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Short Communication

Effect of cooking on anti-nutritional factors and in vitro protein digestibility (IVPD) of faba bean grown with different nutritional regimes

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Abstract

A field experiment was carried out to study the effect of cooking on IVPD and anti-nutritional factors of mycorrhizal-inoculated, phosphorus- and sulphur- fertilized faba bean plants. The results indicated that cooking significantly increased protein digestibility for the control and all treated samples. The increased IVPD was a consequence of significant reduction in antinutritional factors (tannins and phytic acid). © 1999 Published by Elsevier Science Ltd. All rights reserved.

Faba bean is the most important legume crop in Sudan; it is consumed for breakfast and supper in many parts of the country, especially in the urban areas. Faba bean like other beans is a good source of calories, protein, carbohydrate and fibre (El Tinay, Mahgoub, Mohammed & Hamad, 1989). Chemical, organic and biological fertilizers were reported to increase protein content of faba bean (Babiker, Elsheikh, Osman & El Tinay, 1995). Legumes are generally known to contain various natural constituents which affect their nutritional quality. Some inhibit specific enzyme activities, for example, inhibition of proteinase and amylase. Others are the haemagglutinin, saponins, tannins, anti-vitamins and the presence of phytic acid which interferes with mineral element absorption and utilization and reacts with proteins to form complex products which have an inhibitory effect on peptic digestion. The presence of tannin has been associated with lower nutritive value and lower biological availability of macromolecules, such as proteins and carbohydrates (Desphande & Cheryan, 1985). Phytate forms complexes with proteins, thus making them less soluble and less susceptible to enzymatic degradation compared to the same protein alone (Carnovale, Luargo & Lombardi-Boccia, 1988). Cooked beans show trypsin inhibitor activity of the heat-resistant type. Fertilizer treatments could alter the level of antinutritional factors and hence the IVPD. The objective of the present study was to investigate the effect of cooking and nutritional status on antinutritional factors and IVPD of faba bean.

A field experiment was conducted during the 1995/96 season in the Demonstration Farm of the Faculty of Agriculture at Shambat (latitude 15° 40′ N, longitude 32° 32′ E). The land was prepared by disc plough followed by ridging and the spacings between ridges and holes were 70 and 20 cm, respectively. The size of the subplot was 4×4 m consisting of five ridges of 3 m length. Between the main plots 1 m was left as guard area for water control. Sowing of faba bean cultivar "Shambat 75" was done at a rate of two seeds/hole. The crop was irrigated every week. The experiment was arranged in split-plot design with four replications. The treatments were:

- Untreated control plants.
- Plants inoculated with vesicular arbuscular mycorrhiza (VAM) (*Glomus* sp.) as previously described by Mahadi and Atabani (1992).
- Plants fertilized with 200 kg/ha P_2O_5 superphosphate (at sowing).
- Plants fertilized with 50 kg/ha sulphur (at sowing)
- Plants treated with both mycorrhiza and phosphorus (treatments 2 and 3).
- Plants treated with both mycorrhiza and sulphur (treatments 2 and 4).
- Plants treated with both phosphorus and sulphur (treatments 3 and 4).

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Table 1
Effect of cooking on anti-nutritional factors and in vitro protein digestibility (IVPD) of faba bean grown with different nutritional regimes[a]

Treatment	Control	Mycorrhiza	Phosphorus	Sulphur	VAM + P	VAM + S	P + S	VAM + P + S
IVPD								
Uncooked	80.1 ± (1.90)b[b]	66.2 ± (1.20)b	71.6 ± (0.67)b	72.2 ± (1.70)b	74.2 ± (1.40)b	71.3 ± (2.40)b	69.1 ± (2.40)b	71.4 ± (2.80)b
Cooked	84.6 ± (1.08)a	74.6 ± (1.26)a	76.2 ± (1.42)a	77.7 ± (1.00)a	79.7 ± (0.34)a	77.6 ± (1.42)a	75.0 ± (0.97)a	78.2 ± (1.80)a
Tannin content								
Uncooked	0.20 ± (0.007)a	0.34 ± (0.09)a	0.44 ± (0.003)a	0.42 ± (0.006)a	0.34 ± (0.07)a	0.42 ± (0.03)a	0.46 ± (0.03)a	0.42 ± (0.06)a
Cooked	0.10 ± (0.005)b	0.17 ± (0.003)b	0.25 ± (0.001)b	0.21 ± (0.001)b	0.13 ± (0.003)b	0.24 ± (0.24)b	0.21 ± (0.01)b	0.24 ± (0.02)b
Phytic acid content								
Uncooked	0.12 ± (0.003)a	0.22 ± (0.003)a	0.24 ± (0.003)a	0.20 ± (0.005)a	0.12 ± (0.005)a	0.18 ± (0.03)a	0.18 ± (0.02)a	0.27 ± (0.01)a
Cooked	0.10 ± (0.001)b	0.17 ± (0.005)b	0.16 ± (0.003)b	0.10 ± (0.005)b	0.05 ± (0.009)b	0.06 ± (0.01)b	0.11 ± (0.00)b	0.11 ± (0.01)b
Trypsin inhibitor units								
Uncooked	7.50 ± (0.001)a	9.69 ± (0.31)a	7.81 ± (0.31)a	9.06 ± (0.31)a	8.75 ± (0.063)a	10.62 ± (0.62)a	10.94 ± (0.31)a	12.81 ± (0.93)a
Cooked	2.50 ± (0.001)b	4.06 ± (0.31)b	3.13 ± (0.63)b	3.13 ± (0.63)b	3.76 ± (0.005)b	5.50 ± (0.75)b	4.88 ± (0.13)b	5.63 ± (0.63)b

[a] Values are means ± (SD).
[b] Means not sharing a common letter in column, for the same parameter, are significantly different at $p \leqslant 0.05$.

- Plants treated with mycorrhiza, phosphorus and sulphur (treatments 2, 3 and 4).

At harvest the seeds were carefully cleaned then ground to pass through a 0.4 mm screen. Seeds were cooked by boiling 100 seeds in 500 ml distilled water for 45 min. Cooked seeds were dried at 50°C to constant weight and finely ground. IVPD (pepsin digestion) was determined according to the method of Maliwal (1983) as modified by Manjula and John (1991) whereas, tannin was determined according to AOAC (1984). The phytic acid content was determined by the method described by Wheeler and Ferrel (1971), whereas the trypsin inhibitor assay of seed extracts was determined according to Roy and Rao (1971). Each sample, consisting of three separate batches, was analyzed in triplicate and the figures were then averaged. Data were assessed by analysis of variance (ANOVA). The Duncan multiple range test was used to separate means. Significance was accepted at $P \leqslant 0.05$.

The results revealed that the in vitro protein digestibility of cooked faba bean seeds ranged from 74.6–84.6% compared to 66.2–80.1% for the uncooked seeds (Table 1). This indicates that cooking of faba bean seeds significantly affected in vitro protein digestibility. This could be attributed to inactivation of the antinutritional factors, tannins and phytate. The tannin content of cooked faba bean seeds ranged from 0.10 to 0.25% compared with 0.20 to 0.46% for uncooked seeds (Table 1). This indicates that cooking significantly decreases tannin content of faba bean seeds. The effect of tannin on in vitro protein digestibility could be attributed to the formation of indigestible protein–tannin complexes.

Phytic acid content of cooked faba bean seeds ranged from 0.05 to 0.17% compared to 0.12 to 0.27% for uncooked seeds (Table 1). The results show significant decrease in phytic acid content after cooking. Trypsin inhibitor unit of cooked faba bean seeds ranged from 2.5 to 5.6 TUI compared with 7.5 to 12.8 for the uncooked seeds (Table 1). Cooking of faba bean resulted in a significant decrease in trypsin inhibitor units. Although fertilizer treatments of faba bean resulted in considerable increase in anti-nutritional factors (tannin, phytic acid and trypsin inhibitor), cooking was found to be effective in inactivating these factors and consequently giving improved protein digestibilties.

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