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Effect of Some Technological Treatments on the Chemical and Nutritional Properties of Chickpea (*Cicer arietinum L.*) Seeds

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Abstract:
This work was carried out to study the effect of soaking, cooking and roasting on the chemical composition and nutritional properties of two types of chickpea (Cicer arietinum L.) seeds (Kabuli and Desi). The obtained results revealed that: crude protein content was slightly decreased by the three technological treatments (soaking, cooking and roasting). Cooking and roasting effect on protein contents was higher than that of soaking. Roasting helped to occur a slight increase in the ash content, where total carbohydrates of both types of chickpea seeds were not affected by the three treatments. Chickpea seeds are considered a good source of minerals especially iron. Remarkable decrement in minerals content was recorded as a function of soaking and cooking. The loss in minerals content that took place as a function of cooking was higher than those of soaking. In addition, the recorded loss in trace elements were higher than those of major elements. On contrary, minerals of chickpea seeds show slight increases when treated by roasting. Soaking significantly reduced chickpea polyphenols. Furthermore roasting process was less effective than either soaking or cooking treatments in reducing polyphenols. All technological treatments significantly reduced the phytic acid and trypsin inhibitiors. Soaking and cooking treatments were more effective than roasting in reducing phytic acid content, but soaking was less effective than either cooking or roasting treatments in reducing trypsin inhibitiors.

Keywords: *Chickpea, chemical composition, minerals content, polyphenols and antinutritional factors.*

1. Introduction

Pulses are considered the most important food categories that have been extensively used as staple foods to cover basic protein and energy needs throughout the history of humanity. In addition to their low lipid and high dietary fiber content, emerging evidence stresses the importance of pulses as carriers of several constituents of potential biological importance, including enzyme inhibitors, lectins, phytates, oxalates, polyphenols, saponins and phytosterols. Investigations in humans suggest that pulses may contribute to human health and well being, mostly through prevention of coronary heart disease and possibly diabetes. The nutritional value of pulses, which are a key component of the traditional Mediterranean diet, in the pioneering studies of Jenkins *et al.* (2012) on the impact of dietary sources on the postprandial glucose increase in healthy or diabetic individuals, the investigators characterized pulses as "remarkable in how little they raised the blood glucose". Pulses, including beans and chickpea are one of the most important crops in the world because of their nutritional quality. They are rich sources of complex carbohydrates, protein, vitamins and minerals (Costa, *et al.*, 2006 and Wang, *et al.*, 2010). Abd EL-Rahim *et al.* (2004) found that chemical composition of raw and cooked chickpea were 8.69, 8.08 % moisture, 3.84, 2.68% ash, 21.85, 24.73 % crude protein, 4.74, 6.05 % crude fiber,6.13, 4.82 % ether extract and 53.88%, 45% total hydrolysable carbohydrates.

However, pulses have shown numerous health benefits, e.g. lower glycemic index for people with diabetes(Chillo, *et al.*, 2008), increased satiation and cancer prevention as well as protection against cardiovascular diseases due to their dietary fiber content (Goni and Valentin,2003). In chickpea, exist two seed types: Kabuli or garbanzo (large seeds) and Desi (small seeds). Chickpea is an annual

plant generally required a cool season. Bhardwaj, *et al.*, (1999). Chickpea seeds contain 26.3% protein, 7.4% ether extract, 4.8%ash, 6.8% crude fiber, 54.7% total carbohydrate and total calories/100g w ere 385.2, respectively Mobarak and Soliman (2007).
Cooking, autoclaving and germination of chickpea decrease the starch content and increase total soluble sugars, reducing sugars, non-reducing sugars and starch digestibility. Cooking and sprouting also improve starch digestibility (Jood, *et al.*, 1988). Soaking and cooking treatments reduce phytate of the most legume cultivars (El-Tinay, *et al.*, 1989). The oligosaccharides and tannins content of chickpeas were decreased after autoclaving at 120^0C for 15 min, to 0.53% and 0.74%, respectively (Nestares *et al.*,1993). Trypsin inhibitor activity of chickpeas decreased after soaking in cold water at 12^0C for 18 h then boiling for 40 min, and after germination at 25^0C for 72h, to 0.15% and 0.26%, respectively (Savage, *et al.,* 1993). The decotion process caused considerable losses in polyphenols (Attia, *et al.*, 1994). Moreover, according to Márquez *et al*. (1998) inactivation of 0.66% of the trypsin inhibitor activity occurred in chickpeas after dry heating at 140^0C for 6h.

2. Materials and Methods

2.1. Materials
Two types of chickpea seeds (*Cicer arietinum* L.), namely desi and kabuli were obtained from Food Technol. Res. Institute, Agric. Res. Center, Giza, Egypt. All chemicals used in this study were purchased from El- Gomhoria Company for Chemicals and Drugs, Tanta, Egypt.

2.2. Methods

2.2.1. Preparation of Samples:
The dry chickpea seeds were cleaned by removing any foreign seeds and matters, then divided into four parts as follows:

- The first part of each chickpea variety was dried and ground up to pass through 100 mesh screen sieve. The powdered samples were kept and stored in tight glass jars to be used for analyses.
- The second part was roasted at 150-160^0C for 40 min then ground up to pass through 100 mesh screen sieve and stored as a fine powder in tight glass jars.
- The third part was soaked in distilled water (1:5 W/V) for 12 hr at room temperature (25^0C). The soaked seeds were removed from the water, rinsed three times with distilled water and dried in an electric air oven at 50^0C for 24 hr then ground up to pass through 100 mesh screen sieve and stored as a fine powder in tight glass jars.
- The fourth part was soaked then cooked in boiling water (100^0C) in the ratio of 1:6 (W/V) on a hot plate until they become soft when felt between the fingers (45 min) then dried in an electric air oven at 50^0C for 24 hr. The cooked dried seeds were ground up to pass through 100 mesh screen sieve and stored as a fine powder in tight glass jars.

2.2.2. Gross Chemical Composition
Moisture, crude protein, ether extract, ash and crude fiber contents were determined followed the methods described in the A.O.A.C. (2005). Total carbohydrates were calculated by subtracting values of protein, ash and ether extract from the total mass of 100 as reported by Tadrus (1989). Available carbohydrates were calculated by subtracting the crude fiber content from total carbohydrates. Non- protein nitrogen was determined by micro-Kjeldahl method as described in the A.O.A.C. (2005).

2.2.3. Determination of Minerals Content:
Minerals content of chickpea seeds was performed according to the methods of Chapman and Pratt (1978).

2.2.4. Determination And Quantification of Phenolic Compounds :
Total phenolic compounds were extracted according to the method described by Ziada (2002), where total polyphenols were determined in the methanolic extract using Folin-Ciocalteau reagent as outlined by Gutfinger (1981).

2.2.5. Determination Of Antinutritional Factors of Chickpea Seeds:
Phytate was determined according to the method of Haug and Lantzsch (1983), where trypsin inhibitor was performed following the method of Alonso *et al.* (1998).

3. Results and Discussion

3.1. Effect of some technological treatments on the chemical composition of chickpea seeds:
The effect of some technological treatments; namely, soaking in water (1:5w/v) for 12 hrs at room temperature; cooking in water (1:5w/v) at boiling temperature for about 45 min and roasting in an electric oven at 150-160^oC for 40 min. The proximate chemical composition of Kabuli and Desi types of chickpea seeds are given in Tables (1) and (2), respectively. It is clear from the given data that the moisture content increased to 60.40% and 57.18% for the Kabuli type of chickpeas after soaking and cooking, respectively. The same trend was observed for the Desi type of chickpeas, the moisture content increased to 58.23% and 55.21% after soaking and cooking, respectively. On the other hand, roasting of chickpea seeds caused a drastic reduction in moisture content of Kabuli and Desi types by (34.96% and 24.08%, respectively). Not only moisture content was the sole component that affected by the three

technological treatments, but also, crude protein and ash contents were slightly decreased. Soaking, cooking and roasting led to reduce the protein content due to the loss of some water- soluble fractions of the proteins (**Elias *et al*, 1979).** The highest decrease in protein content as shown in Tables (1) and (2) seemed to be due to soaking treatment reduction in protein content by 3.30% and 1.84% which was observed for the Kabuli and Desi types, respectively. The effect of cooking and roasting on protein contents was higher than that of soaking. Decrements by 5.46% and 5.88% and, by 6.91% and 7.23% were recorded in the protein content of Kabuli and Desi types, as affected by cooking and roasting treatments, respectively. The effect of soaking and cooking treatments was invaluable on ash content. Decreasing in ash content for Kabuli chickpea type as affected by soaking and cooking treatments was by 5.83% and 7.87%, respectively. Similarly, the effect of above mentioned two technological treatments on the Desi type was by 4.93% and 9.86%, respectively. Roasting treatment as seen in Tables (1) and (2) showed slight increase in ash content. The increment in ash content of Kabuli and Desi types of chickpeas that took place as a function of roasting treatment was 7.00% and 9.86%, respectively. These increments could be attributed to the losses in the other components such as protein content .The total carbohydrates of both Kabuli and Desi types of chickpea seeds was not affected significantly by neither one of the three tested treatments.

Components %	Treatments			
	Raw seeds	Soaking	Cooking	Roasting
Moisture	4.92	60.40	57.18	3.20
Dry matter	95.08	39.60	42.82	97.80
Crude protein(N x 6.25)	24.85	22.85	22.34	22.24
Non- protein nitrogen	1. 32	1. 27	0.98	1.15
Ether extract	6.85	11.30	11.73	11.95
Ash	3.61	3.23	3.16	3.67
Crude fiber	4.31	3.85	4.31	4.15
Total carbohydrates	64.69	62.62	62.77	62.14
Available carbohydrates	60.38	58.77	58.46	57.99

Table 1: Effect of some technological treatments on proximate chemical composition of Kabuli chickpea seeds (% on dry weight basis)

Components %	Treatments			
	Raw seeds	soaking	Cooking	Roasting
Moisture	4.61	58.23	55.21	3.50
Dry matter	95.39	41.77	44.79	96.50
Crude protein(N x 6.25)	22.11	21.32	20.22	20.15
Non- protein nitrogen	1. 28	1. 16	0.99	1.11
Ether extract	6.51	9.45	10.62	10.69
Ash	2.34	2.12	2.01	2.45
Crude fiber	3.50	3.29	3.67	3.71
Total carbohydrates	68.38	67.11	67.15	66.71
Available carbohydrates	64.88	63.82	63.48	63.00

Table 2: Effect of some technological treatments on proximate chemical composition of Desi chickpea seeds (% on dry weight basis)

3.2. Minerals content of chickpea seeds:

The effect of soaking, cooking and roasting on the minerals content of Kabuli and Desi types of chickpea seeds, are present in Tables (3 and 4) consecutively. The data showed that chickpea seeds are considered a good source of minerals. The results revealed that potassium was the predominant mineral of raw chickpea seeds (794.7 and 810.2 mg/100g, for Kabuli and Desi seeds, respectively), followed by phosphorus (269 and 278 mg/100g). Sodium was found in lowest quantity for major elements in both types of chickpea seeds (109 and 115 mg/100g). On the other hand, calcium content was only 19.67% and 18.83% of their minerals content respectively. These findings are in agreement with the results early reported by Hajipanayiotou and Econo midies, (2001). Apparent also from the same tables that chickpeas may provide a significant amount of minerals to meet the human mineral requirement (Recommended Dietary Allowance). Although the mean Ca: P ratio in chickpea seeds was only 0.58 and 0.55 for Kabuli and Desi seeds, respectively, his ratio should not be less than 1.0, however, mineral supplementation can be used as alternative approach to correct this imbalance (Singh and Jambunathan, 1981). In addition the data given in the same Tables showed that chickpea seeds are a good source of iron (5.4 and 5.8 mg/100g, on dry weight basis for Kabuli and Desi seeds, respectively. However, its availability (91%) is higher than those of other grain legumes (Singh, 1985).

Technological treatments	Elements								
	(Ca)	(P)	(Na)	(K)	(Mg)	(Fe)	(Cu)	(Mn)	(Zn)
Raw seeds	156.3	269	109	794.7	135	5.4	1.18	2.3	4.12
Soaking	151	266	105	775	131	5.2	1.12	2.2	3.9
(%loss)	3.39	1.11	3.81	2.48	2.96	3.70	5.08	4.35	5.34
Cooking	148	260	102	753	128	5.1	1.00	2.1	3.7
(%loss)	5.31	3.35	6.42	5.25	5.18	5.55	15.25	8.70	10.19
Roasting	163.2	275	113	809	139	5.9	1.32	2.7	4.25
(%increase)	4.41	2.23	3.67	1.80	2.96	9.26	11.86	17.39	3.15

Table 3: Effect of some technological treatments on minerals content mg/100g of Kabuli chickpea seeds (values were calculated on dry weight basis)

Technological treatments	Elements								
	(Ca)	(P)	(Na)	(K)	(Mg)	(Fe)	(Cu)	(Mn)	(Zn)
Raw seeds	152.6	278	115	810.2	160	5.8	1.27	2.9	5.2
Soaking	140	270	113	795	158	5.6	1.14	2.8	4.9
(%loss)	8.26	2.88	1.74	1.88	1.25	3.45	10.34	3.45	5.77
Cooking	136	256	109	769	155	5.2	1.05	2.6	4.5
(%loss)	10.88	7.91	5.22	5.08	3.12	10.34	17.32	10.34	13.46
Roasting	159.7	286	119	815.6	163	6.3	1.46	3.2	5.56
(%increase)	4.65	2.88	3.48	0.67	1.87	8.62	14.96	10.34	6.92

Table 4: Effect of some technological treatments on minerals content mg/100g of Desi chickpea seeds (values were calculated on dry weight basis)

In general it could be observed from these Tables that the Desi type of chickpeas was richer in mineral constituents as compared to the Kabuli ones. Similar observations were reported earlier for chickpea and other legumes for their minerals content (Amjad *et al.*, 2006 and Omar, 2009). It should be concluded also from the previous mentioned Tables that there were noticeable effects on the retention of minerals due to subjecting chickpea seeds to the different technological treatments. Decreases in minerals content were observed due to the soaking and cooking of chickpea seeds. Cooking caused noticeable losses in all minerals in both Kabuli and Desi seeds, than those of soaking in water. It could be observed from the a formentioned Tables that losses in trace elements were higher than those of major elements for both Kabuli and Desi chickpea seeds. The highest losses were found in copper (15.25% and 17.32%), then zinc (10.19% and 13.46%) and finally manganese (8.7% and 10.34%), for raw Kabuli and Desi chickpea seeds, respectively. Generally, the reduction in mineral contents may be attributed to leaching that took place in the mineral content of chickpea seeds into the water during cooking process. Furthermore, the loss of divalent metals could be attributed to their binding to protein and also to the formation of a phytate- cation protein complex (Mubarak, 2005). These results are in accordance with those reported by Mubarak (2005) and Omar (2009). On contrary, minerals show slight increases when treated by roasting, as shown in the given data. The increases in mineral contents of chickpea seeds due to roasting process could be attributed to the losses in moisture and protein, and accordingly the increase in ash content. Omar (2009) reported some increases in mineral constituents due to roasting process, but some losses in their contents during the soaking and cooking of chickpea seeds.

3.3. Phenolic compounds content:

Data given in Figure (1) showed that raw Kabuli type of chickpea seeds contained a little higher value (0.33%) of polyphenols than in the Desi type (0.28%). Soaking in water significantly reduced chickpea polyphenols. Decreased values researched 54.54% and 46.43% of the initial levels of polyphenols found in Kabuli and Desi types of chickpea, respectively. The highest effect was found in case of soaking , this could be explained by leaching of water – soluble polyphenols into soaking water (Zia-Ul-Hag *et al*., 2007). In addition, cooking caused a marked reduction (60.60 and 50.00%) in the polyphenols content for Kabuli and Desi chickpea types, respectively. However, roasting did not affect markedly the content of polyphenols where the reduction percentages were (27.27% and 10.71%) for Kabuli and Desi types, respectively. Omar, (2009) obtained similar results, and reported low phenolic compounds contents for both Kabuli and Desi types of chickpeas (0.25 and 0.26%, respectively.). It was also found higher polyphenols reduction in both the two types of the tested chickpeas upon subjecting these types to soaking (43.70% and 46.18%) and cooking (50.79% and 49.62%) treatments but less reduction was recorded by roasting process (18.50% and 6.49%) for Kabuli and Desi types, respectively.

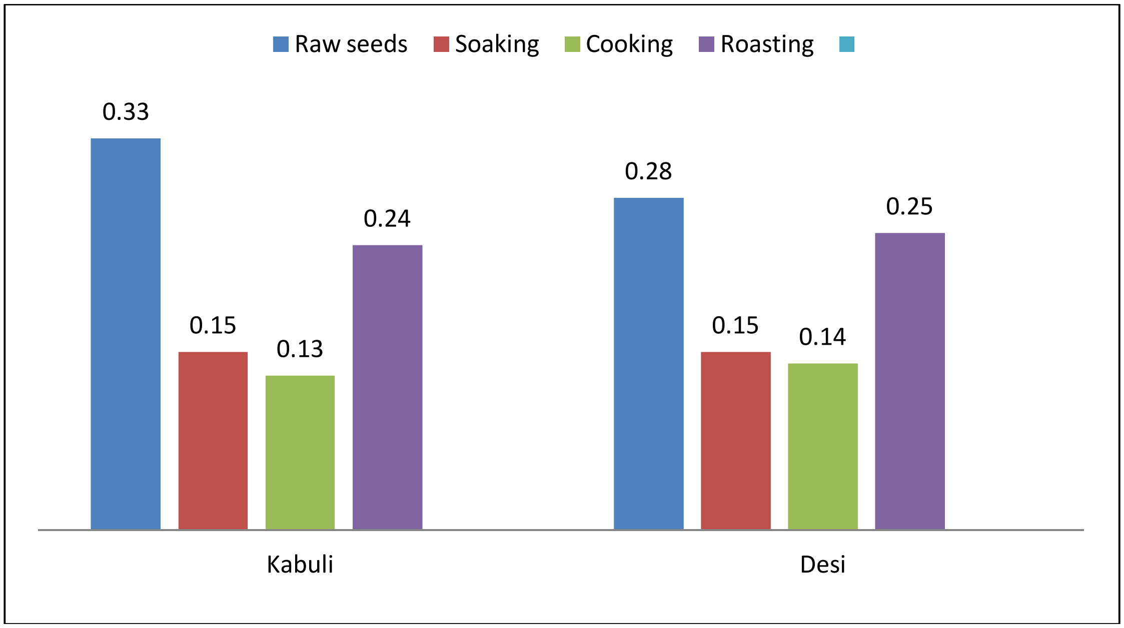

Figure 1: Effect of some technological treatments on phenolic compounds of chickpea seeds (% on dry weight basis)

3.4. Antinutritional factors content in chickpea seeds:

3.4.1. Phytic Acid Content

The results presented in Tables (5 and 6) show clear differences between the two studied types of chickpea seeds for their phytic acid content. The data in reveal that, raw Kabuli chickpea had higher level of phytic acid (2.34%) than that of Desi chickpea (1.43%); which is reflect about 38.88% more of phytic acid content for the former type of chickpea than the later one. These results agree with those of Omar (2009) who obtained values of 2.22% and 1.31% of phytic acid for Kabuli and Desi type of chickpeas, respectively. Clear differences were also noticed on phytic acid contents due to the effect of some technological treatments (soaking, cooking and roasting) as shown in the same Tables. All technological treatments significantly reduced the phytic acid content; however, different levels of reduction were obtained due to different treatments. Soaking process significantly reduced phytic acid contents, but more pronouncely in case of Kabuli type (62.82% reduction) than in the Desi type (45.45% reduction). These findings are in agreement with the results of Khalil *et al*.(2007). Similar results were also recorded by Omar, (2009) who indicated that soaking treatments reduced the phytic acid content by 61.71% and 41.22% for Kabuli and Desi chickpea, respectively.

The reduction in phytic acid content in chickpea seeds due to soaking process may be ascribed to the activation of the endogenous phytase during the time of soaking treatment (Abd El-Hady and Habiba, 2003). Reduction in phytic acid content due to soaking is beneficial, since the phytate molecule is negatively charged at the physiological pH and is reported to bind nutritionally important essential divalent ions, such as iron, zin, magnesium and calcium. This binding forms insoluble complexes, thereby making minerals unavailable for absorption and utilization (Van der Poel, 1990 and Khalil *et al*, 2007). Cooking process also significantly reduced the phytic acid content by 69.23% and 49.65% in Kabuli and Desi types of chickpea, respectively. These obtained findings agree well with other results obtained by other studies. Abd El-Hady and Habiba, (2003) indicated that the soaking and cooking processes decreased antinutrients such as phytic acid. Alajaji and El-Adawy, (2006) obtained a value of 1.21% for phytic acid of chickpea seeds, and this value was significantly reduced by 28.93- 41.32% depending on the cooking methods applied. Similar results were found by Omar, (2009) who monitored a reduction in phytic acid content by 68.01% and 44.27% in Kabuli and Desi types of chickpea, respectively. This could be attributed to cooking process until boiling after soaking in water for 12 hrs. On the other hand, roasting of chickpea seeds was less effective than either cooking or soaking treatments in reducing phytic acid content. Only a reduction in phytic acid content reached 4.7 and 20.3% in Kabuli and Desi types of chickpeas, respectively. Apparent also from the same Tables that phytic acid in Desi type of chickpea is more heat-labile than that in Kabuli type. The same trend was noticed by Omar, (2009) who found a reduction of phytic acid content by 4.50% and 19.85% in roasted samples of Kabuli and Desi chickpea seeds, respectively.

3.4.2. Trypsin Inhibition Activity

Trypsin inhibition activity of raw Kabuli and Desi types of chickpea seeds, as well as the effect of soaking, cooking and roasting on the trypsin inhibition activity were studied and results are shown in Tables (5 and 6). Obtained results indicate that trypsin inhibitor activities of raw Kabuli and Desi types of chickpeas were 11.85 and 12.35 TIU/mg sample, respectively. These values are supported by those of (Bhatty, 1977) who recorded the range of 11-16 TIU/mg for chickpeas. The trypsin inhibition activity significantly decreased by the studied technological treatments. However, soaking was less effective than either cooking or roasting treatments in reducing trypsin inhibition activity, in contrast with the results of phytic acid content. The same Tables indicated also that the highest reduction in trypsin inhibition activity was found after cooking in water (83.71 and 84.29TIU/mg) followed by roasting (75.86 TIU and 72.71TIU/mg) for Kabuli and Desi types of chickpeas, respectively. The lowest reduction in trypsin inhibition activity (16.54 and

14.33TIU/mg) was recorded after soaking of Kabuli and Desi types of chickpeas, respectively. The obtained results were in agreement with those of (Alajaji and El-Adawy, 2006 and Omar, 2009). From these results it can be indicated that trypsin inhibitors do not appear to be a serious problem in foods since they are largely inactivated by either moist or dry heating.

Antinutritional Factors	Treatments			
	Raw	Soaking	Cooking	Roasting
Phytic acid content (%)	2.34	0.87	0.72	2.23
Reduction in phytic acid content(%)	_	62.82	69.23	4.70
Trypsin inhibitor (TIU/mg sample)	11.85	9.89	1.93	2.86
Reduction in trypsin inhibitor (TIU/mg sample)	_	16.54	83.71	75.86

Table 5: Effect of some technological treatments on some antinutritional factors of Kabuli chickpea seeds (% on dry weight basis)
TIU: Trypsin inhibitor unit mg/ dry sample.

Antinutritional Factors	Treatments			
	Raw	Soaking	Cooking	Roasting
Phytic acid content (%)	1.43	0.78	0.72	1.14
Reduction in phytic acid %	_	45.45	49.65	20.28
Trypsin inhibitor (TIU/mg sample)	12.35	10.58	1.94	3.37
Reduction in trypsin inhibitor (TIU/mg sample)	–	14.33	84.29	72.71

Table (6): Effect of some technological treatments on some antinutritional factors of Desi chickpea seeds (mg/100g on dry weight basis).
TIU: Trypsin inhibitor unit mg/ dry sample.

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