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Evaluation of the Cake Quality Made from Acorn-Wheat Flour Blends as a Functional Food

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ABSTRACT: Regarding the nutritional value and availability of acorns in west and southwest of Iran, the effects of partial substitution of wheat flour with acorn flour was investigated. Wheat flour was replaced by treated acorn flour in the formulation of sponge cake and the quality characteristics were evaluated. Density of cakes was increased with increasing the acorn flour. As the substitution degree was increased the textural parameters such as hardness, adhesiveness, gumminess and chewiness were increased and some other characteristics including springiness and cohesiveness were decreased. Sensory attributes also diminished as the concentration of acorn flour increased. Heat treatment of acorns did not exhibited significant effect on the cakes quality. Based on the results obtained in this research work, in order to make the cake as a functional food, lower levels of substitution (less than 10%) had acceptable texture and sensory properties as compared to the control.

Keywords: *Sponge Cake, Acorn Flour, Texture Properties, Sensory Evaluation.*

Introduction

Functional food is a new concept that concerns a food or a constituent that has more positive effect on health than a regular one (Ferrari and Torres, 2003). Thereby consumers' tendency to use herbal supplements are increasing (Molyneaux, 2002). Acorn fruit has biologically active components. Since it can be utilized in the preparation of functional foods (Rakic´, 2000; Cantos *et al.*, 2003; Rakic´ *et al.*, 2004). Acorn has a chemical composition similar to cereals (Wanio and Forbes, 1941). It has about 4% protein, 8% fat, and 59% starch. The majority of the fatty acids found in the acorn oil are unsaturated (about 80%) where linoleic acid constitutes approximately 20% of its total unsaturated fatty acid (Saffarzadeh *et al.*, 1999). Linoleic acid might be considered as the most valuable fatty acid in human nutrition. Acorn oil has also good oxidative stability (Lopes and Bernardo-Gil, 2005) and its flavor is similar to olive oil (León-Camacho *et al.*, 2004).

α-Linolenic acid found in acorn has an important role in prevention of cardiovascular disease (Petrovic *et al.*, 2004). Acorn also shows antioxidant activity and possesses various antioxidants especially α- and γ- tocopherols and tannins (Cantos *et al.*, 2003; Rakic´ *et al.*, 2006). In addition, acorn extract is a disinfectant and diuretic (sharify, 2004) and also has Inhibitory potential on dengue virus type 2 replication (Muliawan *et al.*, 2006). In traditional medicine, oak tree bark and acorn

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fruit are utilized for the treatment of diarrhea (Khosravi and Behzadi, 2006).

Regarding the similarity of acorns and cereals, they can be used in the preparation of cereal based products. Cake is a product of wheat flour. Other types of flour are also utilized for the production of cake that might lower the costs with improved quality such as rice flour (Turabi *et al.*, 2008); rye, triticale, and barley (Gómez *et al.*, 2010a); oats flour (Hera *et al.*, 2013); rye and triticale flour (Oliete *et al.*, 2010); beans flour (Guadagni and Venstrom, 1972); sorghum flour (Glover *et al.*, 1986); tiger nut flour (Chinma *et al.*, 2010); amaranth flour (Capriles *et al.*, 2008) and chickpea flour (Gómez *et al.*, 2008).

The aim of this study is to determine the effects of the partial replacement of wheat flour by acorn (Q. brantii) flour and evaluate the quality of the prepared sponge cake as a functional food.

Materials and Methods

- *Materials*

Acorns (Quercus brantii Lindle.) were supplied locally and commercial white flour containing 9% protein, 10.5% moisture, 0.5% ash and gluten index of 25 (AACC, 2000), sugar, semi-solid oil, whole egg, milk (3% fat), baking powder and vanilla were bought from the open market.

- *Acorn treatment*

Acorns were toasted at 130˚C for 15 minutes as this treatment is traditionally believed to enhanve and improve the flavor. The caps (cupule) and outer skins (pericarp and seed coat) were removed. The acrons were dried (60˚C for 24 h) and crashed and mixed with water to make a batter. The batter was allowed to rest for a period to produce a homogenous texture. The treated acrons were placed in a wooden basket and then introduced to a very mild flow of water in order to remove the bitterness and a sweet taste is formed that is traditionally called "kalg". The batter was spread on an aluminum plate with a thickness of about 5 mm and dried at 60˚C for 24 hours in a circulated-air oven. Finally the product is grinded by a hammer mill and then passed through a 0.4 mm sieve.

- *Preparation of the cake*

The recipe consisted of 100 g sugar, 100g semi-solid oil, 150 g whole egg, 100 g milk (3% fat), 3.4 g baking powder and 0.2 g vanilla per 100 g wheat flour. For the preparation of acorn cakes, wheat flour was replaced by 5, 10, 20 and 30 percent acorn flour. Egg yolk was separated from the white. Vanilla was added to the egg yolk and mixed using a kitchen-aid mixer at low speed. The sugar, oil, milk and flour were added respectively and mixed for 1 min at low speed. Finally whipped egg white was added to the mixture and completely mixed for 1 min at low speed, 1 min at medium speed and two additional minutes at low speed. The batter was transferred to Teflon dish and baked in an electrical oven at 160˚C for 50 min. After the baked cake samples were cooled and packed in the polyethylene packages and stored for 2 days.

- *Chemical analysis*

Wheat flour was analysed for moisture, ash, crude protein and wet gluten and acorn flour was analysed for moisture, ash, crude fiber, fat and crude protein. (AACC, 2000).

- *Density measurement*

Volume and density of cakes were determined by the seed displacement method (AACC, 2000).

- *Textural properties*

Textural parameters were determined by a Brookfield-CT3 texture analyser (Brookfield engineering, Middleboro, USA) provided with the software "Texture Pro CT". A TA 25/1000 probe and a TA-BT-KIT fixture was used in a "Texture Profile

Analysis" test to the strain of 50% at 0.5 mm/s speed test. The delay between first and second bite was 30 s. Hardness, chewiness, adhesiveness, cohesiveness, springiness, and gumminess were calculated from the TPA graphs. Cake samples' dimensions were 26×26×40 mm (Bourne, 2002; Ji *et al.*, 2007; Matsakidou *et al.*, 2010).

- *Sensory analysis*

Nine point hedonic scale was employed to score the cake samples. A total of 10 panelists (students and staffs of Islamic Azad University, Shahrekord Branch) aged 18– 35 years were chosen for this study. The samples (about 30 g) were labeled with random three-digit codes and were served randomly at room temperature. Distilled water was supplied to clean the panelists' mouths between each evaluation. Texture, color, taste and overall acceptance of the samples were evaluated.

- *Statistical analysis*

This study was based on a completely randomized block design. Analysis of variance was performed on the data using the SAS version 16 software package (SAS Institute Inc., USA). Duncan's test was used to evaluate the mean value differences ($P<0.05$).

Results and Discussion

Table 1 presents the chemical analysis of acorn flour. These findings are in close agreement with the work carried out by Safarzadeh *et al.* (1999) who showed that the crude protein, fat, fibre and ash contents of Quercus brantii fruit were 3.93% and 7.70%, 0.37% and 1.5% respectively based on dry weight basis. The difference might be due to the climatical conditions. Similar observations were made in respect of Quercus rotundifolia, Quercus suber (Correia *et al.*, 2009a), Quercus ilex and Quercus suber (Charef *et al*., 2008).

After removing the bitterness, the crude fiber has been increased and the protein content has been decreased that might be due to the separation of soluble components by water. The increase in the reducing sugar might be due to the thermal degradation of starch. This phenomenon has been reported by Correia *et al*. (2009b). Roasted samples have more reducing sugar content that might be due to the thermal treatment.

The volume of the cake samples its significantly decreased as the concentration of the acorn flour is increased. The density of the control sample was 0.44 (g/cm^3) whereas for the samples containing acorn flour with 5, 10, 20 and 30 percent substitution has been increased to 0.45, 0.49, 0.51, and 0.54 respectively. Similar results were reported by other researchers (Capriles *et al.*, 2008; Gómez *et al.*, 2008; Chinma *et al.*, 2010; Hera *et al.*, 2013). The increase in the density is due to the relative decrease in the gluten content. Acorn flour dose not contain gluten therefore it causes the loss of air bubble from the cake batter and decreases the cake volume. Volume (density) is related to hardness that has been corroborated by prior researchers (Gélinas

Table 1. Chemical analysis of acorn flour (%, dry weight basis)

constituents	Before bitterness removal	After bitterness removal (roasted)	After bitterness removal (unroasted)
Moisture	8.72±0.12	7.00±0.09	8.83±0.01
Ash	1.72±0.03	1.87±0.01	1.71±0.01
Crude fiber	1.84±0.18	2.94±0.30	2.84±0.18
Crude protein	7.34±0.07	5.00±0.04	5.11±0.03
Crude fat	9.07±0.24	8.82±0.02	8.99±0.05
Carbohydrate (by difference)	71.31±0.64	74.37±0.46	72.52±0.28
Reducing sugar	3.28±0.03	10.58±0.10	9.89±0.08

et al., 1999; Gómez *et al.*, 2007; Gómez *et al.*, 2010b) Hardness of the cake samples (Figure 1A) has been increased parallel to the increase in the time indicating the retrogradation phenomenon. The increase in the substitution level led to significant increase in hardness. Substitution of acorn flour up to 5 percent had no significant effect on the hardness and was mostly similar to the control sample but as the time increased, the hardness was detected more than the control which might be due to the higher amylose content in the acorn starch granules as this point was reported by Correia and Beirão-da-Costa (2010). The interpretation of the higher substitutions is to some points difficult because when the acorn flour increases consequently the oil content will be increased that could reduce retrogradation rate and the protein content which weakens the gluten network. Furthermore, amino acid composition of acorn flour protein affects its interactions with other proteins (egg proteins, milk proteins and gluten). On the other hand starch granules with different characteristics such as different amylase/amylopectin ratio have been added to the system. Generally speaking relative decrease in gluten will increase the density and produces a compressed texture.

Adhesiveness of blended-flour samples (Figure 1B) has been increased more during storage whilst this factor has been decreased in the control sample. This might be due to the higher oil content from acorn flour that has been migrated to the surface as the time has increased.

Cohesiveness of the samples (Figure 1C) has been decreased as the time has increased but the sample containing 10% acorn flour had a limited reduction. This reduction might be due to the presence of oil and non-gluten proteins of acorn flour.

The substitution of 10 percent acorn flour led to an increase in springiness during the storage time (Figure 1D). This might be due to the effect of acorn oil on gluten matrix but as the acorn flour increases the role of gluten deficiency is more dominant. Regarding the importance of gluten in springiness, it is indicated that the increase in the substitution decreases the springiness. High amylase content of acorn starch affects the springiness because of its tendency to retrogradation.

Gumminess has been increased with an increase in the substitution level (Figure 1E). Regarding the definition of gumminess (hardness multiplied by cohesiveness), an increasing trend is expected. This trend is similar for all substitution levels except for 20 percent substitution. The reason is not clear to the authors at this point.

Chewiness (Figure 1F) is quite similar for all the examined samples. The sample containing 10 percent acorn flour had a little increase in chewiness that might be explained to its higher springiness.

Gomez *et al*. (2008) studied the quality of cake prepared by wheat-chickpea flour. They reported that hardness of the cake samples was increased as the volume decreased. Guinot and Mathlouthi (1991) also reported the same results for chiffon cake containing soy protein. In the research carried out by Gomez *et al*. (2008) other textural parameters like adhesiveness, springiness and elasticity were decrease and hardness, gumminess and cohesiveness were increased as the concentration of chickpea flour in the formulation increased. Hera *et al*. (2013) also reported that hardness, cohesiveness and springiness of cake samples were decreased as oat flour in the formulation increased. Capriles *et al*. (2008) reported the same results that was due to the addition of amaranth flour to cake formula. Generally cake has a complex system and different ingredients in the formulation affect its texture, hence its retrogradation phenomenon unlike bread has been less studied and investigated (Gélinas *et al.*, 1999).

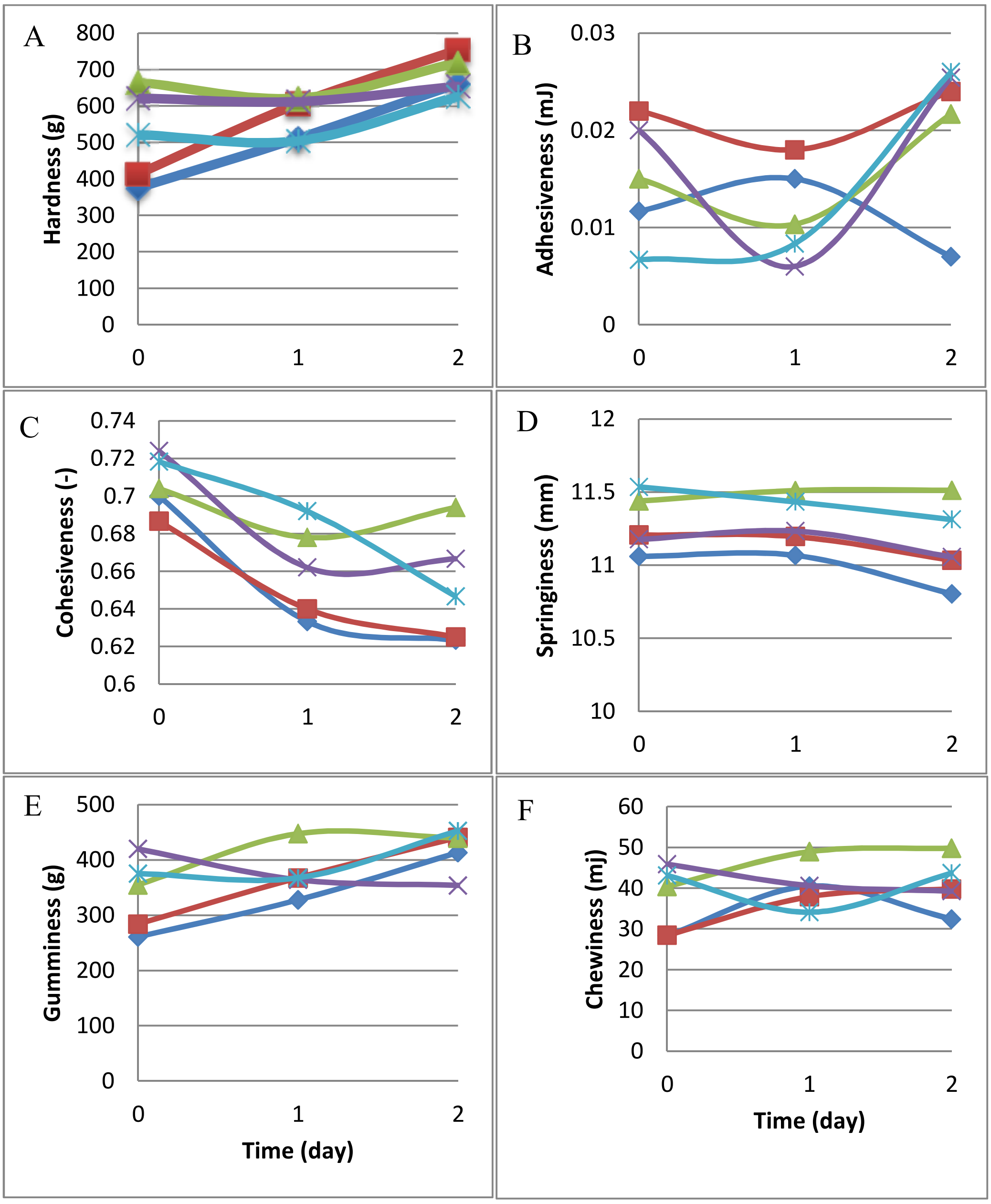

Fig. 1. (A) Hardness; (B) Adhesiveness; (C) Cohesiveness; (D) Springiness; (E) Gumminess; (F) Chewiness of cake samples prepared by wheat-acorn flour. —♦—, Control; —■—, 5% substitution; —▲—, 10% substitution; —×—, 20% substitution, and —ж—; 30% substitution.

The panelists evaluated the texture of the sample containing 5 percent acorn flour similar to that of the control. Color of the cake containing acorn flour was brownish, due to reducing sugars that exist in acorn flour, but it did not have an adverse effect on panelists' evaluation and they scored the sample similar to the control. Increasing in the percent of acorn flour significantly reduced the flavor characteristics of the cakes. Overall acceptance of the sample containing 5 percent acorn flour was quite similar to the control sample (Figure 2).

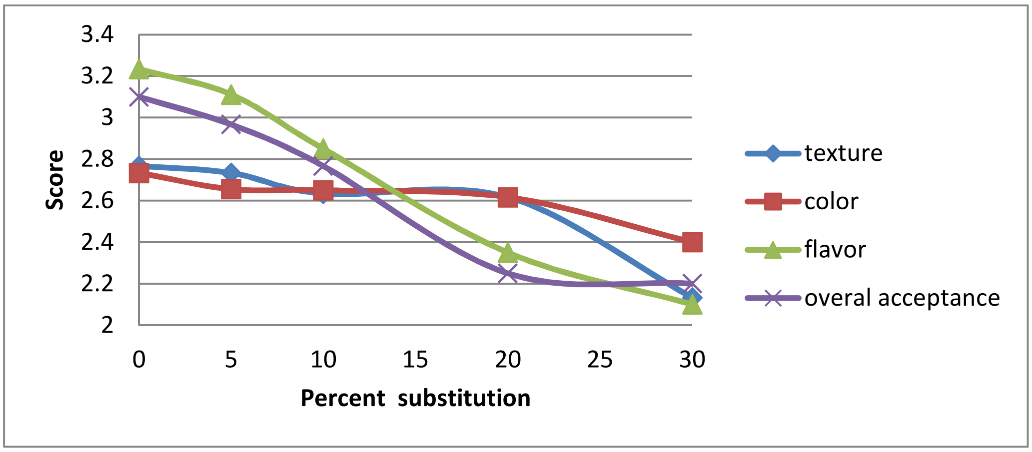

Fig. 2. Sensory evaluation of cake samples prepared by wheat-acorn flour.

Conclusion

The supplementation of cake with acorn flour leads to an increase in its nutritional value. On the other hand, this substitution affects the quality parameters of the cake. The addition of the acorn flour to the cake formula increased its density and hardness. Adhesiveness of the cake samples increased and cohesiveness was reduced during storage time. Springiness of the cakes generally decreased and gumminess diminished. Chewiness of the samples had nearly constant rate. Regarding the chemical analysis of acorn flour one might expect that the major changes that might occur in the samples were due to the relative decrease in gluten, increase in fat content and increase in reducing sugars from acorn flour. Sensory evaluation of the samples indicated that the sample containing 5 percent acorn flour was quite similar to the control. Therefore it can be concluded that low substitution levels (less than 10 percent) could be useful to produce a functional food. In addition, heat treatment applied in this research to acorns did not have significant effect on the quality of the produced cakes.

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