RESULTS AND DISCUSSION

PART I:- Chemical Evaluation of Soybean, Peanut and Broad bean:

1. General analysis:

The chemical constituents of the selected legumes are given in Table (4). It can be observed that the moisture content was lower in the soybean than in the peanut and broad bean samples. For instance, while the moisture content was 5.05% in the Colombus soybean variety, it reached 5.81 and 9.51% in the peanut (Giza 4) and in the broad bean (Giza 1), respectively.

With respect to the protein content, soybean was characterized by higher levels of such component. Data obtained revealed that the protein of the Colombus soybean variety reached 34.11% which represents 1.55 and 1.48 times that of the peanut and broad bean samples, respectively.

The oil content of the soybean Colombus variety was 23.68%, while it was only 1.69% in the broad bean and 51.08% in the peanut.

The obtained results also indicated that the ash content was 5.99% for the Colombus soybean, 2.34 for the peanut (Giza-4) and 3.56% in broad bean (Giza-1).

With respect to content in sugars and related substances, analysis indicated that broad bean (Giza-1) is in the first order with a value of 65.21%. On the contrary, soybean and peanut were characterized by a lower level of these substances. Broad bean was reported to contain starch as the main constituent (Abd El-Hady, 1973), while soybean and peanut were found to contain a negligible amount of starch (Wolf, 1977).

Results of the present study, which indicated that soybean had a higher content in crude protein over peanut and broad bean, are in accordance with those found in the literature (Pellet and Shadarevian, 1970; Wolf, 1977). The crude protein content of the investigated soybean variety is in the range of values reported by Sekhon et al. (1975) for 33 strains of soybean Moreover, results of crude protein analysis in soybean

Table (4):- Chemical constituents of the investigated legumes.
(Calculated on dry weight baisis).

Chemical constituents %	The tested varieties		
	Soybean (Colombus)	Peanut (Giza-4)	Broad bean (Giza-1)
Crude protein	34.11	21.98	23.01
Ether extract	23.68	51.08	1.69
Ash	5.99	2.34	3.56
Sugars and related substances	30.16	19.14	65.21

are in the range indicated by Szyrmer (1977) and Marquard *et al*. (1980) for different strains of soybean. However, the found value for crude protein in the soybean variety is lower than those reported by Mustakas *et al*. (1970) and Wolf, (1977) for some american cultivars.

With respect to oil content, literature data (Mustakas *et al*. 1970, Wolf, 1977), are comparable with that found in the present study. Varietal and environmental differences could explain the wide range in crude protein (33-45%) and oil content (18-25%) for the different soybean cultivars as was indicated by the forementioned investigators.

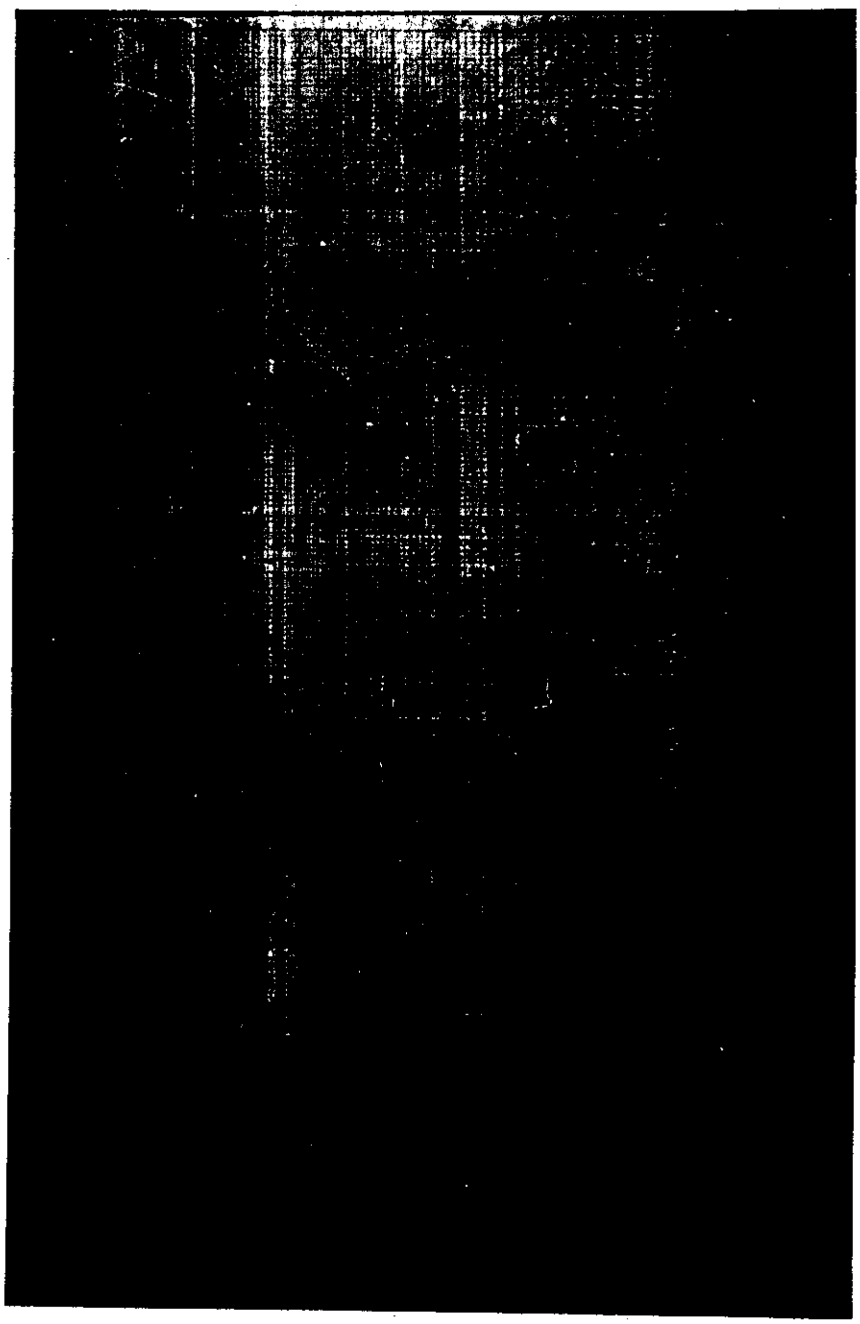
Values for protein content of the investigated broad bean and peanut varieties are lower than these found by many investigators (Hoffpauir, 1953, Pellet and Shadarevian 1970, and Marquardt *et al*.,1975). Although the oil content of the peanut variety compares well with the value reported by Hoffpauir, oil content of the tested broad bean variety is higher than that reported by Marquardt *et al*. (1975).

2. Amino acids composition:

The amino acid composition of a food protein is of fundamental importance in determining its nutritional quality. However, amino acid compositional data are only the first step in the nutritional assement of any food protein or its products chemically speaking, amino acids analysis describe a protein in terms of its content of each amino acid per unit mass of protein and in turn these data are useful in determining the amino acid sequence of such protein.

Chromatograms of the identified amino acids present in the three legumes investigated are presented in Figs.(1,2 and 3). Table (5) shows the amino acid composition of the raw defatted seed flours of the three legumes expressed in g amino acid/16 g nitrogen (g/100 g. protein).

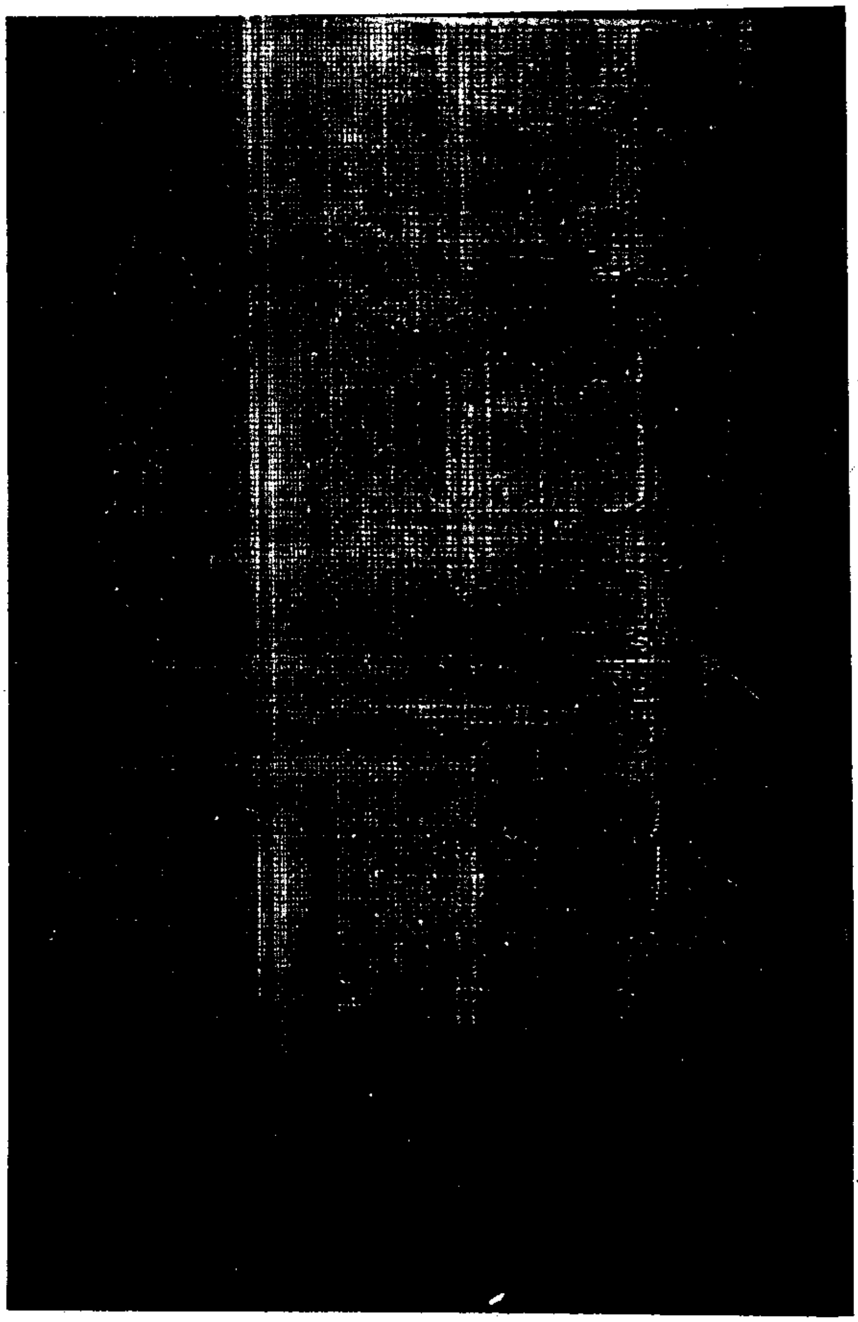
The ion exchange chromatographic analysis revealed the presence of 16 proteinaceous amino acids in seeds of soybean, peanut and broad bean. Tryptophan was determined by microbiological method and was listed also in Table (5). The amino acids compositional



data were not corrected to 100% kjeldahl nitrogen recovery since it is assumed that these samples were exposed to similar hydrolysis conditions. Moreover, the aim of the amino acids analysis of the present study was to make a comparison among the tested legumes rather than with other literature data.

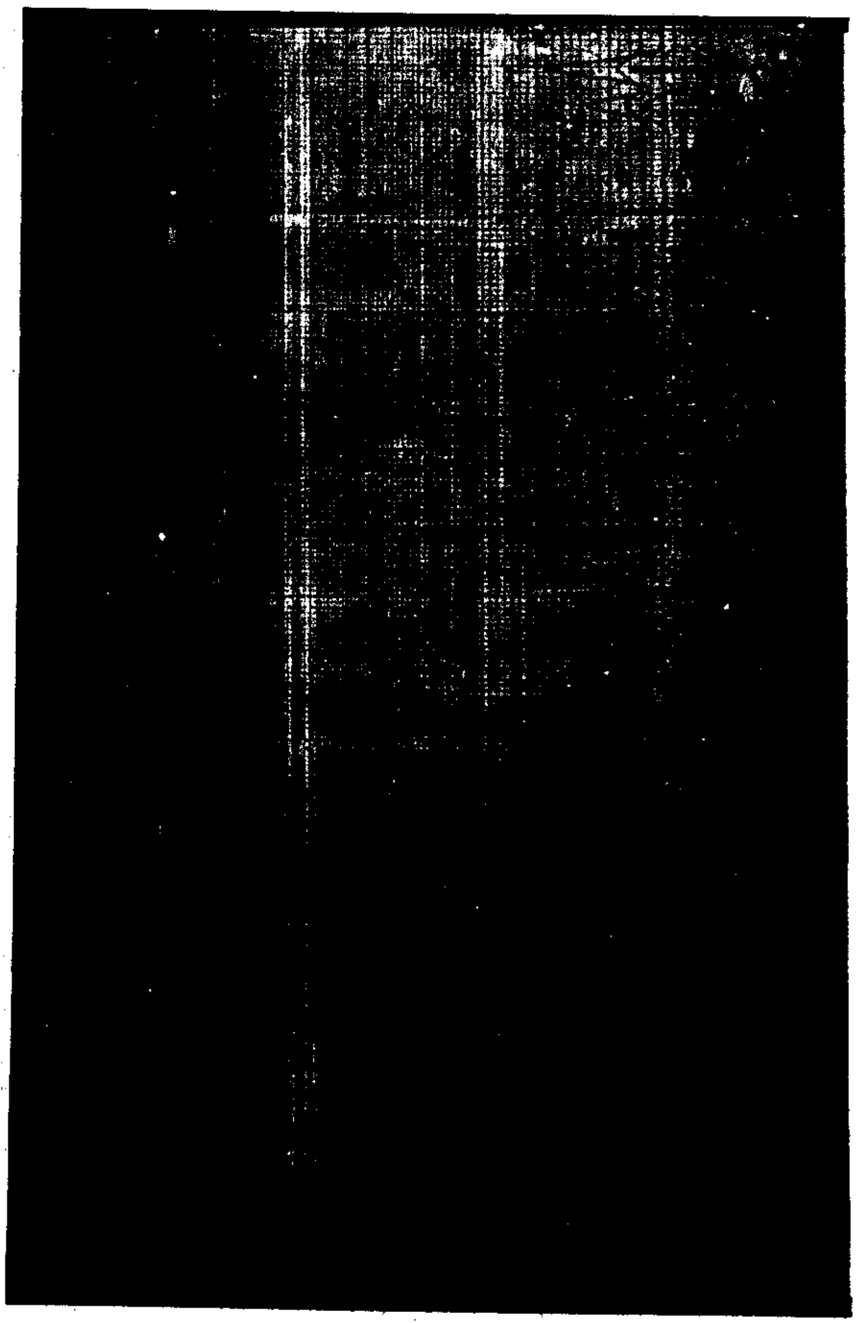
Data on amino acid composition of the investigated legumes revealed that certain differences exist between the amino acid pattern of the defatted samples and in the total amount of amino acids. Peanut signaled the highest amount in total amino acids (118.29 g N/16g N) and total non essential amino acids (84.35) followed by soybean then broad bean. However, soybean exhibited higher amount of total essential amino acids (42.23) over peanut (33.94) and broad bean (32.87).

All of the investigated samples exhibited higher amount of glutamic acid, which exceeded all the other amino acids present. Aspartic acid came in the second order in all samples. Peanut had the highest amount of these two non essential amino acids, while broad bean showed the smallest. However, these acidic amino



acids did not represent the largest percentage of the total amino acids present in the three legumes investigated. Neutral amino acids (Thr, Ser, Pro, Gly, Ala, Val, Leu and Ile) comprised the major part of the total amino acids (40.43, 33.37 and 40% for soybean, peanut and broad bean, respectively). Among the neutral amino acids soybean showed appreciable higher content in valine and isoleucine than the other two legumes. Furthermore, soybean had also a slightly higher content in leucine and threonine.

The basic amino acids (Lys, His and Arg) constituted about 18.88% of the total amino acids in soybean, a ratio which is smaller than those for peanut and broad bean (18.04 and 19.74%, respectively). However, soybean had the highest amount of lysine (7.29 g/16g N), a much high amount than in peanut and broad bean (4.06 and 5.99, respectively). This finding is important since lysine is the limiting amino acids in cereals ((FAO, 1970), the major food for the majority of populations in Egypt and many other developing countries. Moreover, soybean had a slightly higher content in histidine, an essential amino acids for infants (Pellet and Young, 1980).



With respect to aromatic amino acids (Tryp., Tyr. and Phe), peanut exhibited the highest amount (11.02 g/16g N) which represented 9.32% of the total amino acids. This can be attributed to its higher content in Tyr. and Phe. Both soybean and broad bean showed a different amount in these essential amino acids but a similar values when content in these amino acids are expressed in % of the total amino acids. (8.65 and 8.66%).

Among the sulfur amino acids, only methionine was determined under the conditions of the present study. The methionine values in the present study reflect the methionine content only and do not include the oxidation product. Cystine and cysteine are unstable during acid hydrolysis (Blackburn, 1968). Data in Table(5)indicates that soybean had the highest content in methionine, nearly twice that present in peanut or broad bean,and nearly half that present in meat as determined by El-Sanafiry (1983). The lower values for methionine, gives an indication that sulfur amino acids constitutes the least fraction of the total amino acids in all the three legumes.

Table (5):- Amino acids of the raw soybean, peanut and broad bean in compared to beef meat, and the recommended FAO patterns. (gm/16 gm N).

Amino acids	Soy-bean	Peanut	Broad bean	Beef meat	FAO[2] provi-sional pattern	FAO/WHO[3] pat-tern
Lysine	7.29	4.06	5.99	9.95	4.20	5.5
Histidine	2.75	2.55	2.11	3.27	-	-
Arginine	8.09	14.73	10.49	7.92	-	-
Asparatic acid	13.75	22.79	11.16	10.74	-	-
Threonine	3.82	2.84	3.48	4.93	2.80	4.0
Serine	4.71	5.81	5.12	4.61	-	-
Glutamic acid	21.44	23.12	18.22	18.63	-	-
Proline	5.09	4.49	4.95	4.78	-	-
Glycine	4.94	6.76	5.14	6.81	-	-
Alanine	4.41	4.10	4.10	6.53	-	-
Valine	6.07	4.57	3.74	5.83	4.20	5.0
Methionine	1.19	0.55	0.39	2.78	2.20	3.5
Cystine	-	-	-	-	-	-
Iso-leucine	5.73	3.67	3.84	5.33	4.20	4.0
Leucine	8.66	7.23	7.28	9.37	4.80	7.0
Tyrosine	3.22	4.68	3.12	3.54	2.80	3.0
Phenylalanine	5.28	5.51	4.09	4.34	2.80	3.0
Tryptophan[4]	0.97	0.83	0.94	1.14	1.40	1.0

1 Single analysis, uncorrected for 100% nitrogen recovery.
2 FAO (1957).
3 Joint FAO/WHO Ad Hoc Committee (FAO, 1973).
4 Determined by microbiological method.

A comparison of the present data with those found in the literature indicates either higher or similar values for most amino acids with the exception of methionine and tryptophan in all the legumes tested. For example, soybean amino acids data are either higher or similar to those reported by Rackis et al., (1961); FAO (1970); Rackis et al., (1971); Leiner (1977) and Sikka et al., (1978) which were determined by column chromatographic methods. The only exception lies in values for methionine and tryptophan which are lower than those reported by these investigators. In addition, there are lower values for the nonessential amino acids serine and proline than those reported by FAO, (1970). Aside from the possible analytical error, variatal and environmental effect could partly explain these difference in amino acids content. Moreover, methionine has been reported to show a certain loss during acid hydrolysis (Needleman, 1970), and has been implicated as the amino acid with which the most variation has been observed by ion-exchange chromatography (Knipfel et al., 1971). Furthermore, acid hydrolysis incompletely hydrolyze serine under normal conditions (Blackburn, 1968).

The picture of the amino acid content of peanut is nearly the same. Values for amino acids present in peanut are either higher or similar to those reported by FAO (1970) with the exception of methionine, arginine and glycine. However, all values(including methionine)are in the range of amino acids found in 16 peanut varieties as was indicated by the collaborative work of Young and Waller, (1973).

As for broad bean, values found for amino acids contents are either slightly higher or in close agreement with those reported by FAO (1970), with the exception of a slight decrease in isoleucine,valine and lysine. The same trend was also observed upon comparing the present data with those of Kaldy and Kasting (1974) and Marquardt et al., (1975).

Although the essential amino acid pattern of meat (as determined by El-Sanafiry, 1983) exceeds these of the investigated legumes, the present data for soybean, peanut and broad bean compare well with the FAO provisional patterns (FAO, 1965) with the exception of few values, mainly methionine and tryptophan. However, soybean was distinctive in that its amino acid pattern matched or exceeded the FAO provisional pattern (FAO/WHO, 1973) with the exception of methionine and slightly, threonine. This was not the case with the other two legumes which showed a lower values when compared with the FAO pattern (1973) with respect to all essential amino acidswith the exception of leucine, tyrosine and phenylalanine in both legumes and lysine in broad bean only.

3. Chemical indices based on amino acid contents:

According to FAO (1965) and FAO (1970) limiting amino acid could be calculated from the ratios of each essential amino acid in the food protein to its total essential amino acids that expressed as percentage of the ratios between the corresponding amino acid of egg and the total essential amino acids of egg. Table(6)and(7)show values used for calculating the chemical score and essential amino acid index (EAAI) as a mean for evaluating the legumes under investigation.

Tyrosine values have been combined to phenylalanine because the amino acids partially replace phenylalanine as nutritionally essential amino acid.

Methionine which showed the lowest percent with regard to the other tested amino acids was considered the limiting one. Values obtained for chemical scores were 40.79% for soybean variety, 23.55% for the peanut and 17.27% for the broad bean variety (Table 7). Similar conclusions were mentioned by Kapoor and Gupta (1977) who reported that soy protein contained a balanced amino acid pattern with the exception of methionine which was found to be the main limiting amino acid.

Table (6):- Essential amino acids of the tested samples as compared with Hen's egg.

Essential amino acids	Hen's egg as standard mg./100 gm sample[1]	mg./100 gm. samples of		
		Soybean	Peanut	Broad bean
Valine	847	2071	1004	860
Iso-leucine	778	1955	806	883
Leucine	1091	2954	1589	1675
Methionine	416	405	121	90
Cystine	-	-	-	-
Tryptophan	184	332	183	216
Phenyl alanine + Tyrosine	1224	2900	2239	1659
Lysine	863	2487	892	1378
Threonine	634	1304	624	801
Total	6037	14408	7458	7562

1 Source: El-Malky (1974).

Table (7):- Chemical scores and essential amino acid index of soybean, peanut and broad bean proteins.

Essential amino acids	Soybean	Peanut	Broad bean
Valine	102.45	95.95	81.06
Iso-leucine	105.29	83.86	90.61
Leucine	113.45	117.90	122.57
Methionine	40.79	23.55	17.27
Cystine	-	-	-
Tryptophan	75.60	80,51	93.72
Phenyl alanine + Tyrosine	195.85	299.84	217.26
Lysine	120.75	83.67	127.47
Threonine	86.18	79.67	100.86
Essential Amino Acid Index	89.64	86.38	84.56

These data indicate that soybean has a better chemical score followed by peanut then finally broad bean. These scores are necessarily lower than those reported in literature since methionine constituted the only sulfur amino acid under consideration, whereas cystine and cysteine were not determined. Obviously the addition of cystine and cysteine values would increase the chemical scores for the investigated samples. According to FAO (1970) soybean had a chemical score of 62, while peanut and broad bean had scores of 69 and 40, respectively, which are higher than those found in the present study. Kaldy and Kasting (1974) reported that protein scores calculated from amino acid analysis of eight faba bean cultivers was in the range of 36-46 with an average score of 40. These values are nearly double that found for broad bean in the present study.

Essential amino acid index (EAAI) according to Oser (1959) indicates a higher value for soybean (89.64) than peanut and broad bean (86.38 and 84.56, respectively). This is also another indication that soybean is superior to the other two legumes for the nutritional point of view.

A chemical score based on the essential amino acid content of egg protein carried out by Sikka et al., (1978) indicated that 1st limiting amino acids were methionine and cysteine (sulphur amino acids) in vegetable- and grain type var. of soybean. However, the essential amino acid index and biological value were also calculated and found to be well correlated to PER values in the case of vegetable- and grain-type variety.

PART II:- Technological Comparison Between Soybean, Peanut and Broad bean Products:

A technological study was carried out to investigate the suitability of soybean to replace either peanut or broad bean in some popular diets.

1. General analysis:

The methods used in processing different items of legumes, resulted in disturbing the chemical composition of the original legumes as seen in Tables (8), (9) and (10).

For instance, the moisture content of the caked soybean was less than that of the stewed soybean with about 13.58%,

These results may be attributed to the efficiency of the soy to absorp water during processing of the caked soybean or stewed soybean. These findings are in accordance with Simunek and Rottova (1975) who indicated that the soy protein absorped 7.6 ml water/g in 57 min. versus 14.5 ml/g in 55 min. for Japanese IPSO soy protein isolate.

Table (8):- Chemical constituents of the soybean products. (Calculated on dry weight basis).

Chemical constituents %	Raw soybean	Caked soybean		Stewed soybean		Roasted soybean	
		Actual %	Diffe-rence	Actual %	Diffe-rence	Actual %	Diffe-rence
Crude protein	34.11	34.84	+0.72	38.93	+4.82	22.46	-11.65
Ether extract	23.68	23.81	+0.13	22.45	-1.23	52.09	+28.41
Ash	5.99	7.87	+1.88	5.66	-0.33	3.95	- 2.04
Sugars and related substances	30.16	29.03	-1.13	25.90	-4.26	16.40	-13.76

The roasted soybean was characterized by a lower water content (1.83%) due to the loss of moisture during roasting. Moisture content in roasted peanut was 1.03% while that of the caked broad bean amounted to 63.44%. However, the stewed broad bean contained a moisture level of 72.32% which represented 7.60 times that of the raw broad bean.

These results indicated that soybean tends to absorb water through processing with higher rate than that of the broad bean which is very important from the economic point of view. In other words, soybean products especially caked and stewed soybean could successively compete the same products based on broad bean.

With respect to the protein and oil contents of the products, results indicated that soy products were characterized by a higher values of these two constituents than the corresponding products of broad bean. On the other hand, the roasted peanut came in the second order with respect to its fat content as compared with the roasted soybean. This could be explained on the basis that soybean seeds was roasted in oil, which was not the case for peanut seeds.

Table (9):- Chemical constituents of the peanut products.

(Calculated on dry weight basis).

Chemical constituents %	Raw Peanut	Roasted peanut	Difference
Crude protein	21.98	22.54	+0.56
Ether extract	51.08	50.54	-0.54
Ash	2.34	2.37	+0.03
Sugars and related substances	19.14	20.01	+0.87

Data of the present study supported the view that soybean and consequently soybean products contained higher level of protein than the other tested legumes. Soybean is one for the richest source of both protein and fats (Rinne et al., 1975).

The noticeable higher amounts of protein in the caked broad bean "Tamiah" with regard to the main broad bean sample could be explained on the basis that such items was produced from dehulled broad bean.

Regarding the ash content of the soybean products, data given in Table (8) showed that the caked soybean came in the first order with respect to the other soy products. This may be attributed to the other green ingredients which were added throughout the preparation of the caked soybean recipe. On the other hand, the ash content of the roasted soybean (3.95%) could be attributed to the employment of dehulled seeds before roasting. Same findings were noticed for the broad bean products. The ash content of the roasted peanut was approximately similar to that of the raw

Table (10):- Chemical constituents of the broad bean products.
(Calculated on dry weight basis).

Chemical constituents %	Broad bean	Caked broad bean		Stewed broad bean	
		Actual value	Diffe-rence	Actual value	Diffe-rence
Crude protein	23.01	30.27	+7.26	23.95	+0.94
Ether extract	1.69	1.92	+0.23	1.84	+0.15
Ash	3.56	5.42	+1.86	4.44	+0.88
Sugars and related substances.	65.21	59.05	-6.16	63.48	-1.73

peanut since seeds were not dehulled before roasting. It could be concluded that the technological process used for preparing the roasted soybean which employed the removal of the soybean hulls before roasting resulted in minimizing the ash content.

The analysis given in Tables (8), (9) and (10) lead to the conclusion that the lower sugars content of the roasted soybean (16.40%) is a function of the dehulling process. On the other hand the 25.90% sugar content of the stewed soybean may be attributed to the loss of some soluble sugars throughout stewing period which was extended for about 10 hours.

However, the stewed broad bean sample contained about 1.73% sugars less than the raw broad bean. This indicated that such amount may be lost through stewing.

By comparing the percentage loss in sugars during preparation of stewed samples, it seemed that such trend in soybean represented twice that noticed in broad bean sample. This trend is a function of the chemical constituents of the two samples especially the distribution of carbohydrates content in the structural form of both the two samples. Wilson *et al.* (1978) mentioned that starch is nearly nil in soybean (0.8%) while it reached 66.10% in broad bean as stated by Abd El-Hady (1973).

The caked soybean and caked broad bean contained 29.03 and 59.05% sugars, respectively. The latter value is lower than the original value of the raw broad bean because of using dehulled seeds of broad bean in making "Tamiah". The obtained results related to the broad bean products are in agreement to those given by Abd El-Hady (1973) and Darwish *et al.*, (1976). Furthermore, data for protein content are in accordance with those reported by Hussein and Youssef (1976).

Results obtained by Motwalli *et al.*,(1975-a)of the chemical composition of raw and roasted peanut are close to those found by the present study.

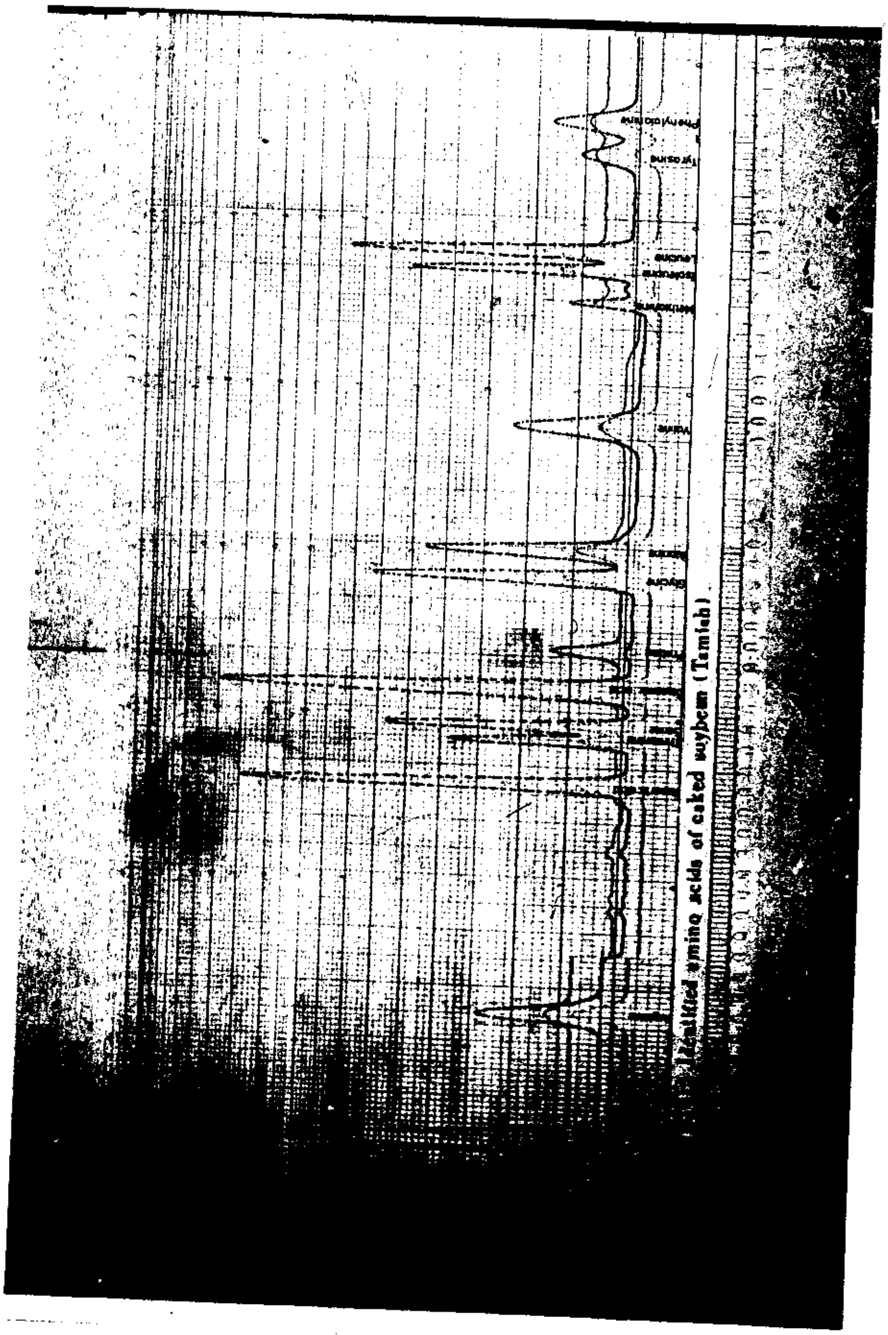
2. Amino acid composition:

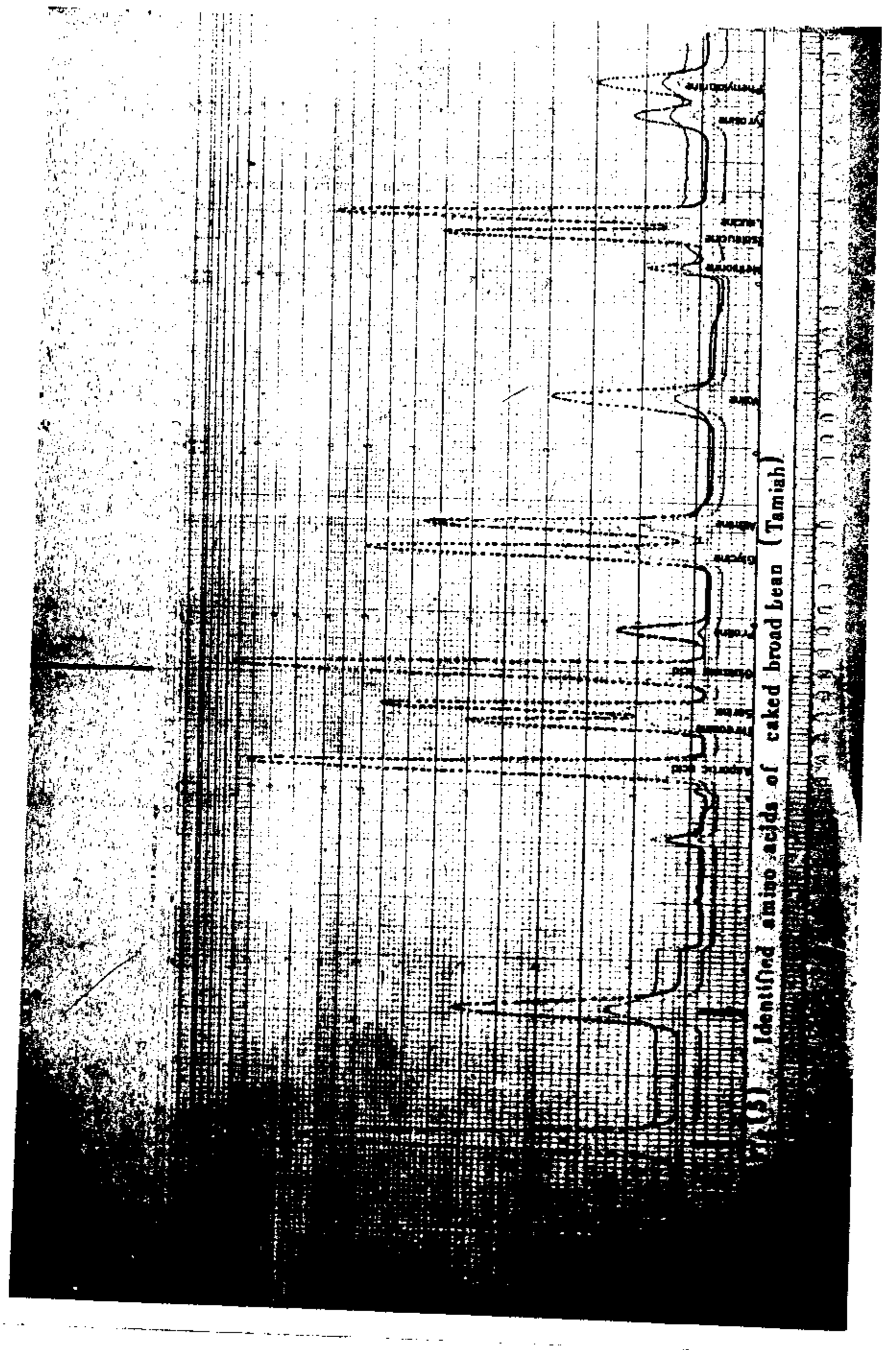
A comparative analysis was carried out to investigate the effect of different methods of preparation on the amino acid pattern of soybean, peanut and broad bean products. Fig. 4 and 5 indicated that the chromatograms of these products have the same amino acids patterns which were orginally present in the starting raw materials. However, Table (11) revealed certain changes in their concentrations. Caked soybean product exhibited a decrease in all amino acids (expressed in g/16 g N) with the exception of tryptophan which was increased. Caked broad bean showed a decrease in its amino acids content but to a much lower extent than caked soybean with the expetion of therionine and tyrosine. In addition, caked broad bean did not show any increase in tryptophan, but a distinctive increase in methionine and glutamic acid and very slight increase in valine.

The forementioned results could indicate that the method of preparation of caked products affect the amino acid pattern of soybean and broad bean. The higher and lower values for certain amino acids in the caked products could be attributed to many factors. The caked products employed dehulled seeds of soybean and broad bean which possibly contained different concentration of most amino acids as a result of the removal of hulls. Moreover , some vegetables like parsley, leek, garlic and onion were incorporated in the caked (Tamiah) paste which might have influenced the amino acid pattern. Furthermore, the soaking procedure for broad bean and soybean seeds before preparing the caked paste could have in fluenced the amino acid composition through the possible loss of non protein nitrogen which in turn resulted in changing the pattern of amino acids. Soybean was reported to have 5-30% of the total nitrogen in the form of non protein nitrogen according to the maturation stage and that the mature soybean were higher in non protein nitrogen when grown under adverse conditions as indicated analysis of 23 varieties grown 16-24 different location in USA and analyzed each year from 1951 to 1957,(Krober and Gibbons, 1962).

The higher loss in amino acid contents in the caked soybean could be evidenced by a lower total amino acids (88.93 g/16 g N) than the original amino acids present in the crude seeds (107.41) which represented about 22% loss. The essential amino acids in the caked products also were decreased similarly by about 22.2% which was not the case for broad bean (8.6% loss). However, the total non essential amino acids were also decreased resulting in no change in essential/non essential amino acid ratio (E:T) for soybean which was maintained for raw and the caked product. This ratio was slightly changed for broad bean from 0.35 for the raw seeds to 0.34 for the caked product.

The contribution of the acidic,neutral, basic and aromatic amino acids to the total essential amino acids did not change upon processing of soybean into caked product. However, this was not the case with broad bean, where the caked product exhibited a decrease in the contribution of acidic, neutral and aromatic amino acids to the total essential amino acids. Both soybean and broadbean caked paste showed an increase in methionine when expressed as percent of the total amino acids over those values found for the raw legumes.


Phenylalanine
Tyrosine
Leucine
Valine
amino acids of caked soybean (Tempeh)



(5) : Identified amino acids of caked broad bean (Tamiah)

Table (11):- Amino acid contents of caked soybean and broad bean[1].

Amino acids	Broad bean				Soybean			
	Raw gm./16 gm.N.	Caked gm./16 gm. N.	Difference gm./16 gm. N.	Percentage	Raw gm./16 gm. N.	Caked gm./16 gm. N.	Difference gm./16 gm. N.	Percentage
Lysine	5.99	6.10	+0.11	1.84	7.29	5.56	-1.73	23.73
Histidine	2.11	2.15	+0.04	1.90	2.75	1.42	-1.33	48.36
Arginine	10.49	8.67	-1.82	17.35	8.09	6.57	-1.52	18.79
Asparatic acid	11.16	11.14	-0.02	0.18	13.75	10.46	-3.29	23.93
Threonine	3.48	2.89	-0.59	15.36	3.82	2.94	-0.88	23.04
Serine	5.12	3.90	-1.22	23.83	4.71	3.84	-0.87	18.47
Glutamic acid	18.22	21.59	+3.37	18.50	21.44	17.41	-4.03	18.20
Proline	4.95	3.79	-1.16	23.43	5.09	4.27	-0.82	16.11
Glycine	5.14	3.76	-1.38	26.85	4.94	3.73	-1.21	24.49
Alanine	4.10	3.43	-0.67	16.34	4.41	3.36	-1.05	23.81
Valine	3.74	3.90	+0.16	4.28	6.07	4.36	-1.71	28.17
Methionine	0.39	0.60	+0.21	53.85	1.19	1.06	-0.13	10.92
Iso-leucine	3.84	3.36	-0.48	12.50	5.73	4.12	-1.61	28.10
Leucine	7.28	6.55	-0.73	10.03	8.66	6.60	-2.06	23.79
Tyrosine	3.12	2.30	-0.82	26.28	3.22	2.80	-0.42	13.04
Phenyl alanine	4.09	3.44	-0.65	15.89	5.28	4.08	-1.20	22.73
Tryptophan[2]	0.94	0.91	-0.03	3.19	0.97	1.35	+0.38	39.18

1 Single analysis, data uncorrected for 100% nitrogen recovery.
2 Determined by microbiological method.

Although of the observed loss in the essential amino acids, soybean content in lysine, cystine, tryptophan and phenylalanine + tyrosine exceeded the provisional pattern of FAO/WHO (1973). In contrast only one amino acid in caked broad bean i.e. lysine, exceeded this provisional pattern. This finding indicates that soybean is superior to broad bean in making a nutritious caked product.

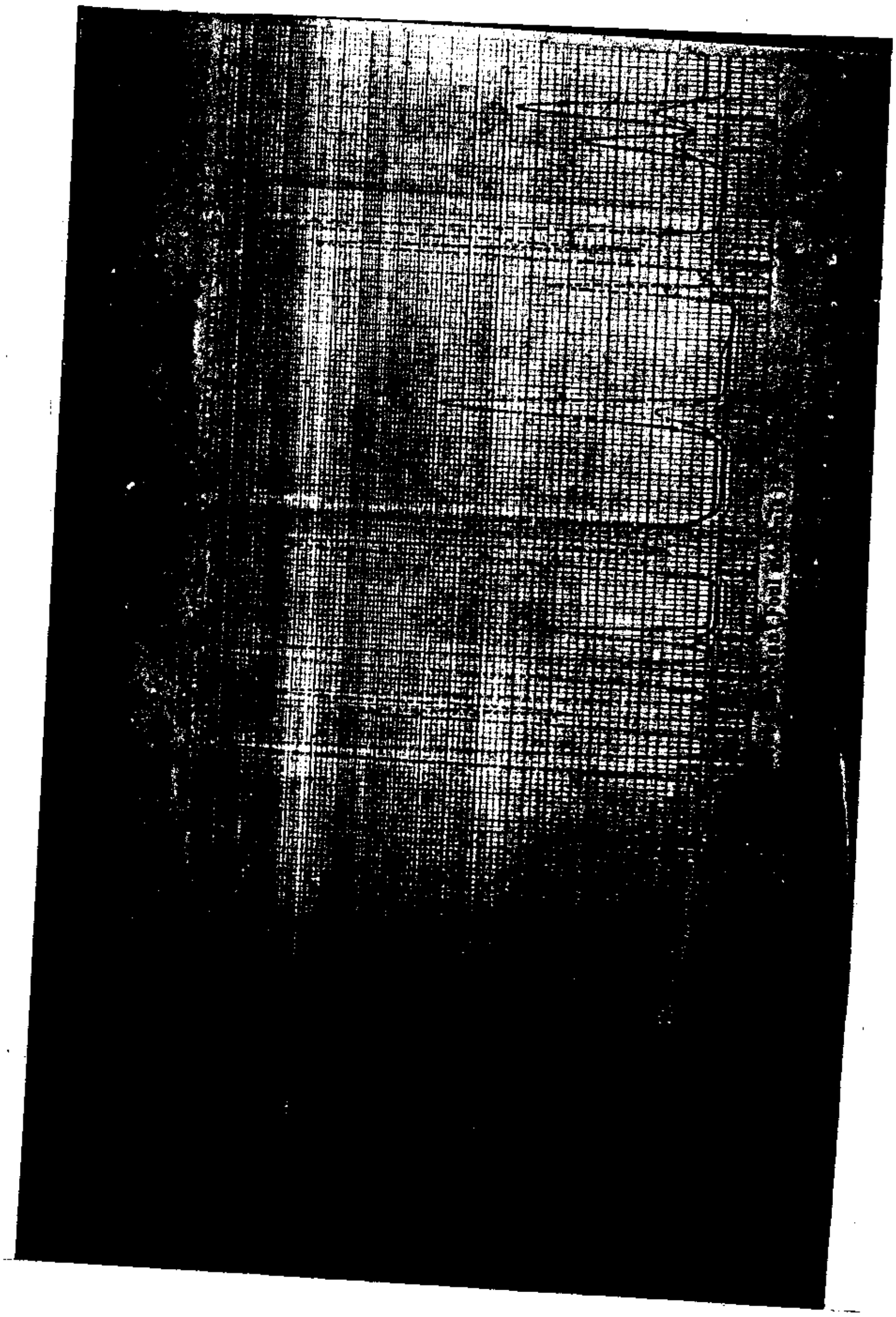
It should be taken in consideration that analysis for amino acids were performed on the caked or "Tamiah" paste before being fried and be ready for consumption. Thus, the thermal effect of frying the paste on the amino acids was not investigated under the conditions of the present study.

The amino acids content of the stewed soybean and broad bean are given in Table 12, while the chromatograms are presented in Fig. 6 and 7. It could be noted that all the amino acids of the stewed broad bean had higher values than those originally present in the raw sample, with the exception of the non essential amino acids proline and glycine which showed a marginal decrease. This was manifested (109.55 vz

94.16 in the raw seeds). However, the total essential amino acids was increased (42.7) at the expense of the total nonessential amino acids (66.84). This means that there was a 23% increase in the total amino acids and 8% increase in the total nonessential amino acids upon processing broad bean into stewed products. These findings resulted in an improvement in the total essential/total amino acid ratio (E:T) for the stewed product. In spite of the observed increase in amino acids content and the inturn increase in their fractions; the proportion of the acidic and basic amino acids to the total amino acid remained constant. The contribution of neutral, aromatic and methionine fractions to the total amino acid was increased.

The amino acid pattern of stewed soybean behaved differently than the stewed broad bean sample. Total amino acids were decreased to 102.9 g/16 g N with a percent of only 4 % decrease, whereas the total essential amino acids was decreased by 6.25% and the total nonessential amino acids was lowered by 4% than values registared in the raw seeds. Some amino acids were slightly increased, namely, threonine, methionine, alanine and serine. Others were increased markedly, namely, tryptophan (80% increase) and serine (10% increase) than values in the orginal seeds. The basic and acidic amino acids suffered from a decrease in their amount. However, most of the decrease was for the basic amino acids (lysine 15%, histidine 14% and arginine 17% decrease). Furthermore, the only fraction which showed a decrease in its contribution to the total essential amino acids upon stewing of soybean was the basic amino acids. Such change in the basic amino acid could be explained by the fact that these amino acids could presumably complexed by the Millard reaction during stewing process. Such effect is marked in soybean than broad bean since soybean is known to contain appreciable amounts of soluble sugars,mainly oligosaccharides(Delente and Ladenburg, 1972),while broad bean contain mainly starch as the source of carbohydrate material and a limited amount of oligosaccharides. (Wolf, 1977, Haivikul and D'Appolonia, 1979).

In contrast to the caked products, amino acids pattern of the stewed soybean and broad bean matched or



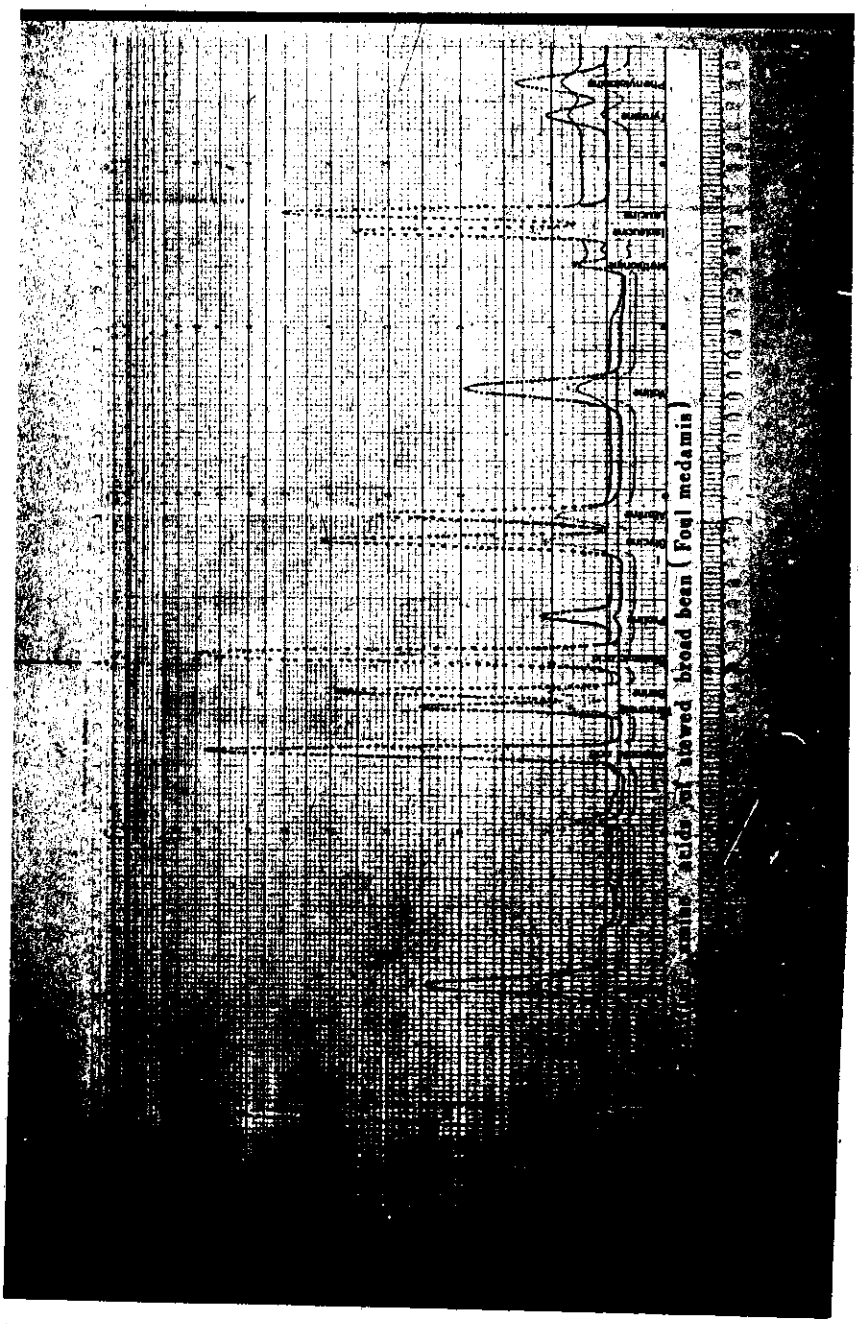

acids of stewed broad bean (Foul medamis)

Table (12):- Amino acid contents of stewed soybean and broad bean[1].

Amino acids	Broad bean				Soybean			
	Raw gm./16 gm. N.	Stewed gm./16 gm. N.	Diffe-rence gm./16 gm. N.	%	Raw gm./16 gm. N.	Stewed gm./16 gm. N.	Diffe-rence gm./16 gm. N.	%
Lysine	5.99	7.47	+1.48	24.71	7.29	6.20	-1.09	14.95
Histidine	2.11	2.70	+0.59	27.96	2.75	2.36	-0.39	14.18
Arginine	10.49	10.76	+0.27	2.57	8.09	6.68	-1.41	17.43
Asparatic acid	11.16	13.45	+2.29	20.52	13.75	12.51	-1.24	9.02
Threonine	3.48	3.87	+0.39	11.21	3.82	4.00	+0.18	4.71
Serine	5.12	5.34	+0.22	4.30	4.71	5.21	+0.50	10.62
Glutamic acid	18.22	20.31	+2.09	11.47	21.44	21.47	+0.03	0.14
Proline	4.95	4.78	-0.17	3.43	5.09	5.94	+0.85	16.70
Glycine	5.14	5.01	-0.13	2.53	4.94	4.53	-0.41	8.30
Alanine	4.10	4.49	+0.39	9.51	4.41	4.65	+0.24	5.44
Valine	3.74	6.10	+2.36	63.10	6.07	5.11	-0.96	15.82
Methionine	0.39	0.96	+0.57	146.15	1.19	1.28	+0.09	7.56
Iso-leucine	3.84	5.68	+1.84	47.92	5.73	5.02	-0.71	12.39
Leucine	7.28	8.46	+1.18	16.21	8.66	8.43	-0.23	2.66
Tyrosine	3.12	3.94	+0.82	26.28	3.22	2.88	-0.34	10.56
Phenyl-alanine	4.09	5.00	+0.91	22.25	5.28	4.92	-0.36	6.82
Tryptophan[2]	0.94	1.23	+0.29	30.85	0.97	1.75	+0.78	80.41

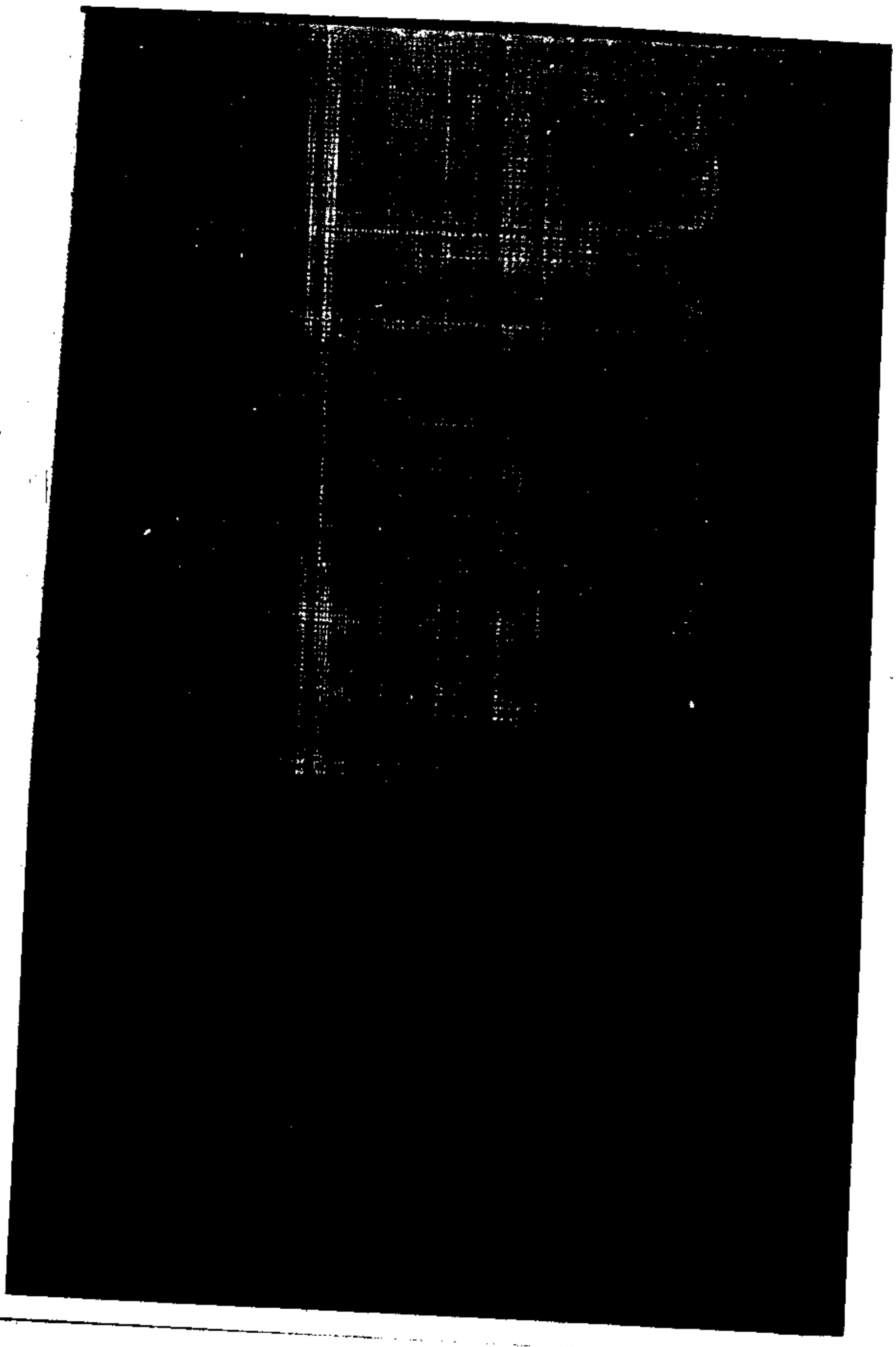
1 Single analysis, data uncorrected for 100% **nitrogen** recovery.
2 Determined by microbiological method.

exceeded the FAO/WHO provisional pattern (FAO, 1973), with the exception of methionine in both products. Threonine content in stewed broad bean was slightly lower than the proposed pattern. This observation indicates that stewed products are superior to the caked pastes and that the thermal treatment upon stewing did not affect greatly the nutritive value of the proteins.

With respect to the roasted products, chromatograms of the identified amino acids are shown in Fig. (8) and (9), while the compositional data of amino acids are given in Table (13). With the exception of tryptophan and methionine, all the amino acids values of the roasted peanut was lower than those for the raw peanut. This was not the case for roasted soybean whereas certain amino acids increased and others decreased in a variable percentage of increase and decrease. Among those decreased markedly in roasted soybean are the essential amino acids lysine, histidine, arginine, valine, methionine, isoleucine, phenylalanine and the nonessential acidic amino acids aspartic acid and glutamic acid. This observation in turn, resulted in a marked decrease in the total essential amino acids in roasted soybean (13% decrease) compared to only 5.6% decrease for the roasted peanut. In fact, most of the decrease in amino acids values in roasted soybean lies in the essential rather than the nonessential (8% decrease) with a total amino acids loss of 10% of the original sample. For peanut, most of the loss was at the expense of the nonessential amino acids (14.6% decrease) with a total amino acids loss of 12%.

Most of the decrease in the amino acids of the roasted soybean could be attributed to the loss in the basic and acidic amino acids, 31.07 and 13.73 g/16 g N respectively), values much lower than those in the original seeds. Furthermore, the contribution of the basic amino acids fraction to the total amino acids was also reduced. The same trend was noted in the roasted peanut, since both the basic and acidic amino acids also were reduced. These findings indicate a complexing of some of the basic amino acids through the Millard reaction upon roasting of soybean by the method employed in the present study and the possible contribution of acidic amino acid to the denaturation process.

The observed difference in amino acid pattern



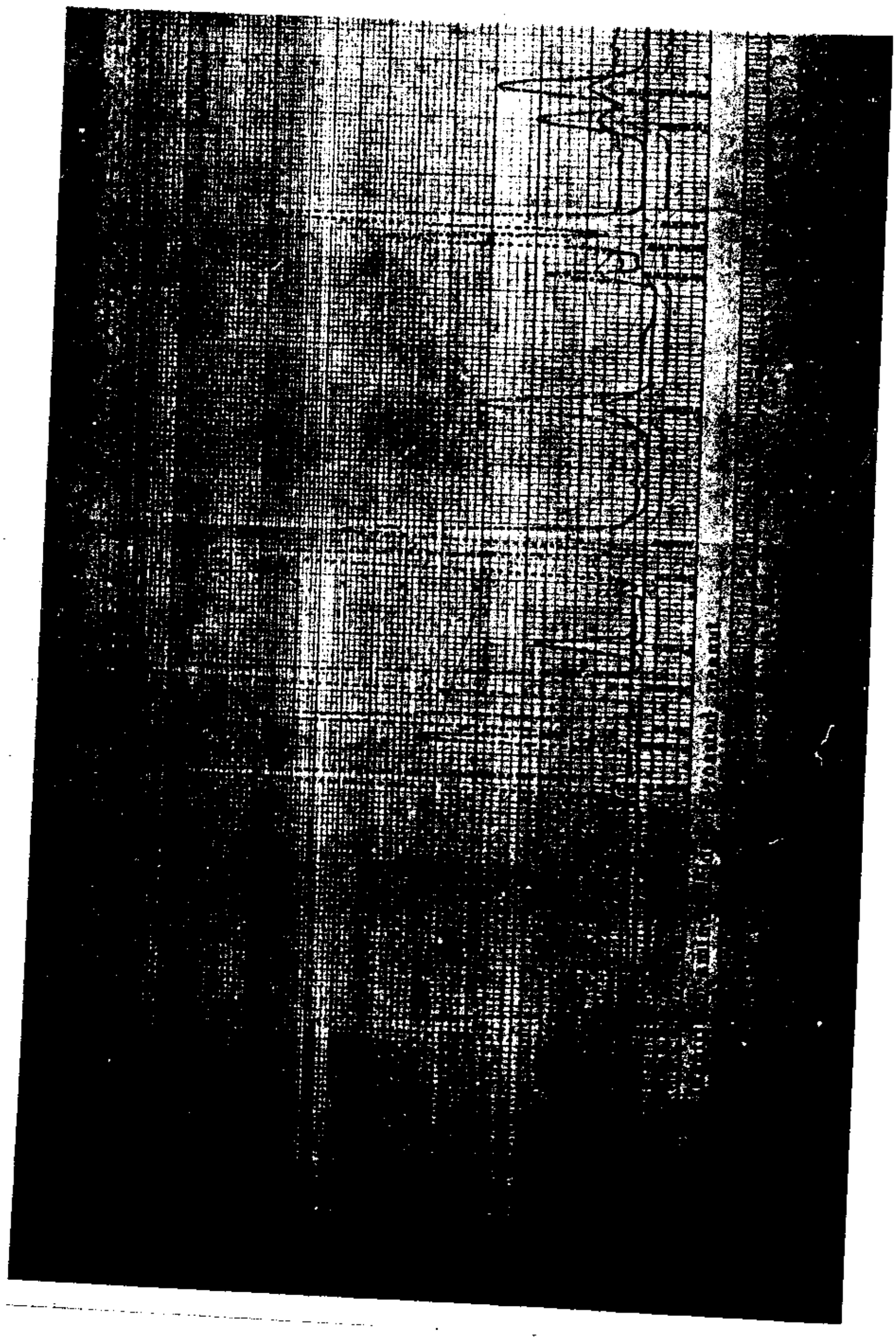


Table (13):- Amino acid contents of roasted peanut and soybean[1].

Amino acids	Peanut				Soybean			
	Raw gm./16 gm. N.	Roasted gm./16 gm. N.	Diffe-rence gm./16 gm. N.	%	Raw gm./16 gm. N.	Roasted gm./16 gm. N.	Diffe-rence gm./16 gm. N.	%
Lysine	4.06	3.56	-0.50	12.32	7.29	5.06	-2.23	30.59
Histidine	2.55	2.31	-0.24	9.41	2.75	2.17	-0.58	21.09
Arginine	14.73	13.81	-0.92	6.25	8.09	6.50	-1.59	19.65
Asparatic acid	22.79	12.96	-9.83	43.13	13.75	11.61	-2.14	15.56
Threonine	2.84	2.63	-0.21	7.39	3.82	3.91	+0.09	2.36
Serine	5.81	5.61	-0.20	3.44	4.71	5.10	+0.39	8.28
Glutamic acid	23.12	22.54	-0.58	2.51	21.44	19.46	-1.98	9.24
Proline	4.49	4.39	-0.10	2.23	5.09	5.34	+0.25	4.91
Glycine	6.76	6.56	-0.20	2.96	4.94	5.28	+0.34	6.88
Alanine	4.10	3.85	-0.25	6.10	4.41	4.53	+0.12	2.72
Valine	4.57	4.57	0.00	0.00	6.07	4.01	-2.06	33.94
Methionine	0.55	1.02	+0.47	85.45	1.19	1.04	-0.15	12.61
Iso-leucine	3.67	3.51	-0.16	4.36	5.73	4.37	-1.36	23.73
Leucine	7.23	6.98	-0.25	3.46	8.66	8.39	-0.27	3.12
Tyrosine	4.68	3.55	-1.13	24.15	3.22	3.44	+0.22	6.83
Phenyl-alanine	5.51	5.14	-0.37	6.72	5.28	5.24	-0.04	0.76
Tyroptophan[2]	0.83	1.06	+0.23	27.71	0.97	1.28	+0.31	31.96

1 Single analysis, data uncorrected for 100% nitrogen recovery.
2 Determined by microbiological method.

between roasted soybean and roasted peanut could be attributed mainly to the preparation and heat treatment to which the two samples were subjected. For soybean, the soaking step might have influenced the amino acid before being roasted. Furthermore, the dehulling step and method of roasting (frying in oil) certainly affected the amino acid pattern. Roasted peanut was prepared without either soaking or dehulling processes, and so the observed change in amino acid pattern could be attributed to the influence of roasting method.

A comparing of the essential amino acids pattern of the roasted products to the FAO provisional pattern (FAO/WHO, 1973) revealed that soybean is superior to peanut in satisfying the proposed amounts in the FAO pattern. However, only three essential amino acids were lower than the corresponding values on the pattern, namely, Lys, Met and Val. Roasted peanut exhibited six essential amino acids to be lower than the corresponding values in the pattern, namely, Ile, Leu, Lys, Thr, His, and Val.

3. Chemical indices based on amino acid contents:

The essential amino acids content of the soya, peanut and broad bean products in the form of "Tamiah", "Medamis" and roasted samples are given in Table (14) Soya bean products came in the first order with the exception of the amino acid valine in the roasted sample. In other words, caked, stewed and roasted preparations produced from soybean contained much higher level of essential amino acids than the similar products prepared from peanut and broad bean.

The formentioned results were based on the absolute comparison between the value of essential amino acids in soya, peanut and broad bean products which should be supported through calculation of the chemical scores and the essential amino acid index.

The chemical scores were calculated and data on Table (15) indicated that soybean products have higher scores for the amino acids valine, isoleucine, tryptophan and phe + tyr. for the caked products, leucine, tryptophan, phe + tyr. and threonine for the stewed as well as isoleucine, leucine, tryptophan, Table (14):- Essential amino acids of soybean, peanut and broad bean products as compared with Hen's egg.

Essential amino acids	Hen's egg as standard mg./100gm sample[1]	mg./100 gm. samples of					
		Soya products			Peanut product	Broad bean products	
		Tamiah	Medamis	Roasted	Roasted	Tamiah	Medamis
Valine	847	1518	1989	901	1030	1136	1462
Iso-leucine	778	1435	1954	982	791	979	1362
Leucine	1091	2298	3282	1885	1573	1908	2028
Methionine	416	369	498	234	230	175	230
Cystine	-	-	-	-	-	-	-
Tryptophan	184	470	681	288	239	264	295
Phenyl alanine + Tyrosine	1224	2396	3036	1850	1958	1672	2143
Lysine	863	1936	2414	1137	802	1777	1791
Threonine	634	1024	1557	879	593	842	928
Total	6037	11446	15411	8256	7216	8753	10239

1 Source: El-Malky (1974).

Table (15):- Chemical scores and essential amino acid index for proteins of soybean, peanut and broad bean products.

Essential amino acids	Soya products			Peanut product	Broad bean products	
	Tamiah	Medamis	Roasted	Roasted	Tamiah	Medamis
Valine	94.58	91.99	77.78	101.74	92.50	101.77
Iso-leucine	97.28	98.39	92.30	85.06	86.79	103.22
Leucine	111.09	117.84	126.34	120.62	120.62	109.60
Methionine	46.78	46.89	41.13	46.25	29.01	32.60
Cystine	-	-	-	-	-	-
Tryptophan	134.72	144.98	114.45	108.67	98.96	94.53
Phenyl alanine + Tyrosine	205.56	191.08	231.15	266.60	187.20	207.79
Lysine	118.32	109.58	96.34	77.75	142.02	122.36
Threonine	85.19	96.20	101.38	78.25	91.60	86.30
Essential amino acid index	95.88	95.95	93.68	93.89	87.99	90.41

lysine, threonine for the roasted samples. However, methionine remained the limiting amino acid for all the products investigated. This is consistent with the findings that methionine is the limiting amino acid in the original starting materials.

Scores for methionine in the soybean products are higher for the caked and stewed than that for the roasted product. However, roasted peanut had higher methionine score than the roasted soybean. Broad bean products showed the lowest methionine scores among the tested legumes. However, the stewed product had a higher methionine score than the caked broad bean product.

The essential amino acid index which is the geometric mean of the chemical score values indicated that soybean products are superior to broad bean products. However, roasted soybean had nearly the same amino index value of the roasted peanut, which is higher than any of the broad bean products.

4. Infrared Spectroscopy:

Infrared spectroscopy can be taken as a mean of characterizing the molecules as containing or lacking certain functional groups. Through comparison with known spectrums, identification of compounds could be easily achieved.

Each different group of atoms in a specific material has its various structural groups and configurations and a mixture of substances yields a spectrum containing the characteristics of all components. The absorbance at any given wave length is the sum of the absorbance of the individual components at that wave length, and the contribution of each component depends upon its concentration and absorptivity. Consequently, the spectrum of a mixture is the sum of the spectra of the components.

The functional groups of the suggested recipes, i.e. Tamiah, Medamis and roasted samples that were made from soybean, peanut and broad bean, as

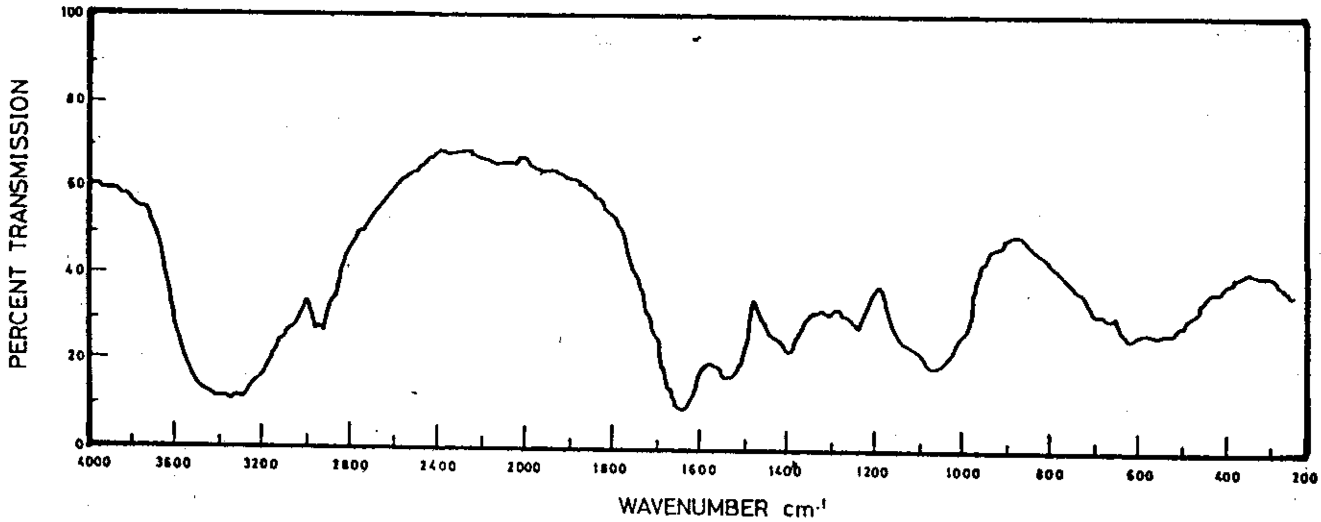


Fig.(10) Infra Red Spectrum Of Soybean Sample.

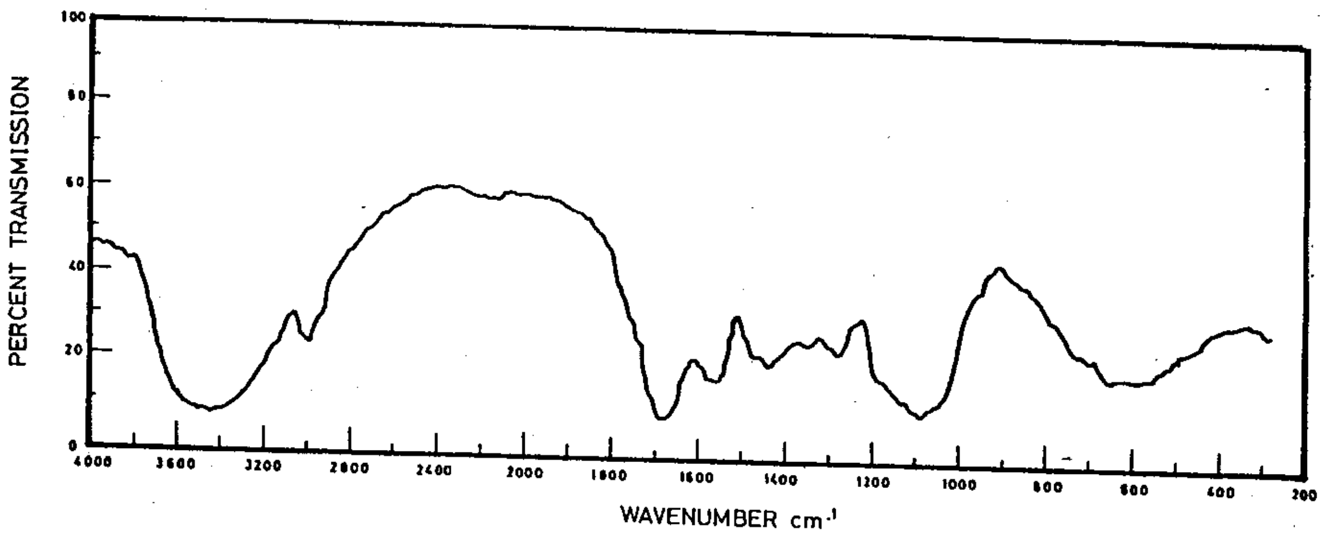


Fig.(11) Infra Red Spectrum of Peanut Sample.

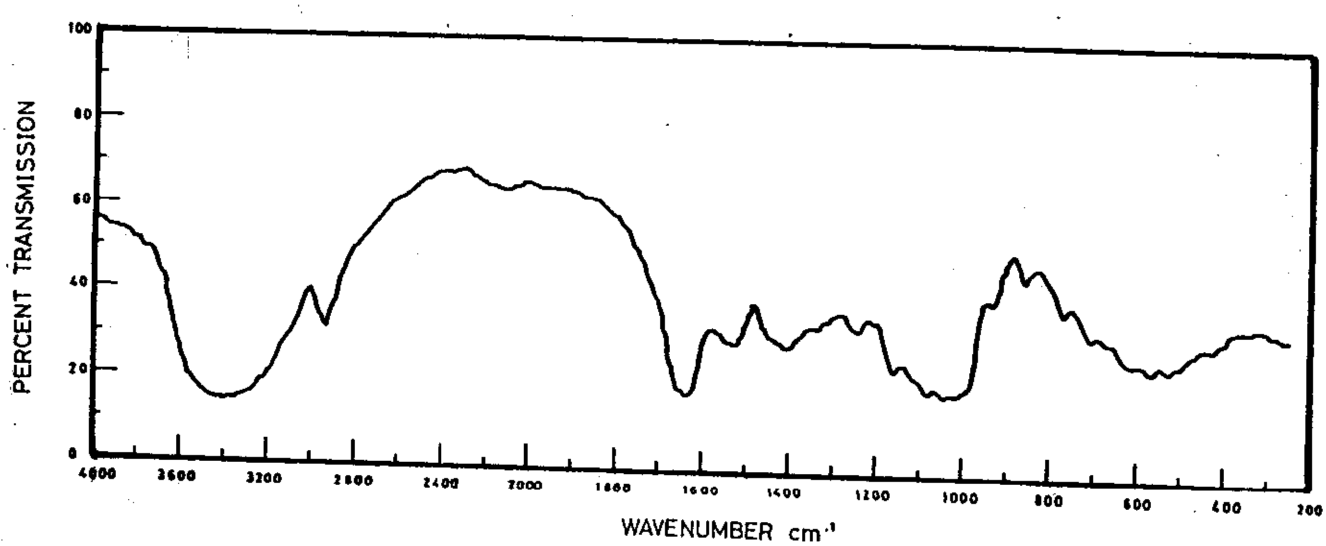


Fig.(12) Infra Red Spectrum of Broad bean.

well as that of the corresponding raw materials were identified according to Bellamy (1964) and Pomeranz and Meloan (1971). The infrared spectrum of the previous samples that were given in Figs. (10 to 18), are summarized in Table (16).

It could be seen from the table that at wave number 540 cm^{-1} the functional group namely -S-S- stretch was detected in raw seed, caked, stewed and roasted samples of soybean and broad bean. However, this group was not detected in peanut **samples**.

With respect to the C-S-Stretch, it was detected only as a characterizing group at wave number 560-570 cm^{-1} in raw and stewed broad bean. However, the same group was shiffted and appeared at 600-630 cm^{-1} in the soy and peanut products indicating the possibility of lacking such group in broad bean sample at such wave number. However, Figs. (10-18) indicates the reappearance of the C-S group at wave number 690-710 cm^{-1} in the roasted soy and peanut as well as in raw broad and stewed soybean samples.

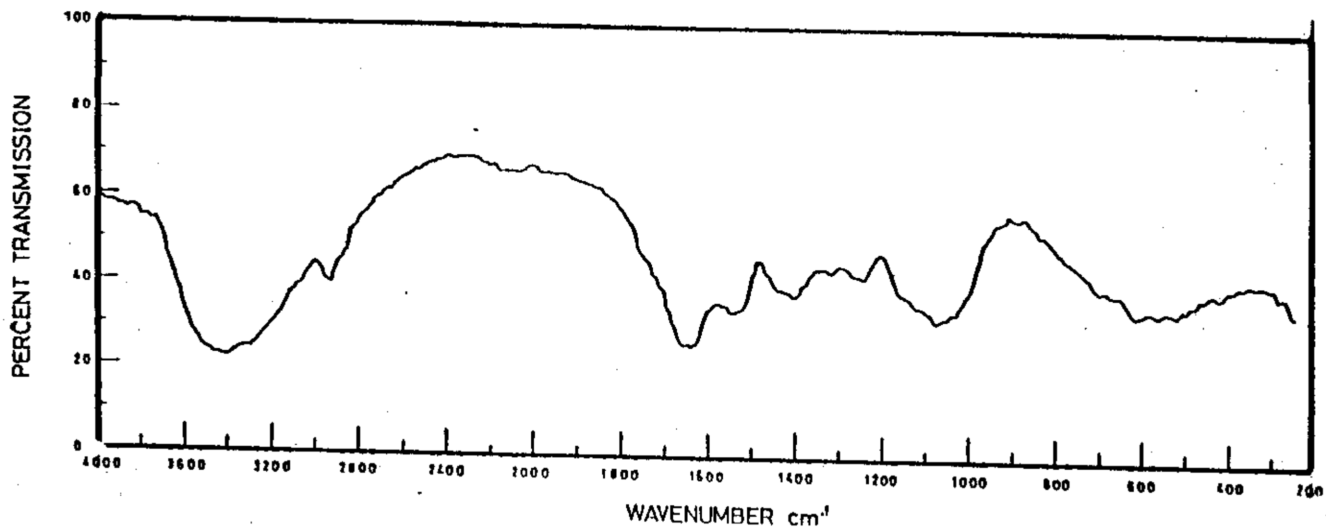


Fig.(13) Infra Red Spectrum of Caked Soybean(Tamiah).

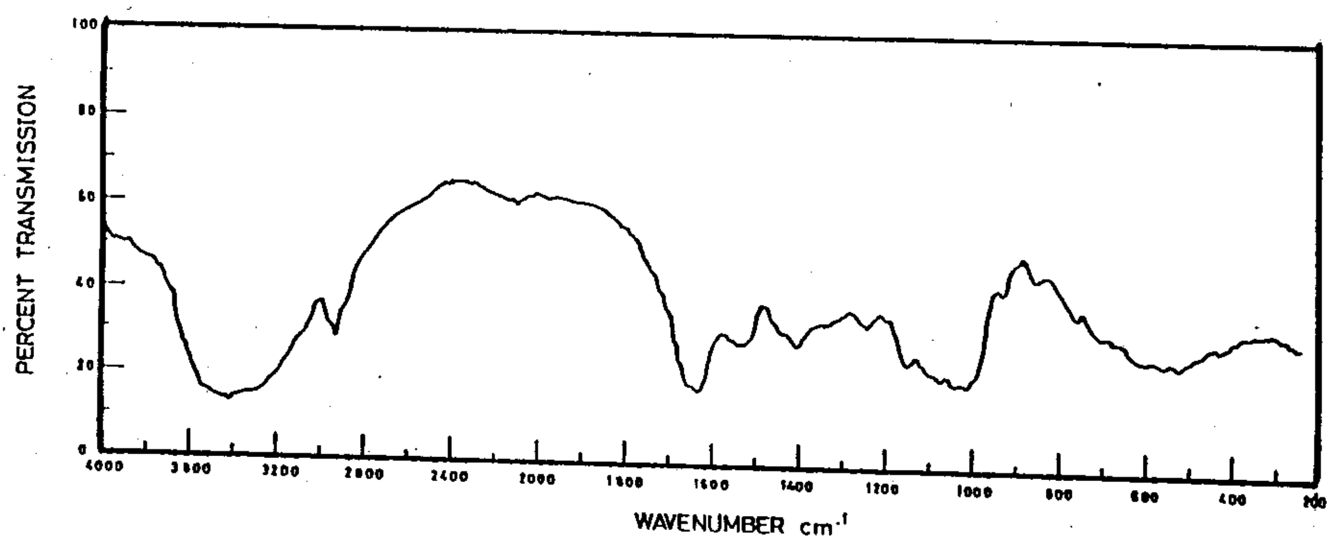


Fig.(14) Infra Red Spectrum of Caked Broad bean(Tamiah).

From the previous results, it could be mentioned that -S-S-stretch or C-S-stretch were ranged from 540 up to 710 cm^{-1} in all samples under investigation.

The presence of -P=S-stretch related to thiophosphoryl chloride failed to be detected in soybean products and appeared in raw and caked broad bean and raw peanut.

The aromatic nitro compound was clearly detected in broad bean products and roasted soybean, while the terminal epoxy group appeared in the same previous products at 910-930 cm^{-1} except the stewed broad bean.

The α-unsaturated second alcohol was presented in all the tested samples with the exception of stewed soybean. However, the carboxylic acids appeared in the broad bean samples only.

The $CONH_2$ group which the base for amino compounds were presented in all samples at wave number

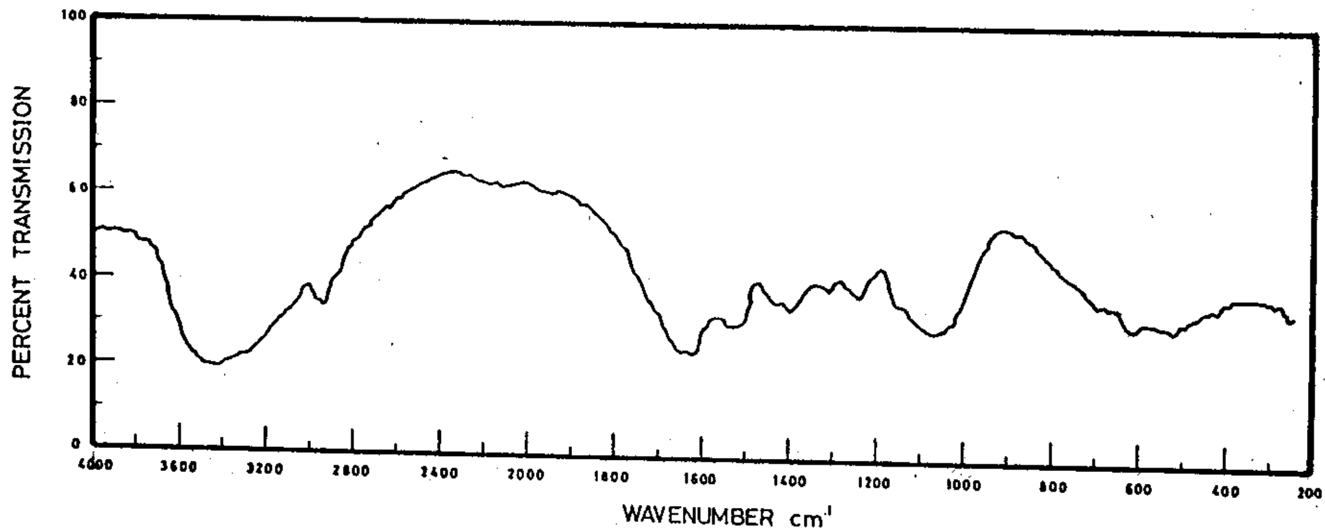


Fig.(15) Infra Red Spectrum of Stewed Soybean (Foul Medamis).

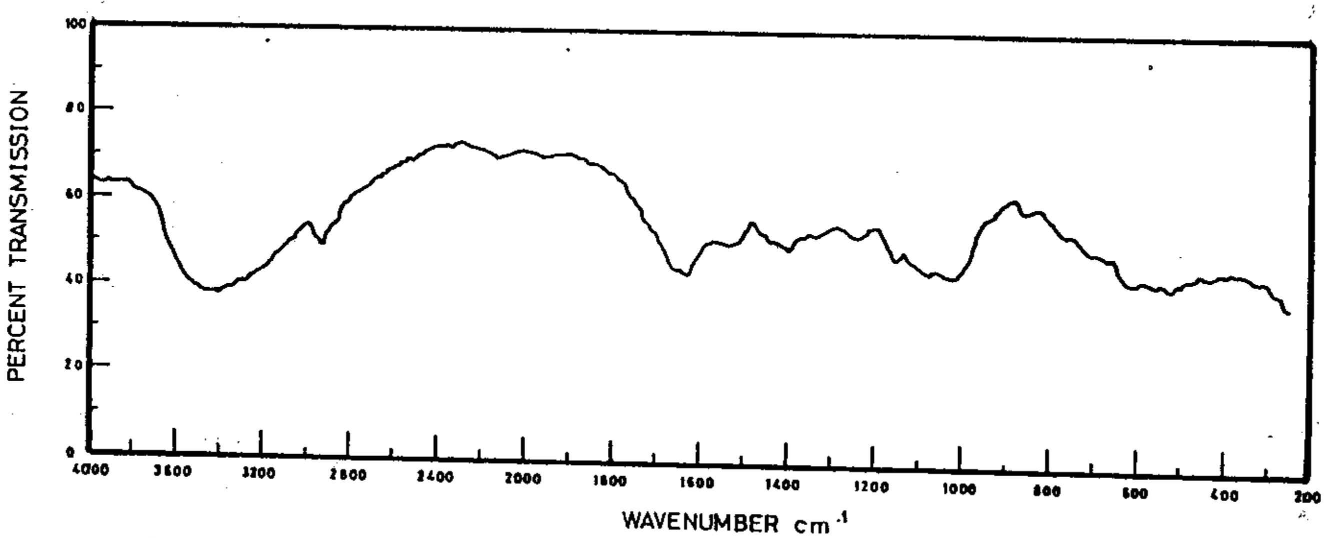


Fig.(16) Infra Red Spectrum of Stewed Broad bean (Foul Medamis).

1390-1440 cm^{-1}. The same findings were observed for the function group C-N=N-stretch detected at wave number 1620-1660 cm^{-1}, and the CH_2-asym. stretch appeared at wave number 2920-2960. The primary amin compounds were presented in all the broad bean and peanut samples and the raw soybean sample.

Data presented in the present study indicated that infrared could be in the discrimination between broad bean, peanut and soybean products since the obtained fingerprints of the recipes highly characterized the general configurations of such samples.

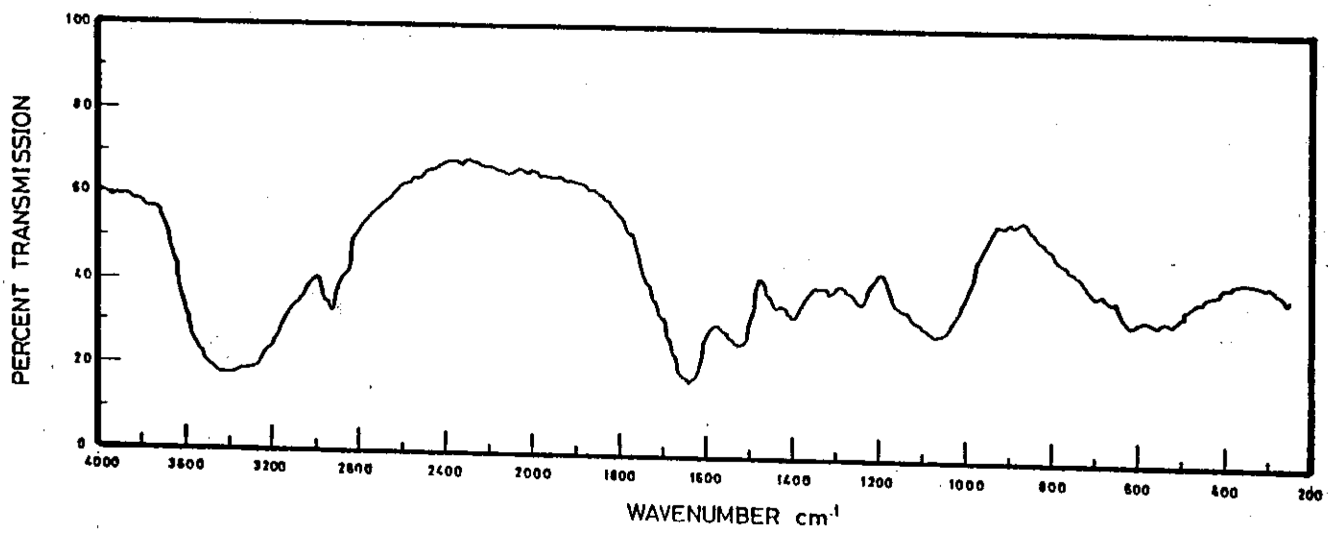


Fig.(17) Infra Red Spectrum of Roasted Soybean.

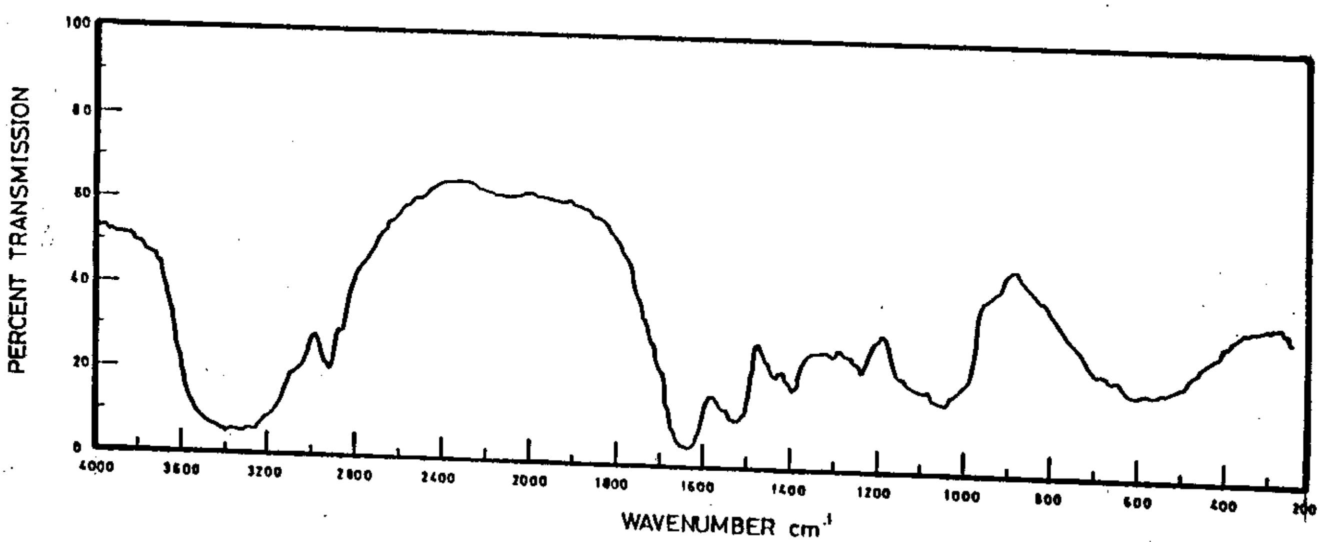


Fig.(18) Infra Red Spectrum of Roasted Peanut.

Table (16):- Infrared analysis of the investigated samples.

Frequency as wave number in cm^{-1}	Nature of vibrations	Type of compounds	Presented in
540	-S-S-stretch	Alkyl disulfides	Soybean Caked soybean Stewed soybean Roasted soybean Broad bean Caked broad bean Stewed broad bean
560-570	-C-S-stretch	$R_1R_2R_3C-S-$	Broad bean Stewed broad bean
600-630	-C-S-stretch	R_1R_2HC-S-	Soybean Caked soybean Stewed soybean Roasted soybean Peanut Roasted peanut
690-710	-C-S-stretch	Ch_2-S-	Broad bean Stewed soybean Roasted soybean Roasted peanut
760-770	-P=S stretch	Thiophosphoryl chloride	Peanut Broad bean Caked broad bean
850-890	-C-N-stretch	Aromatic nitro compound	Broad bean Caked broad bean Stewed broad bean Roasted soybean

Table (16):- Continue

Frequency as wave number in cm^{-1}	Nature of vibrations	Type of compounds	Presented in
910-930	-	Terminal epoxy group in fatty acid deriv.	Broad bean Caked broad bean Roasted soybean
1050-1080	C-OH stretch	α -unsaturated secondary alcohol	Soybean Peanut Broad bean Caked soybean Roasted soybean Caked broad bean Stewed broad bean Roasted peanut
1150-1160	-COOH	Carboxylic acids	Broad bean Caked broad bean Stewed broad bean
1230-1250	C-N-stretch	$(R-CH_2)_2N$	All samples
1300-1330	CH_2wag	Linear hydrocarbon chain	Soybean Peanut Caked soybean Roasted peanut Stewed soybean Roasted peanut Broad bean
1390-1440	$CO-NH_2$ $-CH_3$ asym, bend $CO-NR_2$	Amides Aliphatic hydrocarbon chain. disubstitute amide	All samples

Table (16):- Continue

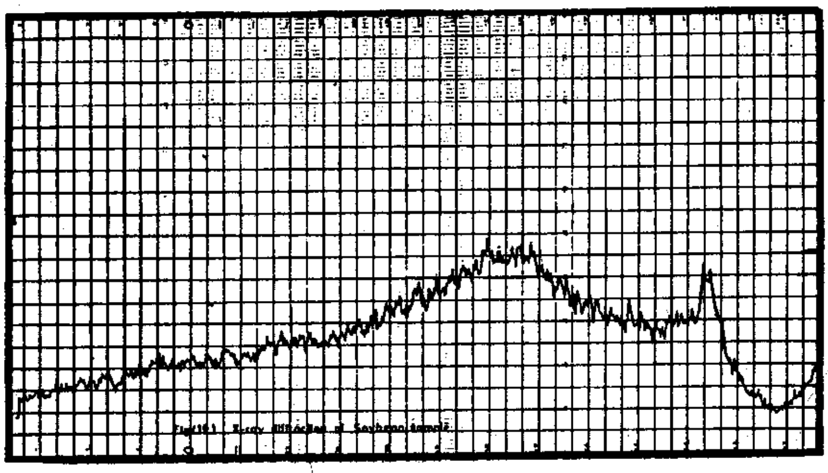
Frequency as wave number in cm^{-1}	Nature of vibrations	Type of compounds	Presented in
1500-1600	$-NH_3^+$ asym. bend	Amino acid hydrochloride and Zwitterion	Soybean Broad bean Caked broad bean Roasted soybean Roasted peanut
1620-1660	-C-N=N stretch	R-CH=NR Aliphatic compound	All samples
2920-2960	CH_2-asym. stretch	Saturated hydrocarbon.	All samples
3200 3800 3440	Free-NH_2 sym. stretch	Primary amin CH_2-NH_2	Soybean Peanut Broad bean Caked broad bean Stewed broad bean Roasted peanut

5. X-ray diffraction:

X-ray analysis was used for differention between the raw soy, peanut and broad bean as well as the processed items of the three previous seeds.

The "d" spacing used for such purpose was calculated from Figs. (19, 20, 21) and summarized in Tables (17, 18 and 19).

Upon comparing the calculated "d" spacing, it was found that there were some similar angles presented in the three tested varieties, while others were denoted in two of the three samples. For instance the following "d" spacing of 5.30, 2.34, 2.20, 1.44 and 1.40 were identified in raw soybean and broad bean samples only. On the contrary the "d" spacing of 2.44, 1.88 were found only in the raw soybean and peanut. The angle $26^{\circ}48'$ of a "d" spacing 1.73 was solely detected in the three samples under investigation. However, the other angles characterized individually the raw soybean, peanut and broad bean samples. Angle $9^{\circ}42'$ characterized the peanut



Fig(19) X-ray diffraction of Soybean sample

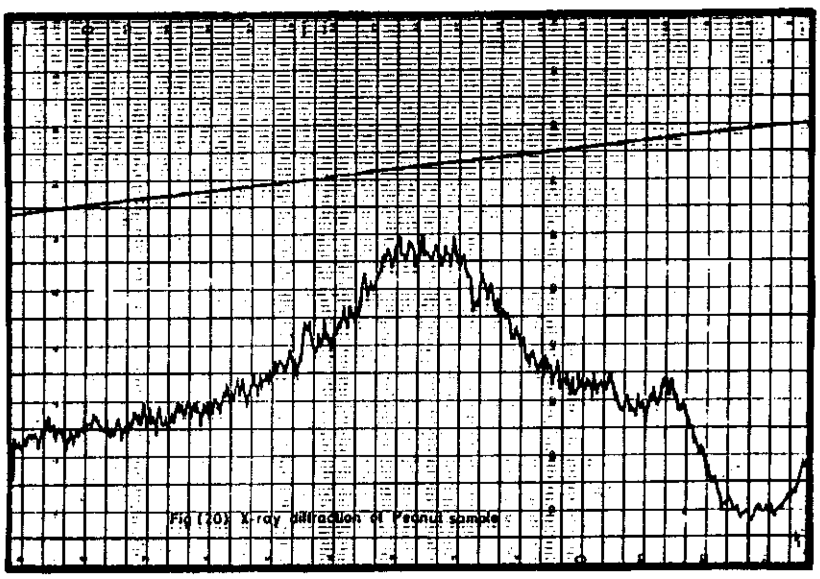
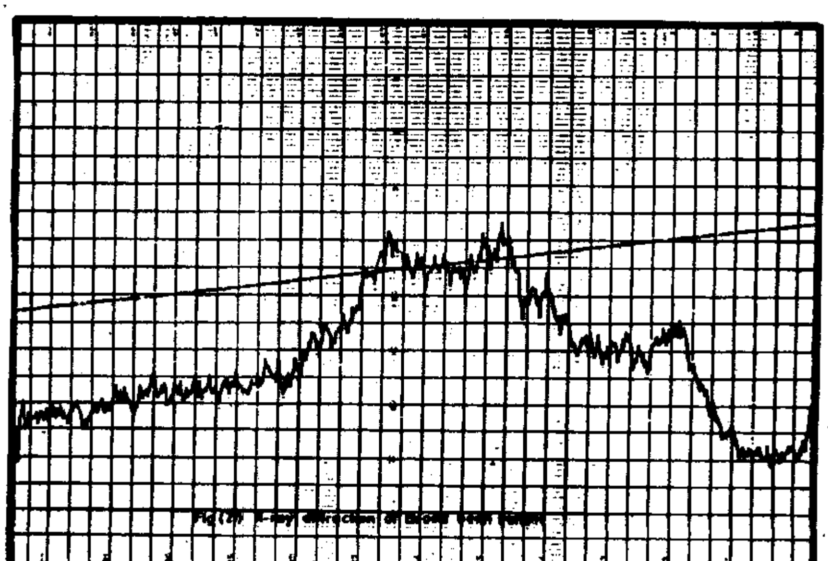


Fig (20) X-ray diffraction of Peanut sample



Fig(21) X-ray diffraction of [illegible]

Table (17):- Calculated "d" spacing of raw soybean sample from X-ray diffractions curves

Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2 \sin\theta}$	Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2 \sin\theta}$
1° 33'	33.17	15° 21'	2.93
2 06	21.42	16 18	2.76
2 18	20.24	16 30	2.74
3 21	13.75	17 18	2.61
3 33	13.26	17 30	2.59
3 42	12.91	18 00	2.49
5 12	8.63	18 36	2.44
6 39	6.92	19 24	2.34
7 03	6.29	20 09	2.24
7 45	5.94	20 48	2.20
8 24	5.37	22 12	2.04
8 36	5.30	23 12	1.96
8 42	5.26	24 15	1.88
9 06	4.89	25 39	1.80
9 54	4.65	26 48	1.73
10 51	4.22	27 09	1.69
11 33	3.92	27 51	1.67
12 39	3.59	28 33	1.62
13 00	3.42	29 24	1.58
13 30	3.35	32 30	1.44
13 57	3.28	33 24	1.40
14 42	3.09	39 39	1.21

Table (18):- Calculated "d" spacing of raw peanut sample from X-ray diffractions curves

Angle"θ" calculated from the curve	"d"spacing $\frac{1.5405}{2\ Sin\theta}$	Angle"θ" calculated from the curve	"d"spacing $\frac{1.5405}{2\ Sin\theta}$
° ′		° ′	
4 54	9.73	18 48	2.43
5 18	8.53	19 24	2.34
6 09	7.26	19 54	2.30
7 42	5.96	20 30	2.22
8 09	5.47	21 18	2.13
8 27	5.35	21 36	2.11
9 24	4.80	22 18	2.04
9 42	4.70	22 36	2.02
10 30	4.31	23.00	1.97
11 15	3.98	23 33	1.94
11 44	3.88	24 12	1.88
12 15	3.66	24 36	1.87
12 51	3.55	25 09	1.82
13 54	3.29	25 54	1.79
14 15	3.15	26 36	1.73
15 09	2.96	26 48	1.73
15 30	2.92	28 12	1.63
15 54	2.87	31 24	1.48
17 00	2.63	32 12	1.45
17.18	2.61	34 00	1.38
17 42	2.57	36 48	1.30
18 09	2.48		

Table (19) .- Calculated "d" spacing of raw broad bean sample from X-ray diffractions curves.

Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2\ Sin\theta}$	Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2\ Sin\theta}$
° ′		° ′	
2 18	20.24	21 00	2.15
3 30	13.38	21 51	2.10
6 33	6.98	22 30	2.03
8 36	5.30	22 51	2.01
9 12	4.86	23 45	1.93
9 24	4.80	24 48	1.86
10 33	4.29	25 12	1.81
11 00	4.04	26 00	1.76
11 12	3.99	26 51	1.73
13 00	3.42	27 00	1.70
15 00	2.98	28 00	1.64
15 18	2.94	29 18	1.58
15 39	2.90	30 00	1.54
16 12	2.77	30 42	1.52
16 48	2.71	31 00	1.50
18 06	2.48	32 00	1.45
18 30	2.45	32 42	1.44
19 09	2.35	33 24	1.40
19 24	2.34	33 48	1.40
19 51	2.31	34 30	1.37
20 24	2.23	36 54	1.29
20 48	2.20		

and broad bean samples since it is completely out of the plane of the soybean sample.

The effect of methods of processing an the pattern of the tested samples through X-ray analysis given in Tables (20-25) and Figs. (22-27) realized a distinctive effect on the overall fingerprint of the product. Several angles dominated in the raw samples were shifted and/or disappeared as a function of processing.

This means that the methods of manufacturing the caked, stewed and roasted soybean modify the plates of the biopolymer structure of the samples. In other words, the chemical constituents of the soybean samples that characterized the internal structure of the soy samples was disordered due to the methods of processing and subsequently changes of the formulated X-ray diffraction. On the other hand, some angles were found to be common in the raw soybean and one of the soy products. For instance six "d" spacings namely 5.37, 3.59, 2.24, 1.69, 1.58, 1.40 that detected in raw soybean were also presented in stewed soybean

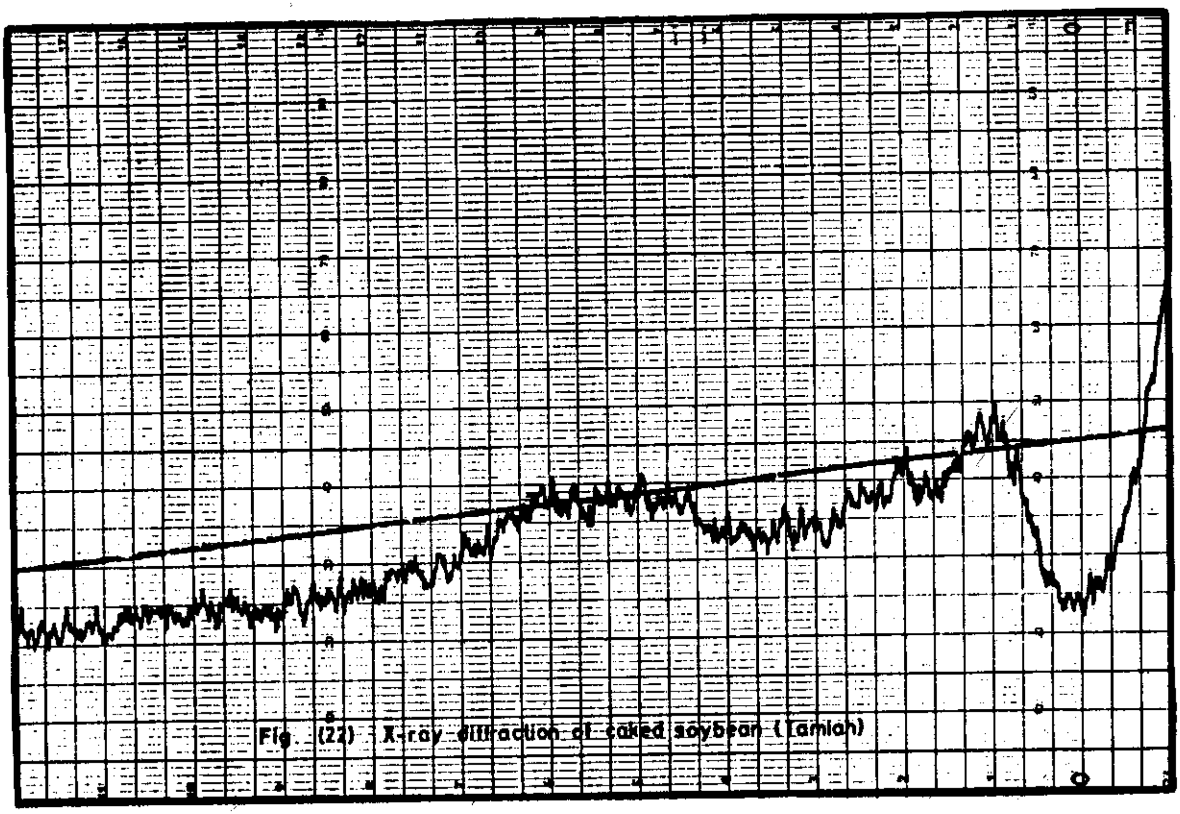


Fig. (22) X-ray diffraction of caked soybean (Tamiah)

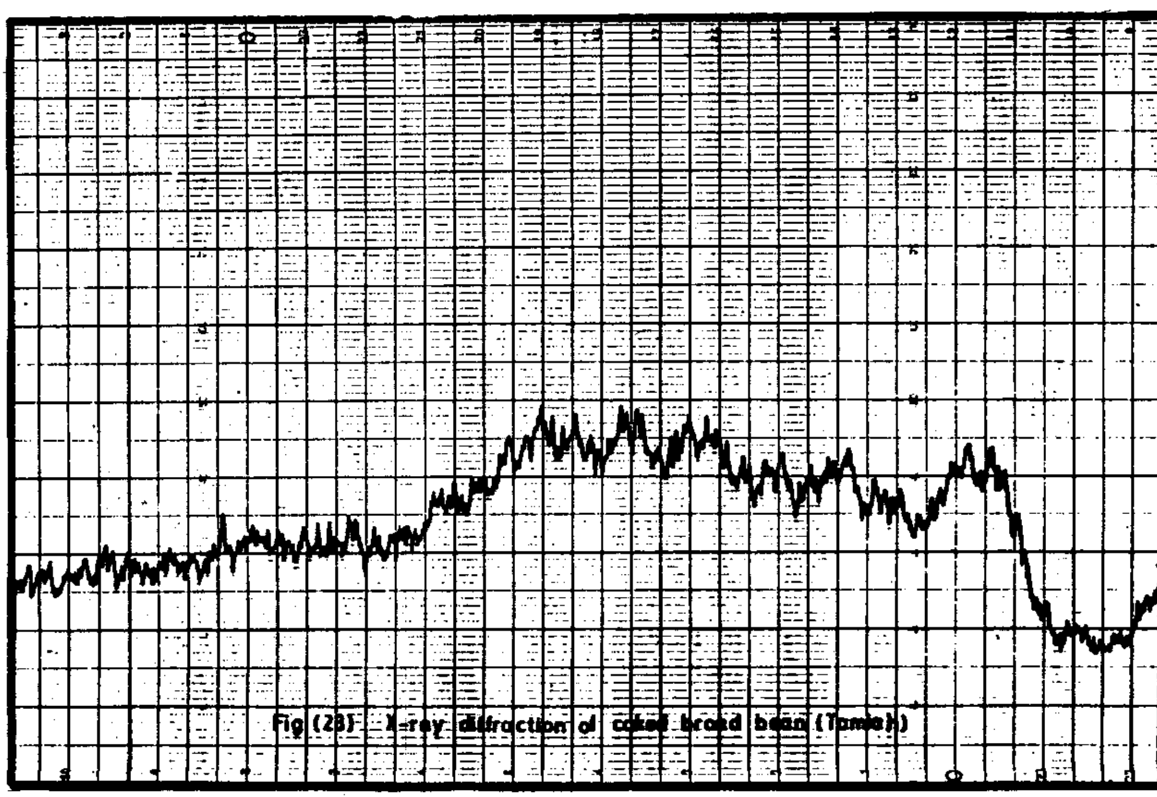


Fig (23) X-ray diffraction of caked broad bean (Tamiah)

Table (20):- Calculated "d" spacing of caked soybean "Tamiah" from X-ray diffractions curves

Angle"θ" calculated from the curve	"d"spacing $\frac{1.5405}{2\ Sin\theta}$	Angle"θ" calculated from the curve	"d"spacing $\frac{1.5405}{2\ Sin\theta}$
° ′		° ′	
2 15	20.52	20.48	2.20
2 42	18.24	20 54	2.19
5 09	8.68	21 51	2.10
5 39	8.20	23 06	1.97
5 54	7.98	23 45	1.93
6 24	7.08	23.51	1.93
8 18	5.41	24 15	1.88
8 54	5.19	25 30	1.80
9 45	4.69	27 24	1.68
10 27	4.32	27 33	1.68
11 24	3.95	28 00	1.64
12 00	3.70	29 00	1.59
12 30	3.61	31 18	1.49
13 06	3.41	31 36	1.48
13 30	3.35	31 48	1.47
15.00	2.98	32 30	1.44
15.24	2.93	34 36	1.36
16 18	2.76	34 42	1.36
17 00	2.63	35 00	1.34
17 51	2.56	36 18	1.30
18 06	2.48	37 18	1.27
19 00	2.37	38.45	1.24

Table (21):- Calculated "d" spacing of caked broad bean "Tamiah" from X-ray diffractions curves.

Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2\ Sin\theta}$	Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2\ Sin\theta}$
° ′		° ′	
2 36	18.70	17 48	2.56
2 54	17.37	18 21	2.46
3 12	14.15	19 54	2.30
4 33	10.20	20 42	2.21
5 00	8.83	21 00	2.15
5 36	8.24	23 24	1.95
6 51	6.79	24 00	1.89
7 30	6.06	24 21	1.88
7 48	5.91	25 51	1.79
8 54	5.19	26 42	1.73
9 48	4.68	27 36	1.06
10 36	4.28	28 12	1.66
11 18	3.97	28 36	1.62
11 54	3.85	30 18	1.53
12 54	3.55	30 48	1.52
14 12	3.16	31 48	1.47
14 45	3.09	33 36	1.40
15 27	2.92	35 00	1.34
16 00	2.79	35 30	1.33
16 30	2.74	35 42	1.33
16 42	2.72	36 30	1.30
17 33	2.58	37 36	1.27

samples. Other five "d" spacings were detected in both the raw and the caked soybean samples at angles $13^{\circ} 30'$, $16^{\circ} 18'$, $20^{\circ} 48'$, $24^{\circ} 15'$, $32^{\circ} 30'$. However, the only "d" spacing that appeared between the raw and roasted soy products was noticed at angle $20^{\circ} 09'$.

Concerning the borad bean and peanut products similar trend as that of soybean was noticed which indicated that changes in X-ray diffraction is a function of the methods used in processing. Moreover, X-ray analysis of a given item could help in predicting the methods of processing.

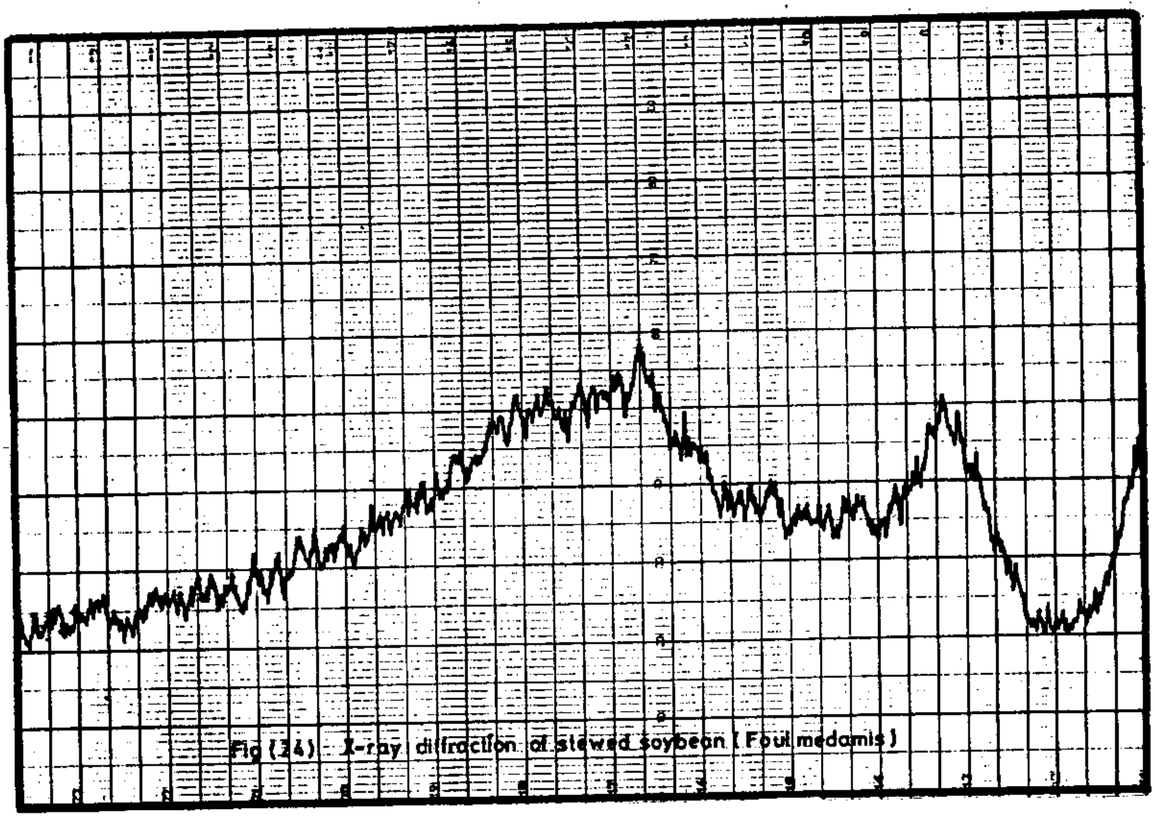


Fig (24) X-ray diffraction of stewed soybean (Foul medamis)

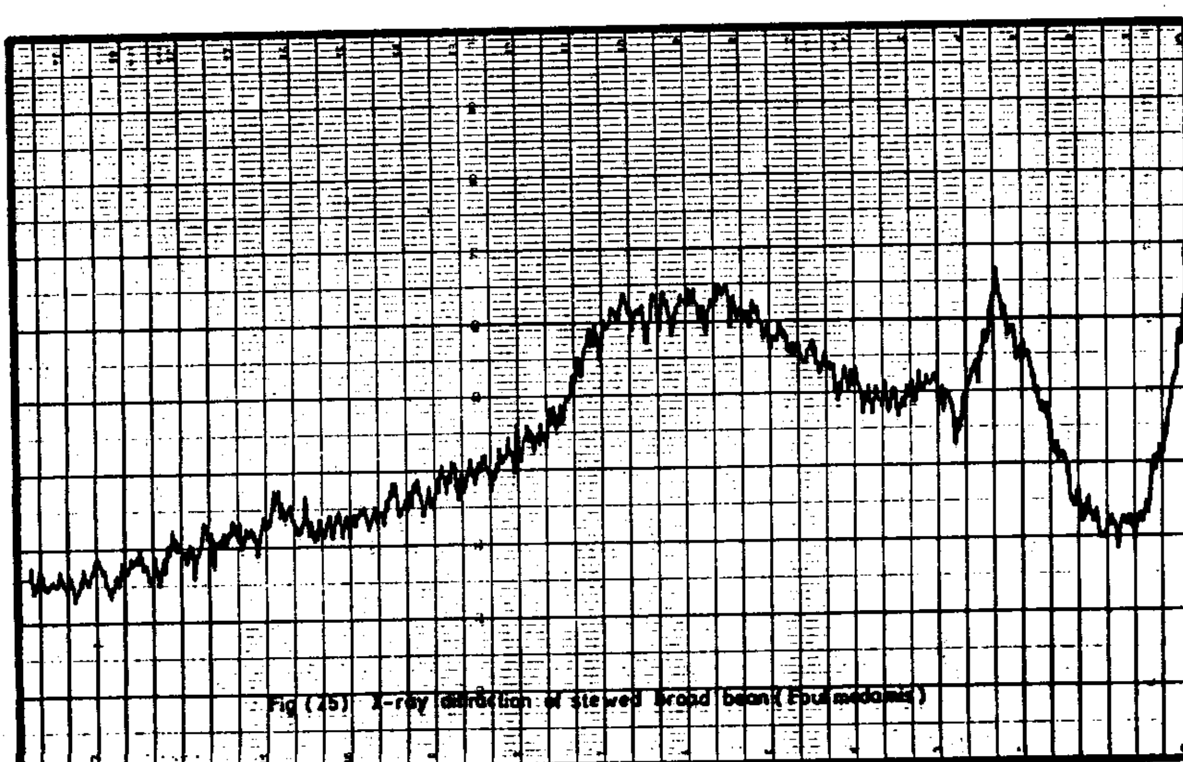


Fig (25) X-ray diffraction of stewed broad bean (Foul medamis)

Table (22):- Calculated "d" spacing of stewed soybean "Foul Medamis" from X-ray diffractions curves.

Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2 \sin\theta}$	Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2 \sin\theta}$
° ′		° ′	
1 42	31.07	14 12	3.16
2 12	20.82	15 00	2.98
2 48	17.79	15 30	2.92
3 18	13.88	16 36	2.73
3 36	13.14	17 00	2.63
4 21	10.49	17 42	2.57
5 00	8.83	17 54	2.55
5 39	8.20	19 00	2.37
6 18	7.15	20 09	2.24
6 48	6.82	21 09	2.14
7 15	6.19	23 06	1.97
7 42	5.96	23 54	1.93
8 24	5.37	25 00	1.82
9 30	4.76	26 06	1.75
9 42	4.70	27 06	1.69
10 39	4.27	28 06	1.64
11 00	4.04	29 15	1.58
11 24	3.95	30 06	1.54
11 42	3.89	30 51	1.52
12 27	3.62	31 33	1.48
12 39	3.59	33 24	1.40
13 18	3.38	35 12	1.34

Table (23):- Calculated "d" spacing of stewed broad bean "Foul Medamis" from X-ray diffractions curves.

Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2 \sin\theta}$	Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2 \sin\theta}$
° ′		° ′	
1 06	41.62	22 45	2.02
1 36	32.44	22 51	2.01
3 39	13.02	23 42	1.94
4 00	11.04	24 00	1.89
6 21	7.12	24 24	1.88
7.00	6.32	25 42	1.79
7 21	6.14	26 45	1.73
8 51	5.20	28 24	1.63
9 42	4.70	28 30	1.62
10 00	4.43	29.06	1.59
11 00	4.04	29 30	1.57
12 00	3.70	30 24	1.53
12 35	3.60	31 36	1.48
13 00	3.42	32 06	1.45
15 00	2.98	32 33	1.44
16 18	2.76	32.42	1.44
18 48	2.43	33 06	1.41
19 33	2.33	33 57	1.39
21 15	2.13	35 12	1.34
21 27	2.12	36 21	1.30
21 51	2.10	36 54	1.29
22 30	2.03	37 30	1.27

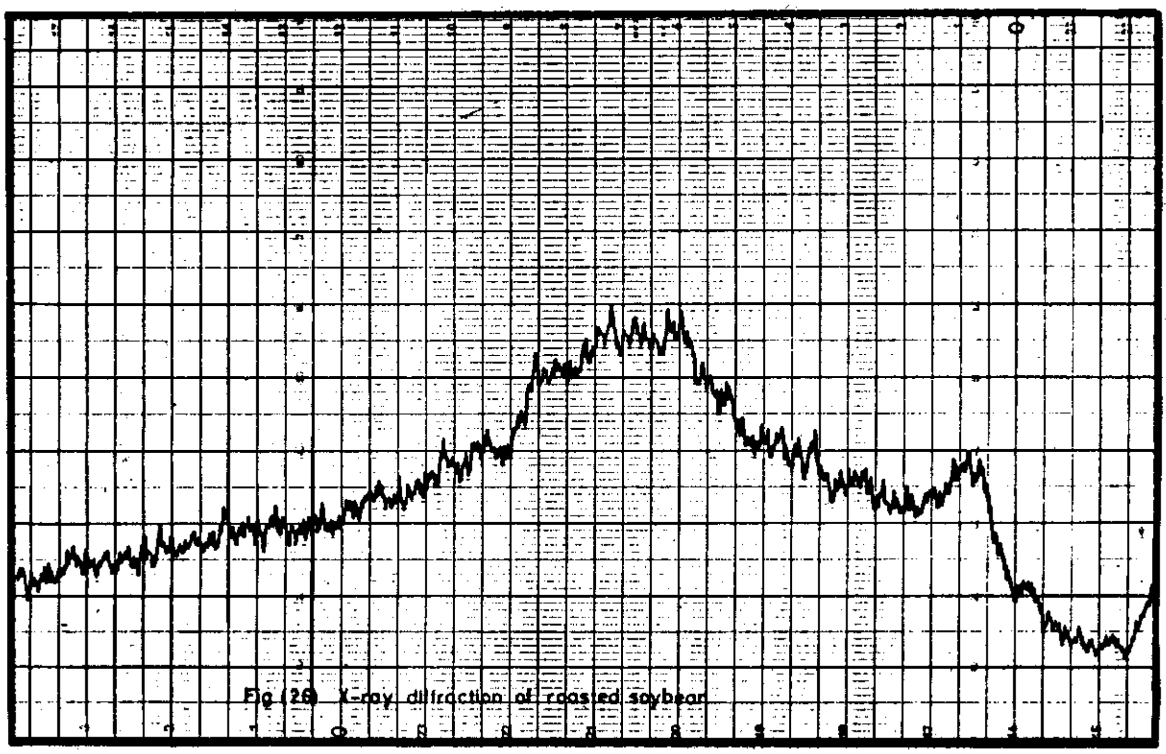


Fig (26) X-ray diffraction of roasted soybean

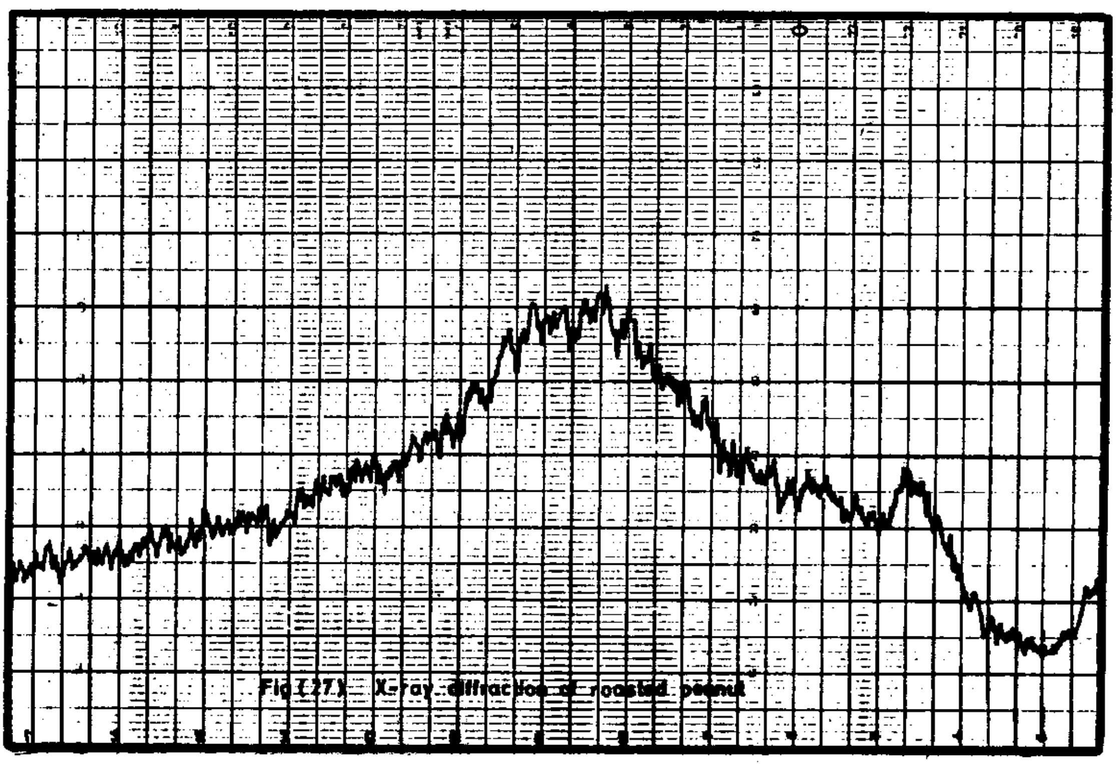


Fig (27) X-ray diffraction of roasted peanut

Table (24):- Calculated "d" spacing of "roasted soy-bean" from X-ray diffractions curves.

Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2 \sin\theta}$	Angle "θ" calculated from the curve	"d" spacing $\frac{1.5405}{2 \sin\theta}$
° ′		° ′	
1 45	30.43	17 54	2.55
2 15	20.52	18 15	2.47
2 21	19.97	18 33	2.45
2 42	18.24	19 24	2.34
3 12	14.15	20 09	2.24
4 24	10.41	20 54	2.19
4 33	10.20	21 24	2.13
4 45	9.92	22 06	2.05
5 33	8.29	23 48	1.93
5 42	8.15	25 24	1.81
6 18	7.15	27 00	1.70
6 42	6.89	29 63	1.56
7 12	6.21	31 21	1.49
8 54	5.19	32 18	1.45
9 21	4.81	33 12	1.41
9 45	4.69	35 27	1.33
12 12	3.67	36 00	1.31
13 21	3.37	36 33	1.30
14 06	3.17	37 18	1.27
15 18	2.94	38 06	1.25
16 12	2.77	38 30	1.24
16 57	2.70	38 42	1.24
17 24	2.60	39 21	1.22

Table (25):- Calculated "d" spacing of roasted peanut from X-ray diffraction curves.

Angle"θ" calculated from the curve	"d"spacing $\frac{1.5405}{2\ Sin\theta}$	Angle"θ" calculated from the curve	"d"spacing $\frac{1.5405}{2\ Sin\theta}$
° ′		° ′	
2 54	17.37	17 15	2.61
3 36	13.14	17 48	2.56
5 27	8.38	18 36	2.44
6 15	7.19	19 18	2.34
7 09	6.24	20 27	2.22
7 51	5.89	21 15	2.13
8 12	5.45	23 00	1.97
8 48	5.22	23 27	1.95
9 21	4.81	24 39	1.86
9 54	4.65	26 00	1.76
10 36	4.17	26 39	1.73
11 06	4.01	27 48	1.67
11 18	3.97	28 06	1.64
11 48	3.87	28 36	1.62
12 45	3.57	28 42	1.62
13 15	3.38	29 48	1.56
13 36	3.33	32 30	1.44
13 51	3.30	34 00	1.38
14 12	3.16	35 00	1.34
15 54	2.87	35 27	1.33
16 15	2.77	36 54	1.30
17 00	2.63	38 00	1.25

6. Electrophoretic patterns of proteins:

The electrophoretic patterns of the soybean, peanut and broad bean proteins are given in Table (26) and Fig. (28). Electropherograms revealed many bands stained to various intensities. As shown in Fig. 28. Specific bands characterized each seed protein for instance the isolated bands at relative mobility of 0.12, 0.34 and 0.48 characterized the soybean variety. While the relative mobility of 0.14, 0.19, 0.71, and 0.78 specified the peanut sample the relative mobility remarked 0.2, 0.28, 0.42, 0.47 as well as 0.61 and 0.83 appeared sharply in the raw broad bean. It could be seen from the same table that 10 zones in soybean and broad bean proteins were successively separated through the electrophoretic field. However, 12 zones were observed in the peanut sample. The formentioned patterns of the three legume varieties had revealed the existance of similar and different zones in the proteins of the tested samples. Such trend was held true and could be reasoned by the nature of the plant protein content of the tested legumes.

With respect to the electrophoretic patterns

Table (26):- Electrophoretic bands of raw soybean, peanut and broad bean samples.

No. and relative mobility of isolated bands in raw		
Soybean	Peanut	Broad bean
0.12	-	-
-	0.14	-
-	0.19	-
-	-	0.20
0.23	0.23	-
-	-	0.28
0.34	-	-
0.38	0.38	-
-	-	0.42
-	-	0.47
0.48	-	-
0.51	0.51	0.51
0.55	-	-
-	0.58	-
-	-	0.61
0.65	-	0.65
-	0.67	-
-	0.71	-
-	-	0.75
-	0.78	-
-	-	0.83
0.85	-	-
-	0.86	-
-	-	0.90
-	0.91	-
0.95	0.95	-

of the processed soybean, peanut and broad bean Table (27) and Figs (29), (30) indicated that the technological method used for making caked (Tamiah), stewed (Foul Medamis) and roasted samples reduced the number of isolated bands in all samples especially in the stewed soybean and caked broad bean, such trend was mainly due to the denaturation of protein as a function of heat treatment. Results for roasted peanut are in accordance to those reported by Angelo and Ory (1975) who also observed that roasted peanut had fewer bands than those from raw peanut.

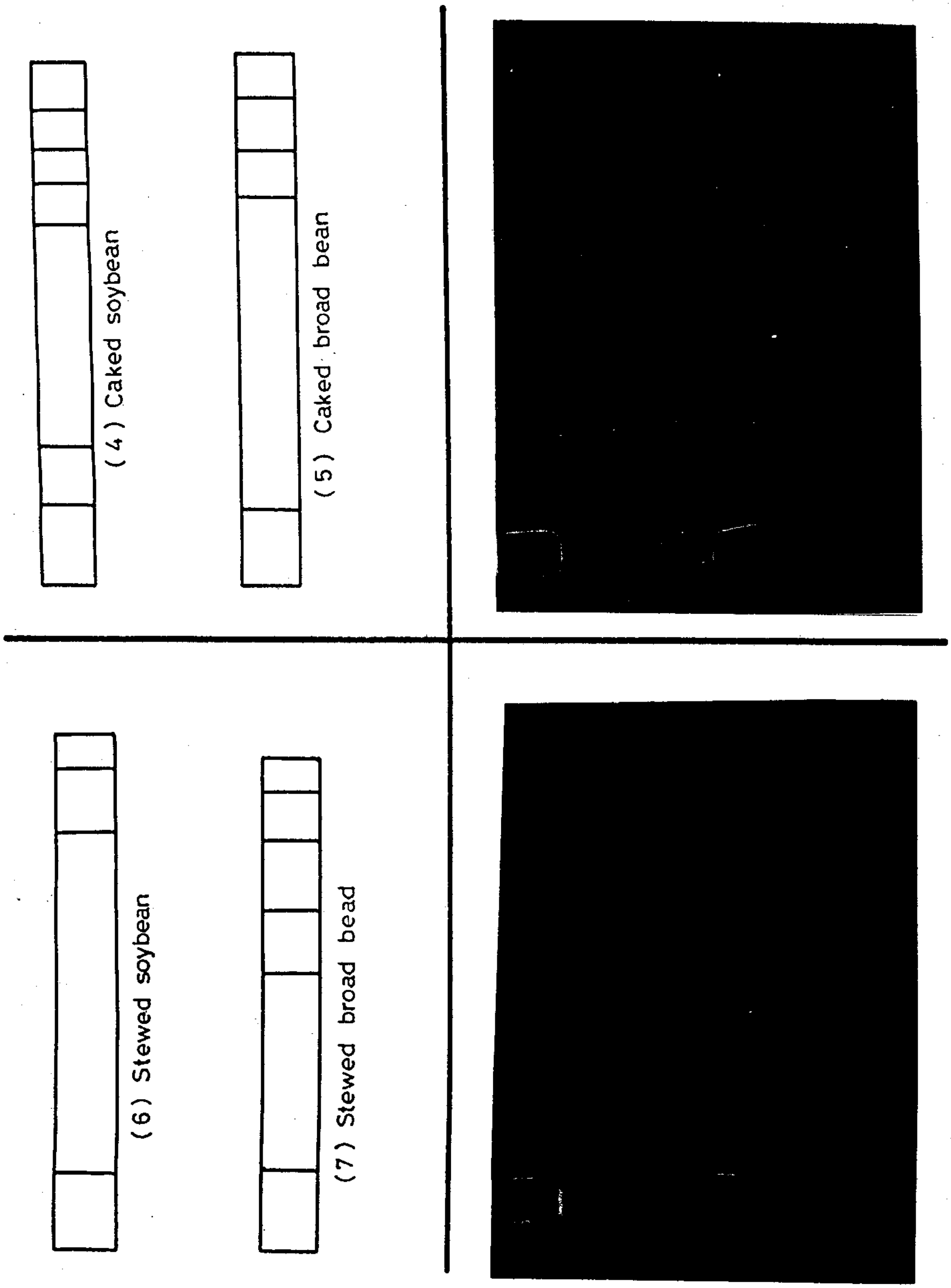


Fig (29) Electrophoretic profiles of soybean and broad bean products

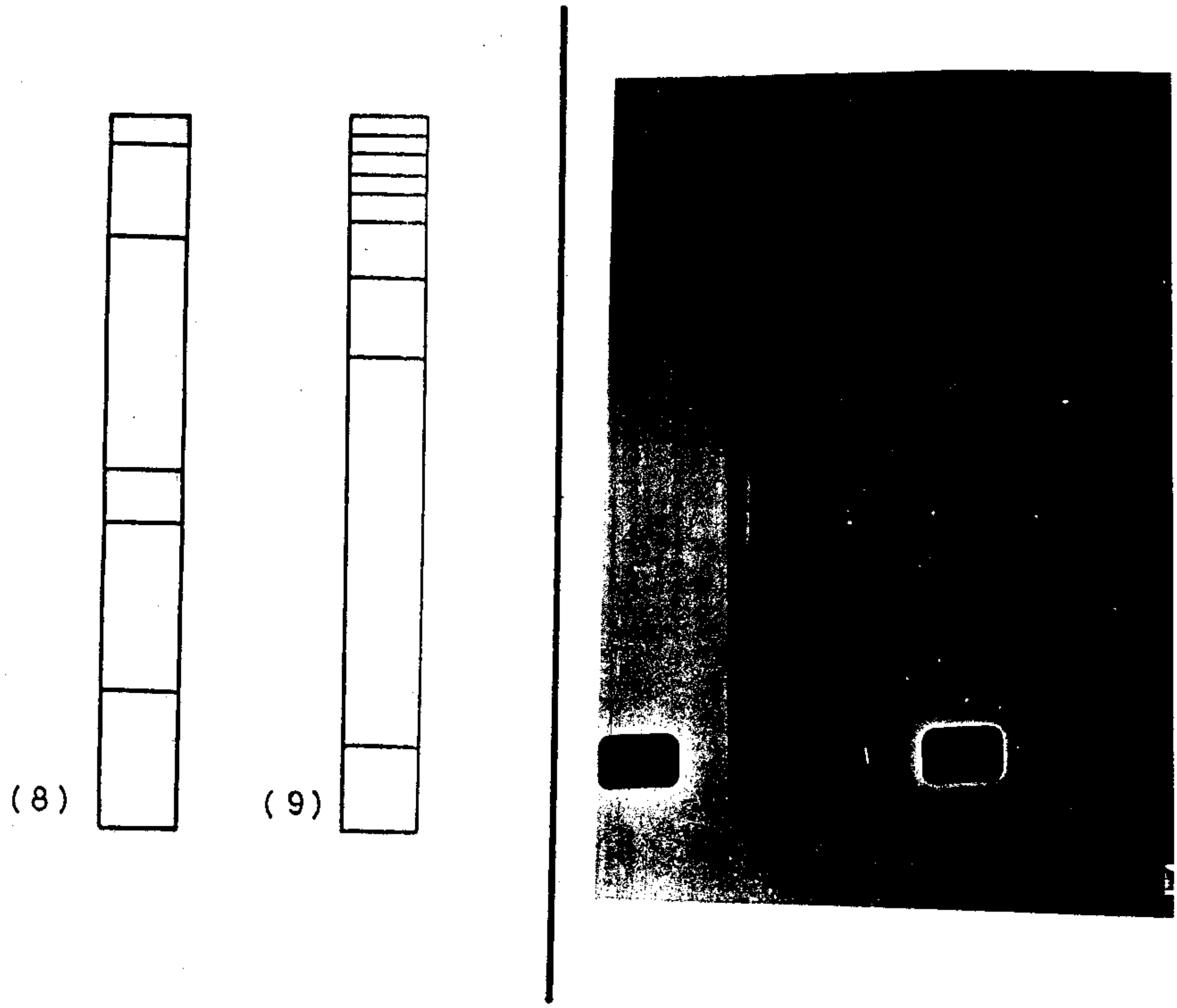


Fig (30) Electrophoretic profiles of roasted soybean (8) and roasted peanut (9)

Table (27):- Electrophoretic bands of soybean, peanut and broad bean products.

No.and relative mobility of isolated bands in					
Caked(Tamiah)		Stewed"Foul Medamis"		Roasted	
Soybean	Broad bean	Soybean	Broad bean	Soybean	Peanut
-	-	-	-	-	0.12
0.15	0.15	-	-	-	-
-	-	0.16	0.16	-	-
-	-	-	-	0.19	-
0.27	-	-	-	-	-
-	-	-	-	0.43	-
-	-	-	-	0.50	-
-	-	-	0.57	-	-
-	-	-	-	-	0.66
0.69	-	-	-	-	-
-	-	-	0.70	-	-
-	0.74	-	-	-	-
0.77	-	-	-	-	-
-	-	-	-	-	0.78
-	-	0.81	-	-	-
-	0.82	-	-	0.82	-
-	-	-	0.83	-	-
0.84	-	-	-	-	-
-	-	-	-	-	0.86
-	-	-	-	-	0.90
0.91	-	-	-	-	-
-	0.92	-	-	-	0.92
-	-	0.94	0.94	-	-
-	-	-	-	0.95	0.95
-	-	-	-	-	0.98

7. Trypsin inhibitor and urease activity:

Table (28) showed that the inhibition percentage in caked soybean reached 48.14% which represented about 2.54 times that of the caked broad bean.

The inhibition percentage of trypsin activity in stewed broad bean was 80% then was followed by the stewed soybean of a value of 67.44%. However, the roasted samples showed higher percentage inhibition being 87.56% in the roasted soybean and 76.72% in the roasted peanut. As shown in Table (28) method of roasting as well as the method of preparing stewed sample exhibited a higher percentage of inhibition. This was held true due to the temperature effect throughout roasting as well as the effect of prelonged time of heat treatment through preparing the stewed samples (10 hr.) The lower precentage inhibition in the caked samples was mainly due to that trypsin was analyzed in the non cooked samples. i.e. no heat treatment was applied. Data presented in this study concerning broad bean samples are in accordance with those reported by Bhatty (1979).

Table (28) :- Trypsin activity as a function of the methods of processing.

Tested varities	O.D[1]	Unit activity = 0.01 O.D	% Inhibition
Soybean	0.86	86.0	100.00
Peanut	0.58	58.0	100.00
Broad bean	0.935	93.5	100.00
Caked soybean	0.446	44.6	48.14
Caked broad bean	0.758	75.8	18.93
Stewed soybean	0.28	28.0	67.44
Stewed broad bean	0.187	18.7	80.00
Roasted soybean	0.107	10.7	87.56
Roasted peanut	0.135	13.5	76.72

[1] O.D. = Optical density.

Urease activity is an index of eliminating the antinutrient factors through processing especially in soybean i.e. hemagglutinin and others.

However, the obtained results showed that the method used for preparing soybean products namely caked soybean, stewed soybean, roasted soybean resulted in reducing urease activity (Table 29).

Table (29):- Urease activity in soybean and its products.

Soybean products	Urease activity	% inhibition
Soybean	1.600	100.00
Caked soybean	0.028	98.25
Stewed soybean	0.019	98.81
Roasted soybean	0.018	98.88

8. <u>Organoleptic evaluation</u>:

The three main indices namely color, taste and texture were organoleptically evaluated for the items produced from soybean, broad bean and peanut as shown in Table (30).

With regard to color no remarkable difference was noticed between stewed soybean and stewed broad bean. On the other hand, the caked broad bean and the roasted peanut scored five marks over the corresponding products of soybean.

Concerning the taste index, the caked soybean and caked broad bean samples were near to the extra standard. Stewed broad bean and roasted peanut were considered as fancy grade from the taste point of view while the corresponding soybean products scored nearly extra standard. This could be explained by the fact that the consumers are accustomed to broad bean and peanut products because they had been already consumed since long time ago. On the other hand soybean is considered as a new item with respect to consumers habits.

With respect to the effect of processing on the texture of the same tested products, data of Table (30) show that the caked soybean got higher scores than those for the caked broad bean. However, the stewed broad bean and the roasted peanut showed reversible trend, i.e. higher scores than the soybean products.

The overall acceptability of the investigated samples calassified samples as fancy grade e.g. the stewed broad bean and peanut; others as extra standard for the caked soybean, caked broad bean, stewed soybean and roasted soybean.

The difference between the roasted peanut and soybean samples may be also related to the volatile substances that are naturally present and are effected by heat of roasting.

Table (30):- Sensory evaluation as a function of the methods of processing.

Tested products	Sensory criterion (scores out of 100)			
	Colour	Taste	Tex-ture	Overall accept-ability
Caked soybean	81	77	78	78.67
Caked broad bean	86	73	65	74.67
Stewed soybean	81	70	73	74.67
Stewed broad bean	82	81	84	82.33
Roasted soybean	82	70	79	77.00
Roasted peanut	87	85	84	85.33