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Protein and Amino Acid Contents in Seeds of Some Soy Bean Cultivars (Glycine max L.)

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ABSTRACT. Protein and amino acids were measured in seeds of 5 soy bean cultivars (Cabrillo, Rillito, Duocrp, CM-3 and RK-315). Cabrillo was found to countain the highest protein content (41. 46%) and RK-315 the lowest (38. 96%). Sixteen amino acids were detected and determined in the protein hydrolyzates; their concentration varied. Essential amino acids like leucine, Isoleucine, lysine, methionine, threonine, valine, phenylalanine were found in different quantities according to cultivars. Glutamic acid and arginine ranged between 900-1200 and 364-454 mg/g total nitrogen in the varieties.

Soy beans (*Glycine max* L.), sometimes called the king of legumes, contain the highest protein content 34-42% (Altschul 1965). Having greater versatility than any of the other legumes, they provide a variety of nutritive products such as tofu, okara, soya sauce and soya milk concentrate for infants (Simpson 1986). The seeds are among one of the worlds most important sources of oil and protein (Duke 1981). The Saudi Arabian agricultural policy aims at to increase the area of land under cultivation as well as introducing new crops to Saudi agriculture. Soy bean is considered to be one of the best potential crops because of its high nutritional value and its positive contribution as a leguminous crop to soil fertility (Al-Saheal *et al.* 1985). Experiences in neighbouring middle eastern countries, *e.g.* Egypt, Syria and Iraq, which have introduced soy bean are encouraging (Hamdi *et al.* 1969, 1974, Hegazy *et al.* 1984). Most of the previously published works in the Kingdom are done on inoculation with *rhizobium* sp. on soy beans (Trabulsi *et al.* 1982, Al-Saheal *et al.* 1985, Sliman 1990). However, information on nutritional value and chemical composition of soy bean seeds in the Kingdom, particularly on protein and amino acid content is limited and in this study these were measured for 5 cultivars grown locally and having agricultural potential.

Materials and Methods

The soy bean seeds were obtained from the Department of Plant Production, College of Agriculture, King Saud University (1990). They Comprised the following varieties, Cabrillo, Rillito, Duocrp, CM and RK-315. After cleaning, the seeds were dried and ground in a mill and the flour was analysed for ash, fat, protein and amino acids individually. Ash was determined according to the methods recommended by A.A.C.C. (1962). Fats were determined using unmilled seeds, which were ground in a reactor with 120 ml perchloroethylene C_2Cl_4 and measuring the fat percentage on the Foss-Let Instrument (A/S Foss Electric, Denmark). Total Nitrogen and protein were determined by a standard method (Basahy 1990) using seed flour by Kjel-Foss Automatic (A/S Foss Electric, Denmark). Three replicates were used in each analysis.

For amino acid content, the soy bean flour was hydrolysed with 6N HCL in evacuated sealed glass tubes, which were kept in a vacuum oven at 110°C ± 1°C for 24 hours. The amino acid composition of the protein hydrolysate was determined using the LKB 4400 Amino Acid Analyser. The buffer calibration mixture and ninhydrin reagent used in this work were all from «Ultropac» range of chemicals.

Results and Discussion

The ash content of soy bean seeds ranged between 4.76-5.23% on dry weight basis. Fats ranged between 18.3-19.4% (Table 1), these results agreeing well with those reported earlier by other investigators (Aykroyd *et al.* 1964 and 1966, and Kapoor and Gupta1977c). The protein content of soy bean seeds ranged between 38.96-41.46 (Table 2), which agrees well with the results reported by (Altschul 1965). However, Martin *et al.* (1967) reported that protein content indicated clearly that there is variation in the protein concentration of the five varieties. The variety Cabrillo contained the highest range of protein (41.56%), while the varieties RK-315 the lowest range of protein (38.46%).

Table 1. 100 seed/weight (g), Ash and fat of five cultivars of soy bean seeds (espressed as % dry weight basis) Mean ± SE

Cultivar	100/Seed weight (g)	Ash %	Fat %
Cabrillo	16.1554 ± 0.05	5.23 ± 1.73	19.4 ± 0.05
Rillito	14.5567 ± 0.07	4.92 ± 0.30	18.7 ± 0.08
Duocrp	12.9320 ± 0.04	4.76 ± 0.05	18.4 ± 1.73
CM-3	13.7419 ± 0.07	5.27 ± 0.04	19.2 ± 1.73
RK-315	13.5370 ± 0.06	5.18 ± 0.01	18.3 ± 0.04

* Values are mean of three replication.

Table 2. Nitrogen and protein content of five cultivars of soy bean seeds (expressed as % dry weight basis). Mean ± SE

Cultivar	Nitrogen %	Protein % (Nx6.25)
Cabrillo	6.65 ± 0.040	41.46^{a} ± 0.00
Rillito	6.45 ± 0.367	40.31^{b} ± 0.30
Duocrp	6.33 ± 0.066	39.58^{b} ± 0.40
CM-3	6.46 ± 0.033	40.42^{b} ± 0.00
RK-315	6.23 ± 0.066	38.96^{c} ± 0.36

* The different letters indicate significant difference using Duncan at 0.01%.

The results of the amino acid composition of 5 varieties are given in (Table 3), and were compared with the standard amino acid run. The quantitative determination of the amino acid composition in the protein hydrolysate of one of the soy bean varieties CM-3, is shown in (Fig.1).

Table 3. Amino acid contents in protein hydrolyzate of five soy bean cultivars (mg/g nitrogen)

Amino acids	Cabrillo	Rillito	Duocrp	CM-3	RK-315
Aspartic acid	730	450	640	725	780
Threonine	241	248	239	242	240
Serine	320	316	312	326	324
Glutamic acid	169	920	900	1200	1160
Glycine	361	342	328	364	460
Alanine	466	420	450	458	400
Cystine	83	45	54	62	86
Valine*	154	166	184	164	186
Methionine*	79	69	64	66	64
Isoleucine*	284	262	249	259	286
Leucine*	436	410	420	486	400
Tyrosine*	196	172	184	158	210
Phenylalanine*	289	296	299	304	289
Histidine*	152	164	136	184	162
Lysine*	399	369	386	350	420
Arginine*	380	364	370	386	454
Total Essential* amino acid	2610	2520	2531	2599	2711
Total amino acid	5531	4863	5212	5684	5921

Almost all of the essential amino acids such as lysine, leucine, threonine, methionine, valine, isoleucine and phenylalanine were significantly present in the seeds of

soy bean varieties; the notable exception was tryptophan. The disappearance of tryptophan could be attributed to its destruction during acid hydrolysis or by being missed by the integrator due to shifting of the retention time. A high peak of ammonia appeared in all the curves (Fig. 1); this could be attributed to the concentration of nitrogen in the soy bean seeds. Moreover, the protein rich cultivars, Cabrillo, CM-3 and Rillito contained the highest concentration of amino acids. The data shows that of all the essential amino acids, leucine was highest in all the cultivars followed by lysine in cultivar RK-315. (See Table 3).

The essential amino acids leucine, agrinine, lysine, phenylalanine, isoleucine, threonine valine, methionine are found in decreasing order of abundance. Overall the concentration of essential amino acids in these varieties is fairly good in amounts. The heaviest weight of seeds cultivar Cabrillo contains fairly good amount of amino acids.

As expected, it is shown that soy bean seeds are rich in protein and amino acids. The results show that cultivars Cabrillo and CM-3 contain more protein and amino acids than Rillito, Duocrop and RK-315. Among the amino acids, glutamic acid was present in high amount in the variety CM-3 representing 1200 mg/g nitrogen. Most of our results of amino acids are in agreement with those of the Food and Agriculture Organization of the United Nations (1970). The National Institute of Nutrition, Indian council of Medical Research (1989) and those obtained by Khattab (1972). The cultivar Cabrillo, Rillito and CM-3 are recommended for cultivation in Saudi Arabia as the seeds of these cultivars are robust and contain more protein.

The present study is part of a continuing work to obtain information about the protein and amino acid content of soybean seeds. It is hoped that a more extensive work would be undertaken in future to calculate the biological value (BV), net protein utilization (NPU), protein efficiency ratio (PER) and Chemical score for other legumes also.

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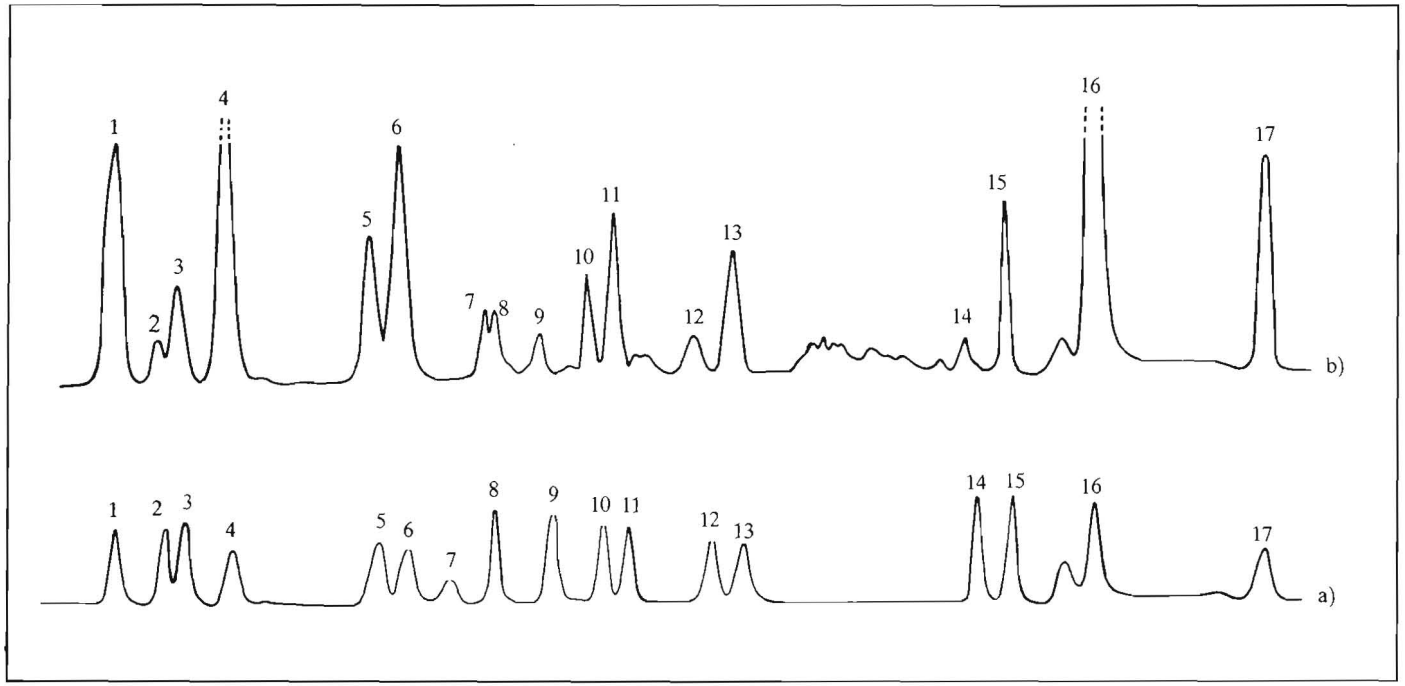

Fig. 1. (a) Standard amino acids run.
(b) Quantitative determination of amino acids in the protein hydrolysate of soy bean seeds from CM-3 cultivar.

1) Aspartic acid
2) Threonine
3) Serine
4) Glutamic acid
5) Glycine
6) Alanine
7) Cystine
8) Valine
9) Methionine
10) Isoleucine
11) Leucine
12) Tyrosine
13) Phenylalanine
14) Histidine
15) Lysine
16) Ammonia
17) Arginine

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المحتوى البروتيني والأحماض الأمينية لبعض بذور فول الصويا

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فول الصويا قد يدعى بملك البقوليات نظراً لاحتوائه على أعلى نسبة من البروتين تصل ما بين ٣٤ - ٤٢٪ الى جانب أن هذه البذور تعتبر من بين أهم المحاصيل في العالم إنتاجاً للزيت والبروتين. وكانت السياسة الزراعية في المملكة العربية السعودية هي محاولة زيادة الرقعة الزراعية بمثل هذه المحاصيل الهامة لقيمتها الغذائية من جهة ومن جهة أخرى لمساهمة هذه البذور في خصوبة التربة نظراً لما تقوم به من تثبيت للنيتروجين، وفي هذه الدراسة تم تحليل فول الصويا لما يحويه من بروتين وأحماض أمينية في خمسة أصناف منه وهي: كابريلو، ريليتو، ديركورب سي ام - ٣ و آر كي ٣١٥، وقد تم تحليل البذور للحصول على محتواها من الرماد، حيث وصلت نسبة ما تحتويه من الرماد ما بين ٤,٧٦ - ٥,٢٣٪ من الوزن الجاف وقد وجد أن تركيز المحتوى البروتيني لهذه البذور يختلف اختلافاً ظاهراً في هذه الأنواع الخمسة من البذور، مسجلاً أكبر محتوى للنوع كابريلو حيث بلغت نسبة البروتين في هذا النوع ٤١ر٤٦٪ يلي ذلك كل من سي ام - ٣ والريليتو.

أما الأحماض الأمينية الرئيسة لهذه الأنواع الخمسة من البذور مثل الليسين، الليوسين، الثيونين، الميثايونين، الفالين، الايسوليوسين والفينايل أمين فانها وجدت في هذه البذور ما عدا حمض الترايبوتونين وربما يعود سر اختفاء هذا الحمض الى تكسره نتيجة للتحلل.

ونظراً الى وجود النيتروجين في فول الصويا فقد ظهر المحتوى النيتروجيني بكميات كبيرة حيث تراوح تركيزه في كل من حمض الجلوتاميك والآرجنين ما بين ٩٠٢ - ١٢٠٠ لحمض الجلوتاميك، ٣٦٤ - ٤٥٤ ملجم/ الجرام للآرجنين، ومن هذا يتضح أن بذور فول الصويا تكون غنية بالبروتين والأحماض الأمينية مما قد يجعل هذه الدراسة من الأهمية بمكان لاعطاء بعض المعلومات عن القيم البيولوجية لهذا النوع من البذور.