Acta Alimentaria, Vol. 46 (3), pp. 290–296 (2017)
DOI: 10.1556/066.2015.7777

EFFECT OF TRADITIONAL PROCESSING STEPS ON CHEMICAL AND NUTRITIONAL COMPOSITION OF LEBLEBI

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(Received: 28 May 2015; accepted: 20 July 2015)

Turkey's and several Middle East countries' people consume "leblebi", which is a traditional snack food made from chickpea (*Cicer arietinum* L.). Leblebi processing steps caused significant decrease ($P<0.05$) in moisture and carbohydrate fractions. The dietary fibre contents were also reduced through leblebi processing steps. Dehulling process caused reduction in cellulose from 2.6 to 1.3%, whereas increase in acid detergent lignin content from 0.27 to 0.85% was observed. The mineral analysis results have shown that leblebi samples supply macro and micro nutrients required in the human diet.

Keywords: chickpea, ethnic food, leblebi, roasted chickpea, snack food

Legumes are consumed in different regions of the world, prepared in various ways. Next to Bengal gram dhal, red gram, a native of South-East Asia, is the most widely consumed legume in South India. There are lots of foods like Rasam, sanber, and other savoury dishes that are prepared with legumes (Tharanathan & Mahadevamma, 2003). Chickpea (*Cicer arietinum* L.) is one of the world's oldest and most widely consumed legumes due to its relatively high protein content and wide adaptability (FAO, 2012).

Leblebi is a traditional snack made from roasted chickpeas common and popular in Turkey and several Middle Eastern countries. Chickpeas used for leblebi are selected for shape, size, colour, and harvesting time. Generally large seeded (5–9 mm in diameter and 25.0–50.0 g of 100- kernel weight), lighter coloured, round and smooth surfaced Kabuli chickpeas are preferred (Köksel et al., 1998; Coşkuner & Karababa, 2004).

There are mainly two different kinds of leblebi as dehulled (yellow leblebi) and non-dehulled (white leblebi) traditionally produced from chickpeas in different parts of Turkey. Today, leblebi is produced traditionally at family plants. Producers try to increase product diversity by coating leblebi with salt, capsicum, chocolate, sugar, sesame, and cloves at the final roasting stage. Furthermore, leblebi has a potential use as a natural ''functional food'' due to its chemical composition. It has high protein, cellulose, and mineral content, and is low in fat. Its low glycemic index (GI) makes leblebi a great snack compared to sugary or high GI snacks. Because of the low moisture content, leblebi has long shelf life. If appropriate packaging materials are used, it can be stored for 6 to 12 months. The present study was aimed at evaluating the effect of traditional processing steps on the nutritional composition of chickpea seed.

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1. Materials and methods

1.1. Materials

Raw chickpea seeds and leblebi samples were obtained from Gülşen Leblebi Company, which is one of the oldest local processors of Çorum, Turkey.

1.2. Leblebi processing steps

Conversion of raw chickpeas to leblebi takes approximately one month and a half. The chickpeas are sorted by size before tempering and resting processes. Tempering takes place at 85–90 ºC for 10 to 15 min for penetration of moisture into the structure. After tempering, there is a long resting phase, which takes nearly 30 days at ambient temperature. Chickpeas are kept in jute bags during resting stages. This resting stage is the most important in leblebi quality, being responsible for the development of organoleptic changes expected in roasted chickpeas. After resting, first roasting process is applied, which peels away the shells of the chickpeas. The leblebi at this stage is known as "single roasted leblebi". These half-mature products need only a final roasting two days later to be ready for sale (Köksel et al., 1998).

1.3. Proximate compositions, dietary fibre and mineral analysis

For analysis, the samples of leblebi or chickpea were ground and passed through a 350 µm mesh sieve. Proximate composition was determined by measuring the fat, ash, moisture, protein (N×6.25), and carbohydrates (by difference) contents in duplicate by standard procedures of AOAC (2000). The Van Soest detergent procedure (Rzedzicki et al., 2008) was used to determine the content of detergent fibre fractions (neutral detergent fibre – NDF, acid detergent fibre – ADF, cellulose – CELL, and acid detergent lignin – ADL). The samples were treated using the microwave digestion technique, and the mineral composition was determined by atomic absorption spectrometry (Wang et al., 2010).

1.4. Determination of total phenolic content and total antioxidant capacity

Total phenolic content (TPC) was determined by the Folin-Ciocalteu reagent (Singleton & Rossi, 1965; Singleton & Lamuela-Raventos, 1999) using gallic acid (GA) as standard. The TPC was expressed as GA equivalents (mg of GAE/g sample) through the calibration curve of GA.

Antioxidant activity was measured using the ABTS [2,2-azino-bis(3-ethylbenzo-thiazothiazoline-6-sulfonic acid) diammonium salt] method (Serpen et al., 2007) with some modifications. All measurements were performed at exactly the 6th min after mixing the sample with the ABTS reagent. The antioxidant activity was expressed as millimole of Trolox (6-hydroxyl-2,5,7,8-tetramethylchroman-2-carboxylic acid) equivalent antioxidant capacity (TEAC) per kilogram sample by means of a dose-response curve for Trolox.

1.5. Statistical analysis

All results in this study are reported as means of two replications. The data were analysed using a one factor analysis of variance (ANOVA) and Tukey mean separation for multiple comparisons with the SPSS 7.5 software. Significance was defined at $P<0.05$.

2. Results and discussion

Analysis of variance showed that leblebi processing steps have significant ($P<0.05$) effects on moisture, fat, ash, and carbohydrate contents (Table 1). Because of water absorption, tempering increased the moisture content of leblebi by nearly 10–30%. During the resting stage, uniform moisture distribution was achieved, but at the same time desorption caused about 20–30% loss of moisture. After exposure to high temperature in roasting step, the moisture content was reduced further by 3%. These reductions in the moisture content during processing were statistically significant ($P<0.05$). The present results are in good agreement with previous reports (Costa et al., 2006; Iqbal et al., 2006; Khattab et al., 2009).

Table 1. Effect of leblebi processing on chemical composition of chickpeas (%)

Sample	Moisture	Protein	Fat	Ash	Carbohydrate*
Raw chickpea	10.78d	19.11a	5.98a,b	2.54a,b	61.59a
1. Tempering	7.25c	19.44a	6.39b,c	2.60a,b	64.32b,c
2. Tempering	3.05a	20.44a	6.85b,c	2.77b	66.89d,e
Roasting	5.38b	20.51a	7.90d	2.46a	63.75b
Last roasting (Dehulled leblebi)	3.31a	20.79a	7.85d	2.49a	62.13a,b

*Values are means of duplicate analysis. Means in the same column with different letters are significantly ($P<0.05$) different.

The protein, fat, ash, and carbohydrate contents of raw chickpea were 19.11, 5.98, 2.54, and 61.59%, respectively. The results of the proximate composition are similar to the study of Milan-Carillo and co-workers (2000), who have reported mean values for desi chickpea cultivars. The ash and carbohydrate contents were 2.49 and 62.13% for dehulled leblebi. The effects of dehulling process on ash and carbohydrate contents are in agreement with findings for chickpea by Singh and co-workers (1992). The protein content of dehulled leblebi was 20.79%. This value showed that protein content of chickpea was nearly unaffected by leblebi processing steps ($P>0.05$).

Dietary fibre is substantial in supporting of health. The Institute of Medicine defines fibre as a non-digestible food plant carbohydrate. According to the Institute of Medicine, dietary reference intake, an adequate intake for total fibre, is set at 38 and 25 g per day for young men (age 14–50 years) and women (age 19–50 years), respectively (USDA, 2007).

The effect of leblebi processing steps on the dietary fibres is shown in Figure 1. The raw chickpea contained 2.6% cellulose and 4.2% ADF, whereas the NDF and ADL contents were 7.4 and 0.27%, respectively. These dietary fibre results showed variations from the reported values in the literature, which is quite likely due to difference in soil, fertilizers, climate, harvesting time, botanical variety, etc. Leblebi processing caused some changes in dietary fibre components, and the changes were more pronounced in dehulled leblebi. First and second phase of tempering of chickpeas caused some changes in cellulose, ADF, and NDF components (Fig. 1). However, these changes were more pronounced at first roasting on chickpeas, because dehulling occurs at this step. Tempering processes did not significantly alter ADL content on dry matter basis. It can be seen in Figure 1 that increase in ADL was only from 0.27 to 0.85% as a result of dehulled processing. The contents of cellulose, NDF, ADL, and ADF significantly (P<0.05) changed at dehulled leblebi processing steps. In general, the observed effect of leblebi processing on individual dietary fibre components in chickpeas depended not only on the tempering steps, but also on the roasting involved. These results were also in good agreement with the findings of Rehman and Shah (2004). Similar changes in dietary fibre contents of chickpeas during cooking processes were noted by other studies (Rehman et al., 2003; Rehinan et al., 2004; Costa et al., 2006).

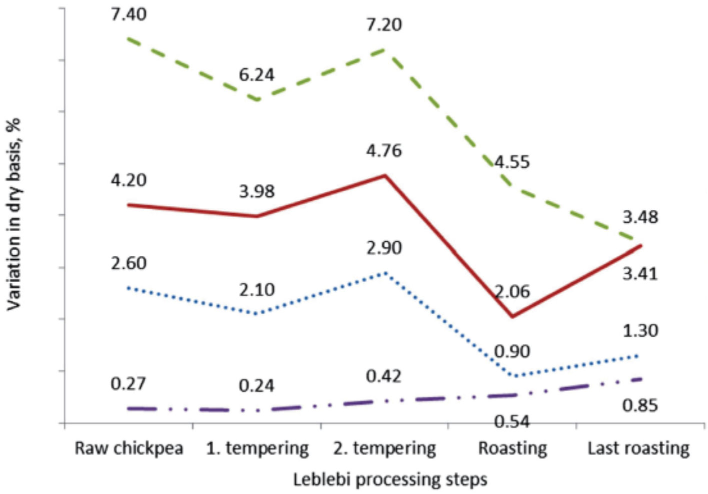

Fig. 1. Effect of leblebi processing on dietary fibres content of chickpeas, %, dry basis
: Cellulose; : ADF; : NDF; : ADL

Figures 2 and 3 show the change of TPC and total antioxidant capacity of chickpeas during leblebi processing steps. The trends are similar for all of them. The early stages of processing steps are characterized by decrease. New antioxidants and phenolics are formed as a result of Maillard reaction, increasing the TPC and total antioxidant capacity at roasting steps, which in some cases restored the original TPC value. TPC of samples ranged between 0.64 and 0.72 mg gallic acid equivalents/g. These values were lower than the concentrations reported as 4.24 catechin equivalent/100 g extract and 1.82 mg gallic acid equivalents/g (Mondor et al., 2009; Vadivel et al., 2011). According to literature, TPC is directly associated with antioxidant capacity. TPC of the samples showed strong positive correlations (r=+0.982) with the antioxidant capacity. This pattern is in agreement with the TPC and total antioxidant capacity of the samples (Açar et al., 2009; Cristobal et al., 2010; Vega et al., 2010).

The antioxidant capacity of samples ranged between 16.12 and 20.43 mmol Trolox equivalent per kg (Fig. 3). Leblebi processing steps significantly (P<0.05) affected the antioxidant activity of chickpeas. Antioxidant compounds are naturally occurring in food generally, but they can occur also as a result of chemical reactions taking place during the thermal treatment applied on the food (Gökmen et al., 2009). The decrease in antioxidant activity observed in the first and second tempering stages is probably due to the amount of thermally labile antioxidant compounds present in chickpeas. During roasting, slight increase in antioxidant activity can be attributed to newly formed antioxidant compounds through Maillard reaction. The reaction is promoted by low water content during roasting of chickpeas.

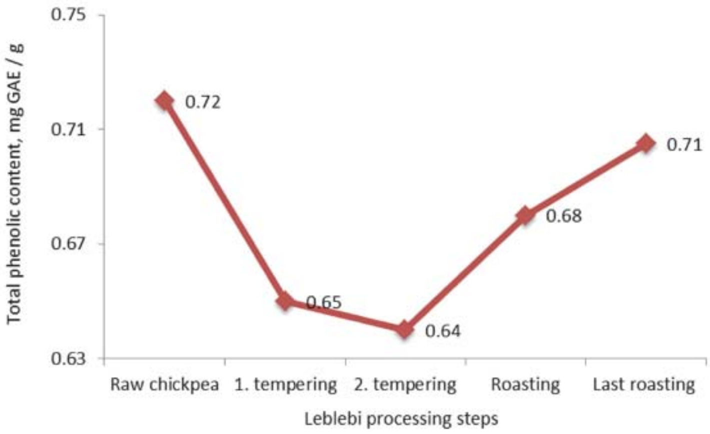

Fig. 2. Effect of leblebi processing on total phenolic content of chickpeas, %, dry basis

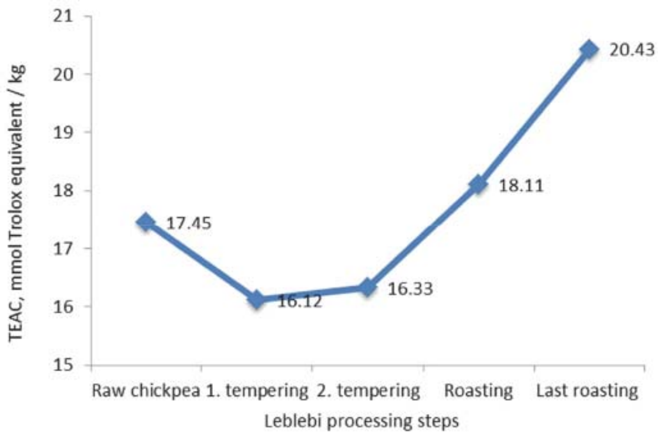

Fig. 3. Effect of leblebi processing on total antioxidant capacity of chickpeas, % , dry basis

Finally, in some processed foods, e.g. roasted coffee, a significant portion of antioxidant compounds is formed due to Maillard reaction (Borelli et al., 2002; Gökmen et al., 2009). The amounts of antioxidant capacity recommended daily intake is 400 mmol Trolox equivalent/kg in terms of the TEAC, therefore one portion leblebi (100 g) can supply nearly 20%.

Minerals content of raw and processed chickpea samples are presented in Table 2. Analysis of variance showed that leblebi processing steps have significant ($P<0.05$) effects on mineral content. The process caused slight decrease in Fe, Zn, K, Na, Mn, and Mg contents, but a high increase in Cu content (from 3.32 to 5.38 mg kg^{-1}) was observed. Ca contents of chickpeas also decreased significantly (from 1277 to 678 mg l^{-1}). The minerals could have drained from the chickpea into the water during leblebi processing steps at varying rates.

These results are similar to findings of ALAJAJI and EL-ADAWY (2006), that the nutritional compositions of chickpea were affected by traditional cooking method.

Table 2. Effect of leblebi processing on mineral contents of chickpeas

Sample	Cu (mg kg^{-1})	Fe (mg kg^{-1})	Zn (mg kg^{-1})	K (mg kg^{-1})	Na (mg l^{-1})	Mn (mg l^{-1})	Mg (mg l^{-1})	Ca (mg l^{-1})
Raw chickpea	3.32b	48.69a,b	56.62a	8441c	58.24b	16.49b	1151b	1277b
1. Tempering	3.50b	58.81b	52.44a	6417a	55.33b	16.36b	1108b	1278b
2. Tempering	2.63a	57.19b	55.12a	7381b	102.0c	18.40c	1031a	635a
Roasting	4.54b,c	39.80a	52.81a	8319c	52.25b	11.94a	1400c	758a
Last roasting (Dehulled leblebi)	5.38c	39.97a	51.68a	6985a,b	43.65a	12.65a	967a	678a

*Values are means of duplicate analysis. Means in the same column with different letters are significantly ($P<0.05$) different.

Overall, leblebi processing showed no significant loss of proximate composition and total phenolic content, but reduced the moisture content. The observed results indicated that leblebi processing would result in considerable losses of carbohydrates, ash, and dietary fibre mainly due to the fact that the outer portions of chickpea containing cotyledon constituents were lost during dehulling operation of the roasting steps of leblebi production. The findings of this study demonstrate the nutritional consequences of the traditional leblebi processing steps used to convert chickpea into consumable forms.

3. Conclusions

Leblebi is widely consumed in Turkey as healthy traditional snack. In this study, chemical composition and nutritional changes during traditional leblebi processing were evaluated. Unlike many of its industrial sugary competitors, leblebi is a rich source of protein, dietary fibre, and minerals, and is low in fat and contains no sugar. Since it is whole grain with no further grinding, it has a very low glycemic index, thus it can be recommended as a health snack for longevity. In view of the overall nutrient and digestibility analysis, this traditional snack food product can be an economic and alternative protein source that would improve overall nutritional status in the world.

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The author is grateful to Hitit University Scientific Research and Development Office for their financial support (Project no: MUH01.13.002) and also to Gülşen Food Corporate, (Çorum/Turkey) for kind donation of chickpea and leblebi samples.

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