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# CHEMICAL AND SENSORY EVALUATION OF CHICKPEA AND SOYBEAN AS AFFECTED BY SOAKING, GERMINATION AND COOKING

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## ABSTRACT

Chickpea (cooker chickpea) and soybean were soaked either in distilled water or in 0.5% sodium bicarbonate solution for 12 hr, germinated for 72 hr and boiling cooked. The best cooked products, were those soaked in distilled water or in sodium bicarbonate solution before cooking. On the other side, germination up to 2 days was superior to three days. Generally, germination process reduced cooking times for the two legumes than soaking. While soaking processes elevated hydration coefficients for the two legumes, germination process reduced them. Also hydration coefficients of cooked unsoaked legumes were higher than those soaked or germinated before cooking. Cooking media of dry legumes contained higher amounts from total solids, ash and protein than soaking only or cooking after soaking or germination. The contents of the soaked distilled water from total solids, ash and protein were less than those of soaked in 0.5 % $NaHCO_3$ solution for both legumes. In contrast, the cooking media of the two legumes those were previously soaked in distilled water contained a higher amounts of the three ones. Soaking and germination processes raised water – soluble solids, wherein cooking process reduced them in all cases: raw, soaked and germinated chickpea and soybean. Soaking, germination and cooking increased crude protein and ether extract of chickpea and soybean. Soaking and cooking decreased ash contents, while they increased by germination. On the other hand, crude fiber was decreased by soaking, germination and increased by cooking. Finally, carbohydrates were decreased as a result of all processes for both legumes. Soaking and germination processes elevated total nitrogen (TN), non protein nitrogen (NPN), protein nitrogen (PN) and free amino nitrogen (FAN). On the other side, cooking process elevated TN, PN and reduced NPN, TFAN of all samples. Both soaking in distilled water or in 0.5 % sodium bicarbonate solution resulted in similar losses (1 – 21 %) for major minerals except sodium that increased by soaking in 0.5% sodium bicarbonate solution. Germination process lowered the contents of Zn, Mn, Fe, Na, K and P, meanwhile raised the contents of Ca, Cu and Mg. On the other side, cooking of dry legumes resulted in losses in all minerals with different ratios. Also, cooking after soaking or germination resulted in losses of some minerals (Zn, Mn, Fe, Cu, Na, K, and P) and increased others (Ca and Mg).

**Keywords:** chickpea, soybean, soaking, germination, cooking, sensory evaluation, cooking time, hydration coefficient, soluble solids, chemical composition, nitrogenous constituents and minerals.

## INTRODUCTION

Legumes are important source of proteins and other nutrients and are commonly used as food and fodder. Particularly in developing countries, legumes represent the major component of daily dietary foodstuffs along with

bread (Shalaby 2000). In Egypt, it could be stated that legumes represent the major Egyptian diets whatever the standard of living (Abd-Allah *et al.*1988).

Chickpea (*Cicer arietinum,* L.) is an important source of protein in several developing countries. Among the world's grain legumes, chickpea is the second to dry beans (*Phaseolus vulgaris, L.*) in cultivated area and the third in production to dry beans and dry peas (*Pisum sativum, L.*)(Singh *et al.*1991).

Soybeans play a major role in agriculture, commerce, industry and nutrition and for centuries have been an important source of dietary protein for millions of people of the Orient (Sutardi and Buckle 1985).

Soaking and germination of legumes are an ancient and popular practice in many parts of the world (Shalaby 2000). Preparation time of dry legumes has been shown to be markedly reduced by procedures that influence cell integrity, texture, water imbibition and heat transfer. These procedures employ the use of a soak treatment capable of softening the seed coat of dry legumes. Several investigators have found that addition of sodium bicarbonate to the soak solution can markedly reduce cooking time of dry legumes by allowing better water imbibition through softening of the seed coat (Kilgore and Sistrunk 1981). A quick cooking method for legumes includes dehulling, soaking, germination and precooking. These processes reduced the cooking time and improved the nutritional value of beans (El-Sahan and Youssef 1992). It was reported that germination reduced cooking times and improved the sensorial attributes of cooked legumes (Trugo *et al.*2000)

The aim of the present investigation was studying effects of soaking in distilled water, 0.5% sodium bicarbonate solution (12 hr) or germination up to 72 hr following by boiling cooking on the sensory qualities, hydration coefficients, cooking times and the proximate composition of chickpea (cooker chickpea) and soybean. The investigation was extended to study solubility of solids, some nitrogenous constituents and minerals content of both legumes.

## MATERIALS AND METHODS

### A- Materials

Two samples of dry legumes, chickpea (*Cicer arietinum, L.*) variety Giza 195 and soybean *(Glycin maxl-merr)* variety Giza 82 (crops of 2004) were obtained from Agriculture Research Center, Giza, Egypt. The dried seeds were cleaned, freed from broken seeds, dust and other foreign materials and stored in polythene bags at 5°C until used.

### B- Methods

#### 1- Technological methods

**Soaking**: The dried seeds were soaked either in distilled water or in 0.5% sodium bicarbonate solution (1:3 w/v) for 12 hr (over night) at room temperature (25 ± 2°C). The unimbided water was recovered and the soaked seeds were rinsed twice with distilled water.

**Germination**: The soaked, washed seeds were germinated on stainless steel screen baskets, which were covered with two layers of cheesecloth. The germination process was carried out at room temperature (25 ± 2°C) for 72 hr. During the germination period, the seeds were rinsed with distilled water every 12 hr.

**Cooking:** The soaked and soaked -germinated seeds were added to boiling distilled water (1:3 w/v) in 500 ml Pyrex glass beaker, covered with aluminium foil and heated to maintain boiling until cooking. The seeds were considered completely cooked when they attained a soft texture and were easily mashed between the fingers (Wanjekeche *et al.*2003). Raw seed samples (control) were washed in distilled water and cooked in the same manner, using a seed to water ratio of 1:5 (w/v). The cooked seeds were drained, allowed to cool at room temperature and homogenized.

2- **Hydration coefficients** were calculated as percentage increases in the weight due to soaking, germination and cooking for the two legumes (Hulse *et al.* 1977).

3- **Sensory evaluation** of cooked seed samples was carried out according to the method described by Watts *et al.* (1989). When the samples were used for sensory evaluation, table salt (0.22% w/w) was added before cooking. The panel was composed of 20 judges, using a fully structured 9-point rating scale to evaluate color, texture, flavor and overall acceptability of the cooked seeds. Drinking water was available for rinsing. The obtained data were subjected to analysis of variance (ANOVA) using the general linear of the Statistical Analysis System (SAS 1988). Also, means comparisons were performed using Duncan´s multiple Range Test (Steel and Torrie 1980).

4- **Analytical methods** The soaked, germinated and cooked seeds were dried in an electric oven at 50°C for 24 hrs, ground to pass through a 60-mesh sieve and stored in polythene bags at 4°C in a refrigerator until used. Also, raw dry seed samples were ground to pass through a 60-mesh sieve and stored as above. All samples were analyzed in triplicate and all results were calculated on dry weight basis.

**Proximate chemical composition** including moisture, crude protein (N x 6.25), ether extract, crude fiber and ash was determined according to A.O.A.C. (1990) procedures. Carbohydrate content was calculated by difference.

**Non-protein nitrogen (NPN)** was determined by extracting the samples with 10% trichloroacetic acid (TCA) according to the method of Paredes-Lopez and Harry (1989). Kjeldahl nitrogen was determined on a 10 ml an aliquot. Protein nitrogen (PN) was calculated as follows: PN = TN - NPN where TN is total nitrogen.

**Total free amino nitrogen** was estimated by means of the ninhydrin colorimetric method outlined by Iodic *et al.* (1966) as tyrosine equivalent and converted to nitrogen by multiplying by the factor 0.077 (nitrogen content of tyrosine).

**Water-soluble solids** were measured according to the procedure of Agosin *et al.* (1989). Two grams of dry sample were suspended in 18 ml of distilled water. The suspension was gently stirred for 30 min at 80°C. The residue

was recovered on Whatmann No 1 filter paper, thoroughly washed, dried and weighed. Soluble solids were calculated by difference.

Zinc, manganese, iron, calcium, cupper, magnesium, sodium and Potassium were measured using Perkin-Elmer atomic absorption spectrophotometer, Model 3300 and following the procedure of Kirk and Sawyer (1991). Total phosphorus contents were determined colorimetrically using the method of Mohamed *et al.* (1986).

On the other side, the cooking media were collected, allowed to cool at room temperature and taken with soaking media to estimate total solids, ash and soluble proteins

## RESULTS AND DISCUSSION

Germination process was carried out at room temperature (25 ± 2°C). Although in the first day, germination was not well for the two legumes (chickpea and soybean), germination process was improved in the second day. After three days, fermentative flavor and sticky touch was observed, especially soybean.

**Sensory evaluation**

The results of the sensory evaluation of cooked legumes are presented in Table1. The statistical analysis revealed significant ($P \leq 0.01$) differences for all parameters for the two legumes unsoaked, soaked or germinated. The best products of the two legumes were those soaked in distilled water or in sodium bicarbonate solution before cooking, respectively. It was noted that texture recorded the 3 rd order for the two legumes, those soaked previously in 0.5 % sodium bicarbonate solution. On the other hand, germination up to 2 days was superior to three days, and for this reason, germinated legumes up to three days were eliminated from the other analysis. Lee *et al.* (1983) reported that beans (soybean and black–eyed peas) soaked in 1 – 3 % $NaHCO_3$ had no equal quality to the control. El–Bagoury *et al.* (2000) stated that lentil soaked in distilled water before cooking was the most acceptable followed by soaking in 0.5 % sodium bicarbonate solution and finally the control (unsoaked).

**Table 1. Sensory evaluation of cooked chickpea and soybean**

| The constituent / The treatment | Color | Texture | Flavor | Taste | Accepta-bility |
|---|---|---|---|---|---|
| **Chickpea** | | | | | |
| 1) Raw (unsoaked) | 6.95 a | 7.60 a | 6.43 a | 6.50 a | 6.87 a |
| 2) Soaked in distilled water (12 hr) | 7.13 a | 7.41 a | 6.90 a | 7.19 a | 7.15 a |
| 3) Soaked in 0.5% $NaHCO_3$ (12 hr) | 7.20 a | 7.18 a | 6.71 a | 6.88 a | 6.99 a |
| 4) Germinated (2 days) | 6.88 a | 6.46 a | 5.73 a | 6.31 a | 6.35 a |
| 5) Germinated (3 days) | 5.59 b | 5.41 b | 4.67 b | 4.72 b | 4.97 b |
| **Soybean** | | | | | |
| 1) Raw (unsoaked) | 6.06 b | 6.56 a | 5.79 c | 5.16 c | 5.89 c |
| 2) Soaked in distilled water (12 hr) | 6.86 a | 6.42 a | 6.50 a | 6.75 a | 6.63 a |
| 3) Soaked in 0.5% $NaHCO_3$ (12 hr) | 7.01 a | 5.37 b | 6.27 b | 6.33 b | 6.25 b |
| 4) Germinated (2 days) | 5.73 c | 4.35 c | 4.57 d | 4.95 d | 4.90 d |
| 5) Germinated (3 days) | 5.14 d | 3.88 d | 3.39 e | 3.75 e | 4.04 e |

*** Score of 9 points.**

**** Values in the same column with different letters are significantly different (P≤0.05) using Duncan's multiple range test**

**Cooking times and hydration coefficients**

Table 2 shows effects of different processes on cooking times and hydration coefficients of chickpea and soybean. Generally, germination process reduced cooking times for the two legumes than both soaking in distilled water or in 0.5% sodium bicarbonate solution. Adequate cooking of unsoaked chickpea required 99 min at 100°C. Chickpea soaked in distilled water or in sodium bicarbonate solution required 52 and 38 min, respectively, while germinated chickpea required only 35 min. The corresponding values of soybean were 126, 87, 75 and 71 min, respectively. Moreover, germination process reduced hydration coefficients, while soaking processes elevated them for the two legumes. Also, hydration coefficients of cooked unsoaked legumes were higher than those soaked or germinated before cooking. Generally, it is clearly that, hydration of both legumes through soaking and some hydrolysis through germination had shortened cooking times. Generally, the obtained results agreed with those of Rockland *et al.* (1979), Wang *et al.* (1979), Silva *et al.* (1981), Lee *et al.* (1983), El- Bedawey *et al.* (1989), Singh *et al.* (1991) and El. Bagoury *et al.* (2000).

**Table 2: Cooking time and hydration coefficient of soaked, germinated and cooked chickpea and soybean**

| The treatment | Cooking time (min) | Hydration coefficient % | | |
|---|---|---|---|---|
| | | Soaking | Germination | Cooking |
| **Chickpea** | | | | |
| 1) Raw (unsoaked) | 99 | - | - | 141.8 |
| 2) Soaked in distilled water (12 hr) | 52 | 132.9 | - | 7.8 |
| 3) Soaked in 0.5% $NaHCO_3$ (12 hr) | 38 | 131.7 | - | 8.9 |
| 4) Germinated (2 days) | 35 | 132.9 | - 4.5 | 13.4 |
| **Soybean** | | | | |
| 1) Raw (unsoaked) | 126 | - | - | 126.2 |
| 2) Soaked in distilled water (12 hr) | 87 | 119.7 | - | 5.4 |
| 3) Soaked in 0.5% $NaHCO_3$ (12 hr) | 75 | 117.5 | - | 7.7 |
| 4) Germinated (2 days) | 71 | 119.7 | -4.9 | 11.1 |

**Room temperature during soaking (12 hr) and germination period (2days) was 25 ± 2 °C.**

$$\text{Hydration coefficient} = \frac{\text{Sample weight after treatment-sample weight before treatment}}{\text{Sample weight before treatment}} \times 100$$

**Losses of total solids, ash and protein into soaking and cooking media**

Total solids, ash and protein of the soaking and cooking media recovered from chickpea and soybean are illustrated in Table 3. The dry legumes lost as much as 9 – 10 % of total solids into cooking medium in comparison to soaking only or cooking after soaking or germination. Also, cooking media of dry legumes contained higher amounts of ash and protein. It was noted that, the contents of the soaked distilled water from total solids, ash and protein were less than those of soaked in 0.5 % $NaHCO_3$ solution for both legumes. In contrast, the cooking media of the two legumes those were previously soaked in distilled water contained higher amounts of the three ones. Finally, the sum losses from the three ones by soaking and germination into the cooking media were nearly to those of cooked dry legumes. The obtained results were confirmed with Wang *et al.* (1979).

**Table 3:Total solids, ash and proteins of soaking and cooking media of chickpea and soybean(g/100g dry wt.).**

| The constituent / The treatment | %Total solids | | Ash % | | Proteins% | |
|---|---|---|---|---|---|---|
| | Soaking | Cooking | Soaking | Cooking | Soaking | Cooking |
| **Chickpea** | | | | | | |
| 1) Raw (unsoaked) | - | 9.306 | - | 1.270 | - | 1.534 |
| 2) Soaked in distilled water (12 hr) | 1.314 | 2.851 | 0.427 | 0.585 | 0.164 | 0.644 |
| 3) Soaked in 0.5% $NaHCO_3$ (12hr) | 1.706 | 2.511 | 0.777 | 0.384 | 0.182 | 0.629 |
| 4) Germinated (2 days) | 1.314 | 4.446 | 0.427 | 0.697 | 0.164 | 0.811 |
| **Soybean** | | | | | | |
| 1) Raw (unsoaked) | - | 10.262 | - | 2.120 | - | 1.395 |
| 2) Soaked in distilled water (12 hr) | 4.013 | 4.381 | 0.885 | 0.960 | 0.437 | 0.552 |
| 3) Soaked in 0.5% $NaHCO_3$ (12hr) | 4.398 | 3.867 | 1.486 | 0.461 | 0.495 | 0.517 |
| 4) Germinated (2 days) | 4.013 | 5.429 | 0.885 | 1.017 | 0.437 | 0.825 |

**Water – soluble solids**

Water – soluble solids of chickpea and soybean are 22.123% and 24.883 %, respectively (Table 4). Soaking processes in distilled water or in 0.5% $NaHCO_3$ raised these values by 45.513%, 55.594% and 32.874%, 37.765% for chickpea and soybean, respectively. Moreover, the germination process raised the solubility, in addition to soaking process, by 14.679% and 17.349%, respectively. On the other side, cooking process for the two legumes, reduced the water-soluble solids in all cases: raw, soaked and germinated legumes, wherein dry legumes (without processes except cooking) recorded the lest value in this regard.

**Table 4: Water- soluble solids of raw, soaked, germinated and cooked chickpea and soybean (on dry wt basis)**

| The treatment | % Soluble solids | |
|---|---|---|
| | Chickpea | Soybean |
| **1) Dry (unsoaked)** | | |
| (A) Control* | 22.123 | 24.883 |
| (B) Cooking | 19.241 | 14.964 |
| **2) Soaked in distilled water (12 hr)** | | |
| (A) Control* | 32.413 | 33.063 |
| (B) Cooking | 16.764 | 16.399 |
| **3) Soaked in 0.5% $NaHCO_3$ (12 hr)** | | |
| (A) Control* | 34.422 | 34.280 |
| (B) Cooking | 17.938 | 18.892 |
| **4) Germinated (2 days)** | | |
| (A) Control* | 37.171 | 38.799 |
| (B) Cooking | 20.908 | 21.941 |

* Control = without cooking

The increase in soluble solids with soaking may be due to hydration process, while it may be due hydrolyzing enzymes through germination process. On the other hand, the reduction in soluble solids by cooking may be due to draining into the cooking medium.

**Proximate chemical composition**

Results in Table 5 show that crude proteins of dried chickpea and soybean were 25.069 % and 39.044, respectively. As a result of soaking in distilled water or in 0.5 % sodium bicarbonate solution for 12 hr, crude protein was increased by 3.690 % and 0.574 % in chickpea and by 10.693 % and 8.708 % in soybean, respectively. Also, crude protein of germinated legumes increased and reached 26.806 % and 43.963% in chickpea and soybean, respectively. On the other hand, cooking caused additional increases in crude protein of dry, soaked and germinated legumes. Such increases may be reflecting the decreases in the other components, especially carbohydrates, as a result of hydrolysis and leaching out. The obtained results are in accordance with those reported by El- Shimi *et al.* (1984 and 1992); Abdella *et al.* (1986); Uzogara *et al.* (1991); El- Bagoury *et al.* (1999 and 2000); Uwaegbute *et al.* (2000) and WanJekeche *et al.* (2003). Some investigators have reported a decrease in the protein content of some legumes as a result of soaking, germination or cooking (Abd – Allah *et al.* 1988; Hamza and Youssef 1988; El- Bedawey *et al.* 1989; El – Sahan and Youssef 1992; khalaf Allah 1995 and Zia – ur – Rehman *et al.* 2003).

It was found that (Table 5) soybean contained higher amount of ether extract (22.727 %) than chickpea (5.549%). Soaking processes in distilled water or in 0.5% $NaHCO_3$ augmented ether extract, since it reached 7.753 % and 8.011 % in chickpea; 23.882% and 24.557% in soybean, respectively. An additional increment was recorded in ether extract of the two legumes by germination. These results are in agreement with those found by Damir and Shekib (1989). On the contrast, Khalaf Allah (1995) did not find change in the lipid content of mung bean after soaking, but there was a slight decrease during germination. Concerning cooking, the cooked legumes, whatever unsoaked, soaked or germinated, contained higher amounts of ether extract.

These increases could be explained by solubility of solids and leaching into soaking, rinsing and cooking media. These results agree with the reports of El – Samra *et al.* (1986), Shehata *et al.* (1994) and El – Bagoury *et al.* (2000). As shown in the same Table, ash content of chickpea and soybean was 3.842 % and 6.482 %, respectively. Soaking in distilled water or in 0.5% $NaHCO_3$ resulted in decrease in ash content of the two legumes. However, germination process induced a slight increase in the ash content (3.312% and 5.894% for chickpea and soybean, respectively.) On the other side, cooking slightly decreased the ash content of the two legumes, regardless of the previous processes. The decreases in the ash content may be due to leaching some minerals into soaking and cooking media.

The obtained results are in the line of Abd-Allah *et al.* (1988); Uzogara *et al.* (1991); El – Sahan and Youssef (1992); Shehata *et al.* (1994); Khalaf Allah (1995); Salama and Ragab (1997); El – Bagoury *et al.* (1999 and 2000); Habiba (2002) and Wanjekeche *et al.* (2003). by 17.480% and 18.388 % in soybean, respectively. Also, germination process resulted in slight decreases. In contrast, cooking raised the fiber content and may be as a result of discarding other components to cooking medium. The obtained results are in agreement with Abdella *et al.* (1986); Shehata *et al.* (1994); Khalaf Allah (1995).

It was observed that, chickpea and soybean contained 60.124% and 26.684% of carbohydrate, respectively. Soaking in distilled water, in 0.5% $NaHCO_3$, germination and cooking processes reduced the quantities of carbohydrate. The decline in the carbohydrate contents may be related to dissolution into soaking, rinsing and cooking media. These results accorded with those reported by Abdella *et al.* (1986); El–Samra *et al.* (1986); Abd – Allah *et al.* (1988); Uzogara *et al.* (1991); Youssef and Abdel – Gawad (1992); Shehata *et al.* (1994); El – Bagoury *et al.* (1999 and 2000); Uwaegbute *et al.* (2000) and El – Adawy (2002).

**Table 5: Proximate chemical composition of chickpea and soybean as a result of soaking, germination and cooking (on dry wt basis).**

| The constituent / The treatment | Moisture % | Crude Protein (Nx6.25) % | Ether Extract % | Ash % | Crude Fiber% | Carbohydrate** % |
|---|---|---|---|---|---|---|
| **Chickpea** | | | | | | |
| **1) Dry (unsoaked)** | | | | | | |
| (A) Control* | 8.067 | 25.069 | 5.549 | 3.842 | 5.416 | 60.124 |
| (B) Cooking | 65.581 | 25.238 | 7.905 | 2.984 | 5.663 | 58.210 |
| **2) Soaked in distilled water (12 hr)** | | | | | | |
| (A) Control* | 60.724 | 25.994 | 7.753 | 2.995 | 5.232 | 58.026 |
| (B) Cooking | 67.521 | 26.244 | 8.428 | 2.749 | 5.487 | 57.092 |
| **3) Soaked in 0.5% $NaHCO_3$ (12 hr)** | | | | | | |
| (A) Control* | 60.922 | 25.213 | 8.011 | 3.163 | 5.105 | 58.508 |
| (B) Cooking | 68.210 | 25.756 | 9.233 | 3.114 | 5.393 | 56.504 |
| **4) Germinated (2 days)** | | | | | | |
| (A) Control* | 62.455 | 26.806 | 7.885 | 3.312 | 5.041 | 56.956 |
| (B) Cooking | 69.453 | 27.356 | 8.374 | 2.504 | 5.239 | 56.527 |
| **Soybean** | | | | | | |
| **1) Dry (unsoaked)** | | | | | | |
| (A) Control* | 7.144 | 39.044 | 22.727 | 6.482 | 5.063 | 26.684 |
| (B) Cooking | 63.612 | 46.350 | 27.623 | 5.782 | 5.205 | 15.040 |
| **2) Soaked in distilled water (12 hr)** | | | | | | |
| (A) Control* | 61.704 | 43.219 | 23.882 | 5.755 | 4.178 | 22.966 |
| (B) Cooking | 67.046 | 45.331 | 28.113 | 4.621 | 4.389 | 17.546 |
| **3) Soaked in 0.5% $NaHCO_3$ (12 hr)** | | | | | | |
| (A) Control* | 61.129 | 42.444 | 24.557 | 5.932 | 4.132 | 22.935 |
| (B) Cooking | 67.155 | 44.169 | 29.627 | 4.374 | 4.421 | 17.409 |
| **4) Germinated (2 days)** | | | | | | |
| (A) Control* | 61.682 | 43.963 | 24.203 | 5.894 | 3.874 | 22.066 |
| (B) Cooking | 70.542 | 46.325 | 28.377 | 4.220 | 4.087 | 16.991 |

*** Control = without cooking. ** Carbohydrate was calculated by difference**

**Some nitrogenous constituents**

The changes in some nitrogenous constituents of chickpea and soybean as a result of soaking, germination and cooking are presented in Table 6. Total nitrogen (TN) of chickpea was 4.011 %, while protein nitrogen was 3.538% that equals 88.207 % of total nitrogen. Mean while, non-protein nitrogen (NPN) was 0.473 %. Soaking processes led to increments in TN, NPN and PN, whereas soaking in distilled water increased them higher than soaking in 0.5% sodium bicarbonate solution. Also, germination process increased these contents. On the other side, cooking process increased TN, PN and decreased NPN for all samples under the study. Also, free amino nitrogen (TFAA) was increased by soaking and germination and decreased by cooking.

**Table 6:Changes in some nitrogenous constituents of chickpea and soybean as a result of soaking, germination and cooking.**

| The constituent / The treatment | TN% | NPN% | PN% | TFAN |
|---|---|---|---|---|
| **Chickpea** | | | | |
| **1) Dry (unsoaked)** | | | | |
| (A) Control* | 4.011 | 0.473 | 3.538 | 4.807 |
| (B) Cooking | 4.038 | 0.327 | 3.711 | 4.699 |
| **2) Soaked in distilled water (12 hr)** | | | | |
| (A) Control* | 4.159 | 0.600 | 3.559 | 15.445 |
| (B) Cooking | 4.199 | 0.543 | 3.656 | 5.858 |
| **3) Soaked in 0.5% $NaHCO_3$ (12 hr)** | | | | |
| (A) Control* | 4.034 | 0.501 | 3.533 | 12.119 |
| (B) Cooking | 4.121 | 0.472 | 3.649 | 0.352 |
| **4) Germinated (2 days)** | | | | |
| (A) Control* | 4.289 | 0.711 | 3.578 | 19.248 |
| (B) Cooking | 4.377 | 0.489 | 3.888 | 1.532 |
| **Soybean** | | | | |
| **1) Dry (unsoaked)** | | | | |
| (A) Control* | 6.247 | 0.260 | 5.987 | 4.612 |
| (B) Boiling cooking) | 7.416 | 0.223 | 7.193 | 1.042 |
| **2) Soaked in distilled water (12 hr)** | | | | |
| (A) Control* | 6.915 | 0.482 | 6.433 | 9.323 |
| (B) Cooking | 7.253 | 0.257 | 6.996 | 1.308 |
| **3) Soaked in 0.5% $NaHCO_3$ (12 hr)** | | | | |
| (A) Control* | 6.791 | 0.397 | 6.394 | 5.307 |
| (B) Cooking | 7.067 | 0.194 | 6.873 | 1.381 |
| **4) Germinated (2 days)** | | | | |
| (A) Control* | 7.034 | 0.540 | 6.494 | 12.070 |
| (B) Cooking | 7.412 | 0.396 | 7.016 | 1.015 |

**TN = Total nitrogen** **NPN = Non-protein nitrogen**
**PN = Protein nitrogen** **TFAN = Total free amino nitrogen**
**TN, NPN and PN were calculated as gm/100 gm dry weight, Where TFAN was calculated as mg/gm dry weight**
***Control = without cooking.**

Protein nitrogen of soybean was 5.987 % that represents 95.838% of total nitrogen (6.247 %). The rest (4.162%) was non-protein nitrogen (0.260%). Soaking and germination increased TN, NPN and PN, whereas these constituents were higher when soybean was soaked in distilled water than in 0.5% $NaHCO_3$. Also, free amino nitrogen (4.612 mg/g) was increased by soaking and germination. Concerning cooking process, TN, PN increased, while NPN, TFAN decreased. It was observed that the changes in NPN were normally parallel with the changes in TFAN with soaking, germination and cooking. Increases in TN by soaking, germination and cooking may be due to high losses in other constituents of chickpea and soybean, especially carbohydrates. The increments in NPN and TFAN by soaking and germination may be due to dissociation of some protein fraction by active proteases. On contrast, the decrements in NPN and TFAN by cooking might be due to leaching them into the cooking media. The obtained results are confirmed, by El – Mahdy and El-Sebaiy (1982, 1985); Akapapunam (1985); Abdel – Aal and Rahma (1986); Allam 1987 and Shehata *et al.* (1994).

**Minerals content**

Tables 7 and 8 review minerals content of chickpea and soybean as affected by soaking, germination and cooking processes. Both soaking in distilled water or in 0.5 % sodium bicarbonate solution resulted in similar losses (1 – 21 %) for major minerals except sodium, that increased by soaking in 0.5% sodium bicarbonate solution (157 – 485 %). Germination process lowered the contents of Zn, Mn, Fe, Na, K and P by 1 – 20 %, meanwhile raised the contents of Ca, Cu and Mg by 2 – 17 %. On the other side, cooking of dry legumes resulted in losses in all minerals with different ratios. Also, cooking after soaking in distilled water or in 0.5 % Sodium bicarbonate solution resulted in losses of some minerals (Zn, Mn, Fe, Cu, Na, K, and P) by 1 – 58 %. In the same time, Ca and Mg raised by cooking to 1 – 9 %. Also, cooking of germinated legumes came to the same result. Ca and Mg are probably bound or otherwise rendered less accessible for leaching into the cooking water than the other major minerals (Chung *et al.* 1981). Generally, the obtained different results are attributed to leaching of some minerals into soaking and cooking media by different ratios; the mineral itself and the different processes. The obtained results are in accordance with those obtained by Chung *et al.* (1981); Abd – Allah *et al.* (1988); Chitra *et al.* (1996) and Salama and Ragab (1997).

From the obtained results, It could be concluded that soaking and /or germination processes of dry legumes reduced cooking time especially germination, concentrated nutritional elements and analyzed complex compounds into simple components that make them more useful.

Table 7. Effect of soaking, germination and cooking on some minerals of chickpea (mg/ 100g dry weight).

| Treatment / Element | Dry (unsoaked) | | Soaked in distilled water (12hr) | | Soaked in 0.5 %$NaHCO_3$ (12hr) | | Germinated (2 days) | |
|---|---|---|---|---|---|---|---|---|
| | Control | Cooking | Control | Cooking | Control | Cooking | Control | Cooking |
| Zn | 3.154 | 2.824 | 2.749 | 2.402 | 2.667 | 2.334 | 2.358 | 2.187 |
| Mn | 1.634 | 1.518 | 1.455 | 1.211 | 1.412 | 1.186 | 1.290 | 1.132 |
| Fe | 17.626 | 16.093 | 17.314 | 16.042 | 17.270 | 15.814 | 17.055 | 15.353 |
| Ca | 145.381 | 139.632 | 125.280 | 137.133 | 115.563 | 118.545 | 128.298 | 154.433 |
| Cu | 1.263 | 1.160 | 1.024 | 0.895 | 1.010 | 0.887 | 1.163 | 0.954 |
| Mg | 136.671 | 123.440 | 121.681 | 124.273 | 118.340 | 120.060 | 125.889 | 142.991 |
| Na | 1185.245 | 1065.614 | 1118.010 | 898.894 | 5435.831 | 2243.720 | 977.441 | 823.868 |
| K | 3436.285 | 3071.834 | 3123.228 | 2170.988 | 2687.636 | 2491.669 | 2065.544 | 1979.765 |
| P | 491.000 | 456.800 | 466.800 | 445.800 | 457.100 | 449.400 | 455.701 | 432.902 |

Control =without cooking



Table 8.Effect of soaking, germination and cooking on some minerals of soybean (mg/ 100g dry weight).

| Treatment / Element | Dry (unsoaked) | | Soaked in distilled water (12hr) | | Soaked in 0.5 %$NaHCO_3$ (12hr) | | Germinated (2days) | |
|---|---|---|---|---|---|---|---|---|
| | Control | Cooking | Control | Cooking | Control | Cooking | Control | Cooking |
| Zn | 2.970 | 2.601 | 2.622 | 2.338 | 2.498 | 2.253 | 2.368 | 2.122 |
| Mn | 2.774 | 2.511 | 2.458 | 2.067 | 2.365 | 2.034 | 2.191 | 1.934 |
| Fe | 22.212 | 20.527 | 20.920 | 18.706 | 20.593 | 17.795 | 19.511 | 17.475 |
| Ca | 174.141 | 149.905 | 144.585 | 154.843 | 139.155 | 145.141 | 148.715 | 177.801 |
| Cu | 1.685 | 1.646 | 1.453 | 1.356 | 1.592 | 1.560 | 1.695 | 1.471 |
| Mg | 144.305 | 138.427 | 131.021 | 141.872 | 129.862 | 134.179 | 135.755 | 152.801 |
| Na | 1139.694 | 979.432 | 983.238 | 869.228 | 2936.841 | 1000.939 | 897.622 | 758.592 |
| K | 3453.284 | 2815.847 | 3124.703 | 2650.740 | 3095.175 | 2241.262 | 2591.848 | 2181.895 |
| P | 698.500 | 657.200 | 685.401 | 663.902 | 671.700 | 639.002 | 671.100 | 601.978 |

Control =without cooking

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## تأثير معاملات النقع والإنبات والطهي على التقييم الكيماوي والحسي للحمص وفول الصويا

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تم نقع كل من الحمص (حمص الطبيخ) وفول الصويا في الماء المقطر أوفى محلول بيكربونات الصوديوم ( ٠,٥ % ) لمدة ١٢ ساعة والإنبات لمدة ٧٢ ساعة ثم إجراء الطهي بالغليان.

وكانت افضل المنتجات المطهية هي تلك التي تم نقعها أولا في الماء المقطر تليها المنقوعة في محلول البيكربونات. وكان الإنبات لمدة يومين افضل من الإنبات لمدة ثلاثة أيام. وبصفة عامة خفضت عملية الإنبات مدة الطهي عن النقع فقط. وكانت معاملات التشرب أعلى في حالة البقوليات المطهية والتي لم يتم نقعها أولا ثم المنقوعة بينما أدت عملية الإنبات إلى خفض معامل التشرب. و احتوت أوساط الطهي للبقوليات الجافة على كميات اكبر من الجوامد الذائبة والرماد والبروتين بالمقارنة بالنقع فقط أو الطهي بعد النقع او الإنبات.وفي حين احتوى ماء النقع المقطر على كميات اقل من الجوامد الكلية والرماد والبروتين بالمقارنة بمحلول البيكربونات حدث النقيض في سائل طهي البقول التي تم نقعها أولا في الماء المقطر.وبينما أحدثت عمليتي النقع والإنبات زيادة فيالجوامد الذائبة في الماء فان عملية الطهي قد أدت إلى العكس.

ولقد ارتفع محتوى الحمص وفول الصويا من البروتين الخام و المستخلص الأثيري كنتيجة لمعاملات النقع والإنبات والطهي بينما انخفض الرماد كنتيجة للنقع والطهي ارتفع بالإنبات.ومن ناحية أخرى نقصت الألياف الخام بالنقع والإنبات وزادت بالطهي.وأخيرا فان الكربوهيدرات نقصت كنتيجة لكل المعاملات.ولقد رفعت معاملتي النقع والإنبات النتروجين الكلى والنتروجين الغير بروتيني والنيتروجين البروتيني والنتروجين الأميني الحر بينما أحدثت عملية الطهي زيادة في النتروجين الكلى والنتروجين البروتيني وخفض النتروجين الغير بروتيني والنتروجين الأميني الحر في كل العينات.وتسببت معاملة النقع في حدوث فقد بنسب من ١ إلى ٢٠ % في غالبية المعادن فيما عدا الصوديوم والذي زاد كنتيجة للنقع في محلول بيكربونات الصوديوم.وتسبب الإنبات في خفض محتويات الزنك والمنجنيز والحديد والصوديوم والبوتاسيوم و زيادة محتويات الكالسيوم والنحاس والمغنيسيوم .وأدى الطهي للبقول الجافة إلى نقص في كل المعادن بينما تسببت معاملة الطهي بعد النقع أو الإنبات في نقص بعض المعادن والى زيادة في البعض الأخر.

وتبين من النتائج السابقة أن معاملة البقول الجافة بالنقع في الماء أو محلول مخفف من بيكربونات الصوديوم أو الإنبات تؤدى إلى خفض زمن الطهي وتركيز العناصر الغذائية وتحليل العناصر المعقدة منها إلى صورة يمكن الاستفادة منها بدرجة اكبر.