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Changes in Some Nutrients of Fenugreek Seeds During Germination

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ABSTRACT

Changes in some nutritive components of fenugreek seeds were determined during soaking and germination. Starch content decreased from 40% to 16% after 4 days of germination. The reduction in starch content was accompanied by a gradual increase in total sugars during germination. Little or no change was observed in total fat content during germination. Ascorbic acid increased from 4·23 to 8·87 mg/100 g after 4 days of germination. The total and protein nitrogen contents increased during germination without any obvious change in non-protein nitrogen. Fenugreek seeds contain considerable amounts of aspartic acid, glutamic acid, glycine, valine, leucine, iso-*leucine and lysine. The amino acid contents decreased slightly after soaking and then increased during sprouting.*

Phytic acid represented 51·2% of the total phosphorus in fenugreek seeds. Sprouting for 2 and 4 days resulted in 23·0% and *47·7% losses in phytic acid contents, respectively, with a simultaneous increase of inorganic phosphorus content. Calcium, manganese and zinc were increased after 4 days of sprouting. The iron and potassium contents*

decreased during germination without any apparent change in magnesium and copper concentrations.

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is an annual herb of the Legumino family indigenous to western Asia and southeastern Europe. It has long been cultivated in the Mediterranean area, in India and in North Africa.

In Egypt, fenugreek seeds are consumed in many forms (for example, boiled and germinated, especially in summer, or cooked with treacle).

Germination as a process can generally improve the nutritive value of seeds (Chen, 1970). Chen *et al.* (1975) reported that germination of seeds did not require sunlight or soil; also, the time of sprouting was short and the production yield was high.

The protein content of fenugreek seed varies between 20 and 32% (Schankaracharya & Naranjan, 1972). It has been reported that ascorbic acid was important in the biosynthesis of certain amino acids.

Kumar *et al.* (1978) observed that, during germination, phytin phosphorus diminished and water-soluble inorganic phosphorus increased. Fenugreek seeds were found to contain 3% ash, 370 mg/100 g total phosphorus, 160 mg/100 g calcium, 14·1 mg/100 g iron and 19 mg/100 g sodium (Schankaracharya & Naranjan, 1972).

The objective of the current work was to study the changes that occur in some nutrients of fenugreek seeds as a result of soaking and germination.

MATERIALS AND METHODS

Materials

Fenugreek seeds were obtained from the local market in Alexandria, cleaned and kept at 5 °C in tightly closed glass jars until used.

Methods

Soaking

Fenugreek seeds were soaked in distilled water at room temperature in jars (2–3 volumes of water) for 14 h (Silva & Luh, 1979).

Sprouting

The soaked seeds were spread on wet cheesecloth in stainless steel baskets. A wooden cover was used to minimize moisture loss and also to protect the seeds from light during germination. The temperature ranged from 25 to 28 °C during the 4 days of sprouting. The seeds were rinsed with deionized water and then sprayed with 0·02% sodium hypochlorite solution at 4-hourly intervals to inhibit microbial growth (Silva & Luh, 1979).

Samples were taken after soaking and after sprouting for 2 and 4 days, frozen at −12 °C for 3–4 h on plastic trays, freeze-dried, milled to pass through a 40 mesh screen and kept in tightly closed jars.

Analytical procedure

Moisture, total and non-protein nitrogen, ascorbic acid and fat contents of dry, soaked and sprouted fenugreek seeds were determined as described by the AOAC (1975). The results are averages of triplicate determinations. Starch content was determined according to the procedure of McCready *et al.* (1950). The sugars were extracted by refluxing for 1·5 h with hot 80% ethanol in the presence of a small quantity of $CaCO_3$ to neutralize the acidity, followed by centrifugation (Palmer & Brandes, 1974).

For the amino acid determinations, the protein in 250 mg of the ground sample was hydrolyzed in a vacuum sealed tube on an electric heater at 110 °C with 8 ml 5·7N HCl for 48 h. After cooling and centrifuging, 2 ml of filtrate were passed through a Dowex 50-WX4 cation exchange column in the H^+ form. The column was washed with 300 ml of water and then eluted with 150 ml 2N NH_4OH. The eluate was evaporated to dryness in a flash evaporator at 50 °C. Amino acids were separated and quantified on a Dionex DC-6A ion-exchange column utilizing the amino acids computing integrator (Southgate, 1976).

Tryptophan was determined colorimetrically in the alkaline protein hydrolyzate according to the method of Miller (1967), using paradimethylamino benzaldehyde.

Phytic acid and phytate phosphorus were determined according to the method of Wheeler & Ferrel (1971). The procedure was modified by boiling the samples for 30 min. The phytate was converted into ferric salt and then determined colorimetrically using potassium thiocyanate solution. Inorganic phosphorus and total phosphorus were determined by the colorimetric method of Allen (1940).

Mineral contents were determined by using a Perkin Elmer atomic absorption spectrophotometer, Model 303 (Gorsuch, 1959).

RESULTS AND DISCUSSION

Changes in moisture, starch, total sugars, nitrogen compounds, fat and ascorbic acid of dry, soaked and germinated fenugreek seeds are shown in Table 1.

The results indicate that there was a decrease in starch content from 40% to 16% after 4 days of sprouting. The reduction in starch content was accompanied by a gradual increase in total sugars. Hsu *et al.* (1973) attributed to the breakdown of starch during germination to increases in amylase and phosphatase activities in respiratory metabolism. This may explain the increases in the sugar contents of germinated fenugreek seeds.

Little or no change was observed in fat contents during soaking and germination of fenugreek seeds.

Soaking of fenugreek seeds caused a loss of 5·67% in ascorbic acid content. The germinated seed was much higher in ascorbic acid than that of the original dry seed. Sprouting for 2 and 4 days increased the ascorbic acid content by 26·9% and 110%, respectively. Kylen & McCready (1975) found that bean sprouts contained higher levels of ascorbic acid than dry or cooked beans.

The protein content of the dry fenugreek seeds was 22·9% which decreased slightly after soaking. An increment in protein content was observed as a result of germination for 2 and 4 days, without obvious change in non-protein nitrogen content. Kylen & McCready (1975) reported that the protein content of germinated lentil was higher than that of ungerminated seeds. This change may be attributed to the loss of water-soluble compounds during the sprouting procedure.

The amino acid contents in the acid hydrolyzates of the fenugreek seed protein before and after germination are shown in Table 2. The results show that soaking of seeds caused a slight decrease in amino acid contents. It could be suggested that the loss in amino acids after soaking is related to the loss of some water-soluble protein such as albumin. Wunschendroff (1919) indicated that fenugreek seeds contain 27% of total protein, of which 25% is globulin, 20% albumin and 55% nucleoprotein.

Glutamic and aspartic acids were the most abundant amino acids in

TABLE 1
Proximate Analysis of Dry, Soaked and Germinated Fenugreek Seeds
(On a dry matter basis)

Treatments	*Starch* (%)	*Total sugars* (%)	*Components* *Nitrogen compounds* (%)				*Fat* (%)	*Ascorbic acid* (*mg*/100 *g*)	*Energy* *Cal*/100 *g*
			TN	*NPN*	*PN*	*CP*			
Dry seeds	40·0	2·72	3·67	0·35	3·32	22·9	7·50	4·23	330
Soaked seeds	32·0	1·95	3·61	0·36	3·25	22·6	7·49	3·99	293
2-day sprouts	18·5	3·57	3·78	0·38	3·40	23·6	7·60	5·37	251
4-day sprouts	16·0	4·83	3·86	0·38	3·48	24·1	7·95	8·87	251

* TN: Total nitrogen.
NPN: Non-protein nitrogen.
PN: Protein nitrogen (calculated by difference).
CP: Crude protein = TN × 6·25.
The moisture contents were: Dry seeds = 7·25 %; soaked seeds = 62·6 %; 2-day sprouts = 69·2 %; 4-day sprouts = 71·4 %.

TABLE 2
Amino Acid Contents of Dry, Soaked and Germinated Fenugreek Seeds
(% on a dry matter basis)

Amino acids	*Treatments*			
	Dry seeds	*Soaked seeds*	*2-day sprouts*	*4-day sprouts*
Aspartic	2·37	2·28	2·06	2·59
Threonine	0·78	0·67	0·69	0·86
Serine	0·93	0·81	0·85	1·06
Glutamic	3·62	2·59	3·22	3·93
Proline	0·98	0·75	0·82	1·04
Glycine	1·07	0·78	1·36	1·18
Alanine	0·88	0·90	0·73	0·97
Valine	1·43	1·01	1·18	1·53
Methionine	0·17	0·12	0·13	0·16
Iso-leucine	1·11	0·83	0·12	1·16
Leucine	1·49	1·19	1·24	1·54
Tyrosine	0·59	0·38	0·48	0·56
Phenylalanine	0·96	0·71	0·80	1·03
Lysine	1·34	0·98	1·18	1·45
Histidine	0·54	0·41	0·46	0·60
Arginine	0·86	0·57	0·72	0·89
Tryptophan	1·08	0·94	1·10	1·25

fenugreek seeds and showed a remarkable increase after 4 days of sprouting. The considerable percentage of these two amino acids in the germinated seeds may be derived from the hydrolysis of glutamine and asparagine (Chen & Thaker, 1978). Other amino acids decreased slightly after soaking and then increased after 4 days of sprouting. These are threonine, serine, lysine, leucine, *iso*-leucine, proline, glycine, arginine and tryptophan. The least abundant amino acid in fenugreek seed is methionine—an essential amino acid for monogastrics—which amounted to 0·174%. The sprouted fenugreek seeds are a good supplement for cereals because of their high lysine and tryptophan contents.

The phytic acid and phosphorus concentrations in fenugreek seeds and sprouts are listed in Table 3. The phytic acid content of dry fenugreek seeds was 164 mg/100 g, a value which represented 51·2% of the total phosphorus content (292 mg/100 g). Gad (1976) found that the phytic acid content of two Egyptian varieties of fenugreek seeds represented 41–46% of the total phosphorus.

TABLE 3
Phosphorus Compounds of Dry, Soaked and Germinated Fenugreek Seeds
(mg/100 g on a dry matter basis)

Treatments	*Phosphorus compounds*			
	Total phosphorus	*Inorganic phosphorus*	*Phytic acid*	*Phytic phosphorus*
Dry seeds	292	77·5	164	55·0
Soaked seeds	290	87·5	160	53·6
2-day sprouts	310	112	132	44·2
4-day sprouts	323	115	95	31·9

Tabekhia & Luh (1979) stated that soaking the dry legume beans in water resulted in a slight decrease in phytate phosphorus. Sprouting of fenugreek seeds for 2 and 4 days showed 23·0% and 47·7% losses in phytic acid contents, respectively. The inorganic phosphorus increased gradually during germination as a result of phytin hydrolysis. Sobolevn (1963) stated that phytin phosphorus is considered as a store of inorganic phosphorus.

Data on K, Ca, Fe, Mg, Mn, Zn and Cu are shown in Table 4. The dry fenugreek seeds were generally a good source of minerals.

During germination of fenugreek seeds, iron and potassium decreased while magnesium and copper remained unchanged. The loss of iron and potassium may be due to leaching during seed germination (Kumar *et al.*, 1978).

Calcium, manganese and zinc showed an increment after 4 days of sprouting; these findings are in agreement with those obtained by Chen *et al.* (1975) and Reddy *et al.* (1978).

TABLE 4
Mineral Contents of Dry, Soaked and Germinated Fenugreek Seeds
(mg/100 g on a dry matter basis)

Treatments	*Minerals*						
	K	*Ca*	*Fe*	*Mg*	*Mn*	*Zn*	*Cu*
Dry seeds	1 250	57·5	10·0	280	1·62	1·25	1·75
Soaked seeds	1 375	68·8	8·75	250	1·87	1·20	1·75
2-day sprouts	1 400	66·3	6·25	275	1·75	1·35	2·00
4-day sprouts	1 150	77·5	8·75	280	1·87	1·42	1·75

It can be concluded that the germination of fenugreek seeds increased their nutritive components, including total sugars, ascorbic acid, proteins and amino acids, and, in addition, decreased their phytic acid contents. Thus, consumption of fenugreek seeds in germinated form is recommended for supplementation and fortification of foods which may be poor in protein, amino acids, ascorbic acid and minerals.

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