*Food Chemistry* **29** (1988) 27–39

# Chemical and Technological Studies on Faba Bean Seeds. I—Effect of Storage on Some Physical and Chemical Properties

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(Received 17 June 1987; revised version received 28 September 1987; accepted 28 September 1987)

*ABSTRACT*

*The effects of different methods of storage on some physical and chemical properties of sun-dried Faba beans were studied. Studied methods of storage were: storage in Makamer (the method most commonly used in Egypt), in tin cans after heating the seeds at 70°C for 2 h, and in tin cans without heating the seeds. The Faba bean seeds (variety Giza 2) were stored for 3, 6 and 9 months in all studied methods. The physical properties studied were seed weight, volume of seeds, bulk density, hydration and swelling coefficients and the percentage of hulls to dehulled seeds. Chemical properties studied were moisture, protein content, total sugar, reducing and non-reducing sugars, starch, phytic acid, ash and minerals such as phosphorus, calcium, iron and magnesium. Storage of Faba bean seeds in Makamer was superior to other methods. Also Faba bean seed can be heated at 70°C and stored in tin cans when required in house.*

## INTRODUCTION

Legume seeds have been used as human food for more than eighty centuries and are still one of the most important foods for the world population (Rockland & Jenes, 1974). Faba beans (*Vicia faba*) and also field beans, horse beans and broad beans, botanically are dicotyledons and belong to the leguminosae family (Cerning *et al.*, 1975). The increasing need for protein in



*Food Chemistry* 0308-8146/88/$03·50 

the world has stimulated scientists and agronomists to search for new sources and Faba beans have attracted attention as a possible home grown protein source. Faba beans are consumed by man and domestic animals, especially in countries with a shortage of higher quality protein (Nitsan, 1971). Faba beans occupy a prominent situation in our national diets; about 14 g of Faba beans are consumed daily per caput, which accounts for about 3 g of protein. Faba bean seeds are stored in many ways and under various conditions after harvesting in April and May. The most common method of storage in Egypt is by placing the dry seeds in pits dug under the ground in dry pots. The pits are usually completely filled with seeds to minimize the amount of air. This practice has been claimed to reduce discoloration and insect infestation. The pits are called 'Makamer', while the name of the pit is Makmura. This storage method is usually known as the 'kamre' process (El-Wakeil, 1955). Few data have been published in Egypt about the storage of Faba beans, especially on the chemical composition and physical properties. Therefore, it is important to study the effect of the kamre process on physical properties and chemical composition of dry Faba beans and on reducing insect infestation. Also the other storage methods (such as storage in tin cans after heating the seeds at 70°C for 2 h and storage in tin cans without heating) need investigation. In this study the seeds were stored for 3, 6 and 9 months using all important commercial methods.

## MATERIALS AND METHODS

### Material

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

### Methods

*Storage of samples*

Faba bean seeds were stored using three methods of storage for nine months. The stored samples were withdrawn every three months to use in the study.

(1) Seeds were stored at Barheem, Monofia Governorate, Egypt. The Makmura was completely filled with beans to minimize the amount of air. Seeds were stored in several Makamer (pits) in order to obtain each sample from a different Makamer.

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

(3) The third lot of seeds was placed in tin cans and carefully closed, then stored at room temperature for nine months.

Samples of all seeds stored in tin cans were taken for each period to obtain representative samples.

## Physical analysis

*Seed weight, volume and bulk density*
One hundred seeds were weighed and their volume was determined by measuring the change in the level of water in a graduated cylinder. The bulk density of Faba bean seeds was calculated.

*Percentage of hulls, and hulls:dehulled seeds ratio*
One hundred seeds were weighed and dehulled manually using a small sharp knife. The hulls and dehulled seeds were weighed separately. The percentage of hulls as well as hulls:dehulled seeds ratio were calculated.

$$\text{Hulls } \% = \frac{\text{Weight of hulls removed from 100 seeds}}{\text{Weight of 100 seeds before removing hulls}} \times 100$$

$$\text{Hulls:dehulled seeds} = \frac{\text{Weight of hulls removed from 100 seeds}}{\text{Weight of dehulled seeds of 100 seeds}}$$

*Hydration coefficient*
The hydration coefficient of raw bean seeds soaked in distilled water for 24 h was calculated as the percentage increase in weight of beans (Youssef, 1978).

$$\text{Hydration coefficient} = \frac{\text{Weight of bean seeds after soaking}}{\text{Weight of bean seeds before soaking}} \times 100$$

*Swelling coefficient*
The volume of raw bean seeds before and after soaking in distilled water placed in a graduated cylinder for 24 h was estimated by determination of displaced water (Youssef, 1978).

$$\text{Swelling coefficient} = \frac{\text{Volume of bean seeds soaked for 24 h}}{\text{Volume of bean seeds before soaking}} \times 100$$

## Chemical analysis

*Preparation of samples*
A representative sample (1 kg from each sample) was sorted to remove any soils or stones, then the seeds were dehulled, manually using a small sharp

knife; the hulls, the dehulled seeds and the whole seeds were crushed separately in a small blender. The powders of dehulled seeds, hulls or whole seeds were placed immediately in airtight containers (Kilner jars) and stored in a refrigerator until required (Youssef, 1978).

*Moisture*

Moisture was determined according to AOAC (1975) methods.

*Protein*

Total nitrogen was determined using the micro-Kjeldahl method outlined in AOAC (1975) methods. Percentage nitrogen was multiplied by 6·25 to obtain percentage protein.

*Carbohydrates*

Sugars were extracted from the samples according to the method outlined by the AOAC (1975). An accurately weighed sample (2–3 g) was extracted with boiling 80% neutral aqueous ethanol for 8 h; then the ethanolic extract was filtered and the ethanol was removed by vacuum distillation. The residue was clarified with neutral lead acetate. Reducing and non-reducing sugars, as well as total soluble sugars, were estimated.

The reducing sugars were measured in the alcoholic extract according to the method described by Somogyi (1945).

Total soluble sugars were also determined in the alcoholic extract after acid hydrolysis following the AOAC (1975) method.

Non-reducing sugars were calculated by subtracting the amount of reducing sugars (before hydrolysis) from the total soluble sugars (after hydrolysis).

Starch contents were determined by acid hydrolysis according to the methods of the AOAC (1975).

Pectin content was determined by the method described by Pearson (1976).

*Ash*

The samples were ashed at 550°C until a light grey ash was obtained in muffle. The percentage of ash was calculated (AOAC, 1975).

*Minerals*

Samples were digested using sulfuric acid (5 ml) and perchloric acid (0·3 ml). Minerals were determined in the digested acid solution using the atomic absorption method (Pye Unicam Model 1900) (Pearson, 1976). Total phosphorus was estimated colorimetrically according to the method described by Snell & Snell (1949).

*Phytic acid*

Extraction of phytic acid and precipitation as ferric phytate was conducted by the method of Wheeler & Ferrel (1971) and modified by Chang (1977).

All determinations were carried out in triplicate.

## RESULTS AND DISCUSSION

### Effect of storage on some physical properties

The seed weight decreased slightly after storage (Table 1). This detected loss in seed weight was more noticeable upon storage in tin cans after heating the seeds than in Makamer or in tin cans without heating the seeds. This may be due to the hydration effect of heating the seeds before placing in cans. The losses in the seed weight were increased gradually and slightly during storage for nine months. On the other hand, it could be seen that storage had no marked effect on the volume of seed.

The stored seeds either in Makamer or in tin cans had bulk densities slightly less than those of unstored seeds (Table 1). Gradual and slight decreases in the bulk density of the seeds were noticed during storage for nine months. The effects of storage in tin cans after heating the seeds on the bulk density were more than that of storage in Makamer and in tin cans without heating the seeds.

Table 1 also demonstrated the effect of storage for nine months on the percentage of hulls and dehulled seeds and on the hulls:dehulled seeds ratio. Storage of seeds in Makamer or in tin cans either after heating or without heating the seeds for nine months gradually decreased (slightly) the percentage of dehulled seeds and hulls:dehulled seeds ratio, while storage of seeds by various methods gradually increased (slightly) the percentage of hulls.

Table 1 shows that storage of seeds either in Makamer or in tin cans for nine months leads to gradual reduction in their hydration coefficient. The decreases of hydration coefficient detected in the stored beans in Makamer, and in tin cans after heating the seeds, were slightly lower than those found in tin cans without heating the seeds. The results also indicate that storage of seeds in Makamer or in tin cans slightly reduces their swelling coefficient. This physical value was decreased gradually with prolonged time of storage.

### Effect of storage on chemical composition

*Moisture*

Table 2 shows the effect of storage on chemical composition of seed parts. The moisture contents of the dehulled seeds, hulls and whole seeds of Faba

**TABLE 1**
Effect of Storage on Some Physical Properties of Faba Bean Seeds[a]

| *Physical properties* | *Unstored (at zero time)* | *Storage method* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *In Makamer* | | | *In tin cans* | | | | | |
| | | | | | *After heating* | | | *Without heating* | | |
| | | *(months)* | | | *(months)* | | | *(months)* | | |
| | | *3* | *6* | *9* | *3* | *6* | *9* | *3* | *6* | *9* |
| Weight of 100 seeds (g) | 62·0 | 61·0 | 60·0 | 59·0 | 59·0 | 58·0 | 59·0 | 60·0 | 59·0 | 58·0 |
| Number of seeds per 100 g | 161·0 | 163·0 | 166·0 | 169·0 | 169·0 | 172·0 | 175·0 | 166·0 | 169·0 | 172·0 |
| Volume of 100 seeds ($cm^3$) | 48·4 | 48·2 | 48·5 | 48·5 | 48·6 | 48·7 | 48·7 | 49·0 | 49·1 | 49·6 |
| Bulk density ($g/cm^3$) | 1·3 | 1·3 | 1·2 | 1·2 | 1·3 | 1·2 | 1·2 | 1·2 | 1·2 | 1·2 |
| Dehulled seeds (%) | 86·2 | 85·1 | 85·0 | 84·0 | 85·1 | 84·0 | 83·6 | 86·0 | 86·0 | 84·6 |
| Hulls (%) | 13·8 | 14·9 | 15·0 | 16·0 | 14·9 | 15·9 | 16·4 | 14·4 | 14·0 | 15·4 |
| Hulls:dehulled seeds | 1:6·3 | 1:6·3 | 1:5·7 | 1:5·3 | 1:5·7 | 1:5·3 | 1:5·1 | 1:6·0 | 1:6·1 | 1:5·5 |
| Hydration coefficient | 262·4 | 236·1 | 210·6 | 208·6 | 235·5 | 208·8 | 208·6 | 234·6 | 206·9 | 196·7 |
| Swelling coefficient | 286·8 | 254·9 | 233·1 | 216·0 | 254·9 | 232·1 | 215·0 | 254·9 | 233·7 | 216·0 |

[a] Mean of three replicates.

bean stored in Makamer and in tin cans without heating did not noticeably change during storage for three, six and nine months. The moisture content of whole Faba bean seeds stored in tin cans after heating at 70°C for 2 h decreased from 10·5% before heating and storage to 8·3% after storage for three months. The water contents of these samples were decreased to 8·4% and 8·1% after storage for six and nine months, respectively. The effects of heating and storage on the moisture contents of dehulled seeds and hulls were almost the same as those found in whole seeds. Table 2 indicates that neither the storage method nor storage period had noticeable effects on the moisture content of fractions of Faba bean seeds, except for the seeds stored in tin cans after heating. The decreases in moisture contents are attributed to hydration of the seeds by heat, while the period of storage had no noticeable effect on moisture contents.

*Proteins*

Both storage methods and periods had noticeable effects on the protein contents of all parts of Faba bean seeds (Table 2). Crude protein content of whole seed decreased from 29·2% to 27·3, 26·8 and 26·3% after storage for three months in Makamer, in tin cans after heating and in tin cans without heating, respectively, while storage for six and nine months resulted in gradual decreases in the protein contents of these samples to reach 23·4, 22·2 and 19·8%, respectively, after nine months storage. These decreases in crude protein may be attributed to the activity of proteolytic enzymes (Lockar, 1960). The decreases in the crude protein present in seeds stored in tin cans without heating were greater than in seeds stored in Makamer or in tin cans after heating. The effects of storage on the crude protein content of seeds stored in Makamer or in tin cans after heating may be due to inactivation of enzymes during heating of the seed or to the anaerobic conditions of Makamer. From these results it was concluded that the storage of Faba beans in Makamer is superior to the other two methods used in this investigation with respect to the protein content of seeds because the losses in their protein contents were the lowest.

*Carbohydrates*

As shown in Table 2, the method of storage of Faba bean seeds had no noticeable effect on the total sugars content of dehulled seeds or whole seeds, but the amounts of these nutrients were slightly influenced by the storage period. Total sugars present in whole seeds and dehulled seeds increased gradually during storage; in contrast, the total sugars content of hulls gradually decreased. Total sugars in dehulled seeds were really unchanged after storage for three months. After storage for six months, the percentages of total sugars of these samples ranged between 5·4% and 5·6%. The

**TABLE 2**
Effect of Storage on Moisture, Proteins and Carbohydrates of Faba Bean Seeds (based on dry weight)[a]

| *Chemical properties and parts of seed* | *Unstored (at zero time)* | *Storage method* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *In Makamer* | | | *In tin cans* | | | | | |
| | | | | | *After heating* | | | *Without heating* | | |
| | | *(months)* | | | *(months)* | | | *(months)* | | |
| | | *3* | *6* | *9* | *3* | *6* | *9* | *3* | *6* | *9* |
| Moisture | | | | | | | | | | |
| Dehulled seeds | 10·7 | 10·4 | 10·9 | 10·3 | 8·6 | 9·8 | 8·4 | 10·5 | 10·7 | 10·2 |
| Hulls | 10·3 | 9·6 | 10·8 | 9·4 | 8·0 | 8·6 | 7·9 | 9·5 | 10·9 | 9·4 |
| Whole seeds | 10·3 | 10·2 | 10·9 | 9·7 | 8·3 | 8·3 | 8·1 | 10·0 | 10·7 | 9·6 |
| Crude protein | | | | | | | | | | |
| Dehulled seeds | 30·0 | 29·1 | 28·2 | 25·5 | 28·9 | 27·9 | 24·2 | 28·4 | 27·1 | 21·2 |
| Hulls | 5·7 | 5·3 | 5·9 | 4·9 | 4·7 | 3·8 | 3·3 | 3·4 | 2·3 | 1·9 |
| Whole seeds | 29·2 | 27·3 | 25·4 | 23·4 | 26·8 | 24·5 | 22·2 | 26·3 | 24·5 | 19·8 |
| Total sugars | | | | | | | | | | |
| Dehulled seeds | 5·4 | 5·4 | 5·4 | 5·7 | 5·4 | 5·6 | 5·8 | 5·4 | 5·6 | 5·9 |
| Hulls | 1·8 | 1·3 | 1·0 | 0·9 | 1·1 | 1·2 | 1·2 | 1·6 | 1·4 | 1·1 |
| Whole seeds | 4·5 | 4·7 | 5·3 | 5·5 | 4·9 | 5·4 | 5·5 | 4·8 | 5·4 | 5·8 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Reducing sugars | | | | | | | | | | |
| Dehulled seeds | 0·6 | 1·3 | 1·7 | 2·5 | 1·0 | 1·6 | 2·2 | 1·6 | 2·5 | 3·4 |
| Hulls | 0·4 | 0·4 | 0·4 | 0·5 | 0·4 | 0·5 | 0·6 | 0·5 | 0·5 | 0·6 |
| Whole seeds | 0·5 | 1·1 | 1·7 | 2·4 | 0·9 | 1·5 | 2·4 | 1·3 | 3·4 | 3·3 |
| Non-reducing sugars | | | | | | | | | | |
| Dehulled seeds | 4·8 | 4·1 | 3·7 | 3·2 | 4·4 | 4·0 | 3·6 | 3·8 | 3·1 | 2·5 |
| Hulls | 1·4 | 0·8 | 0·6 | 0·4 | 0·8 | 0·8 | 0·6 | 0·1 | 0·8 | 0·5 |
| Whole seeds | 4·0 | 3·6 | 3·6 | 3·1 | 4·0 | 3·9 | 3·1 | 3·5 | 3·0 | 2·6 |
| Starch | | | | | | | | | | |
| Dehulled seeds | 64·0 | 61·0 | 58·1 | 46·1 | 57·3 | 52·2 | 40·5 | 58·3 | 54·0 | 42·2 |
| Hulls | — | — | — | — | — | — | — | — | — | — |
| Whole seeds | — | — | — | — | — | — | — | — | — | — |
| Pectin | | | | | | | | | | |
| Dehulled seeds | 1·3 | 1·2 | 1·2 | 1·0 | 1·3 | 1·1 | 1·0 | 1·2 | 1·0 | 0·8 |
| Hulls | 0·8 | 0·7 | 0·7 | 0·6 | 0·8 | 0·7 | 0·6 | 0·7 | 0·6 | 0·5 |
| Whole seeds | 2·0 | 1·9 | 1·9 | 1·6 | 2·0 | 1·8 | 1·6 | 1·9 | 1·6 | 1·3 |

[a] Mean of three replicates.

increments of the total sugars content may be due to conversion of starch to sugars. Total sugars content of hulls was influenced by the storage method and storage period. Decreases occurring in the total sugars of hulls during storage, as shown in Table 2, may be due to the partial hydrolysis of disaccharides to monosaccharides (El-Desouki, 1982). Table 2 also shows that the storage methods, as well as periods of storage, had marked effects on the reducing sugar content of dehulled seeds and of whole seeds of Faba beans, while effects on reducing sugars present in the hulls were slight. Reducing sugar content of dehulled seeds, hulls and whole seeds increased after storage for nine months under various conditions of storage. The reducing sugar content of dehulled seeds, hulls and whole seeds of Faba beans stored in tin cans were higher than those of beans stored in Makamer or in tin cans after heating the seeds. The lowest amounts of reducing sugars were detected in whole seeds and dehulled seeds of heated Faba bean. On the other hand, reducing sugar content of hulls of stored seeds in tin cans, after heating, were slightly higher than those of stored beans in Makamer. The increments in the reducing sugar content occurring in the seeds during storage may be due to conversion of non-reducing sugars to reducing sugars as well as hydrolysis of starch to monosaccharides (El-Desouki, 1982).

Table 2 also shows that storage of Faba bean seeds for three, six and nine months, under various conditions of storage, reduced their non-reducing sugar content. The decreases occurring in non-reducing sugars of dehulled seeds and whole seeds of stored beans in tin cans without heating were higher than those detected in whole seeds and dehulled seeds of beans stored in Makamer or in tin cans after heating. The highest amounts of non-reducing sugars were detected in whole seeds and dehulled seeds of heated seeds stored in tin cans. However, the decreases in non-reducing sugars of hulls of stored seeds in Makamer were higher than the decreases in non-reducing sugars of hulls of seeds stored in tin cans. The hulls of stored seeds in tin cans after heating had more non-reducing sugar content than unheated seeds stored in tin cans or in Makamer. The decreases in non-reducing sugars occurring in Faba bean seeds during storage may be due to conversion of non-reducing sugars to reducing sugars. The high reductions in non-reducing sugars of dehulled seeds and whole seeds of Faba bean stored in tin cans and the high reductions in non-reducing sugars of hulls of beans stored in Makamer may be due to the partial utilization of these sugars by living organisms (El-Desouki, 1982).

As shown in Table 2, starch contents of dehulled seeds were markedly affected by both storage method and period. Starch content of dehulled seeds of Faba bean seeds decreased gradually after storage for three, six and nine months in Makamer, in tin cans after heating and in tin cans without heating. The rate of reduction in the starch content of dehulled seeds

occurring during storage was dependent upon the method of storage. Starch content of dehulled seeds of stored beans in Makamer was higher than that of stored beans in tin cans. The dehulled seeds of stored unheated seeds contained slightly more starch than those of stored heated seeds. The results indicate also that the starch content of dehulled seeds of all samples was decreased sharply during the last three months of storage.

*Pectic substances*

The storage of bean seeds under the studied conditions leads to gradual losses in the pectic substances present in the different parts of seed (Table 2). The decrease ranged from 19% to 31% of the original content after storage for nine months, according to the method of storage. The pectic content of bean seed was influenced greatly by storing the heated beans in tin cans for nine months. The decreases reached 32%, 37% and 35% in hulls, dehulled seeds and whole seeds, respectively. Jones & Boulter (1983) explained that the decrease of cooking rate in *Phaseolus vulgaris* during storage was due to formation of insoluble pectin. Shehata *et al.* (1985) studied the relation of pectic substances to softness of pressure-cooked Faba beans. They found that the water-soluble pectin fraction of dry decoated seeds was more important than absolute pectin fraction content in affecting the texture of cooked beans.

*Ash and minerals*

Table 3 shows that storage of Faba bean seeds in Makamer and in tin cans with or without heating of the beans leads to a moderate reduction in the ash contents of dehulled seeds, hulls and whole seeds. Storage of seeds for nine months led to gradual decreases in the ash contents of all parts of the seeds. The highest percentage of ash was detected in dehulled seeds while the lowest amounts of ash were found in hulls. Unheated seeds stored in tin cans had more ash than other stored seeds, but seeds stored in Makamer contained less ash than heated stored seeds.

Table 3 also demonstrates the effect of storage on phosphorus, iron, calcium and magnesium contents of Faba bean seeds. Storage for three, six and nine months under the three studied conditions of storage had no noticeable effects on these minerals.

*Phytic acid*

As shown in Table 3, neither storage method nor storage period affected phytic acid content. Phytic acid contents of dehulled seeds decreased gradually in Faba bean seeds under various methods of storage (three, six and nine months). On the other hand, phytic acid percentages in dehulled seeds of stored beans in Makamer were lower than those of either heated or

**TABLE 3**
Effect of Storage on Ash, Minerals and Phytic Acid Contents of Faba Bean Seeds (based on dry weight)[a]

| *Chemical properties and parts of seed* | *Unstored (at zero time)* | *Storage method* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *In tin cans* | | | | | |
| | | *In Makamer* | | | *After heating* | | | *Without heating* | | |
| | | *(months)* | | | *(months)* | | | *(months)* | | |
| | | *3* | *6* | *9* | *3* | *6* | *9* | *3* | *6* | *9* |
| Ash (%) | | | | | | | | | | |
| Dehulled seeds | 3·7 | 2·8 | 2·8 | 2·3 | 2·9 | 2·8 | 2·4 | 3·2 | 3·0 | 2·2 |
| Hulls | 3·3 | 2·8 | 2·4 | 2·0 | 2·8 | 2·2 | 1·9 | 3·0 | 2·2 | 1·8 |
| Whole seeds | 3·6 | 2·8 | 2·6 | 2·0 | 2·9 | 2·8 | 2·1 | 3·0 | 3·0 | 2·0 |
| Phosphorus (mg/100 g) | | | | | | | | | | |
| Dehulled seeds | 711 | 711 | 711 | 711 | 711 | 711 | 711 | 711 | 711 | 711 |
| Hulls | 75·0 | 75·1 | 74·9 | 74·9 | 75·0 | 74·0 | 74·8 | 74·8 | 75·0 | 74·0 |
| Whole seeds | 691 | 691 | 691 | 691 | 687 | 691 | 689 | 686 | 690 | 689 |
| Iron (mg/100 g) | | | | | | | | | | |
| Dehulled seeds | 15·6 | 15·6 | 15·5 | 15·5 | 15·1 | 15·5 | 15·0 | 15·5 | 15·5 | 15·0 |
| Hulls | 3·9 | 3·9 | 3·9 | 3·9 | 3·9 | 3·9 | 3·9 | 3·9 | 3·9 | 3·8 |
| Whole seeds | 15·1 | 15·0 | 15·0 | 15·0 | 14·8 | 14·8 | 15·0 | 14·9 | 15·0 | 14·8 |
| Calcium (mg/100 g) | | | | | | | | | | |
| Dehulled seeds | 38·2 | 38·2 | 38·0 | 38·0 | 38·0 | 38·0 | 37·5 | 37·9 | 38·0 | 37·6 |
| Hulls | 250 | 250 | 250 | 248 | 242 | 250 | 243 | 250 | 245 | 247 |
| Whole seeds | 72·0 | 72·0 | 71·4 | 71·8 | 72·0 | 71·7 | 71·8 | 72·0 | 71·9 | 71·1 |
| Magnesium (mg/100 g) | | | | | | | | | | |
| Dehulled seeds | 7·8 | 7·8 | 7·8 | 7·8 | 7·7 | 7·7 | 7·7 | 7·6 | 7·6 | 7·7 |
| Hulls | 28·8 | 28·8 | 28·8 | 28·7 | 28·1 | 28·5 | 28·4 | 28·3 | 28·4 | 28·1 |
| Whole seeds | 8·0 | 8·0 | 8·0 | 7·9 | 8·0 | 7·9 | 8·0 | 8·0 | 7·9 | 7·9 |
| Phytic acid (%) | | | | | | | | | | |
| Dehulled seeds | 1·7 | 1·5 | 1·4 | 1·3 | 1·5 | 1·5 | 1·5 | 1·6 | 1·5 | 1·5 |

[a] Mean of three replicates.

unheated seeds stored in tin cans. Heated and unheated stored seeds had almost the same amounts of phytic acid. Hussein (1982) has reported that phytate content of Faba bean seeds is liable to change according to storage conditions, temperature, humidity and fermentation period.

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