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Chemical composition and protein properties of peanuts

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Summary: Because of the shortage of food proteins throughout the world, peanut has attracted the interest as potential source of protein for human as well as animal consumption. It was shown that peanut from the four different sources contained fair amounts of protein and its products. Mineral elements analysis revealed that K, Mg, Cu, Mn, Fe and P were present in nutritionally significant amounts in all samples. Moreover, K was found in high level. The nutritional value of protein is considered by its content of essential amino acids. Peanuts contained high levels of arginine and histidine. The remaining amino acids were present in substantial quantities except methionine, tryptophan and cystine were considered low. Peanut proteins were extracted from defatted flour by different solvents: deionized water, sodium chloride and calcium chloride solutions at different pH-values. The extracting ability at pH from 1–4 was decreased and increased at pH 4–5 by raising the concentration of sodium chloride solutions, respectively. Whereas on using sodium chloride solutions at pH 6–10, the percentage of extracted protein decreased again. Calcium chloride solutions suppressed protein extractability at all pH-values tested. Both mono and divalent salts increased protein extractability at pH 4–5.5 and the extraction increased with higher salt concentrations.

Zusammenfassung: Der Mangel an Nahrungseiweiß in bestimmten Gegenden der Welt hat auch Erdnußprotein für die menschliche und die Tierernährung interessant gemacht, da Erdnüsse durchaus beachtliche Mengen an Protein enthalten. Außerdem wurde gefunden, daß in allen untersuchten Proben Mg, Cu, Mn, Fe und P in ernährungsphysiologisch relevantem Umfang, K sogar ziemlich viel vorhanden war. Als Maß für den ernährungsphysiologischen Wert des Proteins diente der Gehalt an essentiellen Aminosäuren. Die Erdnüsse enthielten relativ viel Arginin und Histidin; die Gehalte an Methionin, Tryptophan und Cystin waren dagegen gering. Die Extraktion der Proteine – aus dem entfetteten Erdnußmehl – erfolgte mit verschiedenen Lösungsmitteln (entionisiertes Wasser, NaCl- bzw. $CaCl_2$-Lösungen) bei verschiedenen pH-Werten. Die Ausbeute war schlechter bei pH-Werten von 1–4, sie verbesserte sich bei pH 4–5 bzw. bei Erhöhung der Konzentration von NaCl in der Extraktionslösung. Weitere Erhöhung des pH-Wertes auf 6–10 führte bei NaCl-Lösungen zu einer Verminderung der Extraktionsausbeute. $CaCl_2$-Lösungen waren bei allen geprüften pH-Werten weniger geeignet; Erhöhung der Salzkonzentration wirkte sich bei beiden Salzen günstig aus.

Key words: Peanut, Chemical composition, Mineral analysis, Amino acids.

Introduction

Because of the projected shortages of food proteins throughout the world, it is expected that plant materials will play an increasing role in supplying proteins for human as well as animal consumption. Oilseeds and legumes are excellent sources of good quality plant protein which offer a partial solution of this problem. Peanut has attracted a great deal of interest as a potential source of supplementary protein for human food (Altschul, 1965; Woodroof, 1966). It contains a fair amount of protein and its products have found wide acceptance as food throughout the world. It is available in many countries, particularly those regions where protein deficiencies exist.

Therefore, the aim of this study was to investigate and evaluate its role in nutrition as well as the feasibility and amenability of extraction of protein content of Egyptian peanuts by different solvents, namely, sodium chloride and calcium chloride at different pH.

Materials and Method

One kg of peanuts were taken from different localities. The percentage of moisture, nitrogen, fat and ash were determined according to AOAC (1975) for the raw seeds, protein was calculated as $N_2 \times 6.25$. Eleven mineral elements which are considered nutritionally important, were determined in the present study. Fe, Cr, Na, Mn, Mg, Cu, Zn, and K were determined in the dry ash by atomic absorption spectrometry (Perkin-Elmer Crop 1975). Calcium and phosphorus were estimated according to the method used by Stuffins (1967), while chloride was estimated gravimetrically as described in AOAC (1975). The seeds were crushed in a mechanical grinder and defatted by repeated extraction with n-hexane and acetone at room temperature (Alid et al., 1981). For the amino acid analysis, fat free flour containing about 4 mg protein was, hydrolyzed with 6 NHCl at 110 °C for 24 h under nitrogen (Hegazi and Salem, 1972). Methionine and cystine were determined according to the method used by Moore (1963). Tryptophan was determined by the method of Hernandez and Bates (1969). The hydrolysates were analyzed with a Beckman Model 121 amino acid analyzer.

Protein extractions were achieved by treating defatted peanut flour with different solvents, namely, sodium chloride (0.01, 0.3, 1.0 M) and calcium chloride (0.01, 0.3, 1.0 M) as well as deionized water at different pH as recorded in results. The ratio of solid (defatted peanut flour) to solvents was 1:100 (W:V) (Kholief and Al-Afaleq, 1984). The suspensions were then shaked thoroughly for 1 hour and thereafter were centrifuged at 3000 r.p.m. for 20 min. followed by decantation of the supernatant (Rhee et al., 1972). The nitrogen content of the supernatant was determined by the micro-Kjeldahl method (AOAC, 1975).

Results and Discussion

This investigation was carried out to evaluate peanut seeds as a source of protein since fatty acid composition of peanut was clarified by many investigators (Hoffpair, 1953; Rosen, 1958; and Khalil and Chughta, 1978). The proximate composition of the samples investigated are recorded in Table 1. As seen from the table, the peanuts from different localities have almost the same chemical composition. Thus the average percentage of some constituents are as follows –; moisture: 3.26; ash: 7.17; protein ($N_2 \times 6.25$): 21.04; protein content of defatted peanut: 41, and fat: 50.33. These values are within the ranges reported by other investigators (Rhee et al., 1973; Khalil, 1976; McWatters and Cherry, 1977; Khalil and Chughtai, 1978, and Lusas, 1979).

Table 1. Proximate chemical composition of peanuts from different sources (g/100 g).

Sample No.	Moisture	Ash	Protein ($N_2 \times 6.25$)	Fat
1	3.2	7.0	20.9	50.0
2	3.2	7.3	21.1	50.9
3	3.3	7.6	21.2	50.0
4	3.3	7.4	21.0	50.9
Mean	3.3	7.2	21.0	50.3

Mineral elements are of disputable importance in the biochemical processes in vivo (Bell et al., 1976). The mineral elements analysis of the investigated samples are shown in Table 2. Eleven elements are detected which are considered to be essential in human nutrition. It is noted that potassium content as previously reported in some publications exceeds that of other elements (Khalil and Chughtai, 1978, 1983). K, Mg, P, Fe, Cu and Mn were found in nutritionally significant amounts. The average amount of Cr in peanut seeds is 0.31–0.40 mg/100 g, which is nutritionally significant considering that a Cr intake of about 150 μg/day is tentatively recommended for adult subjects (Anonymous, 1980). Because of Cr low requirement, its deficiency is rather rare and occurs in conjunction with protein-energy malnutrition. Cl, Na were present in low amounts; therefore salting peanut seeds with sodium chloride during roasting will raise their content. The ratio of Na/K is low which is of dietetic importance for people on low Na intake. These results are compatible with data published by Derise et al. (1974) and Galvao et al. (1976).

In the last two decades, much interest has been shown in peanut as potential sources of supplementary protein for human foods. This interest has resulted from the lack of adequate protein to provide needed nourishment for large segments of the world's population now and in the years ahead. Peanut protein at higher level is equal to that of beef protein (Khalil and Chughtai, 1977; Rhee et al., 1972; and McWatters and Cherry, 1977).

One of the important criteria of the nutritional value of protein is its amino acid composition. The amino acid make-up of peanut protein has

Table 2. Mineral element contents of peanuts from different sources (mg/100).

Sample No.	Cl	Fe	Cr	Na	Mn	Mg	Cu	Zn	P	Ca	K
1	6.1	1.8	0.3	8.2	1.1	174.2	1.3	4.1	250.5	63.1	671.7
2	6.0	2.1	0.4	13.2	1.1	168.4	1.4	5.1	230.8	55.1	670.7
3	6.7	1.9	0.4	15.2	1.1	170.2	1.3	4.1	290.6	54.1	672.3
4	6.5	2.1	0.3	14.3	1.1	167.8	1.3	5.1	246.1	63.2	593.3
Mean	6.3	2.0	0.3	15.2	1.1	170.1	1.4	4.6	254.5	58.9	652.0

Table 3. Amino acid composition of defatted peanut from different sources (g/100 protein).

Amino acids	Sample No.			
	1	2	3	4
Lysine	3.9	3.8	3.6	3.2
Histidine	2.4	2.6	2.5	2.5
Arginine	11.2	12.4	13.3	13.1
Threonine	2.6	2.7	2.8	2.7
Cystine	1.1	1.0	1.1	1.2
Valine	4.3	4.4	4.5	4.4
Methionine	0.8	1.2	1.1	0.9
Isoleucine	3.8	3.6	3.5	3.9
Leucine	6.5	7.0	6.9	7.2
Phenylalanine	5.0	5.5	5.3	5.4
Tryptophan	0.9	0.8	0.8	0.9

been reported by a number of workers (Busson et al., 1960; Chopra and Sidhu, 1967; Khalil, 1976; Lussas, 1979).

Table 3 shows the amino acids present in the different peanut seeds. Of the ten essential amino acids, arginine and histidine are abundant as in whole egg protein. The remaining essential amino acids are present in substantial quantities. Peanut protein is mainly deficient in methionine, tryptophan and cystine. This is in accordance with published data by McOsker (1962); Ory et al. (1978); Lusas (1979); Khalil and Chughtai (1983).

Extraction of oil is the first step in preparation of food protein ingredients. However, the severe heat treatment applied during processing as well as solvent extraction seriously reduce the nutritional quality of protein (Rhee et al., 1973; Kholief and Al-Afaleq, 1984). In this report the effect

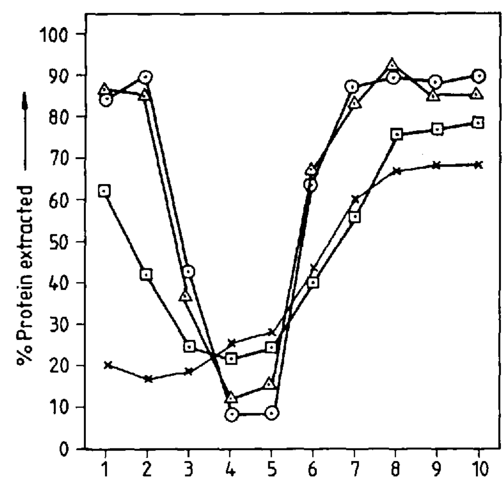

Fig. 1. Protein extraction by sodium chloride solutions at different pH-values. ⊙—⊙, H_2O; △—△ 0.01 M NaCl, 0.3 M NaCl, 1.0 M NaCl.

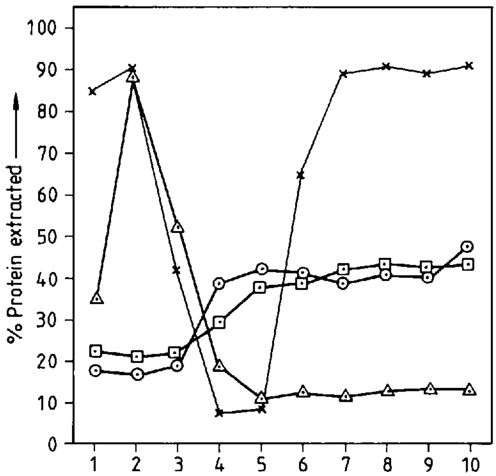

Fig. 2. Protein extraction by calcium chloride solutions at different pH-values. ×—×, H_2O, △—△, 0.01 M $CaCl_2$, □—□, 0.3 M $CaCl_2$, ⊙—⊙, 1.0 M $CaCl_2$.

of salt solutions at different pHs on the percentage of extracted proteins were compared. High percentage of proteins were found from either acidic or alkaline solutions of sodium chloride and water. As shown from Figure 1, the influence of pH of the dispersion on protein extractability indicated that: Using deionized water, the maximum extracted amount was at pH 2.8 and 10 and the minimum amount was at pH 4,5. These data are somewhat similar with that of 0.01 M sodium chloride solution.

In these experiments the tested salt solutions were used in place of deionized water followed by pH adjustment. Sodium and calcium chloride solutions acted to suppress the protein extractability at all tested concentrations (acidic and alkaline pH). This suppressive effect was more pronounced with calcium chloride. In case of monovalent salt, extraction of protein was decreased most by the higher salt concentrations, wheras with divalent salt, the suppression was greatest at lower concentrations. Both mono and divalent salts increased protein extractability in pH range, pH 4–5.5 whereas peanut protein is least extractable in water. At pH 4–5.5 the protein extraction increased with higher salt concentrations.

In acid conditions (pH 3.5 and lower), the protein extractability suppressed significantly with increasing the concentration of sodium chloride. The same effect was observed with calcium chloride solutions (0.3 M or higher). The behavior of proteins in the presence of decreased levels of calcium ions is considerable of practical significance. There is common interest in extending milk supplies by nonmilk proteins. It is accepted that such products should contain nutrients equivalent to cow's milk.

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