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EFFECT OF PRE-TREATMENTS AND SOME PROCESSING TECHNIQUES ON THE ANTINUTRITIONAL PROPERTIES OF SOME LEGUMES

F.A. SALEM, [1] M.I. SHEHATA, [2] E. ABD EL-LATIF[2] AND S.M. ABOU EL-MAATI[1]

1 Dept. of Food Sci. and Technol. Fac. of Agric. Zagazig Univ., Zagazig.

2 Horticultural Research Institute, Agricultural Research Centre, Giza Egypt.

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Abstract

The effect of various per-treatments and processing (Soaking in tap water at room-temperature for 12hr. and cooking by different methods) on the oligosacharides, trypsin inhibitor activity, and phytic acid of Soybean, Fababean, Cowpea, Navybean and Chickpeas were studied. Results indicated that untreated samples contained raffinose, stachyose and sucrose at higher levels compared to soaked and autoclaved samples. Autoclaving was more effective in reducing oligosacharides content than soaking. After soaking, the residual amount of trypsin inhbitory activities (TIA) reached its minimum values to be 39,20,17,43 and 31 TIU/mg. in soybean, fababean, cowpea , navybean and chickpea, respectively. In addition the effect of soaking was more pronounced on fababean, cowpea, navybean and soybean than in chickpea. On the other hand, cooking under atmospheric pressure decreased the TIA of soybean, fababean, cowpea, navybean and chikpea substantially to 13,15,14,22 and 22 TIU / mg, respectively. Besides, autoclaving at 120^{o}C for 120 min . equally decreased the TIA from 46,26,22,52 and 33 to 5,4,2,9 and 6 TIU /mg. in soybean, fababean, cowpea, navybean and chickpea respectively. Results declared that soybean seeds had the highest phytic acid content being 2.26 mg./gm while fababean, navybean and cowpea seeds were intermediate being 1.85, 1.51 and 1.83 mg/g respectively, and the lowest content was found in chickpea seeds (0.92mg/gm.) The retention of phytic acid after soaking for 12 hrs. at room-temperature was 1.98, 1.65, 142, 1.67 and 0.80 mg/g while it was 0.64, 0.53, 0.23, 0.32 and 0.21 mg/g after autoclaving at 120^{o}C for 120 min.

INTRODUCTION

Legumes, consumed by humans, in many forms , are considered excellent sources of proteins, carbohydrates and are fairly considered as good sources of essential amino acids, minerals and vitamins (Aykoryed and Dougth 1977). The world population increases, the importance of protein of a high nutritive value becomes greater. World utilization of dry legumes as human food, however is below potential . This is partially attributed to the presence of several antinutritional factors, low protein and occurrence of flatulence agents. Anti-physiological substances, such as trypsin inhibitor led to decrease the nutritional value of legume Foods (Bahnassey *et al.* 1986). Phytate (inositol hexa phosphoric acid) is considered the principal source of phosphorus. However the interaction of phytate with proteins, vitamins and several minerals limit the nutritive value of dry legume seeds (Chang *et al.* 1977). Several processing methods were used, in order to eliminate the inactivation or removal of antinutritinal and flatulance producing factors.

The present work was carried out to study the effect of processing on oligosaccharides, trypsin inhibitor activity and phytic acid of some legume seeds.

MATERIALS AND METHODS

Five samples of Egyptian dry legumes, soybean (*Glycine max* L. variety crowford, Fababean (*Vicia faba* L.) var. Giza 2, Cowpea (*Vigna sinensis* L) var. Crem 7, Navy bean (*Phaseolus vulgaris* L.) var Giza 3 and Chickpea (*Cicer arietinum* L.) var. 110 were obtained from the Agricultural Research Centre, Giza, Egypt.

Treatments

Soaking

One hundred grams of each rinsed legume were soaked in 300 ml plain tap water 1:3 (W:V) at room temperature for 12 hrs. (Treatment 1).

Cooking : After soaking two cooking procedures were followed:

(1) Cooking under atmospheric pressure until ripeness, seeds were kept in water, i.e,, not less than 300 ml. water were used. (Treatment No. 2).

(2) Autoclaving under pressure of 1.5 kgm/cm. and at 120^{o}C without water

soaking for 30,60,90 and 120 min. (Treatments No. 3,4,5, and 6 resp.).

The processed samples were dried in an oven under atmospheric pressure at 50°C ., then ground to pass through a l-mm mesh sieve and kept for subsequent analyses.

Chemical analysis

(1) Oligosaccharides were analyzed using GLC apparatus after trimethylsilyl performed samples according to the method described by Ellis (1969)

(2) Trypsin inhibitor activity (TIA) was assayed according to Roy and Reo (1971) . The TIA was calculated as the number of trypsin inhibitor units in milligram dry sample.

(3) Phytate was determined according to Haug and Lantzsch (1983). Phytic acid concentration was calculated as mg./gm of dry sample.

RESULTS AND DISCUSSION

1. Effect of processing on oligosaccharides contents

Table 1 and Figs 1,2 and 3 reveal oligosaccharides content of the processed legumes . It could be observed that untreated sample contained raffinose, stachyose, verbascose and sucrose at higher levels compared to soaked and autoclaved samples. Raffinose, stachyose and verbascose were detected in raw soybean whereas stachyose adhered in cowpea and navybean seeds . Verbascose was high in chickpea and fababean while raffinose was high in soybean and fababean and low in other legumes.

Generally, the oligosaccharides were high in fababean, soybean, navy bean cowpea and chickpea (Table 1).

Zamora and Fields (1979) found that raffinose and stachyose contents of raw cowpea and chickpea were 0.33, 0.53 and 0.75%, respectively.

Autoclaving, apparently decreased raffinose, stachyose, verbascose and total oligosaccharides in chickpea, soybean and faba bean. A maximum reduction of oligosaccharides was attained by autoclaving. It is assumed that a type of hydrolysis has occurred and led to increments in monosaccharides. These findings suggest that autoclaving was more effective in reducing oligosaccharides than soaking (Table 1) . These results are in agreement with those obtained by Kon (1979) who found that

Table 1. Changes in sucrose and oligosaccharides composition % during the processing of legumes.

Legumes	Soybean			Faba bean			Cowpea			Navy bean			Chickpea		
Treatments	Cont-rol	1	6	Cont-rol	1	6	Cont-rol	1	6	Cont-rol	1	6	Cont-rol	1	6
Sugars															
Sucrose	1.03	0.96	0.14	2.15	1.20	0.00	1.80	1.13	0.07	2.98	1.87	0.73	1.35	0.75	0.15
Raffmose	2.25	1.98	0.00	2.01	1.71	0.16	0.93	0.62	0.15	0.82	0.63	0.47	1.08	0.83	0.06
Scachyose	2.14	1.82	0.31	0.85	0.58	0.32	2.92	2.06	1.13	3.94	2.79	0.84	1.14	0.80	0.00
Verbascose	1.96	1.41	0.00	3.74	2.54	0.06	1.89	1.65	0.00	1.36	0.90	0.00	3.39	2.46	0.00
Total oligosaccharides	6.35	5.21	0.31	6.60	4.83	0.54	5.74	4.33	1.28	6.12	4.32	1.31	5.61	4.09	0.06

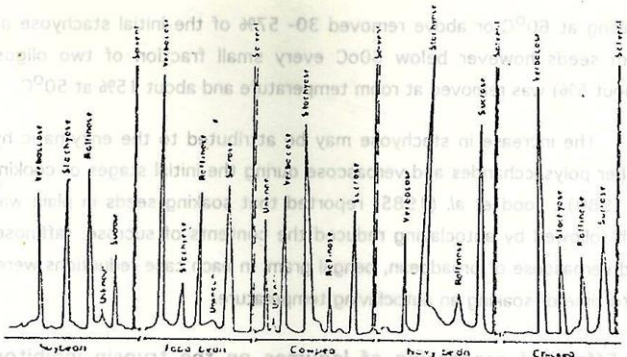

Fig. 1 GLC chromatogram for sucrose and oligosaccharides of raw legumes

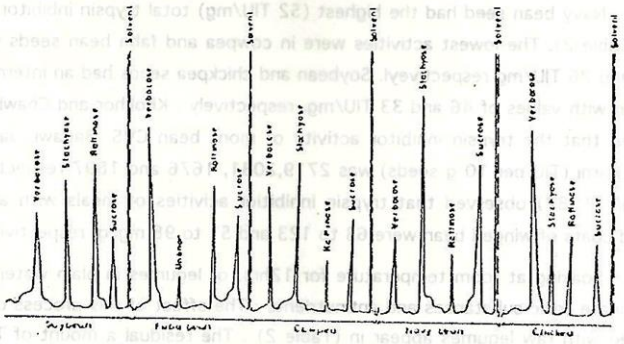

Fig. 2 GLC chromatogram for sucrose and oligosaccharides of cooked legumes

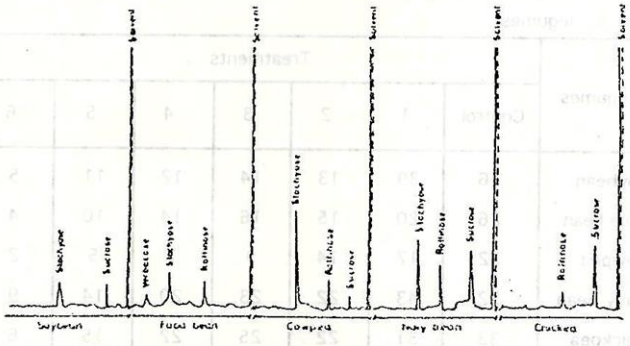

Fig. 3 GLC chromatogram for sucrose and oligosaccharides of autoclaved legumes

soaking at 60°C or above removed 30- 57% of the initial stachyose and raffinose from seeds however below 60oC every small fraction of two oligosaccharides, (about 5%) was removed at room temperature and about 15% at 50°C.

The increase in stachyose may be attributed to the enzymatic hydrolyses of higher polysaccharides and verbascose during the initial stages of cooking (Reddy *et al.* 1980) . Jood *et al.* (1985) reported that soaking seeds in plain water for 6 or 12h followed by autoclaving reduced the contents of sucrose, raffinose, stachyose and verbascose of broadbean, bengal gram. In each case reductions were proportional to time of soaking an autoclaving temperature.

2. Effect of processing of legumes on the trypsin inhibitory activities

Navy bean seed had the highest (52 TIU/mg) total trypsin inbibitor as evident in (Table 2). The lowest activities were in cowpea and faba bean seeds which were 22 and 26 TIU/mg respectiveyl. Soybean and chickpea seeds had an intermediate position with values of 46 and 33 TIU/mg. respectively . Khokhor and Chawhan (1986) found that the trypsin inhibitor activity of mont bean CVS. Badawi, Jadia, Jawala and Karni (TIU per 10 g seeds) was 2719,2031, 1676 and 1897 respectively. Mlsra *et al.* (1987) observed that trypsin inhibitior acivities of meals with and without seed coats of winged bean were 63 to 123 and 51 to 98 mg/g, respectively.

Soaking at room temperature for 12hrs. of legumes in plain water is used to eliminate toxic substances and antinutrients . The effect of this process on TIA compared with raw legumes appear in (Table 2) . The residual a mount of TIA reached

Table 2. Changes in trypsin inhibitory activities (TIU/mg) during the processing of legumes.

Legumes	Treatments						
	Control	1	2	3	4	5	6
Soybean	46	39	13	14	12	11	5
Faba bean	26	20	15	16	14	10	4
Cowpea	22	17	14	9	7	5	2
Navy bean	52	43	22	23	20	14	9
Chickpea	33	31	22	25	22	15	6

the minimum values 39.20,17.43 and 31 TIU/gm in soybean, faba bean, cowpea , navy bean and chickpea respectively . Data indicate that the effect of soaking was more pronounced on faba bean, cowpea, navy bean and soybean than chickpea.

Jaffe (1973) observed that soaking bean seeds in tap water and cooking usually destroy the toxic factors. Soaking for 2-5 min. before heating to 97°C was applied by Antunes and Sgarbieri (1980) . They found that most of the toxicity was eliminated.

It is evident in Table 2 that cooking under atmospheric pressure decreased the TIA of soybean faba bean, cowpea, navy bean and chickpea substantially to 13,15,14,22 and 22 TIU/mg, respectively . Autoclaving at 120°C for 120 min. equally decreased TIA from 46 to 5 TIU/gm, in soybean. Autoclaving reduced TIA from 20 TIU/mg. after soaking to 4 TIU/mg. in faba bean, from 17 to 2 TIU/mg . in cowpea , from 43 to 9 TIU/mg in navy bean and from 31 to 6 TIU/mg in chickpea. The decrease in TIA of legumes during autoclaving probabely is due to the effect of temperature on peptide, disulfide and hydrogen bonds of the inhibitor (Elias *et al.* 1976).

Chan and Lumen (1982) observed that 60% of isolated TIA of winged bean meal was destroyed after heating at 100°C .

Autoclaving destroyed most of the T/A in winged bean. It completely disappeared after heating in boiling water bath for 10min . as reported by Kadum *et al.* (1987).

3.Effect of processing of legumes on the phytic acid content

Results presented in Table 3 show that soybean seeds had the highest total

Table 3. Changes in phytic acid (mg/gm) during the processing of legumes.

Legumes	Treatments						
	Control	1	2	3	4	5	6
Soybean	2.26	1.98	1.22	1.35	1.20	0.99	1.64
Faba bean	1.85	1.65	1.30	1.33	1.07	0.86	1.53
Cowpea	1.51	1.42	1.26	1.31	0.95	0.58	1.23
Navy bean	1.83	1.67	1.11	1.04	0.92	0.42	1.32
Chickpea	0.92	0.80	0.69	0.54	0.50	0.33	1.21

phytic acid content with an average of 2.26 mg/gm, while faba bean, navy bean and cowpea seeds were intermediate (1.85, 1.51 and 1.83 mg/gm, respectively. The lowest content was in chikpea seeds (0.92 mg/gm).

The enzyme phytase is activated during soaking and catalyzes the hydrolysis of phytic acid into inositol phosphates, inositol and orthophosphate. The retention of phytic acid after soaking for 12hr. at room temperature was 1.98 in soybean, 1.65 in faba bean, 1.42 in cowpean, 1.67 in navy bean and 0.80 mg. in chickpea. Decreases of total phytic acid content after soaking may be due to the activation of phytase and phosphatase enzymes. These results agree with those obtained by Sievwright and Shipe (1986). Kon (1979) found that organic phosphates were hydrolyzed to inorganic phosphates by phytase enzyme at low temperature.

Tabekhia and Luh (1980) observed that the total phosphorus in legumes soaked for 12hr. at room temperature ranged from 440$\pm$ 1.8 to 550$\pm$4.5 mg/100g.

Soaking of moth beanin plain water and mixed salt solution followed by cooking under pressure led to 4.7% and 2.6% decrease in phytate. This loss could be attributed to phytate leaching in soaking solutions or to the activation of phytase in wet seeds causing hydrolysis and loss of phytic acid (Khokhor and Chawhan, 1986).

Cooking under atmospheric pressure, decreased the phytic acid content (Table 3) to 1.22 in soybean, 1.30 in faba bean, 1.2 in cowpea, 1.11 in navy bean and 0.69 mg/g chickpea. However, phytic acid conetnt significantly decreased during autoclaving for 30,60,90 and 120 min . Prolongation of autoclaving period was accompanied by rapid decrease in phytic acid.

Chang et al (1977) observed that 90% of phytic acid content was removed by precooking incubation of californin small white beans in water at 60^{o}C for 10 hrs.

The decrease in phytic acid of legumes during cooking and autoclaving is assumed to be due to the effects on ester and glucoside linkages bonds by phytase and phosphatase enzymes rendered active in the initial stages of cooking . Tabekhia and Luh (1980) reported that cooking dry beans at 100^{o}C for 3hr. or canning at 115^{o}C for 3hr. improved the nutritive value through phytate breakdown and increased the availability of certain minerals , especially inorganic phosphorus.

Soaking for 4 hr. at room temperature and cooking for 40 min reduced the phytic acid in pea by 82% . Moreover, it improved the nutritional quality of legumes (Manan *et al.* 1987).

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تأثير عمليات التجهيز والطهي علي مضادات التغذية في بعض البقوليات

محمد ابراهيم شحاته ، فوزي احمد سالم ، السيد عبد اللطيف محمد
سامى محمد أبو المعاطى

قسم علوم الأغذيه - كلية الزراعة جامعة الزقازيق .

قسم بحوث تصنيع الفاكهة - معهد بحوث البساتين - مركز البحوث الزراعية . الجيزة .

تمت دراسة تاثير النقع والطهى والطبخ على مضادات التغذية مثل سكرات الأوليجو (التى تسبب غازات واسهال عند الأطفال) - مثبطات أنزيم التربسين - حمض الفيتيك فى خمسة انواع من البقول الجافة وهى فول الصويا ، الفول البلدى ، اللوبيا ، الفاصوليا والحمص .

وذلك بنقع بذور هذه البقوليات فى الماء العادى على درجة الحرارة العادية لمدة ١٢ساعة - النقع لمدة ١٢ساعة ثم الطهى تحت الضغط الجوى العادى - النقع لمدة ١٢ساعة ثم الطهى تحت ضغط على درجة ١٢٠ م^{o} لمدة ٣٠ ، ٦٠ ، ٩٠ ، ١٢٠دقيقة .

أظهرت النتائج التأثير الواضح لهذه المعاملات على خفض مكونات هذه البقوليات من مضادات التغذية .

كما تظهر اهمية نقع البقوليات لمدة ١٢ساعة قبل طهيها لمدة ١٢٠دقيقة تحت ضغط .