Fe and Zn were estimated by AAS. It was found that almost all the mineral contents were higher except Fe (2.9 mg/100g) and Zn (3.0 mg/100g). Presence of highly toxic and carcinogenic aflatoxin in seed meal was detected by applying ELISA (enzyme linked immunosorbent assay). Aflatoxin found in seed meal was very low, 0.113 ppb than allowable limit (4 ppb) for human consumption. Fatty acids composition of the oil was determined by GCMS that revealed 6 fatty acids. Further, GC-MS study of the seed meal confirmed the presence of thirty bioactive compounds with glycerin 32.77% as predominant and maximum number of phytochemicals were observed.

## Introduction

Sesame (*Sesamum indicum L.*) is an economically and nutritionally important crop and it is prized for oil. The global sesame market demand is rising with increasing health awareness. Sesame is one of the oldest oilseeds and is widely cultivated in both tropical and subtropical areas. Worldwide sesame seed consumption was USD 6559.0 million in 2018 and it will reach USD 7244.9 million by 2024, with a CAGR (compound annual growth rate) of 1.7% [1] In Bangladesh, sesame is an important summer oilseed crop occupying 9.4% of the total oilseed area [2]. Sesame is labeled as the queen of oilseeds because of its high oil content (35-45%), delicious nutty aroma, and flavor [3] and a considerable amount of proteins, carbohydrates, essential minerals. Seeds contain high amount of methionine and tryptophan, fibers as well as secondary metabolites such as lignans, saponins, flavonoids,

and phenolic compounds. Moreover, the seeds are a good source of calcium, phosphorus, iron, small amount of trace elements and are rich in vitamin B, E. Sesame oil has a pleasant, mild taste and is remarkably stable.

It has a high content of polyunsaturated fatty acids as oleic and linoleic acid. Sesame oil cake is good feed for poultry, fish, cattle, goat and sheep [4]. Oil cakes, the coarse residues after the removal of oil from various oilseeds is usually treated as waste products in Bangladesh. The average total production of oil cakes in Bangladesh is about 1,70,000 tons per annum [5]. Oil cakes are rich in protein and minerals, but their inherent values have never been considered actively. They are generally used as poultry and other animal feed or as fertilizer. Among the total production of oil cakes in Bangladesh, 70% of which are used as fertilizer, 10% is being

exported and the remaining 15% is available for animal feeding [6]. Sesame Oil cakes or defatted sesame meal can be an ideal source as a support matrix for various biotechnological processes for the production of enzymes, antibiotics, vitamins, antioxidants [7] and various food products. So, the sustainable utilization of this seed meal is necessary for preparing cattle, poultry and fish feed and also for the preparation of protein and vitamin enriched food stuff for men and poultry, fish farming.

The present work had therefore, been undertaken with a view to finding out the major constituents of the sesame seed oil and defatted seed meal so that the proper and effective utilization of these seed meal may be ensured.

## Materials and Methods

Sesame seeds were purchased from katakhali bazar, Rajshahi, Bangladesh. Then the seeds were cleaned, dried and the oil was pressed out by hydraulic press. The meal thus obtained were freed from residual oil by solvent extraction. The residual oil was extracted in a Soxhlet apparatus with n-hexane. This solvent was selected as extraction solvent because it has better effect over other polar

solvents like alcohol, ketone, aldehyde etc. [8]. Physical properties such as moisture content, refractive index, density, specific gravity and viscosity of the oil were determined by the method described by Garba, et al. [9] and AOAC [10]. Acid value, saponification value, iodine value, peroxide value, unsaponifiable matter and free fatty acid were estimated according to the AOAC [11].

The defatted seed meal were air dried, and analysis of nitrogen was carried out by Micro-Kjeldhal method, and the percentage of protein was calculated [12]. The defatted meal was also used for different analysis like ash [13], fiber [14], carbohydrate [15], residual fat [16] and moisture content [17]. The minerals such as calcium, potassium, phosphorous, magnesium, sodium and iron were determined by atomic absorption spectroscopy (Model: AA-68000, Shimadzu, Japan) coupled with an auto-sampler (ASC-6100). The fatty acid composition of the sesame oil and the chemical compound of seed meal were analyzed by SHIMADZU GC-2010 was equipped with auto-sampler (AOC- 20s), auto-injector (AOC-20i) and SH Rxi 5MS Sill capillary column with 30m×0.25mm×0.25 µm film. Detection of aflatoxin in seed meal is done following by the method Lee & Rachmawati [18] (Figure 1).

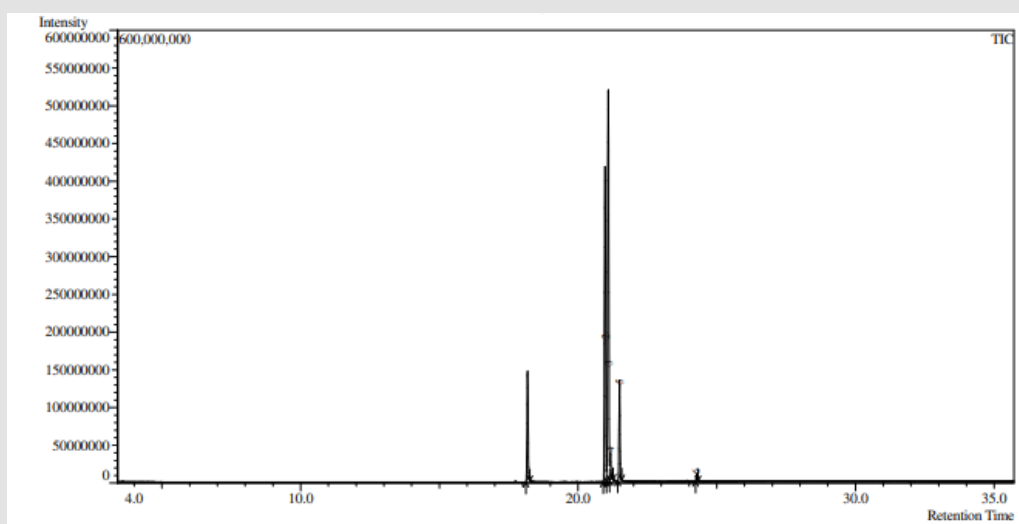


Figure 1: GCMS chromatogram of sesame oil.

## Results and Discussion

Moisture, Density, specific gravity and refractive index of sesame oil were determined and depicted in Table 1. All values were within the WHO/FAO permissible limits. The results showed in Table 1 that the free fatty acid, acid value, peroxide value, iodine value and unsaponifiable matters of oil were 0.40%, 0.81%, 3.96 meq O<sub>2</sub>/kg, 118g I<sub>2</sub>/100g and 2.1 respectively. These results were similar to those reported in other studies [19-21]. The proximate

analysis of defatted sesame seed meal were determined, and the results were given in Table 2. It was found that the protein content of meal was 22.5% and the carbohydrate content was the highest, 56.7%. The content of crude fiber was 4.6% whereas moisture, ash and residual fat content were 5.5%, 6.8% and 3.9% respectively. All values were in an appreciable level. Table 3 showed the mineral contents of defatted sesame meal. Sesame meals contain good percentages of minerals which may added better nutritive value for foods or in pharmacological preparations.

**Table 1:** Physicochemical characteristics of sesame oil.

Properties	Sesame Oil
Moisture content (%)	0.03± 0.01
Density at 25 °C	0.8843±0.30
Specific gravity at 25 °C	0.9019±0.05
Refractive index at 25 °C	1.475±0.11
Free Fatty Acid (as oleic %)	0.40 ±0.14
Peroxide value (meq o <sub>2</sub> /kg)	3.96±0.33
Iodine value (g I <sub>2</sub> /100g)	118±0.45
Acid value (%)	0.81±0.02
Unsaponifiable matter	2.1±0.12

**Table 2:** Proximate composition of defatted sesame meal flour.

Constituent	Amount in Percentage
Moisture %	5.5 ±0.20
Ash %	6.8±0.76
Crude fiber %	4.6±0.51
Residual fat %	3.9±0.22
Protein %	22.5±0.93
Carbohydrate %	56.7±0.52

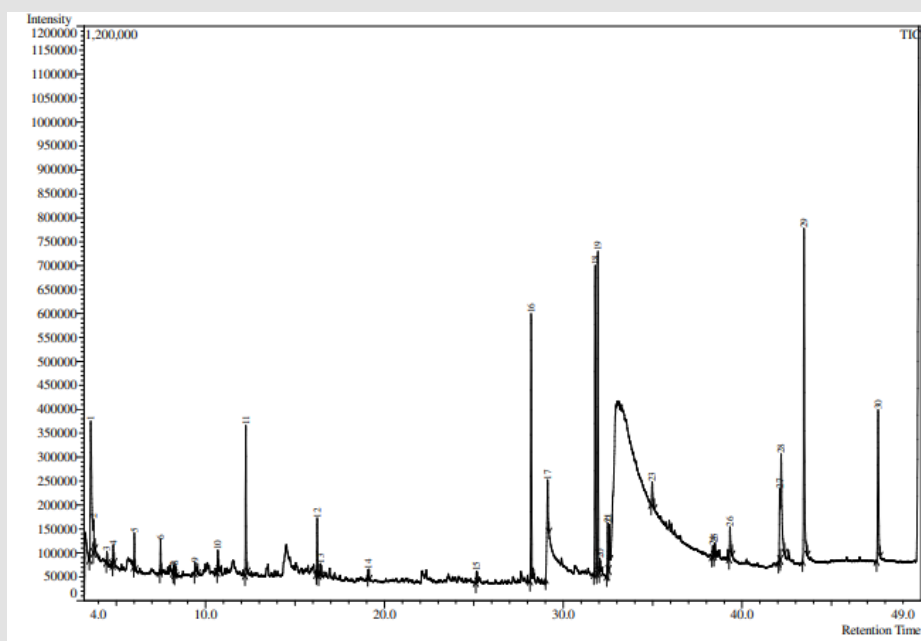
**Note:** All the experiments were performed in triplicate and the results were expressed as mean ± SD (standard deviation).

Scientists are looking for an alternate source of cheaper oil cake with low level of aflatoxin. The literature on the incidence of aflatoxin in sesame oil cake is scanty. Mirocha, et al. [22] reported

the presence of Fusarium toxins in sesame seeds. While Laxma Reddy and Reddy [23] observed the incidence of trichothecene producing fungi was low as compared with that of *Aspergillus* and *Penicillium* species in sesame oil cake. The allowable limit of aflatoxin for human consumption is 4 ppb [24]. Aflatoxin of seed meal was determined shown in Table 3 is 0.113 ppb that is much lower than allowable limit for human consumption. The fatty acid composition is an essential indicator of the nutritional value of the oil. Sesame seed oil belongs to the oleic–linoleic (mono unsaturation-poly unsaturation) acid group. It has 25% poly unsaturated fatty acid, 9,12-Octadecadienoic acid methyl ester and 31% mono unsaturated fatty acid, 9-Octadecenoic acid methyl ester. Oil also consists of palmitic acid 22%, stearic acids 19% and Heneicosanoic acid, methyl ester 2.4% (Table 4).The chemical compounds of sesame seeds were analyzed by GC-MS and summarized in Table 5 and their GC-MS chromatograph in Figure 2.

**Table 3:** Aflatoxin and some mineral contents in defatted sesame seed meal.

Minerals	Amount in mg/100g
Sodium	42.2±0.60
Potassium	120.3 ±0.29
Calcium	251.0±0.78
Magnesium	99.6±0.51
Iron	2.9±0.20
Phosphorus	198±0.73
Zinc	3.0±0.42

**Figure 2:** GCMS chromatogram of sesame seed meal.

**Table 4:** Fatty acid composition of sesame oil.

ID	Name	Retention Time	Area	Concentration %
1	Hexadecanoic acid, methyl ester (Palmitic acid)	18.172	32580890	22.0604
2	9,12-Octadecadienoic acid (Z, Z)-, methyl ester (Linoleic acid)	20.987	37109728	25.12685
3	9-Octadecenoic acid, methyl ester, (E) (Oleic acid)	21.103	37680438	25.51328
4	9-Octadecenoic acid (Z)-, methyl ester (Oleic acid)	21.166	8248245	5.58485
5	Octadecanoic acid, methyl ester (Stearic acid)	21.495	28476534	19.28135
6	Heneicosanoic acid, methyl ester	24.274	3593678	2.43327

**Table 5:** Identification of the chemical compounds present in sesame seed meal.

ID	Name	Retention Time	Area	Concentration %
1	Glycerin	3.575	1270671	33.09018
2	1-Butene, 4-isothiocyanato-	3.732	23642	0.61567
3	2-Propyl-1-pentanol, pentafluoropropionate	4.481	11852	0.30864
4	Benzeneacetaldehyde	4.835	51517	1.34158
5	Nonanal	6.013	24670	0.64244
6	Isoborneol	7.479	41553	1.0821
7	3-Cyclohexene-1-methanol, .alpha.,.alpha.4-trimethyl-	8.226	7028	0.18302
8	Estragole	8.28	5499	0.1432
9	Benzaldehyde, 4-(1-methylethyl)-	9.416	9963	0.25945
10	p-Cymen-7-ol	10.679	39012	1.01593
11	Phenol, 2-methoxy-3-(2-propenyl)-	12.249	121496	3.16394
12	Phenol, 3,5-bis(1,1-dimethylethyl)-	16.243	105315	2.74256
13	3-Allyl-6-methoxyphenol	16.416	14004	0.36469
14	Hexadecane	19.097	24514	0.63838
15	Heneicosane	25.152	17725	0.46159
16	Hexadecanoic acid, methyl ester	28.206	416891	10.85647
17	Eicosanoic acid	29.127	113649	2.95959
18	9,12-Octadecadienoic acid, methyl ester	31.782	190150	4.95179
19	9-Octadecenoic acid, methyl ester, (E)-	31.934	170027	4.42776
20	11-Octadecenoic acid, methyl ester	32.049	7360	0.19167
21	Octadecanoic acid, methyl ester	32.488	70596	1.83843
22	2H-Pyran-2-one, tetrahydro-6-undecyl-	32.578	42734	1.11286
23	(+)-Sesamin	34.972	26040	0.67812
24	3-Cyclopentylpropionic acid, 2-dimethylaminoethyl ester	38.36	42243	1.10007
25	Fumaric acid, 2-dimethylaminoethyl nonyl ester	38.458	68269	1.77783
26	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	39.325	27680	0.72083
27	1,8,11-Heptadecatriene, (Z,Z)-	42.107	55065	1.43398
28	9-Octadecenoic acid, 1,2,3-propanetriyl ester, (E,E,E)-	42.182	87926	2.28973
29	13-Docosamide, (Z)-	43.465	314657	8.19414
30	gamma-Tocopherol	47.609	438276	11.41337

GC-MS analysis of sesame seed meal identified 30 chemical compounds representing the highest yield, 32.77% of glycerin and 11.4% gamma-tocopherol (vitamin E), 10.85% hexadecanoic acid methyl ester and 8.19% 13- docosenamide depending on relative area. Glycerin has antimicrobial and antiviral properties. Gamma-tocopherol is the main component and represented about 90.5% of

total tocopherols, shows a higher antioxidant capacity as compared to alpha-tocopherol. Sesame oil rich in tocopherols and in lignans (notably sesamin and sesamol) provide exceptional oxidative stability compared with other edible oils [25]. Hexadecenoic acid, methyl ester possesses antioxidant and anti-fungal property [26] and the presence of 13-Docosamide impart antioxidant activity

[27]. It was also found that there were some compounds in lower concentration including Phenol, 2-methoxy-3-(2-propenyl)-, 3-Allyl-6-methoxyphenol, 2-Propyl-1-pentanol, pentafluoropropionate that have antimicrobial activity [28].

Compound found in meal Phenol, 3,5-bis(1,1-dimethylethyl)- is a naturally synthesized compound within both plant and bacterial cell that impart antioxidant [29], antibacterial [30] and antifungal activity [31]. Seed meal also contain 11-Octadecanoic acid methyl ester, Fumaric acid, 2-dimethylaminoethyl nonyl ester, Octadecanoic acid, methyl ester, Sesamin as well as many other bioactive compounds with relatively low concentration presented in Table 5. Rahman, et al. [32] reported that 11-octadecenoic acid methyl ester is responsible for antioxidant and antimicrobial activity. Fumaric acid, 2-dimethylaminoethyl nonyl ester has antimicrobial properties and Octadecanoic acid, methyl ester has anti-inflammatory properties. Sesamin, a major lignin isolated from sesame seeds and sesame oil, is known to possess antioxidant and anti-inflammatory properties, play a major role in a variety of cardiovascular diseases and biochemical actions [33].

## Conclusion

Sesame is a valuable seed oil have numerous beneficial properties for applications in food industry. The present investigation indicates that it is a rich source of many essential nutrients that have beneficial and very positive effect on human health. The presence of good percentages of minerals, protein, carbohydrate and various essential bioactive compounds as well as other desirable fatty acids make the sesame seed suitable ingredient in the food and poultry industries.

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