NUTRITIONAL QUALITY OF ROASTED AND PRESSURE-COOKED CHICKPEA COMPARED TO RAW (C*icer arietinum* L.) SEEDS

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ABSTRACT

Raw and processed (roasted and pressure-cooked) seeds of chickpea (Cicer arietinum L.) were analyzed for nutritional and antinutritional qualities. A significant difference was seen between the proximate composition of raw and processed seeds ($P<0.05$). The seeds consist of 19.47-21.27% proteins and 8.53-9.89% fiber. Among the minerals, potassium was highest (725-1171mg/100g) followed by phosphorus (188.3-252.7 mg/100g) and sodium (61.3-100.3 mg/100g). Significant ($P < 0.05$) variation existed in some amino acid of raw and processed seeds or roasted and pressure-cooked seeds. The amino acids: arginine, histidine, isoleucine, leucine, lysine, aspartic acid, glutamic acid were higher in both roasted and pressure-cooked than whole egg protein. Essential amino acids excluding methionine and phenylalanine of all seeds type: raw, roasted and pressure-cooked exceeded than FAO/WHO pattern. The amino acids: leucine, lysine, valine and tyrosine were recorded with lower amount in pressure-cooked seed compared to roasted seed. Polyphenol 153 mg/100g was detected less in pressure-cooked seed compared to roasted and raw seeds (281.3 vs 315.9). In the study there was little loss of nutrients from raw to roasted chickpea seed compared to pressure-cooked.

Keywords: Chickpea, cooking, proximate composition, minerals, amino acids, Polyphenols

INTRODUCTION

Chickpea (*Cicer arietinum* L.) seed is an important and cheap source of legume protein which can be used as a substitute for animal protein because their supply is limited and expensive (Pelletier, 1994). The protein content of chickpea seed is highly variable and determined by both genetic and environmental factors. Chickpea seed contains between 14.9 and 30.6% crude protein (Chavan *et al.,* 1986). Besides protein it is a good source of calories, certain minerals and vitamins (Deshpande, 1992). Chickpea is widespread in Asia and Central and South America (Nestares *et al*, 1996). Kabuli chickpea seeds are grown mainly in the Mediterranean area, the Near East, Central Asia and America (Singh *et al*., 1981).

Legumes are usually cooked before being used in the human diet. This improves the protein quality by destruction or inactivation of the heat labile anti-nutritional factors (Alajaji and El-Adawy, 2006). However, it has been observed that the chemical composition of legumes such as chickpea, lentil and mung bean is affected by cooking. The long cooking time reduces the nutritive value of legumes as the levels of some essential amino acids are markedly decreased (Chau *et al*., 1997). Like other legume chickpea seed is processed and cooked in a variety of forms for consumption. Different processing methods (soaking, sprouting, boiling, roasting, frying, steaming) remove anti-nutritional factors and increase digestibility of chickpea seed (Attia *et al.,* 1994). In spite the fact that chickpea is consumed worldwide as part of human diet, data is scare for the effect of heating on the nutritive quality of chickpea proteins. Gonzalez *et al.* (1960) reported a decrease of certain amino acids, especially lysine, cystine and arginine, when chickpea seeds are cooked. Increasing the time and temperature of cooking was reported to reduce the availability of lysine in chickpea seed (Rama Rao, 1974). To minimize amino acid losses, cooking of chickpea in autoclave (121 ^{o}C) for 1 hour has been suggested (Youseff, 1983). More commonly chickpea seed are boiled (pressure-cooked) or roasted. Boiled seeds are use for curry preparation or prepared with putting pepper, salt and squeeze lemon that is served as side dish. The roasted chickpea seed are widely consumed throughout the world (Coşkuner and Karababa, 2004).

To verify the influence of the most frequently used cooking method on nutritional value of chickpea it was considered crucial to evaluate proximate composition, amino acid profile, minerals and anti-nutritional factors. The current study was therefore conducted with aim to analyze and compare the nutritional qualities of pressure-cooked and roasted chickpea compared to raw chickpea.

MATERIALS AND METHODS

2.1. Samples preparation

Chickpea seeds (*Cicer arietinum* L.) cv CM-72 were purchased from local market. Samples were prepared as raw seeds (milled on 30 mesh size), roasted seeds (roasted on sand bath at 180 ^{o}C for 20 min.) and pressure cooked seeds (soaked in freshwater for 3 h and subsequently in a pressure cooker for 50 min with 1:3 (w/v) water. Pressure-cooked seed were freeze-dried, milled and stored as pressure-cooked seed sample.

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2.2. Proximate analysis

Moisture, crude lipid, crude fiber and ash content were determined by methods of AOAC (1990). Nitrogen (N) content was determined by Kjeldhal apparatus and crude protein was calculated utilizing 6.25 as N conversion factor for legume protein (AOAC., 1990).

2.3. Minerals analysis

Acid digest were prepared by oxidizing each sample with a nitric/perchloric acid (2:1) mixture. Aliquots were used to determine Na and K by flame photometry, P was determine by spectrophotometeric methods (Khalil and Manan, 1990) and Ca, Mg, Mn, Fe, Cu and Zn were determine by atomic absorption spectrophotometry (AOAC., 1990).

2.4. Amino acid analysis

Amino acids were determined using LKB Biochrome automatic amino acid analyser (model 4151). Prior to analysis, samples were subjected to acid hydrolysis in the presence of 6 M HCl at 105 °C for 24 hours. Sulphur-containing amino acids were determined separately in 6 M HCl after oxidative hydrolysis (formic acid + hydrogen peroxide, 9:1 v/v, 20 h at 4 °C). Tryptophan was determined according to the method outlined in AOAC (1990).

2.5. Essential amino acid (EAA) score

The essential amino acids score was determined by employing the formula with reference to the FAO/WHO reference amino acid pattern (FAO/WHO, 1991).

$$\text{EAA score} = \frac{\text{Test amino acid} \times 100}{\text{Reference amino acid}}$$

2.6. Polyphenol content

Total Polyphenol content of the seed powder samples were assayed after extracting twice with 50% methanol in a water bath at 95 °C for 10 min (Rosset *et al.*, 1982). The extract was made up to 10 mL, of which 0.5 mL extract was mixed with equal quantity of distilled water and treated with 5 mL Na_2CO_3 (in 0.1 N NaOH). After 10 minutes, 0.5 mL Folin-Ciocalteu's phenol reagent (diluted 1:2 with distilled water) was added and read at 725 nm. Tannic acid was used as standard.

2.6. Statistical analysis

The data, based on three replications, were subjected to analysis of variance by complete block design (Gomez and Gomez, 1984). Standard deviation of each individual nutrient of each seed type mean was computed and variations among seed type were evaluated by least significance difference (LSD) at the 5% level of probability (P = 0.05).

RESULTS AND DISCUSSION

3.1. Proximate composition

Moisture content of pressure-cooked seeds were lesser than that of raw and roasted seeds (2.49 vs. 5.52% and 7.70%) (Table I). Crude protein of roasted (20.13%) and pressure-cooked (19.47%) seeds were almost similar and falls within the protein range of most legumes (17–30%) (Reddy et al., 1984). The crude protein of raw and processed seeds surpassed whole wheat flour (8.55%), parboiled rice (7.7%) and egg (12.6%) (Livsmedelsverk, 1988). Crude lipid content of raw and processed seeds (6.29-6.99%) was higher than most of the raw legumes seeds: cowpea (4.8%), lentil (3.2%) and green pea (1.5%) (Amjad *et al.*, 2006). Crude fiber of the pressure-cooked seeds was comparatively lesser than raw and roasted seeds (8.53 vs. 9.89, 9.13%). Low crude fiber is nutritionally appreciated because it traps less proteins and carbohydrates (Balogun and Fetuga, 1986). Ash content of raw and roasted seeds was higher than pressure-cooked seeds (3.53, 3.24 vs. 2.97%). The decrease ash content of pressure-cooked seeds was related to that fact that mineral or ash content of vegetative tissues are positively related (J. T. Tsialtas, 2002).

3.2. Mineral composition

Table II shows mineral composition of raw, roasted and pressure-cooked seeds. Pressure-cooking drained most of the minerals from seeds except calcium, copper, zinc and manganese that were similar in roasted and pressure-cooked seeds ($P > 0.05$). The mineral content of raw and processed seeds of the chickpea does not meet the recommended dietary allowance (NRC/NAS, 1989). A decrease in the minerals was also noticed by Aletor and Ojo (1989) after cooking cowpea, which attributed mainly by the enhanced permeability of seed coat of legumes.

3.3. Amino acid profile and nutritional value

The amino acid composition of raw, roasted and pressure-cooked indicated little variation in the content of total essential and non-essential amino acids. However, significant ($P < 0.05$) variation existed in some individual amino acid contents (Table 3). The amino acid profile of roasted seeds was better when compared to pressure-cooked seeds which was similar to the observations of Bressani *et al*. (1987) within the processed seeds of Jackbean (*Canavalia ensiformis* L.) The amino acids of the roasted and pressure-cooked seeds viz., Arginine (8.70, 8.57%), Leucine (7.58, 7.48%) and Lysine (7.61, 7.51%) form a major part of essential amino acids of Chickpea.

Lysine was significantly higher in roasted seed and is comparable with that of whole egg protein (7%) (FAO, 1970). Sulphur-amino acid, cystine was also found more in roasted seeds. Other EAA: Leucine and valine were significantly greater in roasted seed compared to pressure-cooked seed. Except methionine and phenylalanine all essential amino acid of raw, roasted and pressure-cooked seeds exceeded than FAO/WHO pattern (Table 4). Isoleucine and lysine of roasted and pressure-cooked seeds were also comparable with that of FAO/WHO pattern.

3.4. Polyphenol content

Polyphenol content of raw seed was high 315.9 mg/100g and pressure-cooking was effective in removing polyphenol than roasting (281.3 vs. 153 mg/100g) (Fig.1). Polyphenols have been recognized as functionally active molecules, possessing antioxidant, anticancer, antimutagenic properties, as well as exerting protective effects against cardiovascular and other diseases (Nakamura *et al.*, 2001). In the past polyphenol rich foods were considered to be inedible but recently it is considered beneficial. However, there is still unclear that how much dose is beneficial for human but risk of consuming high doses of polyphenols from naturally polyphenol rich foods is low (Louise *et al.*, 2005).

CONCLUSION

Chickpea in future is potential protein source for humans and it is the first study on the comparative biochemical and protein quality evaluation of raw, roasted and pressure-cooked seed of chickpea. The study result revealed that chickpea is nutritionally better in both roasted and pressure-cooked form and except methionine and phenylalanine it has sufficient amount of all essential amino acid. Roasted form exceeds in some amino acids and minerals than pressure-cooked seed so nutritionally roasted is better on the bases of present study. For complete essential amino acids diet how to supplement both types with other protein source would be interesting future research for food technologist and marketers.

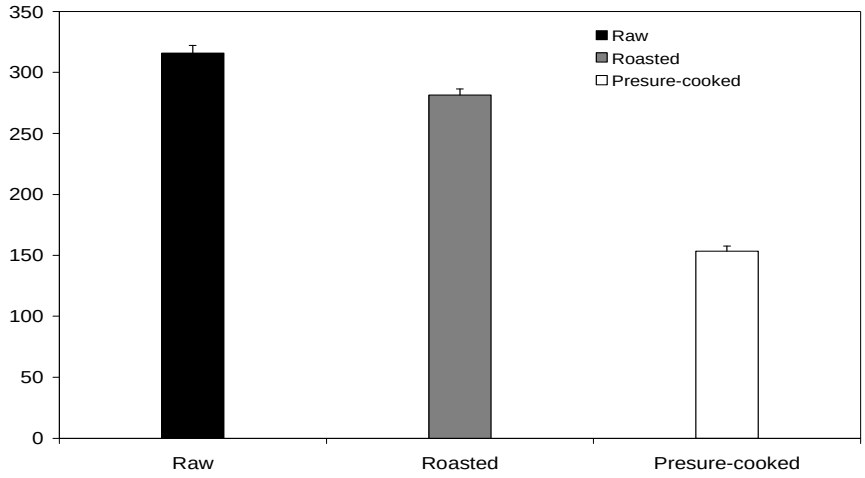

Fig. 1: Polyphenols contents (mg/100g)

Table I. ***Proximate composition of raw, roasted and pressure-cooked seeds of chickpea***

Component (g/100 g)	*Raw seed*	*Roasted seed*	*Pressure-cooked seed*
Moisture	7.70 ± 0.17^{a}	5.52 ± 0.10^{b}	2.49 ± 0.03^{c}
Crude protein	21.27 ± 0.46^{a}	20.13 ± 0.15^{b}	19.47 ± 0.42^{b}
Crude lipid	6.29 ± 0.61^{a}	6.75 ± 0.22^{a}	6.99 ± 0.11^{a}
Crude fiber	9.89 ± 0.11^{a}	9.13 ± 0.13^{b}	8.53 ± 0.05^{c}
Ash	3.53 ± 0.09^{a}	3.24 ± 0.21^{ab}	2.97 ± 0.12^{b}

Each value is the mean ± SD of three independent determinations.
Means across the columns with different superscripts are significantly different ($P < 0.05$)

Table II. ***Mineral composition of raw, roasted and pressure-cooked seeds of chickpea***

Minerals (mg/100 g)	*Raw seed*	*Roasted seed*	*Pressure-cooked seed*
Sodium	100.3 ± 2.08[a]	99.0 ± 1.73[a]	61.3 ± 1.53[b]
Potassium	1171 ± 25.42[a]	1165 ± 21.79[a]	725 ± 5.00[b]
Phosphorous	252.7 ± 2.89[a]	252.0 ± 2.65[a]	188.3 ± 1.53[b]
Calcium	194.0 ± 5.29[a]	193.7 ± 2.52[a]	193.7 ± 3.51[a]
Iron	2.93 ± 0.11[a]	2.71 ± 0.35[ab]	2.36 ± 0.09[b]
Copper	11.37 ± 0.21[a]	11.30 ± 0.44[a]	10.80 ± 0.46[a]
Zink	6.87 ± 0.12[a]	6.70 ± 0.17[a]	6.67 ± 0.12[a]
Manganese	1.93 ± 0.31[a]	1.87 ± 0.06[a]	1.83 ± 0.15[a]
Magnesium	4.70 ± 0.10[a]	4.67 ± 0.12[a]	3.87 ± 0.06[b]

Each value is the mean ± SD of three independent determinations.
Means across the columns with different superscripts are significantly different ($P < 0.05$)

Table III. ***Amino acid composition of raw, roasted and pressure-cooked seeds of chickpea***

Amino acid	*Raw seed*	*Roasted seed*	*Pressure-cooked seed*	Whole egg protein*
Arginine	8.99 ± 0.12[a]	8.70 ± 0.10[b]	8.57 ± 0.06[b]	6.1
Histidine	3.07 ± 0.06[a]	2.87 ± 0.02[b]	2.86 ± 0.01[b]	2.4
Isoleucine	4.82 ± 0.02[a]	4.69 ± 0.06[b]	4.66 ± 0.09[b]	6.3
Leucine	7.71 ± 0.01[a]	7.58 ± 0.06[b]	7.48 ± 0.06[c]	8.8
Lysine	8.04 ± 0.05[a]	7.61 ± 0.02[b]	7.51 ± 0.01[c]	7.0
Methionine	1.58 ± 0.01[a]	1.46 ± 0.04[b]	1.41 ± 0.03[b]	3.4
Phenylalanine	5.06 ± 0.15[a]	4.91 ± 0.46[a]	4.64 ± 0.09[a]	5.7
Threonine	4.36 ± 0.03[a]	4.22 ± 0.11[a]	4.15 ± 0.16[a]	5.1
Tryptophan	1.73 ± 0.02[a]	1.57 ± 0.09[a]	1.53 ± 0.10[a]	1.7
Valine	4.85 ± 0.03[a]	4.40 ± 0.07[b]	3.96 ± 0.05[c]	6.9
Total	**50.21**	**48.01**	**46.77**	
Alanine	4.77 ± 0.21[a]	4.64 ± 0.10[a]	4.70 ± 0.15[a]	5.9
Aspartic acid	11.52 ± 0.03[a]	11.41 ± 0.02[a]	11.33 ± 0.32[a]	9.6
Cystine	0.94 ± 0.04[a]	0.69 ± 0.02[b]	0.41 ± 0.01[c]	5.9
Glutamic acid	17.67 ± 0.02[a]	17.63 ± 0.03[a]	17.66 ± 0.04[a]	12.7
Glyine	3.26 ± 0.04[a]	3.23 ± 0.02[a]	3.15 ± 0.12[a]	3.3
Proline	3.89 ± 0.02[a]	3.78 ± 0.09[a]	3.77 ± 0.06[a]	4.2
Serine	3.43 ± 0.06[a]	3.42 ± 0.08[a]	2.99 ± 0.43[a]	7.6
Tyrosine	3.35 ± 0.04[a]	3.18 ± 0.05[b]	2.92 ± 0.02[c]	4.2
Total	**48.83**	**47.98**	**46.93**	
E:NE amino acid ratio	1.028	1.000	0.996	

Each value is the mean ± SD of three independent determinations.
Means across the columns with different superscripts are significantly different ($P < 0.05$).
*Whole egg protein (FAO, 1970)

Table IV. ***Essential amino acid score of raw, roasted and pressure-cooked seeds of chickpea***

Amino acid	**Reference pattern*	*Raw seed*	*Roasted seed*	*Pressure-cooked seed*
		Essential amino acid score		
Histidine	1.9	161.58	151.05	150.53
Isoleucine	2.8	172.14	167.50	166.43
Leucine	6.6	116.82	114.85	113.33
Lysine	5.8	138.62	131.21	129.48
Methionine	2.5	63.20	58.40	56.40
Phenylalanine	6.3	80.32	77.94	73.65
Threonine	3.4	128.24	124.12	122.06
Tryptophan	1.1	157.27	142.73	139.09
Valine	3.5	138.57	125.71	113.14
E:NE amino acid ratio	1.028		1.000	0.996

*FAO/WHO (1991) amino acid reference pattern of protein for human.

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