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# EFFECT OF PROCESSING OF LEGUMES ON CHEMICAL COMPOSITION AND NUTRITIVE VALUE

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***Abstract***

The chemical composition and nutritional value of the Egyptain legumes seeds soybean, fababean and cowpea before and after soaking and cooking by different methods were studied . Soaking in plain water at room-temperature for 12hrs, cooking under atmospheric pressure and autoclaving decreased the ash, crude protein, crude fiber, starch content, elements (cu,p, k fe)m and some amino acids i.e. sulfur amino acid and lysine . While fat, total sugars free amino nitrogen and most of the non - essential amino acids were increased. Cooked legumes can be considered as a high nutritive food because of their carbohydrate and protein content.

## INTRODUCTION

Legumes are the only higher plants that could utilize atmospheric nitrogen and synthesize a lot of protein. While , grains contain only (10-20%) protein, legumes contain over 30%. Dry legumes contain more protein than meat, Nevertheless most legumes are lacking sulfur amino acids but rich in lysine. Accordingly, legumes can act satisfactorily as a proper supplement for cereal proteins. Legumes are also rich in carbohydrates (50-60%) and contain a variable amount of fat (1-18%). Their high relative content of fiber (2-6%) often leads to intestinal fermentation and flatulence. Besides, legumes are a good source of ash rich iron in and phosphorus but usually deficient in calcium and sodium (Bressani, 1973 and Akpapuman and Achnewhce , 1985).

This study was essentially carried out to investigate the gross chemical components of soybean, cowpea and fababean commonly used in the Egyptian diets and the effect of different methods of soaking and cooking on chemical constituents of legumes i.e. total amino acids, available lysine and free amino nitrogen.

## MATERIALS AND METHODS

Sampling : three legume samples soybean, cowpea nad fababean samples were botained from Agric . Research Centre , Giza Egypt.

### Treatments were as follows

(1) Soaking in plain water for 12 hrs at room temperature.

(2) Soaking in plain water for 12 hrs at room temperature then cooked under atmospheric pressure.

(3) Soaking in plain water for 12 hrs then autoclaving for 30, 60, 90 and 120 minutes at pressure of 1.5 kg/cm2 and 120$^{o}$C without soaking (treatments 3,4,5 and 6 respectively).

Thereafter, processed samples were dried at 50$^{o}$C in hot air oven until reaching a constant weight (48 hrs ) then ground to pass through a 1-mm mesh sieve and stored in air tight polyethylene bags at room temperature.

### Chemical analyses

Moisture content, ash content, ether extract, nitrogen, total crude protein, crude fiber, toal sugar and starch were determined according to the methods reported by the A.O.A.C. (1980) Total amino acids were estimated according to the procedure of Moore and Stein (1963) and Peinska *et al.* (1963).

Available lysine was determined according to Hurrel and Carpenter (1976).

Free amino nitrogen was determined as glycine by minhydrine test as described by Stein and Moore (1954).

While mineral contents : were determined according to Troug and Meyer (1929).

## RESULTS AND DISCUSSION

Data concerning the chemical compostion (ash, fat, protein, crude fiber, total sugars, minerals , free amino nitrogen, available lysine and starch contents are tabulated in Table 1.

### 1 .Ash content

Results obtained show that ash contents of dry soybean, fababean and cowpea, were 4.92%, 3.76%, and 3.45%, respectively, and indicate the importance of legumes as a source of minerals in human diet.

According to El-Nahry *et al.* (1977) and Rockand *et al.* (1979b), soaking in plain water at room temperature slightly decreased the ash content . Such a decrease can be explained by the release of minerals during soaking in plain water for this long period (12 hrs). Okaka and Potter (1979) obtained a decreaseing trend of ash percent upon soaking cowpea at 35$^{o}$C hrs. (from 3.09 to 2.85%) . Such a phenomenon was also noticed by Akpapunam and Achinewhce (1985) who found that the ash was decreased after soaking broad and small beans for 12 hrs. This could be attributed to the leaching of some minerals into the soaking water.

Cooking under atmospheric pressure and other autoclaving treatments lowered the ash content compared to raw soaked legumes. El-Nahry *et al.* (1977) found that the ash content of boiled kidney bean with and without soaking were 3.79% and 4.79% respectively. Results obtained are similar to those preported by Rockland *et al.* (1979 a,b) who noticed a decrease in minerals content of some legumes during cooking .

### 2 . Fat content

It is evident that soybean was the highest in lipids content (17.60%) while fababean, and cowpea, contained as low as 1.64% , and 2.17% , respectively, Such findings are confirmed with the results by Wolf and Thompson (1977) who found that most legumes contained low fat that ranges 2-5%. Also John (1981) found that lipids in dry pea, pintobean, white navy bean and soybean were 3.30 , 2.1, 2.2 and 20.1% respectively. Bhatty and Christison (1984) reported that the ether extract was 1.1% in fababean, and 1.3% for peas. Misra *et al.* (1987) stated that seeds of the 34 varieties of wingedbean contained from 14.1 to 17.6% fat.

A slight decrease in fat content of legumes samples was noticed after soaking for 12 h. at room temperature. Results obtained are in coincidence with those indicated by Okaka and Potter (1979), who found that fat content of cowpea samples decreased from 1.3% to 1.2% after soaking for 10 hrs at 35°C.

As light increase in fat content occurred in all legumes either cooked at atmospheric pressure or autoclaved. Changes in fat content could be explained by the differential solubility of solids with soaking and cooking , as found by El-Nahry *et al.* (1977) and Khan *et al.* (1979)

## 3 . Protein content

Protein content of dry soybean seeds was the highest (36.20%) followed by cowpea (26.98%) , then fababean (25.26%).

The variations noticed in protein content in the above legumes could be attributed to either the genetic differences or the cultivation area. Moreover the locality within the country affected also the protein content (Bhatty and Christison 1984).

Soybean soaked in plain water at room temperature, contained 0.5% less protein than the control . Generally soaking of fababean led to a decrease in their protein content form 25.26% to 24.43%. Also, soaking cowpea seeds decreased the protein concentration from 26.98% to 25.73. Similarly, Okaka and Potter (1979) found that the protein content of cowpea was decreased by soaking.

It is clear that cooking at atmospheric pressure after soaking in plain water lowered the protein contents from 35.63 to 35.53 , 24.43 to 23.90 and 25.73 to 25.35% for soybean , cowpea and fababean respectively.

While autoclaving of legumes at 120°C for 30 min., after soaking in plain water resulted in a decrease of the protein contents to 35.12% (soybean), 23.67% (fababean), and 25.12% (cowpea), the decreasing pattern was greatly pronounced by prolongation of the autoclaving period. Such decrease may be due to the breakdown of some proteins. A slight decrease in protein content of winged bean upon cooking was noticed by Rockland *et al.* (1979 a).

## 4 . Crude fiber content

Concerning the fiber content, the data obained indicate that the legume samples contain high percentages of fibers being 4.63, 4.30, and 3.29 in soybean, fa-

babean, and cowpea, respectively. Such differences were reported by Boloorforoo-shan and Markakis (1979) , Bhatty and Christison (1984) and Misra *et al.* (1978) and could be referred to legume variety and location.

Moderate decreases in the crude fiber content occurred after soaking from 4.63 to 4.30% in soybean, 4.30 to 4.30 to 4.06% in fababean, and 3.29 to 3.04% in cowpea. Such slight decrements could be attributed to the cellulose and haemcellu-lase action during soaking leading to the partial breadkown of fibers to soluble com-pounds.

A light decrease was noticed in the fiber content of legumes after being cooked. Khan *et al.* (1979) stated that cooked cowpea contained from 6.1 to 4.8% crude fiber.

## 5 . Total sugars content

Legumes under ivestigation had high contents of sugars (11.33, 9.89 and 9.49) for fababea, cowpea, and soybean respectively . Results obtained are in agreement with those indicated by Bhatty and Christison (1984).

It is obvious that the total sugars content of legumes were considerably in-creased after soaking in plain water for 12 hrs. at room temperature. Such a phe-nomenon may be ascribed to the change of most of the insoluble carbohydrates espe-cially the starch by the action of hydrolytic enzymes which turned them into soluble sugars. Also , the moderate increase of total sugars was observed in cooked beans which may be attributed to the enzymatic hydrolysis of higher polysaccharides dur-ing initial stages of cooking.

## 6 . Starch content

Dry fababean seeds were the highest in starch content (44.71%) , followed by cowpea (43.59) and soybean (18.68%). Results obtained fell in the ranges reported by Bhatty (1974), Singh *et al.* (1982) and Jood *et al.* (1986)

As a general trend, soaking of legumes reduced starch content from 43.59, 48.31 and 44.82% to 37.64, 41.19 and 39.15% in soybean, fababean and cowpea respectively. These reductions during soaking process were apparently induced by active amylase (Jood *et al.* 1986) . Cooking of soaked legumes under atmospheric pressure lowered their starch content from 17.83, 40,78, and 37.64% , to 13.62 and 35.20 % , in soybean, fababean and cowpea, respectively. Such decrease was

more pronounced after autoclaving of legumes at 120°C and 35.20% , in soybean , fababean and cowpea, respectively . Such decrease was more pronounced after autoclaving of legumes at 120°C especially after a prolonged autoclaving period. These losses may be due to the breakage of glucoside bonds of polysaccharides during cooking and autoclaving.

## 7 . Total amino acids

Most legumes have a reasonable balance of essential amino acids that could supply the minimum requirement to man. They are very rich in lysine but low in sulfur amino acids. Methionine is the first limiting amino acid in, most kinds of legumes (including soybean). The highest amount was recorded for leucine and lysine . Their contents were 8.80 and 7.72 in soybean, 7.20 and 6.93 in fababean, 7.11 and 6.38 in cowpea (gm/16gm N) respectively. The lowest amount was found in methionine which was 1.30, 1.08 and 1.10, gm/ 16gm N in soybean fababean, and cowpea, respectively. It is noticed that legumes contain all essential amino acids. However, low concentrations relative to completely balanced protein was found in some of legume samples (Wilson et al. 1972). The non-essential amino acids glutamic and aspertic were comparatively existing in very high amounts (18.14 and 15.36, 14.14 an 10.14, and 17.39 and 12.11, gm/16gm N in soybean, fababean and cowpea respectively. These findings are in close agreement with those obtained by Sheata and Fryer (1970) Nitsan, (1971) Bolooforooshan an Markakis (1979) and Gervani and Theophilus (1980).

Soacking of raw legume seeds in plain water before cooking resulted in moderate increments in most essential and non-essential amino acids. Cooking after soaking under atmospheric pressure decreased essential and non-essential amino acids namely, methionine, lysine, serine and tyrosine in soybean, leucine lysine, arginine and tyrosine in fababean, theronine, lysine, arginine and serine in cowpea.

Autoclaving reduced amino acid concentration with may be due to more destruction of protein and aminno acids that took place at high temperature during cooking. Autoclaving lowered the sulfur amino acids and lysine . Similar behaviour was noticed by Rama and Rao (1974).

## 8 . Effect of processing on the chemical score (C.S.) and limiting amino acids

Essential amino acid composition of raw and processed soybean, fababean and

cowpea, protein compared with the FAO/WHO committee (1973) for hypothetical high biological value protein. Data obtained appear in (Table 2 ) Raw soybean was deficient in methionine (first limiting amino acid) theronine (second), valine,leucine and lysine, which may limit its biological value. Soaked soybean was deficient in methionine, theronine and valine. Methionine was the limiting amino acid. Soybean cooked under atmospheric pressure was deficient in methionine, lysine and valine which were the limiting amino acids. Autoclaving (for 30,60, 90 and 120 min) led to a deficiency in methionine, valine and theronine being the limiting amino acids.

Raw fababean was deficient in methionine , theronine and isoleucine (the limiting amino acids). Soaking, cooking and autoclaving of fababean resulted in deficiency in methionine (first limiting) isoleucine (second) and theronine (third), respectively.

Raw cowpea was deficient in methionine , isoleucine and valine .Soaked cowpea was deficient in methionine, threonine and valine. Cooked cowpea under atmospheric pressure was deficient in methionine, threonine and lysine . Autoclaving of cowpea for 30min., led to its deficiency in methionine, threonine and lysine. When it was autoclaved for 60 min . deficiency was detected in methionine, threonine and tryptophan. Autoclaving for 90 and 120 min, caused deficiency in methionine, threonine and lysine (limiting amino acids).

## 9 . Effect of processing on the available lysine

The loss of the essential amino acid lysine during heating of legumes had been thoroughly studied and explained as a browining reaction between the epsilon amino group of lysine and reducing sugars. The intensity of the colour formed is to some extent related to the degree of deterioration of the nutritive value of the protein (Geervani and Theophilus, 1980). (Table 1) shows that the higher loss was observed in legumes autoclaved at 120$^{o}$C (for 30,60,90 and 120 min) after soaking for 12hrs, cooking under pressure seemed to be protective for the essential amino acid lysine since the loss was high in the smaples cooked under atmospheric pressure.

Onaymi and Potter (1976) observed high lysine availablity in cowpea seeds indicating good retention of protein quality during processing . The loss of lysine at temperature below 100$^{o}$C was explained by the reaction of lysine with autoxidizing fat, while at 115$^{o}$C - 130$^{o}$C the loss was apparently independent on the presence of fat (Lea *et al.* 1960).

## 10 . Effect of processing on the free amino nitrogen

Amounts of free amino nitrogen of legume samples processed by differnt methods appear in (Table 1) . This amount (mg/g legume) was 1.80 (soybean), 1.77 (fababean), and 2.35 (cowpea). It is clear that the highest free amino nitrogen was in cowpea, followed by soybean and fababean, respectively.

It is obvious that soaking led to an increase in the amino nitrogen of all legumes. This causes the operation of active proteases on the existed proteins. Higher increases in free amino nitrogen was observed in all legume samples autoclaved for different periods relative to the raw and soaked samples. Amounts of free amino nitrogen of legume samples cooked under atmospheric pressure were 2.11, 1.08, and 2.48, mg/g in soybean, fababean , and cowpea, respectively , probably proteins and polypeptides were broken by the high temperature treatmens.

## 11 . Mineral content

Legumes are considered good sources of calcium, phosphorus, potassium and iron in the diet. Besides, legumes contain the trace elements copper, zinc and manganese. Results presented in (Table 1) indicate that Ca,P,Fe and K were the main elements in legume samples. Cowpea contained the highest amount of K in the raw and autoclaved samples for 120 min., which was 2883 and 2120, mg/100g followed by fababean (2499 and 2196 mg/100g.) and soybean (2356 and 2166 mg/100 g then soybean 362 and 315. The highest amount of Ca was found in soybean (111.3 and 81.6 mg/100 g followed by fababean (89.2 and 56.8), and cowpea (38.6 and 25.4). Cowpea and fababean contained the highest amounts of Fe being 12.1 , and 7.1 mg/100g in raw and cooked samples respectively. Soybean contained 3.8 mg/100g. Results concerning the mineral composition of cowpea are in agreement with those obtained by Kon (1979). Similar trend was noticed by Rizley and Sistrunk (1979) who found that legume cooked for 20 min. after soaking contained more Ca, Mg, D and P than in raw sample . It could be concluded from the previous results that legumes can be considered good sources of minerals, One serving of legumes (100-150gm) of about 1/2 to 3/4 cup could fulfil about 40% of the total adult requirements of Ca, 30% of Fe and all the daily requirement of O and K.

Table 1. Effect of processing on the chemical composition of soybean (S), fababean (F), an cowpea (C).

| Compounds | Treatments | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Control | | | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | |
| | S | F | C | S | F | C | S | F | C | S | F | C | S | F | C | S | F | C | S | F | C |
| Moisture (%) | 9.500 | 9.360 | 10.13 | 11.15 | 11.15 | 12.11 | 10.97 | 12.53 | 12.93 | 11.60 | 12.37 | 12.76 | 11.21 | 12.45 | 12.97 | 12.29 | 11.60 | 12.88 | 10.81 | 11.32 | 12.76 |
| Ash (%) | 4.920 | 3.670 | 3.450 | 2.360 | 1.810 | 1.900 | 1.850 | 1.260 | 1.530 | 2.100 | 1.630 | 1.670 | 2.080 | 1.580 | 1.640 | 1.950 | 1.500 | 1.610 | 1.860 | 1.520 | 1.640 |
| Fat (%) | 17.60 | 1.640 | 2.170 | 17.12 | 1.600 | 1.860 | 17.66 | 1.880 | 2.240 | 17.73 | 1.950 | 2.320 | 17.69 | 1.980 | 2.460 | 17.92 | 1.960 | 2.430 | 18.16 | 1.950 | 1.730 |
| Protein (%) | 36.20 | 25.26 | 26.98 | 35.63 | 24.43 | 25.73 | 35.53 | 23.90 | 25.35 | 35.12 | 23.67 | 25.12 | 34.96 | 23.50 | 25.50 | 34.58 | 23.33 | 24.83 | 34.79 | 23.11 | 24.72 |
| Crude fiber (%) | 4.630 | 4.300 | 3.290 | 4.300 | 4.060 | 3.040 | 3.930 | 3.860 | 3.030 | 3.610 | 3.510 | 2.830 | 3.450 | 2.360 | 2.700 | 3.260 | 3.110 | 2.340 | 3.060 | 3.000 | 1.800 |
| Total sugars (%) | 4.490 | 11.33 | 9.890 | 11.04 | 15.83 | 15.92 | 15.99 | 25.84 | 18.17 | 15.40 | 23.44 | 20.84 | 17.60 | 26.18 | 24.61 | 20.24 | 28.04 | 26.30 | 22.39 | 32.61 | 32.01 |
| Starch (%) | 18.68 | 44.71 | 43.59 | 17.83 | 40.78 | 37.64 | 13.62 | 30.16 | 35.20 | 13.16 | 33.52 | 33.51 | 12.36 | 31.67 | 29.15 | 9.130 | 30.18 | 28.90 | 8.520 | 26.86 | 23.31 |
| Mineral content (mg/100gm.) | | | | | | | | | | | | | | | | | | | | | |
| Ca | 111.3 | 89.20 | 38.69 | 93.60 | 65.40 | 32.41 | 92.40 | 53.50 | 28.50 | 92.20 | 50.80 | 28.43 | 90.40 | 59.40 | 26.15 | 86.90 | 54.10 | 25.91 | 81.60 | 56.80 | 25.43 |
| P | 362 | 488 | 483 | 336 | 344 | 321 | 318 | 334 | 295 | 291 | 339 | 306 | 311 | 324 | 298 | 301 | 336 | 311 | 315 | 339 | 319 |
| Fe | 3.800 | 7.400 | 12.10 | 2.100 | 6.200 | 9.400 | 1.800 | 5.300 | 8.100 | 1.600 | 5.800 | 8.900 | 1.900 | 5.100 | 7.500 | 1.700 | 4.300 | 7.400 | 1.500 | 4.800 | 7.10 |
| K | 2356 | 2499 | 2883 | 2241 | 2239 | 2289 | 2198 | 2197 | 2155 | 2183 | 2229 | 2113 | 2226 | 2203 | 2146 | 2173 | 2185 | 2103 | 2166 | 2196 | 2120 |
| Free amino nitrogen (mg/100 gm.) | 1.800 | 1.770 | 2.350 | 1.990 | 1.970 | 2.440 | 2.110 | 2.080 | 2.480 | 2.060 | 2.030 | 2.440 | 2.140 | 2.140 | 2.390 | 2.210 | 1.170 | 2.390 | 2.230 | 2.200 | 2.380 |
| Available lysine(%) | 1.339 | 1.316 | 1.251 | 1.344 | 1.328 | 1.272 | 1.102 | 1.015 | 0.789 | 1.322 | 1.311 | 1.263 | 1.292 | 1.300 | 1.257 | 1.276 | 1.280 | 1.256 | 1.288 | 1.265 | 1.212 |

1= Initial body wt. (gm.) 2= Final body wt. (gm.) 3= Body wt. gain (gm.) 4= Total food intake (gm.)
5= Total protein intake (gm.) 6= PER value

$P > 0.05$

Table 2. Effect of processing on the amino acid content (mg/16 gm/v) of soybean (S), fababean (F), an cowpea (C).

| Compounds | Treatments | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Control | | | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | |
| | S | F | C | S | F | C | S | F | C | S | F | C | S | F | C | S | F | C | S | F | C |
| Essential : | | | | | | | | | | | | | | | | | | | | | |
| Leucine | 8.80 | 7.20 | 7.11 | 9.33 | 7.27 | 7.52 | 8.63 | 6.90 | 7.62 | 8.65 | 7.10 | 7.51 | 8.31 | 6.92 | 1.43 | 8.22 | 6.80 | 7.11 | 8.01 | 6.83 | 6.63 |
| Isoleucine | 5.31 | 3.45 | 3.71 | 5.96 | 3.44 | 4.93 | 5.20 | 3.52 | 4.90 | 5.11 | 3.32 | 4.83 | 4.73 | 3.30 | 4.52 | 4.52 | 2.96 | 4.80 | 4.32 | 3.00 | 4.32 |
| Threonine | 4.24 | 3.32 | 3.83 | 4.25 | 3.66 | 4.08 | 4.00 | 3.69 | 3.73 | 4.10 | 3.51 | 3.78 | 3.79 | 3.42 | 3.12 | 3.60 | 3.40 | 2.16 | 3.32 | 3.25 | 2.30 |
| Phenylalunine | 5.36 | 4.25 | 5.13 | 6.01 | 4.26 | 5.90 | 5.06 | 4.10 | 5.26 | 5.86 | 3.98 | 4.16 | 5.45 | 3.97 | 4.01 | 4.31 | 4.01 | 3.21 | 4.26 | 4.06 | 3.67 |
| Treptophane | 2.04 | 1.20 | 1.20 | 2.16 | 1.25 | 1.50 | 1.17 | 1.11 | 1.03 | 1.80 | 1.09 | 1.08 | 1.31 | 1.04 | 1.01 | 1.15 | 0.93 | 0.94 | 1.00 | 0.89 | 0.92 |
| Valine | 5.70 | 4.60 | 4.64 | 5.91 | 4.81 | 5.13 | 4.81 | 4.83 | 5.15 | 4.72 | 4.86 | 5.73 | 4.40 | 4.53 | 5.80 | 4.10 | 4.41 | 4.59 | 4.02 | 4.22 | 4.16 |
| Lysine | 7.72 | 6.93 | 6.38 | 7.93 | 7.18 | 6.81 | 5.17 | 6.09 | 5.10 | 6.11 | 5.88 | 6.13 | 6.15 | 5.80 | 5.83 | 6.10 | 5.72 | 4.31 | 5.99 | 5.60 | 4.14 |
| Methionine | 1.30 | 1.08 | 1.10 | 1.35 | 1.15 | 1.54 | 0.80 | 1.10 | 1.00 | 1.11 | 1.02 | 1.21 | 0.96 | 0.99 | 1.14 | 0.85 | 0.85 | 1.05 | 0.72 | 0.82 | 0.84 |
| Nonessential : | | | | | | | | | | | | | | | | | | | | | |
| Histidine | 4.16 | 2.63 | 3.15 | 5.26 | 3.16 | 4.12 | 5.03 | 3.15 | 4.13 | 5.10 | 3.10 | 4.22 | 5.07 | 3.19 | 4.26 | 4.81 | 2.51 | 3.86 | 4.55 | 2.69 | 4.19 |
| Arginine | 9.10 | 8.20 | 5.37 | 10.81 | 8.91 | 5.43 | 10.00 | 7.31 | 4.22 | 10.13 | 8.11 | 4.18 | 10.10 | 8.05 | 4.15 | 10.02 | 8.03 | 4.21 | 9.87 | 8.00 | 4.11 |
| serine | 5.91 | 4.70 | 4.94 | 5.96 | 4.73 | 4.98 | 5.17 | 4.00 | 3.63 | 5.66 | 4.51 | 4.90 | 5.43 | 4.42 | 4.73 | 5.81 | 4.32 | 3.27 | 5.36 | 4.11 | 3.78 |
| Glycine | 4.03 | 4.21 | 3.54 | 4.39 | 4.20 | 3.62 | 4.48 | 4.29 | 3.14 | 4.21 | 4.13 | 3.60 | 4.51 | 4.19 | 3.56 | 4.36 | 4.25 | 2.91 | 4.40 | 4.18 | 2.86 |
| Alanine | 5.81 | 4.86 | 4.60 | 9.00 | 4.93 | 5.16 | 9.11 | 5.04 | 4.03 | 9.03 | 5.00 | 4.21 | 8.89 | 4.80 | 4.13 | 8.80 | 4.72 | 4.00 | 8.50 | 4.56 | 4.20 |
| Tyrosine | 4.40 | 2.16 | 2.89 | 4.48 | 3.11 | 3.13 | 4.32 | 1.81 | 3.26 | 4.26 | 1.72 | 2.51 | 4.13 | 1.66 | 2.36 | 4.10 | 1.60 | 1.60 | 4.15 | 1.49 | 1.43 |
| Prolinr | 3.66 | 4.20 | 3.85 | 4.18 | 4.28 | 3.87 | 4.01 | 4.11 | 3.71 | 4.10 | 4.15 | 3.66 | 3.91 | 4.12 | 3.21 | 4.06 | 4.03 | 3.11 | 4.80 | 4.60 | 2.02 |
| Aspartic | 15.36 | 10.14 | 12.11 | 17.37 | 11.26 | 12.53 | 17.12 | 10.10 | 10.12 | 17.10 | 11.00 | 9.33 | 17.39 | 10.89 | 9.63 | 17.45 | 9.81 | 9.06 | 17.11 | 9.68 | 8.13 |
| Glutamic | 18.14 | 14.41 | 17.39 | 19.20 | 15.43 | 17.90 | 19.03 | 14.00 | 17.16 | 19.00 | 15.36 | 16.90 | 18.96 | 15.30 | 16.81 | 18.80 | 15.22 | 16.19 | 18.61 | 15.11 | 15.64 |

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# تأثير العمليات التصنيعية علي التركيب الكيماوي والقيمة الغذائية لبذور بعض البقوليات

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تم دراسة التركيب الكيماوى والقيمة الغذائية لبعض بذور البقوليات التى تزرع بمصر مثل فول الصويا ، الفول البلدى واللوبيا، قبل وبعد النقع والطبخ بالطرق المختلفة . وأظهرت نتائج هذه الدراسة أن :

النقع فى ماء عادى على درجة حرارة الغرفة لمدة ١٢ساعة والطبخ تحت الضغط الجو العادى وتحت تفريغ بالأتوكلاف أدى الى نقص فى المحتوى من الدماء والبروتين الخام والالياف والنشا والمعادن وبعض الأحماض الأمينية الكبريتية والليوسين بينما تحدث زيادة فى نسبة الدهن والسكريات والنيتروجين الامينى الحر والاحماض الامينية غير الأساسية .

وطبخ البقوليات يحسن من قيمتها الغذائية والسعرية لاحتوائها على نسبة عالية من الكربوهيدرات والبروتين .