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Original Article

Nutritional composition of chickpea (*Cicer arietinum* L.) as affected by microwave cooking and other traditional cooking methods

Saleh A. Alajaji, Tarek A. El-Adawy*

Food Process Technology Department, Buraydah College of Agriculture Technology, P.O. 266, Al-Qassim, Buraydah, Kingdom of Saudi Arabia

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Abstract

The effects of microwave cooking and other traditional cooking methods such as boiling and autoclaving on the nutritional composition and anti-nutritional factors of chickpeas (*Cicer arietinum* L.) were studied. Cooking treatments caused significant ($P<0.05$) decreases in fat, total ash, carbohydrate fractions (reducing sugars, sucrose, raffinose and stachyose, while verbascose was completely eliminated after cooking treatments), antinutritional factors (trypsin inhibitor, haemagglutinin activity, tannins, saponins and phytic acid), minerals and B-vitamins. Cooking treatments decreased the concentrations of lysine, tryptophan, total aromatic and sulfur-containing amino acids. However, cooked chickpeas were still higher in lysine, isoleucine and total aromatic amino acid contents than the FAO/WHO reference. The losses in B-vitamins and minerals in chickpeas cooked by microwaving were smaller than those cooked by boiling and autoclaving. In-vitro protein digestibility, protein efficiency ratio and essential amino acid index were improved by all cooking treatments. The chemical score and limiting amino acid of chickpeas subjected to the various cooking treatments varied considerably, depending on the type of treatment. Based on these results, microwave cooking is recommended for chickpea preparation, not only for improving nutritional quality (by reducing the level of antinutritional and flatulence factors as well as increasing in-vitro protein digestibility and retention rates of both B-vitamins and minerals), but also for reducing cooking time.

Keywords: Chickpea seeds; Boiling; Autoclaving; Microwave cooking; Antinutritional factors; Nutritional composition

1. Introduction

Chickpeas (*Cicer arietinum* L.) are one of the oldest and most widely consumed legumes in the world, particularly in tropical and subtropical areas. Kabuli chickpea seeds are grown mainly in the Mediterranean area, the Near East, Central Asia and America (Singh et al., 1991). The seeds are large in size, salmon-white in color, and contain high levels of carbohydrate (41.10–47.42%) and protein (21.70–23.40%). Starch is the major carbohydrate fraction, representing about 83.9% of the total carbohydrates (Rincón et al., 1998).

Generally, legumes have been reported to have low nutritive value because of low amounts of sulfur-containing amino acids, low protein digestibility and the presence of anti-nutritional factors. 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 (Chau et al., 1997; Wang et al., 1997; Vijayakumari et al., 1998). However, cooking causes considerable losses in soluble solids, especially vitamins and minerals (Barampama and Simard, 1995).

In Egypt, chickpea seeds are usually consumed at the raw green and tender stage (unripe stage), called *Malana*, or in the form of mature dry seeds after parching as a popular snack food. The dry seeds can also be consumed as whole or decorticated after cooking and processing in different ways. In addition to these uses, the flour of decorticated chickpea seeds is used in several dishes and as a supplement in weaning food mixes, bread and biscuits (van der Maesen, 1972). The chemical composition and oligosaccharides of raw and germinated chickpea seeds were reviewed by Singh et al. (1991). The effect of cooking on the constituents of chickpea seeds has been reported by Attia et al. (1994). Increasing the time and temperature of

*Corresponding author. Tel.: +20 48 238 788; fax: +20 257 69495.
E-mail address: el_adawy@hotmail.com (T.A. El-Adawy).

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processing has been reported to reduce the nutritive value and available lysine of legumes (Chau et al., 1997; Kon and Sanshuck, 1981).

Cooking of chickpea by microwave has not been extensively studied but it has been shown to reduce antinutritive agents in soybean (Rajko et al., 1997) and have positive effects on protein digestibility (Khatoon and Prakash, 2004) in eight whole legumes. A study on chickpea cooked by microwave is thus needed to know whether this treatment could improve nutritional quality and eventually replace traditional cooking methods, which are not only costly in energy but also cause important losses in soluble solids. This experimental study was therefore carried out to determine the effect of boiling, autoclaving and microwave cooking on the nutritional composition and nutritive value of chickpea seeds.

2. Materials and methods

2.1. Materials

One batch (10 kg) of local chickpea seeds (*Cicer arietinum* L.) were purchased from the local market (Menofiya Governorate, Egypt) during the summer season (August) of 2003. The seeds were hand-sorted to remove wrinkled, moldy seeds and foreign material, then stored in polyethylene bags in the refrigerator (4 °C ± 1) until used.

2.2. Processing: cooking treatments

Chickpea seeds were soaked in distilled water (1:10, w/v) for 12 h at room temperature (~25 °C). The soaked seeds were drained and rinsed three times with 600 mL distilled water, then cooked by the methods described below:

- *Boiling*: The rinsed soaked seeds were cooked in tap water (100 °C) in the ratio of 1:10 (w/v) on a hot plate until they became soft when felt between the fingers (90 min).
- *Autoclaving*: The rinsed soaked seeds were autoclaved using vertical autoclave (Systec, Model Systec V-150, Wettenberg, Germany) at 15 lb pressure (121 °C) in tap water (1:10, w/v) until 50% of the seeds were soft when felt between the fingers (35 min).
- *Microwave cooking*: The rinsed soaked seeds were placed in a glass beaker (Type Birex, England) with tap water (1:10, w/v), then cooked in a microwave oven (Goldstar, Model ER-50540, 2450 MHz, Egypt) on high for 15 min (about 50% of the seeds were soft when felt between the fingers). The cooked seeds were dried in an electric air draught oven (VEB MLW Medizinische, Geräte, Berlin, Germany) at 50 °C for 20 h.

Cooking treatments were replicated three times. Raw and processed chickpea seeds were ground in an electric mill equipped with stainless steel blades (Braun, Model 1021, Germany) to pass through a 60 mesh (British standard screen) nylon sieve.

2.3. Analytical methods

Chemical composition. Moisture (14.004), fat (14.018), ash (14.006), crude fiber (14.020) and protein $N \times 6.25$ (14.026) were determined as described by AOAC (1990). The crude fiber was determined in the portion of the moisture and fat-free sample that remained after digestion with weak acid and base; it is of low digestibility and composed of cellulose, hemi-cellulose and some lignins. Non-protein nitrogen was measured as soluble nitrogen in 30% trichloro-acetic acid using method of Patel et al. (1990). The content of reducing sugars was determined in the 70% ethanol extracts by the phenol–sulphuric acid method used by Dubois et al. (1956). Starch content was determined as reducing sugars after complete acid hydrolysis. Flatulence factors (stachyose, raffinose and verbascose) and sucrose were determined according to Tanaka et al. (1975) using thin layer chromatography.

B-vitamins. B-vitamins were determined microbiologically using *Lactobacillus plantarum* ATCC 8014 for niacin, *Lactobacillus casei* ATCC 7469 for riboflavin, *Lactobacillus fermentum* ATCC 9338 for thiamin and *Saccharomyces calsbergensis* (obtained from National Research Center, Cairo, Egypt) for pyridoxine, according to the methods described by György and Pearson (1967).

Minerals. Minerals were determined after wet ashing by concentrated nitric acid and perchloric acid (1:1, v/v). Na, K and Ca were determined by flame photometer (Corning 410, England), while Mg, Mn, Zn, Fe and Cu were determined using an atomic absorption spectrophotometer (Perkin–Elmer, Model 2380, USA). Phosphorus was estimated photometrically via the phosphorus molybdate complex described by Taussky and Shorr (1953).

Antinutritional factors. Total tannins (9.098) were determined colorimetrically as described in AOAC (1990). Phytic acid was determined according to the method of Wheeler and Ferrel (1971). Trypsin inhibitor activity was determined according to the method of Kakade et al. (1969) using benzoyl-DL-arginine-P-nitroanalide hydrochloric as the substrate. Haemagglutinin activity was estimated according to the method of Liener and Hill (1953). Saponin content was assayed by the hemolysis test described by Rodriguez et al. (1986) using red cells from sheep blood.

Amino acids. Amino acids were determined using a Mikrotechna AAA 881 automatic amino acid analyzer (Model 118/119 CL, Czech Republic) according to method of Moore and Stein (1963). Hydrolysis of the samples was performed in the presence of 6 M HCl at 110 °C for 24 h under a nitrogen atmosphere. Sulfur-containing amino acids were determined after performic acid oxidation. Tryptophan was chemically determined by the method of Miller (1967).