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Nutritive studies on some raw and prepared leguminous seeds commonly used in the Arab Republic of Syria

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With 2 figures and 5 tables

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Lentils (Lens esculentus) and chick pea (Cicer arietinum) are two popular leguminous seeds cultivated and consumed in the Syrian Arab Republic.

Reports have been published in the literature concerning the amino acid pattern of certain varieties of lentils and chick pea (1, 2). Investigations on the toxic factors of such seeds were carried out by *Sohonie* and *Bhandarker* (3, 4), who stated the presence of trypsin inhibitors in *Cicer arietinum*. *Honavar* (5) reported that Haemagglutinins are absent from chick pea. The PER of lentils alone or supplemented with D-L methionine were 0.91 and 2.51 as determined by *Nath* and *Nath* (6). *Chakrabati, Saxena* and *Nath* (7) found that the B.V. of lentils protein supplemented with 1 % protein from polished rice concentrates at 12 % protein level was 48.2. The PER of Bengal gram (Cicer arietinum) studied by *Esh* and *Basu* (8) ranged from 1.95 to 2.11 when studied on mixtures of *Cicer arietinum* and wheat at 12 % protein level of which 58 % was from chick pea and 42 % was from wheat.

Lentils is cooked with borghoul (parboiled wheat) to form a dish called *Mjaddara*. Chick pea is soaked in water, cooked and mixed with other food commodity to form another dish called *Taskia*. These two dishes are very popular in Syria.

The present work was designed to assess the nutritive value of lentils and chick pea cultivated in the Arab Republic of Syria. The presence of toxic factors in the seeds was also tested and assayed. The amino acid content of the whole seeds either raw and/or decorticated and cooked was also determined. Determination of the NPU of the raw and cooked seeds were carried out either alone or after being supplemented with authentic samples of amino acids.

Experimental

1. Sampling and analysis

The raw lentils and chick pea used through all these studies were brought from Syria. Each of the following treatments was carried out on 2 kg. of seeds.

1) Raw lentils seeds.
2) Lentils seeds cooked in boiling water for one hour.
3) Raw decorticated lentils seeds.
4) Decorticated lentils seeds cooked in boiling water for one hour.
5) Raw chick pea.
6) Chick pea cooked in water for 2 hours.

Immediately after respective treatments, all samples were subjected to the following analysis. Moisture, nitrogen, fat, crude fibre, ash and iron content of seeds were determined according to the methods described by A.O.A.C. (9). Calcium and phosphorus were determined as described by *Stuffins* (10). The amino acid content of samples were assayed using the paper chromatography technique of *Levy* and *Chung* (11), after being hydrolysed with hydrochloric acid according to *Khan* and *Baker* (12). Cystine and methionine were determined according to the method of *Jamalian* and *Pellet* (2). The colorimetric method of *Blauthi, Chareziniski* and *Berbec* (13) was used for estimation to tryptophan.

1.1. Determination of toxic factors

a. Trypsin inhibitors

Seeds were extracted with ammonium formate-formic acid buffer at pH 3.2. The trypsin inhibitors were assayed according to the method described by *Laskowski* and *Laskowski* (14).

b. Haemagglutinating activity of the isolated seed extract was determined according to the method of *Liener* and *Hill* (15), using rabbit red blood corpuscles.

c) Alkaloids were tested using Wagner's reagent. Their percentage was determined by the method of *Jenkins, Christian* and *Hanger* (16).

d. Cyanogenetic glucosides were tested according to the method of *Burnside* (17).

e. Saponins were determined as described by *Ain-shoka* (18). The alcoholic seed extracts were evaporated under vacuum and the residue was dissolved in normal saline. About 1 ml of solution was added to 10 ml of suspension of red blood corpuscles in normal saline (1 in 40). Hemolysis indicates the presence of saponins in the seeds.

1.1.1. Rat feeding experiments

For the determination of net protein utilization, the method given by *Miller* and *Bender* (19), was followed using hooded rats. One group of rats was fed the basal protein free diet of *Miller* and *Bender* (19). The protein sources under test were incorporated into the basal protein free diet at the expense of maize starch at the level to contribute 10 % crude protein to the diet as shown in table 1. After ten days the rats were killed and the NPU were calculated.

Results and discussion

Table 2 shows the average percentage composition for chick pea and lentils calculated as g/100 g sample.

Table 3 shows the amino acids content of the two seeds raw and cooked. 17 amino acids were detected and separated from the samples which were alanine, arginine, aspartic acid, cystine, glutamic acid, glycine, histidine, leucine + isoleucine, lysine, methionine, tryrosine, serine, threonine, phenylalanine and valine. Tryptophan was estimated colorimetrically. The tyrosine, arginine, glycine, aspartic acid, leucine + isoleucine and serine content of raw chick pea were far below those previously reported by *El-Nockrashy* and *Osman* (1). Glutamic acid, histidine, methionine and phenylalanine content of the seed exceeded their given values, while alanine, lysine, threonine and valine content of the seeds were similar to those published by *El-Nockrashy* and *Osman* (1) on local variety of chick pea, cultivated in Egypt. On the other hand, with regard to alanine, arginine, cystine, histidine, glycine, methionine, serine, glutamic acid and tryptophan contents of the raw chick pea, our results agreed with those

Table 1. Supplement to the basal diet (a. Chick pea).

Diet No.	A. A. Supplement DL-Meth. g. %	DL-Tryptoph. g. %	Raw Quantity added %	Protein added %	Cooked Quantity added %	Protein added %
1 Protein free.	–	–	–	–	–	–
2 Raw.	–	–	44.5	10.0	–	–
3 Raw. + Suppl.	0.5	0.1	41.8	9.4	–	–
4 Cooked.	–	–	–	–	51.3	10.0
5 Cooked+Suppl.	0.5	0.1	–	–	48.2	9.4

Table 1. Supplement to the basal diet (b. Lentils).

	A. A. Supp.		Raw		Cooked		Raw decort.		Cooked dec.	
Diet. No.	DL-Meth. g. %	DL-Trypt. g. %	Quantity added %	Protein added %	Quantity added %	Protein added %	Quantity added %	Protein added %	Quantity added %	Protein added %
1	–	–	–	–	–	–	–	–	–	–
2	–	–	42.3	10.0	–	–	–	–	–	–
3	0.5	0.1	39.8	9.4	–	–	–	–	–	–
4	–	–	–	–	46.3	10.0	–	–	–	–
5	0.5	0.1	–	–	43.5	9.5	–	–	–	–
6	–	–	–	–	–	–	39.6	10.0	–	–
7	0.5	0.1	–	–	–	–	36.7	9.4	–	–
8	–	–	–	–	–	–	–	–	42.3	10.0
9	0.5	0.1	–	–	–	–	–	–	39.8	9.4

obtained by *Jamalian* and *Pellett* (2). Comparing our results for the amino acid composition of raw lentils with those of *Jamalian* and *Pellett* (2), it was found that for lysine, methionine, cystine, aspartic acid, glutamic acid tyrosine no differences were observed. Valine, threonine, phenylalanine, leucine + isoleucine, histidine, glycine, arginine, and alanine values were slightly lower than those estimated by *Jamalian* and *Pellett* (2). Tryptophan values were within the range obtained by them.

The problem of fulfilling human requirements with respect to protein quality can justly be approached by comparing the pattern of essential amino acids in foods and diets with a desirable pattern based on knowledge of requirements of healthy human beings for essential amino acids. Comparing our results for the amino acid content of the two seeds with the provisional amino acid pattern given by the FAO (20), it could be observed that amongst the individual values were the low level of tryptophan and the sulphur-containing amino acids in the two seeds. The

Table 2. Proximate analysis of raw lentils and chick pea.

Item	Chick pea	Lentils
	g. %	g. %
Moisture	10.23	10.16
Protein	22.54	23.59
Ether extract	6.69	1.44
Carbohydrate by diff.	52.79	55.00
Fibre	4.65	4.25
Ash	3.10	5.65
	mg %	mg %
Calcium	164.8	382.4
Phosphorus	173.6	41.3
Iron	6.8	41.3

isoleucine, leucine, lysine, phenylalanine, threonine and valine contents of raw chick pea and raw lentils exceeded the values given by the FAO (20) provisional pattern.

Cooking the seeds resulted in slight losses for most of the amino acids studied, while the amounts of lysine and tryptophan increased slightly (see table 3). *Myklestad, Bjoernstad,* and *Leif* (21) showed that most individual amino acid levels decreased as the temperature increased. The slight increase in some amino acids was also observed by other workers. *Phadke* and *Sohonie* (22) reported an increase in the amounts of threonine, histidine, methionine and tryptophan for the double beans autoclaved for five minutes. *Kakade* and *Evans* (23) came to the same conclusion. They found that certain amino acids, namely isoleucine, leucine, threonine, tryptophan and valine were increased after autoclaving the kidney beans for five minutes at 121° C, while arginine, lysine, and methionine were decreased after autoclaving the beans for four hours. A loss in the values for most of the amino acids studied was observed when lentils seeds were cooked, with the exception of tryptophan and lysine.

Decorticating raw lentils seeds led to the increase for most of its amino acids content, this increase was due to the fact that the testa of lentils seeds contained traces of protein.

Cooking the decorticated lentils seeds decreased most of its amino acids with the exception also of tryptophan and lysine. *Talanov* (24) found that cooking hulled beans previously subjected to blanching led to a substantial decrease in their total amino acids.

Raw chick pea contained 633 u/g trypsin inhibitor (see table 4). Cooking chick pea in boiling water for one hour led to the destruction of all trypsin inhibitors. *Wagh, Klaustermeier, Waibel* and *Liener* (25) indicated that autoclaving red kidney bean for 30 minutes was sufficient to destroy all antitryptic activity. *Rakis* (26) came to the same conclusion, on treatment of soybean by live steam for 15 minutes.

Table 3. Amino acids content of raw and treated chick pea and lentils as compared with the FAO provisional amino acid pattern*).

Item	Raw chick pea	Cooked chick pea	Raw lentils	Cooked lentils	Raw decor. lentils	Cooked decor. len.	FAO patt.
Alanine	263	251	246	239	257	250	–
Arginine	526	502	492	470	507	473	–
Aspartic acid	675	662	705	687	710	704	–
Cystine	88	80	66	60	68	66	126
Methionine	88	75	57	52	61	53	144
Glutamic acid	1053	1034	991	992	1013	986	–
Glycine	175	151	238	231	243	243	–
Histidine	176	161	164	150	176	158	–
Tyrosine	190	165	170	158	182	162	180
Leucine + Isole	632	602	584	552	615	559	576
Lysine	430	441	475	480	486	487	270
Phenylalanine	465	445	246	240	250	230	180
Serine	307	301	295	268	304	276	–
Threonine	237	231	213	208	223	211	180
Tryptophan	52	60	48	60	49	62	90
Valine	289	271	287	269	291	276	270

*) Calculated as mg/g total nitrogen.

Table 4. Toxic substances present in the raw and treated chick pea and lentils.

Treatment	Saponins	Trypsin inhibitor U/g	Haemagglutinin U/g
Raw chick pea	+ ve	673	— ve
Cooked chick pea	+ ve	0	— ve
Raw lentils	+ ve	421	26
Cooked lentils	+ ve	0	0
Raw decorticated lentils	+ ve	435	29

No haemagglutinating activities were detected in the raw and cooked chick pea. *Honavar* et al. (5) stated that no haemagglutinins were detected in chick pea seeds.

Saponins were detected in raw and cooked chick pea. *Birk, Bondi, Gestetner* and *Ishaaya* (27) found that haemolytic activity of the soybean saponins was unaffected by the heat treatments necessary to produce optimum nutritive value of soy bean meal. It was found that lentils seeds contained 421 u/g trypsin inhibitor. Cooking the seeds destroyed the trypsin inhibitor and Haemagglutinins. Similar findings were reported by *Kakade* and *Evans* (28), *Jaffe* (29), *Wagh* et al. (28) and *Liener* and *Hill* (15).

The net protein utilization of raw and treated chick pea and lentils are shown in table 6. The weight curves of rats fed the different diets of chick pea and lentils are shown in figure 1 and figure 2, respectively.

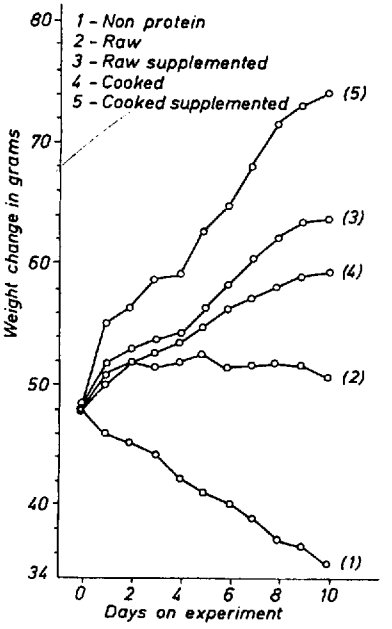

Fig. 1. See text.

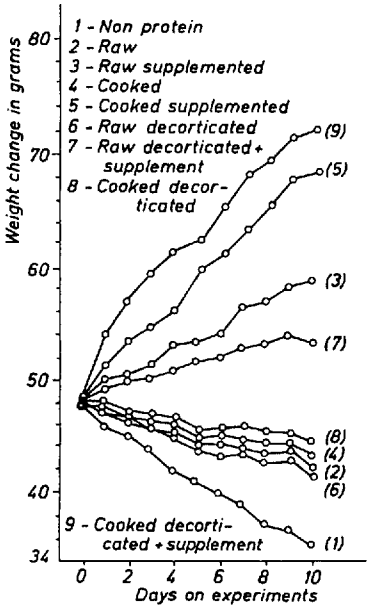

Fig. 2. See text.

Cooking chick pea in boiling water for two hours improved its nutritive value. The NPU of cooked chick pea was 58. *Kakade* and *Evans* (23) stated that mild heat treatment improved the nutritive value of navy bean. They attributed this improvement to be due to the destruction of trypsin inhibitors present in navy bean.

When raw chick pea was supplemented with the limiting amino acids, methionine and tryptophan, then fed to the rats, it was found that they gain weight and the NPU values increased from 53 to 56. This could be explained in the light of the relation between trypsin inhibitors, previously detected in raw seeds and sulphur-containing amino acids. Trypsin inhibitor was the substance responsible for the poor nutritive value of the unheated beans as it inhibits proteolysis. Methionine improved the nutritive value of raw soy bean. The following table given by *Liener, Deuel* and *Fevold* (30) indicates that the trypsin inhibitors somehow interfered with the availability or utilization of methionine from raw legumes.

Diet	Proteiny efficiency ratio
Raw soybean meal	1.33
Autoclaved soybean meal	2.62
Raw soybean meal + 0.6 % methionine	2.42

There is a little doubt that pancreatic hypertrophy observed on rats fed raw soybean meal is one of the primary physiological effects. *Booth, Rablins, Ribelin* and *De Eds* (31) were of the opinion that pancreatic hypertrophy leads to an excessive loss of endogenous protein in the form

Table 5. Body weight change, carcass nitrogen, nitrogen intake of rats and NPU of raw and treated seeds.

Rats fed on diet No.	Body weight change in g	Carcass nitrogen in mg	Nitrogen intake in mg	NPU
		a. Chick pea		
1	− 51	958.5	34.5	—
2	+ 8	1363.5	823.6	53
3	+ 42	1593.0	1153.5	58
4	+ 62	1722.6	1206.5	66
5	+108	2025.0	1550.7	71
		b. Lentils		
1	−57	837.5	31.5	—
2	−23	1134.0	863.1	38
3	−22	1147.5	898.7	38
4	−15	1188.0	977.5	39
5	− 9	1228.5	880.0	48
6	+20	1431.0	961.5	65
7	+43	1593.0	1249.2	63
8	+79	1836.0	1560.5	66
9	+95	1944.0	1625.7	70

of exocrine protein secreted by the pancreas. Since this protein is rich in cystine, this represents a net loss of cystine from the body. An increased need for cystine from protein biosynthesis during pancreatic hypertrophy is reflected by an increase in the conversion of methionine to cystine in the pancreas (32). This would explain why the need for methionine is particularly acute in diets containing raw chick pea which contains a large amount of trypsin inhibitors. As shown in table 5, rats fed on cooked chick pea supplemented with methionine + tryptophan increased in weight more than those fed on cooked chick pea alone. The NPU values increased from 58 to 71 for cooked and cooked supplemented chick pea, respectively. *Tannous, Cowan, Rinnu, Asfour,* and *Sabry* (33) demonstrated the improvement of biological value of legume protein brought about by supplementation with methionine.

Rats fed on the diet containing whole raw lentil seeds showed a loss on their body weight and low NPU value. Decorticating or cooking of the raw seeds did not improve their nutritive value. On the other hand the seeds which were decorticated before cooking showed a slight improvement in their nutritive value. When whole raw seeds were supplemented with the limiting amino acids (methionine and tryptophan), an increase in the growth weight of rats was observed and the NPU values of this diet increased to 66. A remarkable improvement in the nutritive value of supplemented seeds which were decorticated before cooking was also observed.

Summary

1. The proximate analysis of raw Syrian lentils *(Lens esculentus)*, variety red chick pea *(Cicer arietinum)* variety balady, has been made. The protein content of the two raw seeds were 23 and 22 g% for lentils and chick peas, respectively. Ethereal extract, fiber, ash, calcium, phosphorus and iron content of the two raw seeds have been also assayed.

2. The levels of most of the amino acids were also estimated in the raw and cooked seeds. It was found that tryptophan- and sulphur-containing amino acids were the most limiting ones. Cooking the seeds by the same methods commonly used in Syria resulted in the loss of most of the amino acids, with the exception of lysine and tryptophan which were slightly increased.

3. Trypsin inhibitors and saponins were detected in the raw seeds. Haemagglutinins were present in raw lentils only. Cooking the seeds destroyed the trypsin inhibitors and haemagglutinins and did not affect the saponins.

4. The net protein utilization of whole lentils and chick peas were 38 and 53, respectively. Decortication of lentils or cooking without decortication has no effect on the NPU values. Cooking the decorticated lentil seeds raised its NPU values from 38 to 56.

Cooking chick peas resulted in a slight increase in their NPU. Supplementation of the raw and treated seeds with methionine and tryptophan raised its NPU values markedly.

Zusammenfassung

1. Es wurde eine näherungsweise Analyse roher syrischer Linsen *(Lens esculentus)* und verschiedener roher Erbsen *(Cicer arietinum)* durchgeführt. Der Proteingehalt der rohen Samen betrug 23 g% für Linsen bzw. 22 g% für Erbsen. Ebenso wurden die Werte für den Ätherauszug, Faser- und Aschestoffe sowie für den Calcium-, Phosphor- und Eisengehalt für beide Samenarten ermittelt.

2. Die Werte der meisten Aminosäuren wurden bei den rohen und gekochten Samen ermittelt. Der Anteil tryptophan- und schwefelhaltiger Aminosäuren war begrenzt. Die in Syrien gebräuchliche Art des Kochens führte zu einem Verlust der meisten Aminosäuren; lediglich der Gehalt an Lysin und Tryptophan nahm leicht zu.
3. In den rohen Samen wurden Trypsin-Inhibitoren und Saponine festgestellt. Hämagglutinine wurden lediglich in rohen Linsen festgestellt. Der Kochvorgang zerstörte die Trypsin-Inhibitoren und die Hämagglutinine, während die Saponine dadurch nicht beeinflußt wurden.
4. Die Nettoproteinausbeute aller Linsen und Erbsen betrug 38 bzw. 53. Das Schälen der Linsen oder Kochen ohne Schälung veränderte die Nettoproteinausbeute nicht. Das Kochen geschälter Linsen erhöhte ihren Nettoproteinausbeutewert von 38 auf 56. Das Kochen der Erbsen bewirkte einen leichten Anstieg der Nettoproteinwerte. Ein Zusatz von Methionin und Tryptophan zu den rohen wie behandelten Samen erhöhte die Nettoproteinwerte erheblich.

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