EFFECT OF PROCESSING ON THE PROTEIN QUALITY OF SOME EGYPTAIN LEGUMES

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Abstract

The effect of processing conditions on the protein quality of some legume seeds (Soybean, Fababean, Cowpea, Navybean and Chick-pea) was studied. The protein efficiency ratio "PER" was estimated as a parameter to evaluate and select the most suitable process which could be used in the industry. Soaking and cooking significantly improved the protein quality, as the PER increased. PER was higher in raw and Soaked chickpea diets than in soybean, Faba bean and cowpea diets . Autoclaving for 120 min. led to an increase in the PER values of all legumes except chickpea. On the other hand, all rats reared on navy bean diets died; probably due to the presence of haemaglutinin and higher trypsin inhibitor activity PER was found to be high in samples that were Soaked before autoclaving for 120 min. Compared to raw samples, Cooked Soybean , Faba bean and chickpea had higher PER values than cowpea and navy bean.

INTRODUCTION

Protein quality is usually chemically and biologically assessed. Chemical methods include estimation of total and available amino acids. while biological methods are based on the ability to promote growth and nitrogen utilization. All legumes may not require the same conditions of processing to attain a maximum protein quality. The benefical effect of heat on the protein of legumes was explained by Kuppusway

et al. (1958) and Krehl and Barbariak (1960), who indicated that heat inactivated the trypsin and growth inhibitors -haemaglutinins and other toxic factors. Furthermore Devadas *et al.* 1964, Bender (1968) and Khan *et al.* (1979) reported that cooking improved the nutritive value, digestibility and availability of sulfur containing amino acids of most legumes due to destruction of trypsin inhibitor and toxic substacnces . In addition soaked boiled beans showed higher PER value and better protein quality (El-Nahry *et al.* 1977).

Therefore, this study was designed to select the suitable treatments of legumes to improve their biological protein value.

MATERIALS AND METHODS

Five legumes , Soyabean, Fababean, Cowpea, navy bean and chickpea samples were obtained from Agric. Research Centre, Egypt.

Legume samples were treated as follows:

(1) Raw legumes (Control).

(2) Soaking in plain water for 12hrs.

(3) Autoclaving at 120^{o}C for 2hrs.

The abovementioned treated samples were dried at 50^{o}C in hot air oven until constant weight (48 hrs) then ground in an electric grinder to pass through a 100-mesh sieve and kept at room-temperature in polyethylene bags until used.

Protein quality evaluation; Albino rats about 21-day old with weight of 34 to 90 gm. were obtained from the laboratories of the Nat. Res. Centre, Dokki and divided into 16 groups. 8 rats each (4 males 4 females were fed on normal diet for one week before the beginnig of the experiment.

Each rat was individually kept in a box. The experiment was carried for 28 days . In (Tables, 1:3) the composition of diets fed to the rats are shown . PER procedure was followed as described by Osboene and Mendel (1919) . A single level of protein was fed (usually 15% of diet) and the ratio of the weight gain over a four weeks period to the protein intake was calculated.

The mean PER for all groups was calculated by estimating the sum of PER calculated for each group.

Table 1. Constituents of diets prepared from different treated legumes samples and casein .

Ingredients	Diets of treated samples															
	Soy bean			Faba bean			Cowpea			Navy bean			Chickpea			Casein
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	15 %
Protein (15 %)	41.0	42.2	43.4	60.0	62.5	62.5	57.6	58.8	58.8	71.4	73.1	73.1	62.5	65.2	62.5	16.0
Matze starch	51.9	50.8	50.2	25.9	23.5	23.6	28.5	27.2	27.3	14.9	13.1	13.1	26.2	23.2	26.2	69.0
Cottonseed oil	2.1	2.0	1.4	9.1	9.0	8.9	8.9	9.0	8.9	8.7	8.8	8.8	6.3	6.6	6.3	10.0
Salt mixture	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vitamin mixture	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Diet No. 1 Contains raw legumes .

Diet No. 2 Legumes, soaked in water for 12hrs .

Diet No. 3 Legumes treatment by autoclaving at 120°C for 2hrs .

Table 2. Composition of salt mixture (From Briggs and Williams, 1963).

Salt mixture	Amount in grams
$CaCO_3$	725.0
$CaHPO_4$	1130.0
Na_2HPO_4	660.0
KC	730.0
$MgSO_4$	230.0
$MnSO_4H_2O$	15.4
$ZnCO_3$	5.3
$CuSO_4$	5.0
Ferric citrate	59.0
KIO_3	0.3

Table 3. Composition of Vitamin mixture (Morcos, 1967).

Vitamin mixture	Amount in grams
Thiamine hydrochloride	0.300
Riboflavin	1.000
Pyridoxine hydrochloride	0.200
Calcium pantothenate	6.000
Nicotinic acid	20.000
Inositol	20.000
P-Amino benzoic acid	60.000
Biotin	0.200
Folic acid	0.200
Cyanocobolamin	0.005
Choline chloride	60.000

Made up to one kilogram with maize starch.

Cholin chloride was dissolved in a small amount of ethanol and added slowly to the mixture.

The following equation was applied:

$$PER = \frac{\text{Gain in body weight (gm)}}{\text{Protein consumed (gm)}}$$

Statistical Analyses : Standard error and standard deviation of the mean were calculated according to the following formula:

$$S.E. = \frac{d^2}{n\,(n\text{-}l)}$$

S.D. = S.E.

Where :

S.E. = Standard error of the mean.
S.D. = Standard deviation of the mean.
n = Number of cases
d = Deviation form the mean.

RESULTS AND DISCUSSION

From data presented in (Table 4) and Fig. 1 it could be observed that diets containing raw legumes had low PER values which ranged from 0.97 to 1.3 Best PER (1.3) occurred by using chickepea diet (1.06) as compared to those of fababeans (1.02) , Soyabeans (0.97) and Cowpeas (1.06). Raw navy bean diet led to negative results as all rats fed on such diet died during the early weeks of experiment.

Soaking legumes for 12hrs. in water resulted in fair improvements of PER (Table 4 and Fig. 1) with positive results for navy beans diet (0.69). Other legumes showed PER values that ranged from 1.12 to 1.5. Soaking improved the legumes protein quality . On the other hand, autoclaving noticeabl increased the PER values. Higher PER was recorded for soyabean diet (1.75) followed by fababean (1.65) , Chick pea (1.46) , Cowpea (1.21) and navy bean (1.16) . All compared to those of the casein diet (2.8) A decrement in PER values for navy beans and cowpea diet was observed after autoclaving.

Such results indicated that autoclaving was better in improving the protein

Table 1. Constituents of diets prepared from different treated legumes samples and casein .

Diet		Raw legumes						Sooaked in water for 12 hrs.						Autoclaving at 120°C for 2hrs.					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Casein	Mean	50.10	146.9	96.30	248.0	37.20	2.80	-	-	-	-	-	-	-	-	-	-	-	-
	S.D.	19.70	23.10	12.30	41.42	6.22	0.42	-	-	-	-	-	-	-	-	-	-	-	-
	S.E.	7.00	8.20	4.40	14.70	2.21	0.16	-	-	-	-	-	-	-	-	-	-	-	-
Soybean	Mean	50.30	80.00	29.80	207.4	31.13	0.97	51.40	86.50	35.13	192.0	28.80	1.22	53.00	93.13	40.13	155.6	23.34	1.75
	S.D.	19.78	24.28	5.80	41.97	6.33	0.66	17.56	22.10	6.71	35.87	5.38	1.12	16.04	17.80	7.24	30.24	4.54	0.37
	S.E.	7.01	8.61	2.06	14.88	2.24	0.23	6.23	7.84	2.38	12.72	1.91	0.04	5.96	6.31	2.57	10.72	1.61	0.13
Faba bean	Mean	50.60	87.40	36.80	240.9	36.14	1.02	51.60	87.50	35.88	179.5	26.93	1.32	53.00	91.13	30.38	163.3	24.50	1.56
	S.D.	19.82	21.49	6.30	32.49	4.86	0.11	17.09	20.82	8.87	31.57	4.74	0.23	15.96	15.02	6.55	20.85	3.13	0.22
	S.E.	7.03	7.62	2.23	11.52	1.72	0.04	6.06	7.38	3.15	11.20	1.68	0.08	5.66	5.33	2.32	7.39	1.11	0.08
Cowpea	Mean	51.10	79.90	28.80	179.6	26.90	1.06	52.00	81.90	29.90	176.0	26.40	1.12	52.78	96.13	43.25	23.75	35.81	1.21
	S.D.	18.91	19.31	5.23	19.29	2.89	0.09	17.05	15.53	8.32	37.49	5.62	0.17	14.89	11.31	6.36	24.64	3.70	0.20
	S.E.	6.71	6.85	1.85	6.84	1.02	0.03	6.05	5.51	2.95	13.29	1.99	0.06	5.28	4.01	2.26	8.74	1.31	0.07
Navy bean	Mean	51.50	Dead	-	-	-	-	52.40	63.13	10.63	101.5	15.23	0.69	53.00	93.13	40.13	231.38	34.50	1.16
	S.D.	18.75	-	-	-	-	-	16.59	17.32	3.11	22.83	3.42	0.17	15.01	11.51	7.45	30.39	4.38	0.11
	S.E.	6.65	-	-	-	-	-	5.88	6.14	1.10	8.10	1.21	0.06	5.32	4.08	2.64	10.78	1.55	0.04
Chickpea	Mean	51.10	89.40	38.30	189.1	30.20	1.30	52.63	92.25	40.88	188.25	28.24	1.50	53.87	99.75	45.87	208.87	31.28	1.46
	S.D.	17.64	19.54	5.01	17.86	2.68	0.20	16.47	22.33	9.82	38.26	5.74	0.23	14.99	12.44	8.53	26.71	4.01	0.22
	S.E.	6.26	6.93	1.87	6.30	0.95	0.07	5.84	7.92	3.48	13.57	2.04	0.08	5.32	4.41	3.02	9.47	1.42	0.08

1= Initial body wt. (gm.) 2= Final body wt. (gm.) 3= Body wt. gain (gm.) 4= Total food intake (gm.)
5= Total protein intake (gm.) 6= PER value

$P > 0.05$

quality that soaking.

The foregoing results conicide with those obtained by Elias (1976), El-Nahry *et al.* (1977) , Sgarbieri *et al.* (1979) , and Kadum *et al.* (1987).

Accordingly , the soaking of the legumes under investigation for 12 hrs and a preliminary heating by autoclaving 120°C for 2 hrs. could be recommended for the treatment of legumes in order to raise the biological value of the proteins by increasing the protein efficiency ratio, as such treatments minimize the trypsin inhibitor activity, phytic acid content, and the oligosaccharides (raffinose, stachyose and verbascose). Soyabean protein was found to be suitable for the preparation of infant diets after treatments while navy bean protien was not suitable even after the being treated.

REFERENCES

1 . Bender, A.E. 1968. Factors affecting the nutritive value of protein foods. International Symposium Series, 14:319. Wenner - Gran Center.

2 . Briggs , G.N. and M.A. Williams , 1963. A new mineral mixture for experimental rat diets and evaluation of other mineral mixtures. Fed. Proc. 22:261.

3 . Devadas, R.P., R. Lula, E.N. Chandrasekaran, 1964. Effect of cooking on the digestibility and nutritive value of the proteins of black gram and green gram. J. Nutr. Dieter, 1:84.

4 . Elias, L.C., M. Harnadez, and B Bressani, 1976. The Nutritive value of precooked leugme flour processed by different methods. Nutrition Reports Internationa. 14 (4) 385 - 403 .

5 . El-Nahry, F., N.M. Darwish, and S. Tharwat, 1977. Effects of preparation and cooking on the nutritive value of local kidney bean Qual plant. Ph. Hum. Nut., 27.

6 . Kadum, S., R.R. Smithard; M.D. Eyte, and D.G. Armstrons, 1987. Effect of heat treatments of antinutritional factors and quality of proteins in winged bean. J. Science of Food and Agriculture, 39 (3) 667 - 675.

7 . Khan, M.A., I. Jacobson, and B.O Egyum, 1979. Nutritional value of some improved varieties of legumes. J. Sci. Food Agric . 30 : 395.

8 . Krehl, W.H. and E.F. Barbariak, 1960. Factors affecting utilization of Food Nutrients by the Normal Organism. In Nutritional Evaluation of Food Processing. Harris, R. Sand Von. Loescok, Heds. 527 . 534. 521, John willy New York.

9 . Kuppuswamy , S., N. Srinivasan, and Subrahinanyans, 1958. Protein in foods. Spec. Rept. Ser. No. 33. Indian Council of medical research.

10 . Osboene, T.B. Mendel , 1919. The nutritive value of the wheat Kernel and its milling products . J. Biol. Chem., 37 : 223, 551.

11 . Sgarbieri, V.C., L.P. Antunes, and L.D. Almeida, 1979. Nutritional evaluation of four varieties of dry beans . J. Food Sci. 44:1306.

تأثير عمليات التجهيز والطهي علي جودة البروتين فى بعض البقوليات

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فى هذه الدراسة تم دراسة تأثير عمليات التجهيز والطهى بالطرق المختلفة على جودة البروتين فى بذور بعض البقوليات مثل فول الصويا ، الفول البلدى ، اللوبيا ، الفاصوليا والحمص وذلك بتغيير قيم البروتين المستفاد (PER) على حيوانات التجارب .

وذلك كمقياس لاختيار أفضل طرق تجهيز وطهى البقوليات حيث تعتبر دليلا على سرعة النمو واهمية البروتين فى المحافظة على سلامة الجسم (فئران التجارب) .

وأثبتت الدراسة ان عمليات النقع والطهى تحت ضغط لمدة ١٢٠دقيقة على ١٢٠م^{o} أدى الى تحسن ملحوظ فى قيم البروتين المستفاد .

ومن ناحية أخرى فقد كانت القيمة الحيوية لبروتين الحمص سواء الخام او المنقوع أعلى من مثيلاتها من البقول تحت الدراسة .

كما لوحظ أثناء التجربة موت مجموعة حيوانات التجارب التى تغذت على وجبة الفاصوليا الخام ويرجع ذلك لوجود مادتى السبيا جلوتين ومثبط انزيم التربسين بنسبة عالية ويمكن التخلص منها بعمليات النقع والطبخ .

كما أكدت الدراسة على ان عينات فول الصويا والفول البلدى والحمص المطبوخ أعلا فى قيم البروتين المستفاد (PER) تليها اللوبيا والفاصوليا مما يدل على أهمية بروتين فول الصويا فى التغذية .