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Different Methods for Candied Chestnut Production

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Abstract: Turkey is the third largest producer of chestnuts. In Turkey, chestnut fruits are widely consumed fresh as well as processed into candied chestnut. The objective of this study was to determine the most suitable method for candied chestnut production. For that purpose, eleven different methods were tested. Fresh chestnuts were peeled and divided into three groups. First group was held at -20°C overnight. Second group was precooked at 121°C for 5 min without sugar syrup. The third group received no pre-treatment. All samples were cooked at 121°C for 10 min in 50°Bx sugar syrup and then cooked in sugar syrups with different concentrations at 121°C for 10 min. All samples were evaluated for color and sensory properties which are important quality attributes that affect consumer preference. The most suitable processing steps were determined as: holding at -20°C overnight, thawing, cooking in 50°Bx sugar syrup at 121°C for 10 min and then cooking in 60°Bx sugar syrup at 121°C for 10 min. Taste, odor, texture and color properties of the candied chestnuts produced according to the above mentioned processing steps were found to be excellent.

Key words: Chestnut, candied chestnut, color, sensorial evaluation, thawing

INTRODUCTION

Turkey is the third largest producer of chestnuts (*Castanea sativa* Mill. and its hybrids). Chestnuts are grown largely in the Aegean, Marmara and Black Sea regions of Turkey (Korel and Balaban, 2006). Chestnuts come on the market commercially as fresh or processed. Consumers prefer boiled or roasted chestnuts; the shell is then peeled and the kernel is eaten. In Turkey, fresh consumption is widespread. Very little portion of the production is used in confectionery industry mostly for candied chestnut production. The method of production differs from producer to producer so, the quality of candied chestnuts in the market had great variability.

Research has been performed to determine the compositional properties of raw chestnuts. McCarthy and Meredith (1988) reported the nutrient compositions of American, European and Chinese chestnuts, consumed in the United States. Ferreira-Cardoso *et al*. (1999) determined the composition of 23 shelled chestnut kernel samples belonging to 7 different cultivars of *C. sativa* Mill. in Portugal. Senter *et al.* (1994) compared total lipids, fatty acids, sugars and nonvolatile organic acids in nuts from *C. dentata* (Marsh) Borkh (American), *C. sativa* Mill. (European), *C. mollissima* B1 (Chinese) chestnuts and *C. pumila* (L) Mill. (chinkapin). Erturk *et al.* (2006) studied on the chemical compositions of the fruits of cultivars and genotypes belonging to the species *Castanea sativa* Mill. and the foreign hybrid cultivars. Pereira-Lorenzo *et al.* (2006) performed a comparative study of nutrient composition of Spanish chestnut cultivars. Borges *et al.* (2007) investigated the variation in crude fat and fatty acid composition among 17 cultivars of sweet chestnut fruits from traditional economically important portuguese cultivars. Yildiz *et al.* (2009) determined physical and chemical properties of wild chestnut fruit grown in Turkey.

Studies in the literature focus mainly on raw materials and only a few assess the impact of different heat treatments on chestnut composition. The effects of boiling, steaming (107°C) and roasting in a 200°C oven (Shin *et al*., 1981) and roasting at 220°C (Kunsch *et al*., 2001) were studied. Morini and Maga (1995) reported the changes in fatty acid composition of chestnuts during roasting at 182°C. Krist *et al.* (2004) determined the volatile flavour compounds of roasted Italian chestnuts by capillary gas-chromatography with a mass selective detector. Korel and Balaban (2006) determined the composition, color and mechanical characteristics of pretreated candied chestnuts. Chenlo *et al.* (2009) were investigated the evolution of the moisture, sucrose, glucose and fructose contents of chestnuts along the preservation time of 10 weeks at different environments (with and without vacuum-pack in bags) and temperatures

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(room, cold chamber and -18°C). Correia *et al.* (2009) evaluated the effect of drying conditions on morphological and chemical properties of two portuguese *Castanea sativa* varieties. They found drying temperatures affected both chemical composition of flours and morphological properties of starch and generally decreased colour parameters of the flours with increasing drying temperature. Moreira *et al.* (2011) studied the effect of osmotic pre-treatment with sodium chloride and drying temperature on the air drying kinetics of the peeled and cut chestnuts.

The objective of this study was to determine color and sensorial properties of candied chestnuts produced according to different methods and to determine the most suitable method.

MATERIALS AND METHODS

Chestnuts taken from the SA 5-1 genotype were used in this experiment. According to the nut size, degree of burr seperation from the shell, ease of pellicle removal, testa peeling and entering to the seed attributes, this genotype was found to be appropriate for candied chestnut production (Serdar, 1999). Raw chestnut samples were harvested from Sinop Province of Turkey.

Before processing width, length, weight, color, dry matter and starch values of chestnuts were established. The chestnuts were peeled, weighed into 200 g jars and either 50, 60 or 70°Bx sugar syrup each containing 0.5% citric acid were poured into them. The sugar concentrations of the syrups were the acceptable concentrations determined by performing preliminary tests. The samples were completely covered with the solution. During the treatments in order to prevent evaporation losses, the jars were kept capped. Eleven different candied chestnuts were produced (Table 1).

Table 1: The methods used in candied chestnut production

	Processing steps					
Methods	I	II	III	IV	V	VI
1	-	+	+	+	A	-
2	-	+	+	+	B	-
3	-	-	+	+	A	-
4	-	-	+	-	B	-
5	-	+	+	-	A	a
6	-	+	+	-	B	b
7	-	-	+	-	A	a
8	-	-	+	-	B	b
9	+	-	+	-	A	-
10	+	-	+	-	C	-
11	+	-	+	-	B	-

[a]'+': Treated; '-': Untreated ; [b]I: After peeling, freezing storage at -20°C overnight, II: Autoclaving at 121°C for 5 min, III: Autoclaving in 50°Bx sugar syrup at 121°C for 10 min, IV: Dipping into 50°Bx sugar syrup at room temperature overnight, V: Autoclaving in sugar syrup (A: 50°Bx, B: 70°Bx, C: 60°Bx) at 121°C for 10 min, VI: After autoclaving in sugar syrup: [a]dipping into 50°Bx sugar syrup at room temperature overnight, [b]dipping into 70°Bx sugar syrup at room temperature overnight

Whole chestnuts were divided into groups. In the process of freezing when water in the cells freezes, an expansion occurs and ice crystals cause the cell walls to rupture. Consequently, the texture of the produce is generally much softer after thawing when compared to non-frozen produce. So, in order to explore if freezing the raw material affects the quality of the final product or not some of samples were held at -20°C overnight, cooked in 50°Bx sugar syrup at 121°C for 10 min and then cooked in was cooked at 121°C for 10 min in 50°Bx sugar syrup and then cooked in different sugar syrups (50°Bx or 70°Bx) at 121°C for 10 min.

Color and sensorial properties of candied chestnuts were determined. Length, width and height were measured by a compass. Nut and kernel weight were determined by weighing. The dry matter contents of the samples were analyzed by drying them until constant weight in the hot air oven at 70°C (AOAC, 2000). Total sugar, reducing sugar and unreducing sugar were determined by Luff-Schoorl Method as described by Lees (1975). After reduction process, starch content were analyzed by Luff-Schoorl Method.

The color of candied chestnuts were evaluated by means of a reflectance colorimeter (CR 300, Chromometer, used standardize the instrument. The color was measured in terms of Hunter L Minolta, Japan). A white tile (No.: 21733001) was *, a* and b* values. Hunter L* represents the lightness or darkness of the object and it is measured on a scale of 0-100. L* value of 100 represents white and L* of 0 represents black. Hunter a* represents redness or greenness. A positive value of Hunter a* is assigned for red, zero for gray and negative for green. Hunter b* represents yellowness or blueness. A positive value of Hunter b* is assigned for yellow and a* negative value is assigned for blue.

Since, color is a combined effect of all three coordinates (L*, a* and b*), it should be viewed as a combined index. To evaluate the effect of different processing methods on the averall combined color of candied chestnuts, The index Total Color Difference (ΔE) given by following equation was calculated by taking the color of raw chestnut as the base value:

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

where, $\Delta L^* = L^* - L^*_{raw}$, $\Delta a^* = a^* - a^*_{raw}$ and $\Delta b^* = b^* - b^*_{raw}$ and L*, a*, b* are the color coordinates of the candied chestnut and L^*_{raw}, a^*_{raw} and b^*_{raw} are the color coordinates of the raw chestnut. Sensory evaluation of all treated chestnuts was conducted using a taste panel consisting of 12 trained panellists both female 3 and male 9 of Food Engineering Department of Ondokuz Mayis University. Full instructions were given to the panellists before the evaluation. Samples of treated chestnuts were n a plateplaced i and evaluated by the panellists using a six point scale where 6 indicated the highest and 1 the lowest intensity of each attribute being assessed. The attributes analyzed were color, flavour and hardness. The overall quality was taken as the total sum of these three attributes (Pinnavaia *et al*., 1993).

Data are reported as mean of three replicates. The one way Analysis of Variance (ANOVA) using the Duncan's multiple range test at level of significance $p<0.01$ was used for the statistical analysis (SPSS 11.5).

RESULTS AND DISCUSSION

The physical and chemical characteristics of raw chestnuts used in the candied chestnut production are shown in Table 2. Mean values of color and sensorial evaluation attributes and the results of the statistical analysis are given in Fig. 1-3.

There were statistically significant differences ($p<0.01$) between the candied chestnut processing methods with respect to all parameters examined. The highest L* value expressing brightness was found in the sample which was frozen-thawed and autoclaved in 50°Bx sugar syrup at 121°C for 10 min (sample 9) and the lowest was found in the sample which was precooked at 121°C for 5 min and then cooked in 50 and 70°Bx sugar syrups, respectively at 121°C for 10 min (sample 6). Precooking without sugar addition caused a decrease in brightness. During precooking, the changes due to high temperature in chlorophyll and carotenoid pigments that give the characteristic color of chestnuts is thought to decrease the brightness. Brightness was well protected in the samples cooked directly in sugar syrup.

The highest a* value, expressing redness was found in the sample 9 while the lowest value was found in the sample 6 which was precooked at 121°C for 5 min, autoclaved in 50°Bx sugar syrup at 121°C for 10 min, kept in this syrup overnight and then kept in 70°Bx sugar syrup at 121°C for 10 min the following day (sample 6). b* value, expressing yellowness was the highest in sample 9 and the lowest in sample 6. As can be seen redness and yellowness values were the highest in sample 9 and the lowest in sample 6. Increasing a* value indicates increasing redness. However to comment, this increase as browning is not true. It is difficult to estimate

Table 2: Physical and chemical composition of raw chestnut samples

Parameters	Mean±standard deviation
Width (mm)	20.7±1.600
Length (mm)	34.1± 2.50
Height (mm)	28.7±1.900
Nut weight (g)	11.7±2.100
Kernel weight (g)	9.9±1.500
L*	75.48±2.28
a*	+0.37±1.24
b*	+27.77±1.69
Dry matter (g/100 g)	49.87±0.02
Total sugar (g/100 g)	9.41±0.19
Reducing sugar (g/100 g)	1.92±0.00
Unreducing sugar (g/100 g)	7.11±0.18
Starch (g/100 g)	33.60±0.42

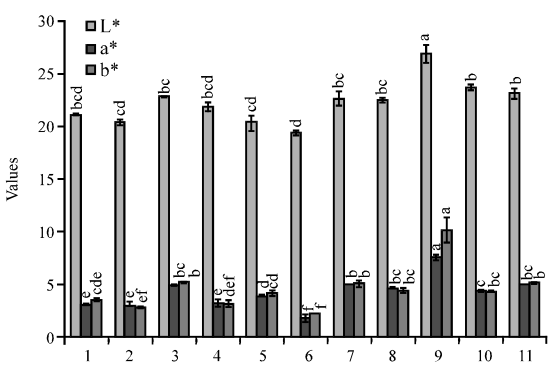

Fig. 1: The color values of candied chestnuts produced by different methods ($p<0.01$)

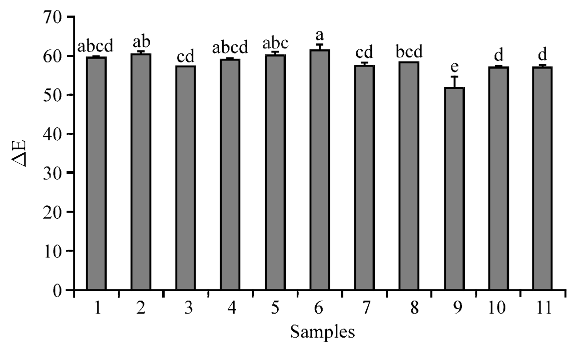

Fig. 2: The color difference values of candied chestnuts produced by different methods ($p<0.01$)

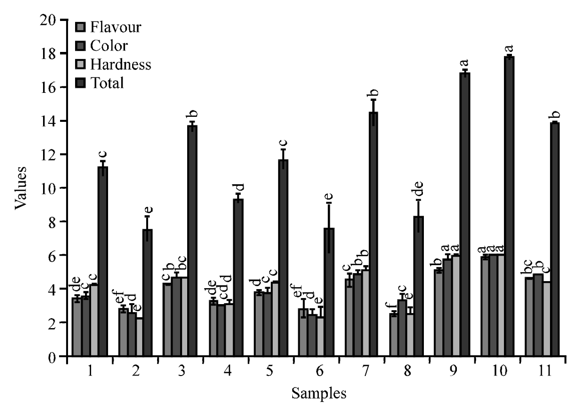

Fig. 3: The sensorial evaluation scores of candied chestnuts produced by different methods ($p<0.01$)

of browning merely from L*, a* or b* values. Hence, L* as well as a* and b* values must be interpreted together and supported with sensory evaluation results.

As shown in Fig. 2, the lowest color difference value was found in the sample which was frozen-thawed and autoclaved in 50°Bx sugar syrup at 121°C for 10 min (sample 9). The highest value was found in the sample which was precooked at 121°C for 5 min and then cooked in 50 and 70°Bx sugar syrups, respectively at 121°C for 10 min (sample 6).

When sensory evaluation results are examined, sample 10 which was processed as freezing-thawing, autoclaving in, respectively 50 and 60°Bx sugar syrups at 121°C for 10 min showed the highest scores for all three parameters. Sample 9 followed: the panellists preferred the candied chestnuts melting in the mouth, having pleasant aroma and light brown color.

Because of the highest total score for perfect product was 18, it is clear that the samples judged by a score below 9 were not accepted. From this point of view, it appears that the samples 2, 6 and 8 were poor in sensorial quality and the sample 4 was consumable. As can be shown from Table 1, the common properties of above mentioned samples were cooking the unfrozen chestnuts in 70°Bx sugar syrup at the fifth processing step. The high sugar concentration of the syrup used in this step hardened the texture and darkened the color of the chestnuts. As expected, the reaction between amino acids and sugars via Maillard reaction and the caramelisation reaction were responsible for the development of brown color. During preliminary tests, it was determined that at candied chestnuts, produced directly by using 70°Bx sugar syrup, the sugar could not diffused enough so, the candied chestnuts exhibited a rather flat taste. In order to solve this problem, the chestnuts were kept in 50°Bx sugar syrup at first.

Freezing and thawing of the chestnuts significantly affected the quality of candied chestnuts. In such produced samples, sugar could rapidly diffuse into the chestnuts and chestnut candies exhibited desirable color and melting texture. The color and textural properties of candied chestnuts are important quality attributes that affect consumer preferences. According to the Turkish Candied Chestnut Standard (Turkish Standards, 1999), the color of candied chestnuts should not be dark brown and the texture of the product should be neither too soft nor too hard.

CONCLUSION

In this study, eleven different candied chestnut processing methods were tried. Especially afterwards freezing and thawing, the sample held in 50°Bx sugar syrup for 10 min at 121°C and the sample held in 50°Bx or 60°Bx sugar syrups for 10 min at 121°C were found to exhibit perfect flavour-aroma, texture and color properties. The methods preferred by the panellists are 9 and 10. In spite of the significant color difference this not influences the panellist evaluation and so this difference is not perceptible for the taster. The increase of Brix syrup increase ΔE and decrease the preference of panellists in all attributes and these differences are high when it was applied the II proceeding step.

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