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The Effect of Chestnut (*Quercus Brantii)* Flour Substitution on the Physicochemical and Sensory Properties of Burgers

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Abstract

In this study, the effect of chestnut flour substitution on the physicochemical and sensory properties of burger (30% meat) was investigated. Chestnut flour levels were 0, 3, 6 and 9% that were replaced with toasted flour in the formulation. Chestnut flour improved all the treatments cooking characteristics significantly (P<0.05) including diameter reduction, thickness increase, cooking loss, shrinkage and fat retention capacity and also texture indices except adhesiveness. The color parameters of L* and b* of the treated sample were significantly (P<0.05) higher than control sample whereas its a* was lower. In samples sensory analysis, all of chestnut flour treatments got higher scores compared to control sample in terms of flavor, texture, juiciness and overall accepting. But the control sample was more favorable in terms of color index. According to the obtained results, with chestnut flour replacement in the formulation of burgers, physicochemical and sensory characteristics of this product can improve acceptably.

Keywords: Burger, Chestnut flour, Physicochemical Properties, Sensory Evaluation

Introduction

The use of non-meat ingredients in the production of meat products, is considered an important factor in maintaining the quality, technological and nutritional properties of these products. Nowadays, cereal flour is widely used in meat products as a binder and additive. For instance, oat flour improves fat and moisture retention in meat products (Serdaroglu, 2006). Due to the increasing consumer demand for healthy fast food, many attempts have been made to improve the quality and stability of meat products such as burgers (Besbes, Attia, Deroanne, Makni, & Blecker, 2008). Chestnut tree belongs to the family of *Fagaceae* and *Quercus* genus. This tree grows mainly in Europe, Asia, North Africa, Middle-East and North America. Acorn is a perennial 'grain' crop that can play an important role in reduction of starvation and malnutrition (Özcan, 2006). It is a rich source of carbohydrates, unsaturated fatty acids, vitamins E and C and dietary fiber. Therefore, it could be used for producing human food in mixtures of potato, wheat, bean and corn flour

(Borges, Gonçalves, de Carvalho, Correia, & Silva, 2008, 2007; Pereira-Lorenzo, Ramos-Cabrer, Díaz-Hernández, Ciordia-Ara, & Ríos-Mesa, 2006). Due to the high annual production of this nut in the country and high consumer demand for healthy meat products such as burgers, the use of chestnut can benefit us in several ways such as improving physicochemical and sensory characteristics of the burger through blending the flour in the formulation of the burger.

Material and methods

Materials

Acorns were collected from forest areas of Shahre Kord city in Chaharmahal and Bakhtiari Province, Iran. After peeling and drying, the nuts were ground using an industrial grinding mill with 20 meshes.

Burger production

Burger Samples (meat 30%), were prepared through an industrial process, and then ttoasted flour was replaced with Chestnut flour in the formulation with levels of 0, 3, 6 and 9%. Samples weight and thickness were 80 g and 1 cm respectively. After packaging, they were kept under low temperature conditions (-18 °C) until analysis. The experiments were conducted within 3 days.

Burger analysis

Chestnut flour functional characteristics

The analyses of oil- water absorption capacity and oil- water holding capacity were performed according to the procedures dictated by Beuchat (1977) and Larrauri, Rupérez, Borroto, & Saura-Calixto (1996) respectively.

Chemical and physical analysis

The Moisture, ash, protein and fat contents of chestnut flour and burger samples were specified by national standard methods of Iran. Additionally, pH determination was performed using a pH meter.

Cooking characteristics

The burger samples were cooked by oven at 150 °C temperature (Sánchez-Zapata *et al.*, 2010). Samples diameter and thickness were measured using a digital caliper, and then diameter reduction and thickness increase were calculated through Eq. (1) and (2).

$$\%\text{Diameter reduction} = \left(\frac{raw\ diameter - cooked\ diameter}{raw\ diameter}\right) \times 100 \quad (1)$$

$$\%\text{Thickness increase} = \left(\frac{raw\ thickness - cooked\ thickness}{raw\ thickness}\right) \times 100 \quad (2)$$

Cooking loss, shrinkage, and the amount of fat and moisture retained in samples were calculated according to Eq. (3), (4), (5) and (6), respectively.

$$\%\ \text{Cooking loss} = \frac{(raw\ weight - cooked\ weight)}{raw\ weight} \times 100 \quad (3)$$

$$\%\ \text{Shrinkage} = \frac{(raw\ thickness - cooked\ thickness) + (raw\ diameter - cooked\ diameter)}{raw\ thickness + raw\ diameter} \times 100 \quad (4)$$

$$\%\ \text{Fat retention} = \frac{(cooked\ weight \times \%fat\ in\ cooked\ burger)}{raw\ weight \times \%\ fat\ in\ raw\ burger} \times 100 \quad (5)$$

$$\%\ \text{Moisture retention} = \frac{(\text{cooked weight} \times \%\text{Moisture in cooked burger})}{\text{raw weight} \times \%\ \text{Moisture in raw burger}} \times 100 \quad (6)$$

Color determinations

Color parameters (*L**, *a** and *b**) were measured on the surface of raw and cooked burgers using a chromameter. The chromameter was standardized with a white tile (*L**=98.14, *a**= -0.23 and *b**=1.89).

Texture analysis

Texture profile analysis (TPA) was carried out on the cooked samples at 4±1 °C with a texture analyzer (AMSA, 1995; Sánchez-Zapata *et al*., 2010). The measured parameters were hardness, cohesiveness, springiness, gumminess, chewiness, adhesiveness and resilience.

Sensory evaluation

The evaluations included color, texture, flavor, juiciness and overall acceptance that were performed using a 5-point structured hedonic scale, from very favorable to very unfavorable, that was answered by 15 panelists.

Statistical analysis

This study was performed with two replications. One-way analysis of variance (ANOVA) was used to determine the significant differences between treatments using SPSS software (version 16). Furthermore, Duncan's multiple range test was used to compare the means. Significance level was equal to (P<0.05).

Results and discussion

Proximate composition and pH values

Increasing the level of chestnut flour resulted in a significant (P<0.05) increase of moisture and fat; however, no significant differences (P<0.05) were found for ash, protein and carbohydrate. This increase is due to higher moisture and fat content of chestnut flour compared to those of ttoasted flour. With increasing the levels of chestnut flour, the pH values decreased significantly (P<0.05), which is as a result of lower pH level of chestnut flour (4.96) compared to that of the toasted flour (5.30).

Fat and moisture retention

Chestnut flour treatment (9%) had the highest fat retention and the lowest moisture retention rate. These two indices are related to the ability of protein to retain fat and moisture in its matrix (Besbes *et al*., 2008). Fig. (1) shows the effect of chestnut flour levels on fat retention index of the burger samples.

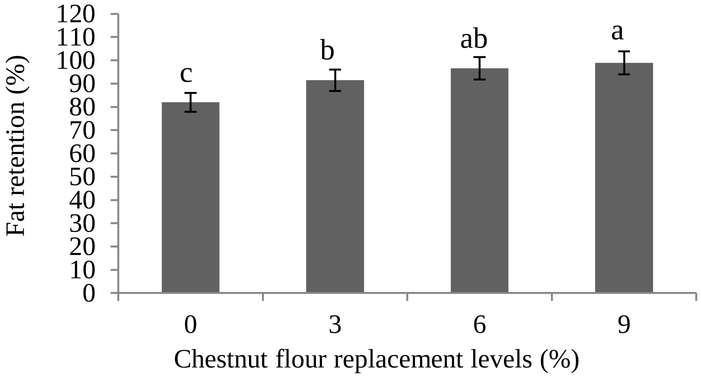

Fig. 1. Fat retention index of burgers formulated with chestnut flour
Non-identical Latin letters per day show a significant difference (P<0.05).

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Diameter reduction and thickness increase

The control sample showed higher diameter reduction and thickness increase compared to chestnut flour treatments. Adding chestnut flour reduced this index in burgers significantly (*P*<0.05). The reduction in diameter is as the result of the protein denaturation in meat with the loss of moisture and fat (Besbes *et al*., 2008, 2010). Chestnut flour fat-binding capacity limits deformation of the product dduring cooking.

Cooking loss and shrinkage

Similar to the change of diameter and thickness indices, with increasing the chestnut flour levels, cooking loss and shrinkage decreased significantly (*P*<0.05). The use of fillers, improved the moisture and fat retention capacity in meat products and, thus shrinkage reduced and cooking yield improved (Sheridan *et al*., 1991). Cooking loss of burger samples are presented in Fig. (2).

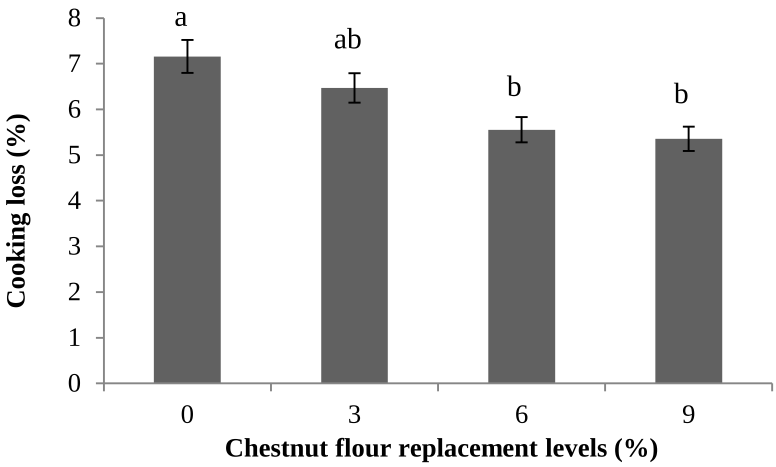

Fig. 2. Cooking loss of burgers formulated with chestnut flour
Non-identical Latin letters per day show a significant difference (*P*<0.05).

Color parameters

Chestnut flour had a significant effect (*P*<0.05) on the color parameters *L**, *a** and *b**. After adding chestnut flour to the samples formulation, *L** and *b** indices decreased more compared to those of the control sample, while *a** index increased. The lower *L** index of the treatments can be due to the darker color of the chestnut flour with lower *L** value than toasted flour. Also the presence of phenolic compounds in chestnut flour can be due to the higher *a** values in treatments containing chestnut flour. Because the increase of lipid oxidation reduces the redness (*a**) (Aleson-Carbonell, Fernández-López, Pérez-Alvarez, & Kuri, 2005).

Texture

Chestnut flour was effective on all of the samples textural properties and reduced all of them significantly (*P*<0.05). However, it was not significantly effective (*P*<0.05) on adhesiveness (Table 1). Research has shown that fat content of meat products affects textural indices and reduces them (Gregg, Claus, Hackney, & Marriott, 1993; Troutt *et al*., 1992). Treatments containing chestnut flour, due to high fat retention capacity, showed lower values for textural properties than control samples did.

Table 1. Texture parameters of burgers formulated with chestnut flour

Parameter	Chestnut flour replacement levels			
	0	3	6	9
Hardness (N)	3.23±0.29^{a}	2.88±0.11^{a}	2.12±0.11^{b}	1.82±0.10^{b}
Springiness (mm)	0.60±0.07^{a}	0.53±0.02^{ab}	0.47±0.01^{b}	0.42±0.00^{b}
Cohesiveness	0.54±0.04^{a}	0.48±0.04^{ab}	0.43±0.01^{b}	0.39±0.01^{b}
Chewiness (kg/cm)	104.88±3.60^{a}	103.69±8.47^{a}	69.47±13.14^{b}	63.55±6.30^{b}
Gumminess (N)	1.80±0.02^{a}	1.71±0.02^{a}	1.50±0.04^{b}	1.13±0.06^{b}
Resilence (mm)	0.24±0.02^{a}	0.17±0.00^{b}	0.14±0.01^{b}	0.12±0.01^{b}
Adhesiveness (N/mm)	-0.70±0.02^{a}	-0.45±0.22^{a}	-0.34±0.29^{a}	-0.23±0.08^{a}

Sensory evaluation

Sensory evaluation results indicated that increasing the chestnut flour in the formulation resulted in a significant (P<0.05) increase in juiciness, texture, flavor and overall acceptance. However color values decreased significantly (P<0.05).

Conclusion

In conclusion, the use of chestnut flour in burger formulation resulted in reduction of cooking loss, shrinkage, diameter reduction and thickness increase; however, it increased the fat retention capacity. The use of chestnut flour treatment with 9% level showed the highest decrease in hardness, springiness, cohesiveness, gumminess, resilience and chewiness as compared with those of the control sample. With increasing the level of chestnut flour from 0 to 9%, sensory values of juiciness, texture, flavor and the overall acceptance increased, however, the color values decreased.

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