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Chemical and Technological Studies on Faba Seeds: Effect of the Stewing Process on Physical, Organoleptic and Chemical Properties

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ABSTRACT

The effects of the stewing process on some physical properties, organoleptic qualities, chemical composition of unstored and stored faba beans were studied. Hydration and swelling coefficients, as well as organoleptic qualities, were affected significantly by stewing the faba bean seeds. The protein content was decreased noticeably more in stewed faba beans made from seeds stored in tin cans than those stored in Makamer (pits). Total sugars, reducing and non-reducing sugars, starch and pectin contents present in unstored and stored faba beans were decreased after stewing the seeds. Stewing of stored beans either in Makamer or tin cans after heating led to marked reductions in ash, phosphorus, iron, calcium, magnesium and phytic acid contents.

INTRODUCTION

Higher meat prices, during recent years, and the need for protein-rich foods have led people to shift their consumption to certain grain legumes. In Egypt, legumes constitute a staple food and are consumed in large amounts, which are relatively rich in proteins when compared with most other foods of plant origin. Faba beans occupy a prominent position in the national diet. The most popular way of preparing faba beans in Egypt is the stewed form (Fool Medames). The stewed faba beans are served at breakfast as well as in

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sandwiches at any time of the day. Due to the popular consumption of stewed faba beans, medames may be considered the main national dish in Egypt. Although the stewing process of faba beans represents an important technological problem in Egypt, there are few studies on factors that may affect the variation in cookability of the different seeds. This investigation was carried out to study effects of the stewing process on some physical properties, organoleptic qualities and chemical composition of faba beans. The effects of storage time and method on these qualities of stewed faba beans were also studied.

MATERIALS AND METHODS

Faba bean seeds

Sun dried faba bean seeds (*Vicia faba*) of Giza 2 variety, cultivated in El-Menia Governorate, Egypt, were used in this study.

Storage of samples

Faba bean seeds were stored using two methods of storage for nine months. The stored samples were withdrawn every three months to use in this study. The storage methods were carried out as described in previous work (El-Refai *et al.*, 1988) as follows:

(1) The most common method of storage in Egypt is by placing the dry seeds in pits dug under the ground in dry pots at Berheem, Monofia Governorate, Egypt. The pits are usually completely filled with seeds to minimize the amount of air. The pits are called Makamer. Seeds were stored in several Makamer (pits) in order to obtain each sample from different Makamer.

(2) Another lot of dry seeds was heated in an oven at 70°C for 2 h, the heated seeds were cooled to reach room temperature and placed in tin cans. The cans were stored at room temperature for nine months.

Stewing process (Tadmees)

The dried seeds were washed using running tap water and added to boiled water in pots. The boiled water was twice the volume of the seeds. The pots were placed over a flame high enough to just keep its contents gently boiling for 10 to 12 h until the seeds became soft, according to the method described by Gabrial (1982). Water volume was constant during the stewing process.

Hydration and swelling coefficients

Hydration and swelling coefficients were calculated according to Youssef (1978) and described in detail in previous work (El-Refai *et al.*, 1988).

Organoleptic qualities

Texture, colour and taste of stewed beans were evaluated by ten panelists as described by Youssef (1978).

Chemical analysis

After stewing, the excess water (stewing liquor) was removed, kept in glass jars and stored in a deep freezer at −20°C until used. The stewed faba beans were left in plates, dried at 70°C under vacuum and ground to pass through a 40-mesh sieve for chemical analysis (Salem, 1975). All determinations were done in duplicate. Moisture, protein, reducing sugars, total soluble sugars, non-reducing sugars, starch and ash were determined according to the methods of AOAC (1980). Total solids contents were determined in stewing liquors using a vacuum oven at 70°C as described by Youssef (1978). Soluble solids were determined by Abbé refractometer at 25°C. Insoluble solids were estimated by subtracting the percentage of soluble solids from the percentage of total solids. Pectin was determined by the method of Carre and Haynes described by Pearson (1976). Phytic acid was determined according to the method of Wheeler & Ferrel (1971) and modified by Chang (1977).

Minerals were determined in the digested acid solution of stewed faba bean samples using atomic absorption (Pye Unicam SP 1900) (Pearson, 1976). Total phosphorus was estimated colorimetrically according to the method described by Snell & Snell (1949).

RESULTS AND DISCUSSION

Some physical properties of stewed seeds

Table 1 shows that the hydration coefficient of stewed faba bean seeds was more than those of uncooked seeds. Storage of seeds either in Makamer or in tin cans for nine months led to gradual reductions in the hydration coefficient of the stewed beans. The decreases of hydration coefficient detected in the stewed stored beans in Makamer were slightly lower than those of stewed stored beans in tin cans. From these results it could be seen

TABLE 1
Hydration and Swelling Coefficient of Stewed Faba Bean Seeds 'Fool Medames'

Properties	*Unstored*	*Stored in Makamer*			*Stored in tin cans after heating*		
		3months	*6months*	*9months*	*3months*	*6months*	*9months*
Hydration coefficient							
Raw seeds	262·37	236·10	210·59	208·55	235·47	208·84	208·60
Stewed seeds	304·16	287·67	271·18	262·70	285·41	266·66	235·96
Swelling coefficient							
Raw seeds	286·76	254·92	233·06	216·00	254·92	232·08	215·00
Stewed seeds	340·00	320·00	290·00	250·00	320·00	290·00	250·00

that the hydration coefficient of uncooked beans was positively related with the hydration coefficient of stewed faba beans.

The swelling coefficient of stewed faba bean seeds was more than those of uncooked seeds (Table 1). Storage of seeds either in Makamer or in tin cans for nine months led to gradual reduction in the swelling coefficient of the stewed beans. The conditions of storage had no effect on the swelling coefficient of stewed faba bean seeds. Both consumers and processors prefer beans that have high hydration and swelling coefficients as these produce greater quality (Shehata, 1982).

The organoleptic qualities of stewed unstored and stored samples of faba bean seeds were evaluated by taste panellists. The results in Table 2 showed that storage of faba bean seeds for nine months noticeably affected the organoleptic qualities of stewed seeds prepared from the stored seeds either in Makamer or in tin cans. The scores given for the texture, colour and taste of these processed seeds were decreased gradually with increasing storage

TABLE 2
Organoleptic Qualities of Stewed Unstored and Stored Faba Beans Seeds

Organoleptic qualities	*Unstored*	*Stored in Makamer*			*Stored in tin cans after heating*		
		3months	*6months*	*9months*	*3months*	*6months*	*9months*
Texture	9·10	8·40	7·30	6·40	8·10	6·90	6·10
Colour	9·40	9·20	9·20	7·40	9·20	8·40	7·40
Taste	9·30	8·90	8·70	6·90	8·70	7·60	6·70
Total	27·80	26·50	25·00	20·70	26·00	22·90	20·20

Average scores given by panellists for texture, colour and taste (Each out of 10).

time either in Makamer or in tin cans. These results are in agreement with those given by Youssef (1978) who found that the scores given by panellists decreased markedly for all stored samples for 6 months. On the other hand, Table 2 shows that the scores given for the texture, colour and taste of the stewed beans produced from seeds stored in Makamer were higher than those of stewed beans produced from seeds stored in tin cans for 6 months (after heating). However, results revealed no noticeable differences between the cooking qualities (texture, colour and taste) of stewed faba beans produced from stored seeds in Makamer and in tin cans for nine months. From these results it could be seen that the texture of stewed faba bean seeds was related to the bulk density of the raw beans and to the hydration and swelling coefficients of stewed faba bean seeds. These findings were in accordance with those reported by Youssef (1978) and Shehata *et al.* (1982).

Chemical composition of stewed faba bean seeds

Moisture and total solids

Table 3 demonstrates that neither storage method nor time had noticeable effects on the moisture content of stewed faba beans. It also shows that the stewing process increased the moisture contents of unstored and stored samples. These results are in agreement with those outlined by Darwish *et al.* (1976), who reported that moisture content of faba beans increased from

TABLE 3
Moisture and Total Solids of Stewed Faba Bean Seeds and Stewing Liquor

Chemical properties	*Unstored*	*Stored in Makamer*			*Stored in tin cans after heating*		
		3months	*6months*	*9months*	*3months*	*6months*	*9months*
Moisture (%)							
Raw seeds	10·31	10·22	10·88	9·66	8·32	8·33	8·12
Stewed seeds	72·50	72·30	72·00	72·12	71·90	72·00	72·90
Total solids (%)							
Raw seeds	89·69	89·78	89·12	90·34	91·68	91·67	91·88
Stewed seeds	27·50	27·70	28·00	27·88	28·10	28·00	27·10
Total solids of stewing liquor (%)	12·85	12·53	12·49	12·20	12·28	12·25	12·00
Soluble solids of stewing liquor (%)	6·00	6·00	7·00	7·00	6·00	7·00	7·00
Insoluble solids of stewing liquor (%)	6·85	6·53	5·47	5·20	6·28	5·25	5·00

9·26% to 72·25% after stewing. The liquor of stewed seeds prepared from stored seeds in Makamer or in tin cans after heating contained slightly less total solids than those of stewed unstored seeds (Table 3). The conditions of storage had no effect on the total solids content of the liquor. Storage of the seeds for nine months led to gradual and slight decreases in the total solids detected in the liquor of stewed seeds. The liquor of stewed unstored faba bean seeds contained 6·0% total soluble solids and 6·85% total insoluble solids. The total soluble solids contents of the liquors which accompanied the stewed stored samples were slightly more than those of liquor of unstored seeds. Storage of seeds led to a slight reduction of the total insoluble solids of their liquor after stewing. The effect of storage on both total soluble solids and total insoluble solids was more noticable upon prolonging the time of storage. The liquor of stewed seeds (made from seeds either stored in Makamer or in tin cans) had the same quantities of total soluble solids and total insoluble solids. The increments in the total soluble solids of the liquor are due to conversion of insoluble matter to soluble matter and/or increments in the solubility of some constituents occurring during storage of the seeds.

Crude protein

Table 4 shows the crude protein contents of stewed unstored and stored faba bean seeds. It also indicates that stewed seeds made from seeds stored either in Makamer or in tin cans contained less crude protein than stewed unstored beans. Storage for nine months led to gradual reduction in the protein content of the stewed beans. The decreases were more noticeable in stewed faba beans made from seeds stored in tin cans than those stored in Makamer. The results indicate also that the stewing process decreased the crude protein content of all unstored and stored samples. This decrease may be due to the reaction between amino acids (resulting from protein hydrolysis) and sugars forming coloured compounds (Salem, 1975). Youssef *et al.* (1987) also found (by soaking faba beans for 12 h and/or germination for 3 days) a further significant reduction in the protein content of the cotyledons.

Carbohydrates

As shown in Table 4, the total sugars, reducing and non-reducing sugars of stewed faba beans made from stored seeds were less than those present in stewed faba beans prepared from unstored seeds. Storage of seeds in tin cans led to production of stewed seeds with slightly higher sugar contents than stewed seeds made from seeds stored in Makamer. Increasing the time of

TABLE 4
Protein and Carbohydrates Contents of Stewed Faba Bean Seeds (Expressed as % of Dry Weight)

Chemical properties	*Unstored*	*Stored in Makamer*			*Stored in tin cans after heating*		
		3months	*6months*	*9months*	*3months*	*6months*	*9months*
Crude protein (N × 6·25)							
Raw seeds	29·2	27·3	25·5	23·4	26·8	24·5	22·2
Stewed seeds	25·6	23·7	23·2	21·4	23·1	22·2	22·2
Total sugars							
Raw seeds	4·53	4·72	5·31	5·54	4·85	5·42	5·65
Stewed seeds	1·81	1·45	1·41	1·33	1·33	1·51	1·42
Reducing sugars							
Raw seeds	0·52	1·09	1·69	2·41	0·90	1·50	2·01
Stewed seeds	0·35	0·27	0·25	0·20	0·31	0·25	0·26
Non-reducing sugars							
Raw seeds	4·01	3·63	3·62	3·13	3·95	3·92	3·63
Stewed seeds	1·46	1·18	1·16	1·13	1·22	1·23	1·16
Starch							
Raw seeds	64·0	61·0	58·1	46·1	57·3	52·3	40·5
Stewed seeds	47·0	34·2	31·5	28·2	32·7	29·8	23·5
Pectin							
Raw seeds	2·03	1·94	1·92	1·61	2·03	1·79	1·62
Stewed seeds	1·60	1·50	1·44	1·37	1·45	1·36	1·33

Starch content of raw seeds was determined in cotyledons.

storage of seeds in Makamer or in tin cans led to gradual and slight increases in the sugar contents of stewed seeds made from these stored seeds. Data also indicate that total sugars, reducing sugars and non-reducing sugars present in unstored and stored faba bean seeds were decreased after stewing the seeds. These decreases may be due to the conversion of non-reducing sugars to reducing sugars and after this, parts of the reducing sugars and free amino acids were involved in reactions responsible for the brown colour formed after stewing, with subsequent decrease of those components (Salem, 1975). The starch content of stewed faba beans made from stored seeds was less than that present in stewed faba beans prepared from unstored seeds. Storage for nine months led to gradual decreases in the percentage of starch present in stewed seeds made from the stored seeds. Results also show that the starch content of stewed faba beans made from seeds stored in Makamer

was slightly higher than the starch content of stewed faba beans prepared from stored beans in tin cans.

Results indicated that storage of faba bean seeds for nine months led to gradual and slight reduction in the pectin content of stewed seeds made from these stored seeds (Table 4). There was no noticeable difference between pectin contents of stewed faba beans made from stored seeds in Makamer and in tin cans.

Ash and minerals

Table 5 shows the ash and some minerals (phosphorus, iron, calcium and magnesium) contents of both unstored and stored faba bean seeds. The effects of storage of seeds on the ash content (after stewing) increased as time of storage increased. Stewed unstored and stored faba beans either in Makamer or in cans had almost the same amounts of phosphorus, iron,

TABLE 5
Ash, Minerals and Phytic Acid Contents of Stewed Faba Bean Seeds (Based on Dry Weight)

Chemical properties	*Unstored*	*Stored in Makamer*			*Stored in tin cans after heating*		
		3months	*6months*	*9months*	*3months*	*6months*	*9months*
Ash (%)							
Raw seeds	3·59	2·80	2·59	2·00	2·90	2·79	2·09
Stewed seeds	1·20	1·10	0·90	0·80	1·10	0·92	0·81
Phosphorus(mg/100g)							
Raw seeds	691	691	691	691	687	691	689
Stewed seeds	482	481	482	482	481	482	481
Iron (mg/100 g)							
Raw seeds	15·1	15·0	15·0	15·0	14·8	14·8	15·0
Stewed seeds	10·0	9·98	10·0	9·85	10·0	9·50	9·93
Calcium (mg/100 g)							
Raw seeds	72·0	72·0	71·4	71·8	72·0	71·7	71·8
Stewed seeds	54·0	54·5	53·9	54·0	53·3	54·2	53·9
Magnesium (mg/100 g)							
Raw seeds	8·00	8·01	7·95	7·90	8·00	7·91	8·00
Stewed seeds	5·87	5·80	5·19	5·75	5·82	5·75	5·75
Phytic acid (%)							
Raw seeds	1·69	1·46	1·36	1·27	1·51	1·50	1·46
Stewed seeds	0·90	0·78	0·72	0·65	0·80	0·76	0·70

Phytic acid content was determined in cotyledons.

calcium and magnesium. Ash, phosphorus, iron, calcium and magnesium contents of both unstored and stored faba bean seeds were decreased after stewing. The decrease may be due to leaching out of minerals into the stewing liquor. These results are in agreement with those outlined by Darwish *et al.* (1976) who reported that ash, calcium, phosphorus and iron contents of raw beans decreased after stewing from 3·77%, 75·15 (mg/100 g), 346 (mg/100 g) and 6·9 (mg/100 g), respectively to 1·21%, 21·94 (mg/100 g), 113·78 (mg/100 g) and 2·18 (mg/100 g), respectively.

Phytic acid

Results showed that stewing of stored beans either in Makamer or in tin cans after heating led to marked reductions in their phytic acid contents. The stewed beans produced from seeds stored in Makamer contained almost the same amount of phytic acid as that made from heated seeds stored in tin cans. The effects of storage of seeds on the phytic acid remaining after stewing increased as time of storage increased. These results are in agreement with those observed by previous workers (de Boland *et al.*, 1975; Reddy *et al.*, 1978) who reported that a reduction in phytate content results from heating. Gad *et al.* (1982) found that the loss in phytic acid in three varieties (Giza 1, Giza 2 and Rebaya 40) ranged between 51% and 54% as a result of stewing. Other researchers (Manan *et al.*, 1987) have reported that cooking of both peas and lentil seeds resulted in a reduction of phytic acid (82% and 76%, respectively). It has been reported that soaking of dry beans decreased the phytate content (Tabekhia & Luh, 1980; Beal & Mehta, 1985; Youssef *et al.*, 1987).

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