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Biochemical Study of Some Oil Seeds (Brassica, Sesame and Linseed)

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Abstract: Three varieties of oil seeds (brassica, sesame and linseed) have been studied for a comparative data on their chemical composition and nutritive value. Moisture and ash content of different varieties are not very different but their oil contents vary significantly. Among these three sesame seed contains the highest percentage of oil (43.0%). All varieties contain a reasonable amount of protein (25-35%), starch, free sugar, reducing sugar, crude fibre, inorganic materials and vitamin-C. Physical properties, such as specific gravity and refractive index are very similar. Saponification value, acid value, iodine value and peroxide value for these seed oils were also determined. Brassica seed oil and linseed oil are edible because of their low acid values (1.06-1.42) but sesame seed oil is not due to high acid value (9.80).

Key words: Brassica seed, linseed, sesame seed, saponification value, iodine value, refractive index

Introduction

Vegetable oils, meals and seeds are the most important group of agricultural commodities, in terms of value in the world trade. Brassica (*Brassica campestris*, Sarisa), sesame (*Sesamum indicum*, Til) and linseed (*Linum usitatissimum*, Tisi) play an important role in international market. The importance of these crops is further enhanced by their wide adaptation. They are cultivated on the farming areas of Canada, Europe, Africa and Asia to the subtropics. In Bangladesh, they are mainly cultivated in the fertile land of Chor and Bill area (alluvial deposit). The oils and meals from these seeds have different characteristics. These oil seeds contain significant amounts of both saturated and unsaturated fatty acids (Lander and Morrison, 1962). Besides these they also contain an appreciable amount of proteins, carbohydrates, vitamins and minerals. Oils of these seeds are used for edible as well as industrial purposes. The cakes are usually used for baby food, break fast food, dairy cattle and energy rich foods for disaster victims and young stock. Sometimes these oil seeds are used in confectionery and for making margarine in the country. The cakes are also used as fertilizer. They can also be used in the manufacture of soaps, cosmetics, perfumes, insecticides and pharmaceutical products. These oil seeds have some importance in the treatment of colds, cough and bronchial infections, inflammation of the urinary tract, gonorrhea and diarrhea and also used in the relief of local inflammation and ulcers (Gutkin, 1950).

The present study has been undertaken with a view to compare the nutrient contents of the three varieties of oil seeds (brassica, sesame and linseed), with particular emphasis on their moisture, ash, oil, crude fibre, carbohydrate, protein, amino acid, phosphorus, calcium and iron contents.

Materials and Methods

Materials: Mustard (*Brassica campestris*), sesame (*Sesamum indicum*) and linseed (*Linum usitatissimum*) were collected from Bangladesh Agricultural Research Institute, Shampur, Rajshahi. Petroleum ether, hydrochloric acid, sulfuric acid, glucose, anthrone were obtained from BDH Co. Ltd., Poole, England. Sodium hydroxides, dinitro salicylic acid, phenol, diethyl ether and chloroform were purchased from E. Merck Chemical Co., Germany. All of the reagents were of analytical grade and were used without further purification.

Estimation of different contents: After having the knowledge of moisture content of oil seed by conventional methods, the seeds were subjected to following estimations.

* Protein content of different varieties of seed cakes were determined by the microkjeldahl method (Jayaraman, 1985).
* Crude fibre was estimated by the following method. The fat free cake (2-3 g) was mixed with 0.2 N H_2SO_4 and boiled for 30 min. The mixture was filtered and residue was washed with hot water, until free from acid. The residue was boiled with 1.25% NaOH for 30 min and filtered and again washed with hot water until free from alkali, followed by washing with ethanol and ether. Finally it was dried at 100 °C overnight in a crucible, cooled and weighed. The crucible with its content was then heated at 600 °C for three hours, cooled and weighed. The difference in weight represents the amount of crude fiber (A.O.A.C., 1980).
* Free sugar and starch contents of oil seeds were determined colorimetrically following the anthrone method (Morse, 1947) and reducing sugar content was estimated by DNS-method (Miller, 1972), using glucose as a standard.
* Phosphorus and iron contents were estimated spectrophotometrically (Vogel, 1961), while calcium content was determined by titration (Bernard, 1965).
* The amount of vitamin-C was estimated titrimetrically following the Bessey's method (Bessey, 1944).

Identification of free amino acids: Free amino acids present in seed cake were identified by two dimensional paper chromatography method (Jayaraman, 1985), using n-butanol, acetic acid and water in 3:1:1 ratio and phenol with water (4:1) solvent systems.

Extraction and Purification of the oil: The oil was obtained from the oil seeds by the solvent extraction process, using petroleum ether as a solvent (40-60°C) by Soxhlet apparatus (Southcombe, 1926).

For purification, the oil was taken in a separating funnel along with water (100 ml), ether (200 ml) and saturated sodium chloride solution, the content was shaken well and allowed to

stand. The aqueous layer was discarded and the process was repeated two times with organic layer. Finally the ethereal extract was taken in a conical flask and dried over anhydrous sodium sulfate (20 g) and was evaporated at 40 °C to get the purified oil.

Physical properties of the oil: Specific Gravity and refractive index of the oil were determined using the standard methods (Hildich, 1949).

Chemical properties of the oil: The saponification value (Hildich, 1949), the quantity of unsaponifiable matter, iodine value (Williams, 1966) and peroxide value (Jacobs, 1959) were determined by standard methods. The saponification equivalent (Hildich, 1949) of the oil was calculated from its saponification value. Acid value of the oil (Williams, 1966) was determined as the percentage of free fatty acid (as oleic acid) present in the oil.

Results and Discussion

The moisture, ash, oil and cake contents of different varieties of oil seeds are presented in Table 1. The amount of moisture in the fresh oil seeds varies from 5.50 to 8.50%. Brassica and linseed have higher percentage of moisture. The results for brassica and linseed are slightly higher than those reported by Pathak (1973). On the other hand the amount of moisture obtained from sesame seed is very similar to that reported by Krishnamurthy *et al.* (1960). The lowest amount of moisture content in the sesame seed indicates that this seed is much easily preserved than the other two varieties. The ash contents of the sesame, brassica and linseed are 4.50, 3.50 and 3.10% respectively. These results appear to indicate that sesame seed contains higher percentage of minerals matter than those of the other two. The oil content of the three varieties of seed varies between 33-43%. Brassica seed contains 33% oil. This value is very similar to that reported by Richet *et al.* (1947). The linseed and Sesame seed contains 37 and 43% oil respectively. Similar results were reported for Indian sesame seed (43-56.80%) by Krishnamurthy *et al.* (1960). These findings clearly indicate that the oil content of the sesame seed is significantly higher than those of the brassica and linseed.

The defatted cake content of the seeds varies between the range 47-56%. Brassica and sesame seed showed the highest (56%) and the lowest amount of cake (47%) content respectively (Table 2). It was found that 12 amino acids are present in the brassica and sesame seed but 10 amino acids were detected in the linseed. The essential amino acids, methionine, tryptophan, threonine, valine, lysine and leucine were present in all the varieties. Alanine was present only in brassica seed and tyrosine in sesame seed. Isoleucine is absent in brassica seed but present in the other two varieties. The protein, crude fiber, carbohydrate and vitamin-C contents of the three varieties of oil seed cakes are presented in Table 3. The protein content was found to vary between 25-35%.

Table 1: Moisture, ash, oil and cake content in different varieties of oil seeds*.

Name of the oil	Moisture (gm %)	Ash oil (gm %)	Cake (gm%)	Seeds (gm %)
Sesame seed	5.50	4.50	43.00	47.00
Brassica seed	8.50	3.50	33.00	56.00
Linseed	8.50	3.10	37.00	54.00

* Estimation was done thrice for each variety and the mean value was tabulated.

Table 2: The free amino acid content of different varieties of oil seeds.

Amino acid	Varieties		
	Brassica seed	Linseed	Sesame seed
Alanine	+	-	-
Arginine	-	+	+
Aspartic acid	+	-	-
Asparagine	-	-	-
Cystine	+	-	+
Valine	+	+	+
Glutamine	-	-	-
Glutamic acid	+	-	-
Histidine	+	+	+
Hydroxyproline	-	-	-
Isoleucine	-	+	+
Leucine	+	+	+
Lysine	+	+	+
Methionine	+	+	+
Phenylalanine	-	+	+
Proline	-	-	-
Serine	+	-	-
Threonine	+	+	+
Tyrosine	-	-	+
Tryptophan	+	+	+

"+" indicates presence and "-" indicates absence.

The three varieties have protein content in following order: brassica> sesame> linseed. The results indicate that linseed and sesame seed contain similar amounts of protein although their oil contents are very different.

The crude fibre content of the three varieties of oil seed cakes were found to range between 8.40-13.60%. Sesame seed contains the lowest (8.40%) while brassica seed contains the highest amounts of crude fibre (13.60%). These values are in close agreement with the ratio as reported on Indian brassica, sesame and linseed (13.40- 14%, 7.50-8.60% and 9.50%) respectively (Lander and Morrison, 1962).

The amount of free sugars in brassica, sesame and linseed cakes are found to be 11.0, 12.0 and 11.2% respectively. The amount of polysaccharide (starch) present in different varieties of oil seed cakes ranged between 23.40-26.50%.

The study also showed that all these seeds contain trace amounts of reducing sugar.

Brassica, linseed and sesame seed contain 0.43%, 0.67% and 1.00% reducing sugars respectively. These results are very similar to those reported for Indian seeds by Krishnamurthy *et al.* (1960). Vitamin-C was found to be present in trace amount in all of the three seeds. Vitamin-C

Table 3: Composition of the three varieties of oil seed cakes*.

Name of the variety	Crude fibre (gm %)	Protein (mg %)	Carbohydrate			Vit. C (gm %)
			Starch (gm%)	Free sugar (gm%)	Reducing sugar (gm%)	
Brassica seed	13.60	35.00	25.50	11.00	0.43	0.50
Linseed	10.40	25.00	23.40	11.20	0.67	0.21
Sesame Seed	8.40	27.00	26.50	12.00	1.00	0.10

* Estimation was done thrice for each variety and the mean value was tabulated.

Table 4: Phosphorus, iron and calcium contents of the three varieties of oil seed cakes*.

Name of varieties	Phosphorus (mg%)	Iron (mg%)	Calcium (mg%)
Brassica seed	405.00	8.44	947.34
Linseed	295.00	13.55	614.21
Sesame seed	470.00	9.00	3154.34

* Estimation was done thrice for each variety and the mean value was tabulated

Table 5: Physical characteristics of the oils obtained from different varieties of oil seeds*.

Name of the sample	Specific gravity at 251 °C	Refractive Index at 25 °C
Brassica oil	0.909	1.470
Linseed oil	0.931	1.478
Sesame oil	0.921	1.475
** Olive oil	0.915-0.919	1.465-1.466
** Sunflower oil	0.924-0.926	1.465-1.472
** Cottonseed oil	0.921-0.945	1.474
** Soybean oil	0.922-0.928	1.472-1.475

* Estimation was done thrice for each variety and the mean value was tabulated.

** Adapted from Peach and Tracey (1955).

Table 6: Chemical characteristics of the oils obtained from different varieties of the oil seeds*.

Name of the sample	Saponification value	Saponification equivalent	Iodine value	Peroxide value	Acid value	Free fatty acid (%) as oleic	Unsaponifiable matter (%)
Brassica oil	173.00	324.25	96.50	108.67	1.06	0.532	2.10
Linseed oil	191.00	295.23	190.00	395.00	1.42	0.713	1.05
Sesame oil	196.00	286.48	105.00	144.20	9.80	4.926	1.12
** Olive oil	190-145	287-295	-	80-88	0.5-1.2	0.25-0.60	0.50-1.20
** Sunflower oil	190-194	287-295	-	125-140	0.3-0.9	0.15-0.45	0.30-0.90
** Cottonseed oil	190-198	283-293	-	102-114	0.8-1.8	0.40-0.41	0.80-1.80
** Soybean oil	190-195	287-295	-	129-137	0.7-1.6	0.35-0.85	0.70-1.60

* Estimation was done thrice for each variety and the mean value was tabulated.

** Adapted from Peach and Tracey (1955).

content of brassica, linseed and sesame seed were 0.50. 0.21 and 0.10 mg % respectively. The results indicate that these seeds are not good source of vitamin-C.

Table 4 shows that the amount of calcium, phosphorus and iron in the oil seed cakes were in the ranges of 614.21-3154.34 mg%, 295.00-470.00 mg% and 8.44-13.55 mg% respectively. The data suggests that these oil seed cakes may be considered as good source of calcium and phosphorus, so can be used as fertilizer.

Characterization of oils: Physical and chemical tests help to evaluate the suitability of given oils or fats for a specific purpose. The physical and chemical constants of the three varieties of the oils are listed in Table 5 and 6.

The specific gravity of practically all fats and oils lies between 0.90 and 0.95 (Hildich, 1949). The observed specific gravity of brassica, linseed and sesame seed at 25°C are 0.909, 0.931 and 0.921 respectively (Table 5 along with those of some commercial oils).

The refractive index of brassica, linseed and sesame seed oil at 25 °C are 1.470, 1.478 and 1.475 respectively. These results are very similar to those reported for olive oil, sunflower oil and soybean oil respectively (Table 6). These results indicate that all these three varieties of oils contain fairly large amounts of unsaturated fatty acids, so can not be stored for long, due to rancidity hazard.

The observed saponification values of brassica, linseed and sesame seed oil are 173.00, 191.00 and 196.00 respectively. These results indicate that brassica seed oil contains more long chain fatty acids than the other two oils. The saponification equivalents of brassica, linseed and sesame seed oil are 324.25, 295.23 and 286.48 respectively. Fats and oils consisting largely of C_{18} fatty acids generally have a saponification equivalent of 290. Higher value indicates the presence of appreciable quantity of longer chain acids. The results clearly indicate that brassica seed oil contains mainly fatty acids of higher molecular weight i.e., C_{18} and above. The iodine value is a measure of unsaturation. The high iodine value of an oil indicates the abundance of unsaturated fatty acids in oil. The iodine value of brassica, linseed and sesame seed oils are 96.50, 190.00 and 105.00 respectively (Table 6).

The peroxide value of brassica, linseed and sesame seed oil are 108.67, 395.00 and 144.20 respectively (Table 6). From the results it may be concluded that the linseed oil contains higher percentage of unsaturated acids than the other two.

The acid values of brassica, linseed and sesame seed oils are 1.06, 1.42 and 9.80 (Table 6) respectively. The percentage of free fatty acid (as oleic) was calculated from acid value and were found to be 0.53%, 0.71% and 4.92 % (Table 6) respectively. As high percentage of free fatty acid is a determinant or indication of unsuitability of an oil for edible purpose (Carroll and Noble, 1957), it seems that brassica and linseed oil may be suitable for edible purpose but sesame seed oil is not.

The amounts of unsaponifiable matter of brassica, linseed and sesame seed oil are 2.10 %, 1.05 % and 1.12 % (Table 6) respectively. These results suggest that each of the oil under investigation contain sterols, tocopherols, hydrocarbons etc. Among these brassica seed oil contains the highest amount of

unsaponifiable matter and is not suitable for people suffering from cholesterol problems. It may be concluded that except sesame seed oil the other two varieties of seeds oil are suitable for edible purposes as it contain relatively higher amounts of unsaturated fatty acid, very close to those reported for the edible oils. As these seed oils contain higher percentage of longer chain higher fatty acids, it could be used in the manufacture of soap as well.

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