



Utilization of buckwheat flour in gluten-free egg noodle production

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Received 4 January 2008, accepted 2 April 2008.

Abstract

Buckwheat, pseudo-cereal, has an important role in celiac diets due to being gluten free. Egg noodle, erişte, is a widely consumed traditional cereal product in Turkey. In this research gluten-free egg noodles were made with buckwheat flour, rice flour and corn starch at a ratio of 20:40:40 or 30:35:35 and with 3% xanthan gum, 20% whole egg and 0.5% salt. Control noodle was prepared with wheat flour, egg and salt. Cooking quality (weight and volume increase, cooking loss), chemical composition (ash, protein, cellulose, crude fat, phytic acid, Ca, Mg, K, P, Fe and Zn contents), color values (L, a and b) and sensory properties (color, taste, stickiness, firmness and overall acceptability) of gluten-free noodles were evaluated and compared with control samples. Noodles containing 30% buckwheat flour gave the highest weight and volume increase in all samples. Cooking loss of gluten-free noodles containing buckwheat flour was higher than that of control sample. Ash, crude fat and phytic acid contents of noodles were significantly ($p < 0.05$) affected by formulation type and increased with buckwheat flour addition. Especially K and Mg contents were higher in gluten-free noodle containing 30% buckwheat flour. Dark color of buckwheat flour significantly ($p < 0.05$) affected the color values of gluten-free noodles and decreased the lightness (L) of noodles. As the buckwheat flour addition ratio increased in gluten-free noodle formulation, redness (a) values increased. Noodles with 20% buckwheat flour received the highest taste score in all noodle samples. Overall acceptability scores of control and gluten-free noodle with 20% buckwheat flour were found statistically similar.

Key words: Buckwheat, gluten-free, noodle, corn, rice, xanthan gum.

Introduction

Celiac disease is a chronic enteropathy caused by the intake of gluten proteins from wheat, rye, barley and possibly oats¹. Corn, rice, millet, sorghum and some pseudo-cereals like buckwheat, amaranth and quinoa can be used safely in celiac diet due to being gluten free. Gluten-free noodle is a good choice for celiac patients with a long shelf-life and ease of transportation from a controlled processing center².

Buckwheat (BW) is a traditional crop in Asia and Central and Eastern Europe. Although there is no botanical relationship between BW and wheat families, BW shows similarity to wheat in terms of chemical composition. BW is an important raw material in functional food production with balanced amino acid composition, high digestible protein content and high contents of vitamins (B1, B2, B6 and E), minerals (P, Fe, Zn, K and Mg), polyunsaturated essential fatty acids, sterols, flavanoids (rutin, quercetin and quercitrin) and fagopyratol³. Some functional components of buckwheat has a health benefit like reducing high blood pressure, lowering cholesterol, controlling blood sugar and preventing cancer risk⁴⁻⁶. In different countries, whole kernel and its milling products or sprout form of buckwheat are used in the formulation of pasta, macaroni, noodle, bread, cookie, cake, crepe, breakfast cereal and soap⁷⁻⁹. The objective of this study was to improve gluten-free egg noodles with BWF, corn starch and rice flour.

Materials and Methods

Materials: Wheat flour, corn starch and rice flour were purchased from a local market in Konya, Turkey. Xanthan gum was obtained

from Vatan Gıda A.Ş., Istanbul, Turkey. Buckwheat (BW) groats were obtained from Yar Gıda, Antalya, Turkey. BW groats were ground in a hammer mill (Falling Number-3100 Laboratory Mill, Perten Instruments AB, Huddinge, Sweden).

Noodle preparation: To prepare control noodle sample at laboratory conditions, flour (200.0 g), whole egg (40.0 g), salt (1.0 g) and water (80 ml) were used. For gluten-free noodle preparation wheat flour (200 g) replaced with BW flour (40 g) + corn starch (80 g) + rice flour (80 g) in Formulation A and BW flour (60 g) + corn starch (70 g) + rice flour (70 g) in Formulation B. Xanthan gum (3%) was added in gluten-free noodle formulation. In order to improve the dough forming ability of flours, the rice flour and corn starch were gelatinized at the levels of 25% according to methods described by Yalçın². Noodle making and cooking tests were performed according to Uzunoğlu¹⁰ and Özkaya and Kahveci¹¹.

Chemical analysis: AACC methods were followed for determinations of moisture, ash, protein, crude fat and cellulose contents of ingredients and noodle samples¹². Mineral contents were determined by inductively-coupled plasma spectroscopy, ICP-AES (Vista series, Varian International AG, Switzerland)¹³. Phytic acid was measured by a colorimetric method according to Haugh and Lantzsch¹⁴. Phytic acid in the sample was extracted with a solution of HCl (0.2 N) and precipitated with solution of Fe III ammonium iron (III) sulphate·12H₂O.

Color measurement: Color of the samples was evaluated by measuring the L (100 = white; 0 = black), a (+, red; -, green) and b (+, yellow; -, blue) values using a Hunter Lab Color QUEST II Minolta CR-400 (Minolta Camera, Co., Ltd., Osaka, Japan).

Sensory analysis: Noodle samples (100 g) were simmered in one litre unsalted water for 18 minutes and drained. Sensory tests were applied after 10 minutes of draining. Eight panelists were asked to score the cooked noodle in terms of color, taste, stickiness, firmness and overall acceptability using a 5-point hedonic scale with 1 dislike extremely, 3 acceptable and 5 like extremely.

Statistical analysis: TARIST (version 4.0, Izmir) software was used to perform the statistical analyses. Duncan's multiple range test was used to differentiate between the mean values.

Results and Discussion

Wheat and buckwheat flour properties: Wheat and buckwheat flours (BWF) contents (g kg^{-1}) were for ash 5.5 and 18.9, protein 112 and 125, cellulose 7 and 13, fat 5 and 30, and phytic acid 1.32 and 14.95, respectively. Steadman *et al.*¹⁵, Marshall and Pomeranz⁷ and Wijngaard and Arendt³ reported similar values in literature. BWF had lower lightness (L) and higher redness (a) and yellowness (b) values than wheat flour. Ca, Mg, Fe, K, P and Zn contents (g kg^{-1}) of wheat and BWF were for Ca 0.25 and 0.18, Mg 0.48 and 2.40, Fe 0.016 and 0.025, K 1.42 and 4.10, P 1.30 and 4.80 and Zn 0.007 and 0.021, respectively. Steadman *et al.*¹⁵ and Wijngaard and Arendt³ reported that the levels of Mg, Zn, K, P and Cu of BW were high when compared with other cereals.

Cooking properties and chemical composition of noodle: Weight and volume increase and cooking loss values of noodle samples are given in Table 1. Weight and volume increase values were found higher in gluten-free (GF) noodles due to the higher starch composition and xanthan gum content of Formulation A and B. Cooking loss was affected negatively in GF-noodles and increased up to 7.12% in samples with 30% BWF. Increasing starch content and absence of gluten in GF-noodle formulation increased cooking loss. Also, BWF addition might be effective on increment of cooking loss. Duarte *et al.*¹⁶ reported that the cooking loss of spaghetti containing BWF was significantly higher than that of the control. Ash content was highest in Formulation B with 30% BWF (Table 1). Rich ash content of BWF which was produced from whole groat, significantly ($p < 0.05$) increased the ash content of GF-noodles. Protein content decreased and cellulose content did not change. GF-noodle samples with BWF had higher crude fat and phytic acid content compared with control sample (Table 1). Phytic acid is an antinutritional agent due to its ability to bind minerals. Steadman *et al.*¹⁵ reported phytic acid content being highest in BW bran without hulls ($35\text{--}38 \text{ g kg}^{-1}$). In the present study BWF produced from whole groat contained 14.95 g kg^{-1}

phytic acid. High phytic acid concentration of BWF directly affected the phytic acid content of noodles.

Color values of noodle: Color values (L, a and b) of noodles are presented in Fig. 1. GF-noodles with BWF had lower lightness (L) and higher yellowness (b) and redness (a) values than control sample. As the BWF addition level increased in formulations, redness of the noodles increased. BWF affected adversely the color values of noodle due to produced from whole BW groat. Literature knowledges on color values of spaghetti containing BWF confirmed our results¹⁶.

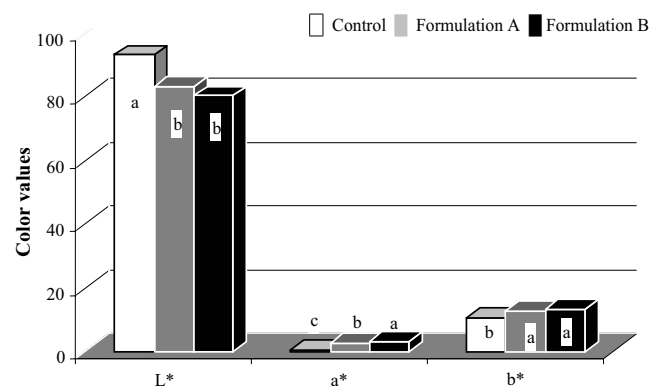


Figure 1. Effect of different formulations on color values of noodles. Formulation A: BWF (20%) + CS (40%) + RF (40%); Formulation B: BWF (30%) + CS (35%) + RF (35%).

Mineral contents of noodle: Mineral contents of noodles are presented in Fig. 2. Composition of BWF, rich in K, P and Mg, increased mineral content of GF-noodles. As the BWF addition ratio increased in GF-noodle formulations, especially K, P and Mg contents increased significantly ($p < 0.05$). When compared with control sample, the increment ratio of K, Mg and P contents of noodle containing 30% BWF were found as 1.14, 1.68 and 1.34 times, respectively.

BWF addition didn't change the Ca contents of noodles due to the fact that BWF was not good source of Ca. Steadman *et al.*¹⁶ reported that Ca was more concentrated in bran with hulls of BW. Fe and Zn contents of GF-noodles decreased slightly with BWF addition but as the BWF addition level increased, the amount of Fe and Zn in noodles didn't change significantly.

Sensory properties of noodle: Results of sensory evaluations are presented in Fig. 3. The acceptability of noodle color was best at control sample. Noodles prepared with 20% BWF addition received the highest scores for taste acceptance. Addition level of 30% BWF decreased the taste score and increased the stickiness

Table 1. Cooking quality and chemical properties of noodle samples*.

	Weight increase (%)	Volume increase (%)	Cooking loss (%)	Ash (g kg^{-1})	Protein (g kg^{-1})	Cellulose (g kg^{-1})	Crude fat (g kg^{-1})	Phytic acid (g kg^{-1})
Control	251 ^c	300 ^c	6.32 ^b	11.1 ^c	129 ^a	6.0 ^a	22 ^b	0.95 ^b
Formulation A	260 ^b	310 ^b	6.89 ^a	13.3 ^b	87 ^b	6.9 ^a	25 ^a	4.02 ^a
Formulation B	266 ^a	322 ^a	7.12 ^a	14.7 ^a	97 ^b	7.9 ^a	27 ^a	4.88 ^a

* Figures in the same column sharing a common letter are not significantly different at 0.05 level. Values are the average of triplicate measurements on the duplicate sample.

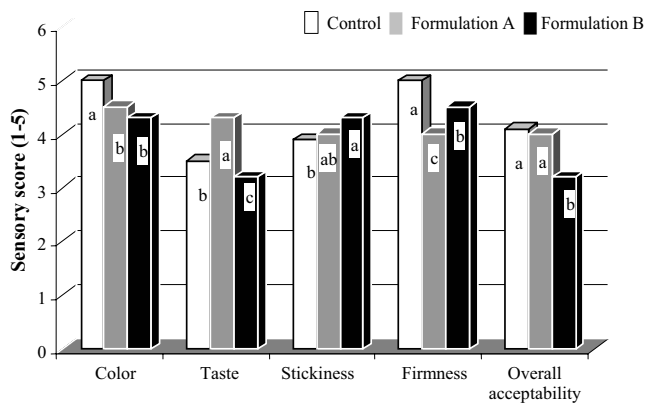


Figure 2. Effect of different formulations on sensory properties of noodles. Formulation A: BWF (20%) + CS (40%) + RF (40%); Formulation B: BWF (30%) + CS (35%) + RF (35%).

of the noodles. GF-noodles containing 20% BWF and control noodles were found similar in terms of overall acceptability by the panelists.

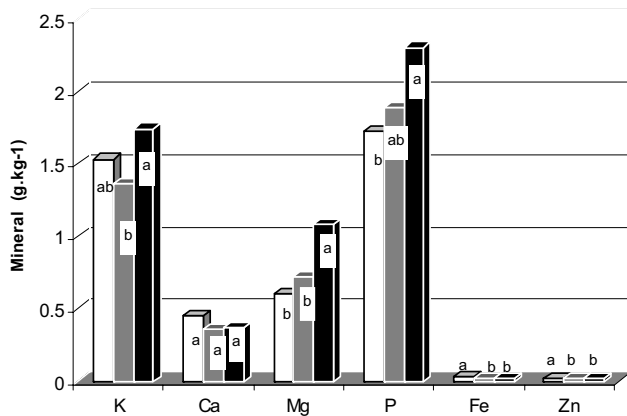


Figure 3. Effect of different formulations on mineral contents of noodles. Formulation A: BWF (20%) + CS (40%) + RF (40%); Formulation B: BWF (20%) + CS (40%) + RF (40%).

Conclusions

BWF addition into noodle formulation had considerable effects on cooking quality, chemical and sensory properties and color values of noodles. As the BWF addition ratio in GF-noodle formulation increased, weight and volume increase, ash, K, Mg and P content increased. BWF negatively affected cooking loss, color values and phytic acid content of noodles. As the result of panel test, overall acceptance of noodles were found best at control and GF-noodle containing 20% BWF. It can be concluded that BWF addition improved the mineral composition of GF-noodle, but 30% BWF addition level adversely affected color and sensory properties of samples.

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