# EFFECT OF HEAT PROCESSING ON AMINO ACIDS, TOTAL SOLUBLES AND DIGESTIBILITY OF PEANUT PROTEIN

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*Abstract*

Peanut seeds were roasted by oven at 170°C for 20 minutes, and microwave at 500 watt for 5 and 7 minutes. Protein digestibility, amino acid contents and soluble protein were determined. The results showed that thermal processing caused changes in peanut protein and lead to the improvement protein digestibility and its nutritive value.

## INTRODUCTION

An increasing demand for edible-grade vegetable protein products is stimulating the development of new technologies to process foods from peanut (Ory and Conkerton, 1983). The uses and functionality of peanut protein have been recently and extensively reviewed by Conkerton and Ory (1987) and Cherry (1990).

The essential amino acids in 77 peanut lines and cultivars and the average quantities, expressed in total amino acids are 3-3.53% lysine, 2.44% histidine, 9.19% arginine, 4.16% threonine, 3.7% valine, 0.79% methionine, 3.04% isoleusine, 5.92% leucine, 5.06% phenylalanine and 0.88% tryptophane (Pancholy *et al.*, 1980). Peanut proteins were classified by Basha, (1988) to albumins, arachin and conarachin. Lysine, methionine and half cystine contents were found in higher amounts in conarachin than in arachin, while tyrosine and phenylalanine were higher in arachin (Chiou, 1990). Arachin had been reported to be more resistant than conarachin to dry heating at 150°C indicating that the essential ami-

no acids in arachin were more likely to be present in roasted peanut products (Chiou, 1990).

Young *et al.*, (1974) mentioned that peanut proteins undergo changes during thermal processing such as reduction in the total free amino acids and protein solubility. The decrease in protein solubility during heating had been attributed to protein denaturation (Neucere *et al.*, 1989). Roasting had been reported to decrease the availability of lysine, therionine and methionine by 5, 11 and 10%, respectively (Mcosker, 1962).

Fractionation of peanut protein on polyacrylamide gel electrophoresis showed when arachin and conarachin were treated with SDS they were reduced to polypeptide subunits (Cherry, 1990).

This study was conducted to evaluate the effect of heat processing by oven and microwave on amino acid contents, total soluble and digestibility of peanut protein.

## MATERIALS AND METHODS

Peanut seeds of Giza 2 variety were obtained from the Oil Crops Research Dept., Agric. Res. Cent. of Egypt. The samples were shelled manually and heated using two different methods, conventional oven at 170°C for 20 minutes, and microwave (Model MW 500 Mikrowell) at 500 watt (frequency of 2460 MHZ) for 5 and 7 minutes. After removing the red taste and the undesirable nuts, the sound nuts were defatted three times by grinding with acetone in a mortar at room temperature, filtered over buchner funnel under Vacuum, then dried at 40°C for 30 minutes (Stegmann *et al.*, 1987). Protein content and protein digestibility were determined according to the methods of A.O.A.C (1980) and Santosh and Chauhan (1986), respectively. Amino acid contents were determined by HPLC (Waters 600 Emultisolvent delivery system, Pico Tag) as stated by Millipore Cooperative (1987).

Chemical score was calculated according to FAO (1991). The essential amino acids in the samples compared with the standard amino acids in egg protein were arginine, histidine, isoleucine, leucine, lysine, methionine and cystine, phenylalanine and tyrosine, therionine and valine in amounts of 3.7, 3.2, 5.4, 9.5, 8.5, 3.5, 11.1,

4.2 and 6.3 g/100 protein, respectively.

Protein was extracted with tris Boric buffer pH 8.9 as stated by Stegmann *et al.*, (1987) and the total soluble proteins were identified using discontinuous sodium dodecyle sulfate-polyacrylamide gel Elctrophoresis (SDS-PAGE) according to the method of Laemli, (1970).

## RESULTS AND DISCUSSION

Heat treatment is known to improve the nutritional value of seed protein.

Table 1. Protein content and protein digestibility of peanut seeds roasted by oven and microwave.

| | Control | Roasted peanut | | |
|---|---|---|---|---|
| | | Oven 170°C/120 min | Microwave 5 min. | 7 min. |
| Protein Content* | 20.01 | 19.75 | 19.60 | 19.65 |
| Protein digstibility | 66.72 | 76.08 | 77.84 | 75.49 |

* ( g / 100 g ) on dry basis.

Data presented in Table 1 and Fig. 1 show protein content and protein digestibility of peanut seed roasted by oven and microwave. Protein content of untreated peanut reached 20.01%, while after heat treatments by oven and microwave for 5 and 7 minutes the protein contents were 19.75, 19.60 and 19.65%, respectively.

the effect of heating processes either by oven or microwave on protein digestibility showed that the highest protein digestibility value was obtained when peanut was microwaved for 5 minutes. In all cases of heating the protein digestibility increased by 14%, 16% and 13% over the untreated peanut. This had been relatd directly to the destruction of some inhibitors and the formation of the new proteins into a more readily digestible form (Kakade *et al.*, 1973). Also this could be due to that heating caused irreversible distruption of the quaternary structure of conarachin which is less resistant than arachin to dry heating (Chiou, 1990).

Table 2. Chemical score of essential amino acids of peanut seeds roasted by oven and microwave.

| | Egg protein | Peanut control | Roasted peanut | | |
|---|---|---|---|---|---|
| | | | Oven 170°C/20 min. | Microwave 5 min. | 7 min. |
| Arginine | 3.7 | 8.78 | 11.6 | 9.90 | 11.2 |
| Histidine | 3.2 | 2.81 | 2.78 | 2.03 | 2.61 |
| Isoleucine | 5.4 | 4.88 | 3.58 | 4.06 | 2.51 |
| Leucine | 9.5 | 5.94 | 6.11 | 5.78 | 5.89 |
| Lysine | 8.5 | 3.51 | 2.94 | 4.11 | 3.67 |
| Methionine & cystine | 3.5 | 4.29 | 2.20 | 4.45 | 2.21 |
| Phenylalanine &tyrosine | 11.1 | 10.9 | 8.19 | 9.09 | 7.1 |
| Therionine | 4.2 | 3.04 | 2.75 | 2.84 | 2.48 |
| Valine | 6.3 | 4.74 | 4.42 | 4.37 | 4.13 |
| Total | 55.4 | 48.89 | 44.57 | 46.63 | 41.80 |
| Chemical score | 1100.0 | 88.25 | 80.45 | 84.17 | 75.45 |

Data in Table 2 and Fig. 2 show the compositional changes in the essential amino acid content (g/100 g protein) and the chemical score compared to the essential amino acids in egg protein. The total essential amino acids in the control reached 48.89% while after heating by oven at 170°C or microwave for 5 and 7 minutes, it reached 44.57%, 46.63% and 41.8%, respectively. Mcosker (1962) mentioned that roasting decrease the availability of some essential amino acids.

The chemical score of the tested samples showed that the untreated peanut

had 88.25% while roasted peanut for 5 minutes by microwave had higher chemical score (84.17%) than those roasted by oven (80.45%) or microwaved for 7 minutes (75.45%). These results agree with the data of protein digestibility (Table 1) which indicated that roasting improve protein digestibility.

The total soluble protein of untreated, conventional heated and microwave heated (2460 MHZ) for 5 and 7 minutes were plotted on SDS-PAGE 12% to study the effect of different roasting methods on protein pattern distribution (Fig. 3). The results of SDS-PAGE clearly indicated that the unheated peanut seeds had a total of 24 protein bands with a molecular weight of 6.0 to 92.0 Kilo dalton (KD), while both microwave and conventional heating had peanut with a total of only 21 protein bands with a molecular weight ranging from 6.0 to 78.0 KD. The SDS-PAGE results also showed no significant differences in protein pattern distribution between roasted peanut using conventional oven or microwave heating. The scanner chromatogram obviously indicated that peaks (a), (b) and (c) were highly degraded after heat treatment either with oven or with microwave (Fig. 4). No significant difference was found in peak (e) between unheated and conventional heated sample, while it decreased in microwave heating for 5 and 7 minutes in comparison with unheated and conventional heated samples. The heat treatment caused a degradation of three proteins (marked with the arrows in the gel) with MW of 92.0, 62.0 and 26.0 KD, respectively. The three proteins disappeared after heat treatmentusing conventional or microwave heating. It was also clear that the higher MW protein (92.0 KD) had degraded to give an improved protein digestibility.

In conclusion, thermal processing of peanut seeds had led to the improvement of protein digestibility and its nutritive value.

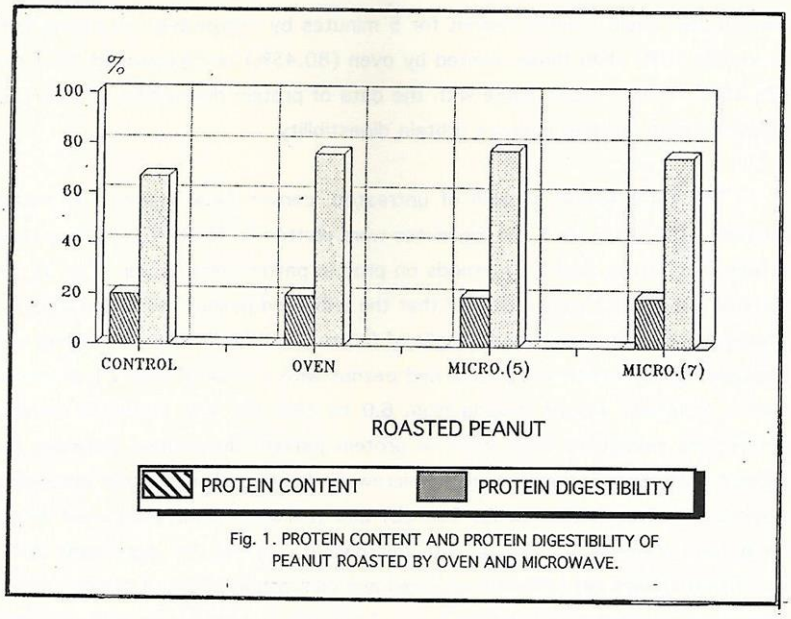


Fig. 1. PROTEIN CONTENT AND PROTEIN DIGESTIBILITY OF PEANUT ROASTED BY OVEN AND MICROWAVE.

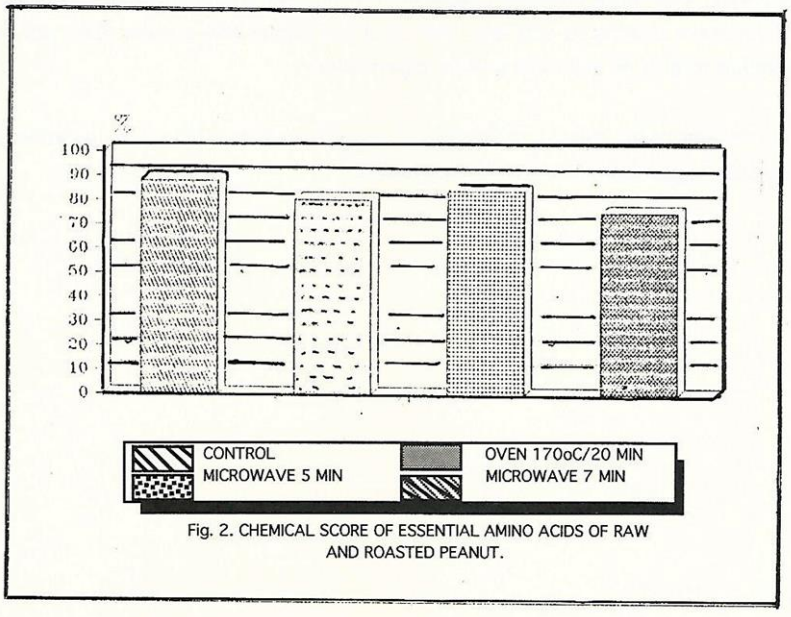


Fig. 2. CHEMICAL SCORE OF ESSENTIAL AMINO ACIDS OF RAW AND ROASTED PEANUT.

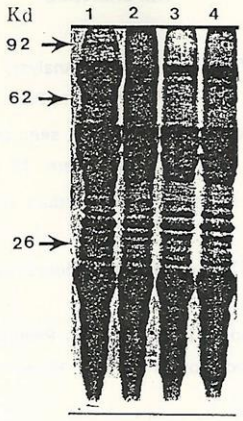


Fig. 3. SDS-PAGE 12% Electrophotogram of peanut total soluble proteins; where : unheated peanut (lane 1), conventional heated (lane 2), 5 minutes microwave heated (lane 3) and 7 minutes microwave heated (lane 4).

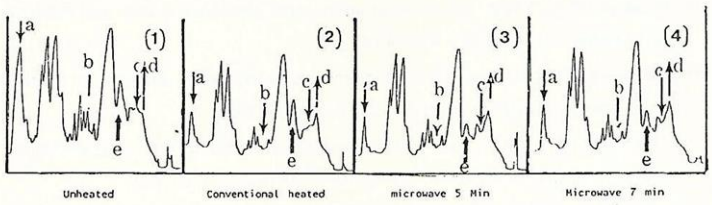


Fig. 4. SDS-PAGE scanning chromatogram of the unheated and heated peanut samples. The numbers (1) through (4) indicate the gel lanes 1 to 4, the letters with the arrows a through e indicate the changing peaks which also served as indicators for the changing of bands on the gel.

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# تأثير بعض المعاملات الحرارية علي الأحماض الأمينية والبروتينات الذائبة ومعامل هضم بروتين الفول السوداني

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تم إجراء عمليات تحميص الفول السوداني بإستخدام الفرن الكهربائي علي درجة ١٧٠ °م لمدة عشرين دقيقة وكذلك بإستخدام الميكروويف لمدة خمسة وسبعة دقائق . تم تقدير التغير في الأحماض الأمينية وكذلك معامل هضم البروتينات كما تم فرد البروتينات بواسطة الألكتروفوريسس لمعرفة مدي التغير الحادث نتيجة هذه المعاملات الحرارية .

وقد أوضحت النتائج زيادة في معامل هضم البروتينات بالرغم من بعض النقص الذي حدث في الأحماض الأمينية الأساسية وذلك بالنسبة لمعاملة التحميص بواسطة الميكروويف لمدة خمس دقائق كما أوضحت نتائج Chemical Score تفوق نفس المعاملة عن بقية معاملات التحميص .