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The Changes in the Lipid Composition of Mung Bean Seeds as Affected by Processing Methods

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The Changes in the Lipid Composition of Mung Bean Seeds as Affected by Processing Methods

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Abstract

This study was conducted to assess in detail the possible effects of some technological processes such as soaking, germination, cooking, soaking + cooking, and germination + cooking on the lipid composition of mung bean seeds of Giza 1 variety. TLC analysis of mung bean lipids showed that the phospholipids and triglycerides recorded the highest percentage among lipid fractions (32.26 and 30.10%), while the 1,3 diglycerides constituted the least percentage (2.80%) in mung bean seeds. The soaking, germination and cooking processes caused a decrease in the phospholipids, triglycerides and hydrocarbons accompanied with an increase in monoglycerides, 1,2-(2,3)-diglycerides, sterols and free fatty acids. Eleven fractions were separated from phospholipids class of the studied samples; seven of these fractions were identified. The major component of phospholipids was phosphatidyl choline, amounting to 21.30, 17.84, 16.21, 13.87, 13.20 and 11.47% of the total phospholipids in raw, soaked, germinated, raw-cooked, soaked-cooked and germinated-cooked mung bean seeds, respectively. Gas liquid chromatography of the total lipids of mung bean seeds showed that the unsaturated fatty acids represented 69.58, 64.35, 63.3, 63.16, 61.84 and 61.12%, while the levels of saturated fatty acids were low being 30.37, 34.05, 35.66, 34.64, 37.93 and 38.75% of the total fatty acids in raw, soaked, germinated, raw-cooked, soaked-cooked and germinated-cooked, respectively. The total essential fatty acids (linoleic and linolenic) represented the highest proportion of fatty acids (50.10% of the total fatty acids).

KEYWORDS: lipid fractions, mung bean, mung bean lipids

Erratum

Tables 1, 2, and 3 were reformatted slightly to improve readability. The changes did not affect any text or data herein.

1 INTRODUCTION

Very little information was available in the literature concerning lipids and phospholipid components of legumes. However, Katiyar and Bhatia (1988) reported that the commonly consumed legumes viz. phaseolus vulgaris, vicia faba and vigna auriculata of Kashmir valley have been analysed for their phospholipid composition. The beans contained 1.9 - 2.5 % lipids of which phospholipids constituted 35 - 55 %. Phosphatidyl ethanol amine, the major component, varied from 30 - 53 % of the total phospholipids, while phosphatidyl choline made up 30 - 40 %. Phosphatidyl serine ranged between 5.3 and 22.8 % and phosphatidyl inositol from 7.0 to 19.7 %.The major fatty acids (%) were : 16 : 0, 16-23; 18 : 1, 11 - 18; 18:2, 24 -30 and 18 : 3,18-35.The lower fatty acids (%) were:10 : 0, 0 - 1.4; 12 : 0, 0 - 1.4; 16 : 1, 1.2 - 5.2; 18 : 0, 2.2 - 9.0.

Duperon et al. (1968) found that during germination of beans in darkness, without any supply of exogenous nutrients, the cotyledons rapidly lost a considerable amount of dry matter. This may be due to disappearance of starch, protein and lipids including phospholipids. The growing axial parts were enriched in protein, lipids, phospholipids and sterols. A comparison between the entire seeds before and after germination demonstrated an early important synthesis of additional sterols and a less synthesis of additional phospholipids.

El-Rify et al. (1986 b) stated that lysolecithins, sphingomyleins, serinphospholipids and glycerophospholipids markedly increased, while lecithins and ethanolamin phospholipids considerably decreased after germination of fenugreek seeds. The total unsaturated fatty acids decreased whilst the total saturated fatty acids increased after the germination of seeds. The objective of this study was to examine the comparative influences of soaking, germination and cooking on the lipid composition of mung bean seeds.

2 MATERIALS AND METHODS

2.1 Source of samples:

Mung bean (Vigna radiata (L.) wilczek) seeds of the Giza-1 variety were obtained from Agronomy Department, College of Agriculture, Assiut University, Egypt.

2.2 Preparation of samples:

2.2.1 Soaking:

Seeds freed from broken seeds, dust and other foreign materials were soaked in water for 12 h at 25 °C. A seed to water ratio of 1 : 5 (W / V) was used. The soaked seeds were washed twice with ordinary water followed by rinsing with distilled water and then dried at 55 °C for 30 h.

2.2.2 Germination:

The presoaked (12 h) seeds were spread on wet filter paper in stainless steel baskets. The temperature ranged from 20 to 23 °C during the 72 h of sprouting. The seeds were rinsed with 0.3 % sodium hypochlorite solution each 12 h to inhibit microbial growth. The germinated seeds were then dried at 55 °C for 30 h.

2.2.3 Cooking:

Both soaked (12 h) and germinated seeds (72 h) were rinsed in distilled water and put in a stainless steel pan. After adding distilled water (three times the weight of dry seeds), the samples were boiled until soft, as felt between fingers. The cooking water was decanted and the cooked seeds were dried at 70 °C for 36 h. Raw seeds were also cooked in the same manner, using a seed to water ratio of 1 : 7 (W/V).
Different seed samples were ground in a laboratory Wailly mill to pass through a 40 mesh screen. Then, the ground samples were stored in polyethylene bags at 5 °C until required for analysis.

2.3 Analytical methods:

2.3.1 Lipids extraction:

Lipids were extracted from the samples of mung bean flour by chloroform: methanol mixture (2 : 1 V/V) according to the method described by Folch et al. (1957).

2.3.2 Thin layer chromatographic for total lipids and phospholipids:

The total lipids of mung bean samples were fractionated by the method of Malins and Mangold (1960) using silica gel, G 60 Merck type 5721 and 20x20 cm glass plates with 0.25 mm thickness. The developing solvent system was n-hexan : diethyl ether : acetic acid glacial (80: 20: 2, V/V/V).
The phospholipid class was separated on silica gel G 60-coated plates. The developing solvent system was chloroform: methanol: water (65: 25: 4, V/V/V) as outlined by Kates (1972). The separated fractions of total lipids

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and phospholipids were visualized by exposure to iodine vapor in a closed chamber after drying.

All lipid fractions were identified on thin layer plates by comparing their Rf values with those of known lipid standards.

For quantitative analysis, the different lipid fractions were scanned by using Shimadzu TLC-Scanner (C-S-910). The area under each peak was measured by the triangulation method (Kates, 1972).

The percentage of each component was calculated with regard to the total area as follows:

$$\%\, Component = \frac{Area\ of\ each\ peak}{Total\ peaks\ area} \times 100$$

2.3.3 Determination of fatty acid

The methyl esters of extracted mung bean flour lipids were prepared according to Rossell, *et al*. (1963). Gas Liquid Chromatography analysis was carried out in the Central Lab., Faculty of Agriculture, Alexandria University using a Perkin- Elmer Gas Liquid Chromatography Apparatus (model F22) . The peaks were identified by comparison with pure methyl ester standards by means of their relative retention times under identical conditions.

3 RESULTS AND DISCUSSION

3.1 Total lipid fractions:

Chromatograms of the various of lipid fractions isolated from raw, soaked, germinated and cooked mung bean seeds are shown in Figure1. These fractions were identified as follows: phospholipids; monoglycerides; 1,2-(2,3)-diglycerides, sterols; 1,3 diglycerides; free fatty acids; triglycerides and hydrocarbons. Results of the effect of treatments used in this study on lipid classes are given in Table 1.

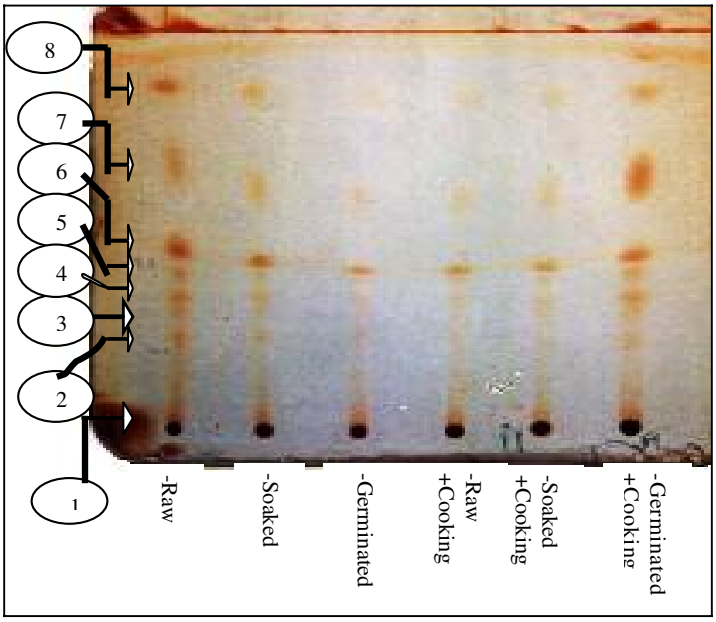

Fig. (1) Thin layer chromatograms of total lipid fractions in raw and processed mung bean seeds

Phospholipids showed the highest percentage among lipid fractions followed by triglycerides (32.26 and 30.10%, respectively). Similar findings were reported by Katiyar and Bhatia (1988) who found that phospholipid content of 6 legumes varieties ranged from 35 to 55%. While the 1, 3 diglycerides constituted the least percentage (2.80%) in raw mung bean seeds. Furthermore, monoglycerides, 1,2-(2,3)-diglycerides, sterols, free fatty acids and hydrocarbons were 7.55, 6.55, 5.67, 8.37 and 6.73%, respectively.

The soaking, germination and cooking processes caused a decrease in the phospholipids, triglycerides and hydrocarbons accompanied with an increase in monoglycerides, 1,2-(2,3)-diglycerides, sterols and free fatty acids (Table 1). These results are in agreement with those reported by El-Rify et al. (1986 a, b) and Youssef et al. (1986). These changes in lipid fractions might be attributed to the decomposition of triglycerides and phospholipids components into simpler compounds during soaking, germination and cooking of mung bean seeds (Hitchcock and Nicholas, 1971; Lee, 1975; El-Sebaiy et al., 1984; and Yossef et al., 1985).

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Table (1) the total lipid fractions of raw and processed mung bean seeds (% of total lipids)

Fraction No.	Lipid fractions (%)	Treatments*					
		1	2	3	4	5	6
1-	Phospholipids	32.26	30.65	27.23	27.38	23.41	22.18
2-	Monoglycerides	07.55	09.30	11.03	09.83	10.37	12.21
3-	1,2&2,3-diglycerides	06.55	08.58	10.76	07.81	10.66	11.49
4-	Sterols	05.67	07.50	09.11	08.31	09.37	09.50
5-	1,3-diglycerides	02.80	03.24	05.62	03.20	05.24	06.18
6-	Free fatty acids	08.37	11.11	14.38	10.23	14.06	17.30
7-	Triglycerides	30.10	25.23	18.12	27.96	23.74	17.50
8-	Hydrocarbons +Sterol esters	06.73	04.43	03.81	05.25	03.13	03.58
Total lipids % (dry weight basis)		02.86	02.30	02.69	03.56	03.12	03.25

1 = Raw 2 =Soaked 3 = Germinated 4 = Raw-cooked 5 = Soaked-cooked 6 = Germinated-cooked

Besides, the increment in sterols during cooking of mung beans might be due to the protein denaturation which affects the liberation of sterols from the protein-lipid complex during heat treatment (Sivetz, 1963; Tutunikov, 1974).

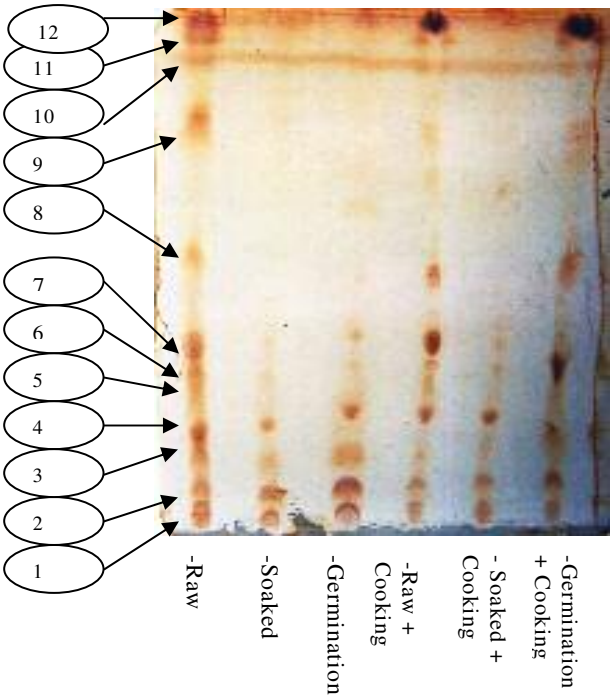
1.1 Phospholipid fractions:

The phospholipids class was fractionated on TLC plate and the results are illustrated in Fig. (2). Eleven fractions were separated from phospholipids class of the studied samples. Only seven fractions were identified. These fractions included the following components starting from the base line, phosphatidyl serine, lysophosphatidyl choline, phosphatidyl inositol, phosphatidyl cholin, phosphatidyl ethanolamine, phosphatidic acid and phosphatidyl glycerol.

The percentages of the above mentioned fractions are tabulated in Table The data showed that the major component of phospholipids was phosphatidyl choline, which amounted to 21.30, 17.84, 16.21, 13.87, 13.20 and 11.47% of the total phospholipids in raw, soaked, germinated, raw-cooked, soaked-cooked and germinated-cooked mung bean seeds, respectively. It was followed by phosphatidyl ethanolamine. Similar findings were reported by Katiyar and Bhatia (1988).

Soaking and germination processes reduced phosphatidyl serine, phosphatidyl choline, phosphatidyl ethanolamine, and phosphatidic acid, while the percentage of lysophosphatidyl cholin, phosphatidyl inositol, and phosphatidyl glycerol were increased. These compositional changes in the phospholipid fractions might be attributed to the breakdown of phospholipids due to the phospholipase activity (El-Rify et al., 1986b).

Moreover, the data given in Table 2 revealed that the percentages of phosphatidic acid and phosphatidyl glycerol increased after cooking process, while other phospholipid fractions were decreased. This decrease might be due to decomposition of phospholipids during cooking (Hitchcock and Nicholas, 1971; and Lee, 1975).



1-Phosphatidyl serine
2-Unidentified (1)
3-Lysophosphatidyl choline
4-Unidentified (2)
5-Unidentified (3)
6-Phosphatidyl inositol
7-Phosphatidyl choline
8-Phosphatidyl ethanolamine
9-Unidentified (4)
10-Phosphatidic acid
11-Phosphatidyl glycerol
12-Neutral lipids

Fig. (2) Thin layer chromatograms of phospholipid fractions in raw and processed mung bean seeds.

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3.3 Fatty acid composition:

Results of gas chromatographic analysis of the methyl esters of saturated and unsaturated fatty acids of raw, soaked, germinated and cooked mung bean seeds are presented in Table 3. The data showed that the unsaturated fatty acids represented 69.58, 64.35, 63.30, 63.16, 61.84 and 61.12%, while the levels of saturated fatty acids were low amounting to 30.37, 34.05, 35.66, 34.64, 37.93 and 38.75% of total fatty acids in raw, soaked, germinated, raw-cooked, soaked-cooked and germinated-cooked mung bean seeds, respectively. Furthermore, the essential fatty acid linoleic (C18:2) represented the highest proportion of the fatty acids (33.12%) of the total. Meanwhile, lauric (C12:0) represented least percentage among the fatty acids of the raw mung bean seeds.

Likewise, the results in Table 3 indicated that there was a markable decrease in the total unsaturated fatty acids content after soaking, germination and cooking processes of mung bean seeds accompanied by an apparent increase in the total saturated fatty acids. These changes in fatty acid contents could probably be due to the oxidation of fatty acids during soaking, germination and cooking processes (Lee, 1975; Youssef et al., 1985; El-Rify et al., 1986a; and Youssef et al., 1986).

Table (2) Phospholipid fractions of raw and processed mung bean seeds (% of total phospholipids).

Fraction No.	Phospholipid fractions (%)	4 Treatments*					
		1	2	3	4	5	6
1-	Phosphatidyl serine	07.66	06.79	05.21	06.75	04.97	03.37
2-	Unidentified (1)	08.78	08.69	11.11	09.43	15.27	12.58
3-	Lysophosphatidyl-coline	08.44	15.34	11.31	07.93	05.16	07.42
4-	Unidentified (2)	09.32	09.72	12.79	16.51	16.30	17.66
5-	Unidentified (3)	05.34	06.90	06.96	02.58	04.77	03.61
6-	Phosphatidyl inositol	07.93	09.65	09.61	06.81	07.20	06.02
7-	Phosphatidyl choline	21.30	17.84	16.21	13.87	13.20	11.47
8-	Phosphatidyl-ethanolamine	13.94	10.04	08.81	10.34	08.80	06.53
9-	Unidentified (4)	07.98	07.33	07.49	07.99	05.37	06.90
10-	Phosphatidic acid	04.68	03.74	03.61	09.26	05.89	12.95
11-	Phosphatidyl glycerol	04.44	04.54	07.27	08.38	05.98	08.42

* 1=Raw 2=Soaked 3=Germinated 4=Raw-cooked 5=Soaked-cooked 6=Germinated-cooked

The process of germination caused an increase in the levels of capric, myristic, palmitic, stearic and linolenic acids, while lauric, heptadecanoic, behenic, palmitoleic, oleic and linoleic acids were decreased. Such changes in the fatty acid levels might be due to the lipolytic activity of the mung bean lipase, which agrees with Zimmerman and Klosterman (1965) findings for germinated flax seed. The increase in the above mentioned fatty acids was also observed in the boiled mung bean seed samples.

Also, it can be seen from Table 3 that both raw and processed mung bean seeds had high percentages of the total essential fatty acids (about 50% of the total fatty acids), and according to Katiyar and Bhatia (1988) the high proportions of the two essential fatty acids, linoleic (C18:2) and linolenic (C18:3), which cannot be biosynthesised and must come from the diet, show the importance of dietary pulses as source not only of protein, but also of dietary fat.

Table (3) Fatty acid composition of raw and processed mung bean seeds (% of total fatty acids).

Fatty acid	Carbon chain	Treatments*					
		1	2	3	4	5	6
Saturated :							
Capric	10:0	02.35	02.47	05.24	03.20	04.50	06.48
Lauric	12:0	00.94	01.08	tr.**	tr.**	tr.**	01.74
Myristic	14:0	01.04	01.21	02.97	02.62	01.30	01.83
Palmitic	16:0	16.15	17.82	17.46	19.58	20.58	18.58
Heptadecanoic	17:0	01.78	01.68	01.57	tr.**	00.77	00.86
Stearic	18:0	06.33	08.28	07.73	07.44	08.68	07.86
Behenic	22:0	01.78	01.51	00.69	001.80	02.10	01.40
Unsaturated:							
Palmitoleic	16:1	03.70	tr.**	tr.**	tr.**	tr.**	tr.**
Oleic	18:1	15.78	13.15	14.40	14.66	11.79	13.10
Linoleic	18:2	33.12	31.71	30.56	30.27	30.40	28.81
Linolenic	18:3	16.98	19.49	18.34	19.73	19.65	19.21
Saturated		30.37	34.05	35.66	34.64	37.93	38.70
Unsaturated		69.58	64.35	63.30	64.66	61.84	61.12
Essential		50.10	51.20	48.90	50.00	50.05	48.02

*1=Raw 2=Soaked 3=Germinated 4=Raw-cooked 5=Soaked-cooked 6=Germinated-cooked ** Traces

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