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Reutilisation of rice byproduct: study on the effect of rice bran addition on physical, chemical and sensory properties of erişte

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RESEARCH ARTICLE

Abstract

In this study, rice bran (RB) replaced wheat flour in order to enrich the nutritional properties without affecting technological properties of erişte. For this purpose, RB was used in erişte up to 25% level. Crude ash, mineral contents, colour values, cooking and sensory properties of erişte samples were determined. Crude ash, calcium, potassium, magnesium, phosphorus, manganese, iron and zinc contents of erişte samples increased with RB addition level. As a result, utilisation of RB in erişte improved nutritional content of the erişte. RB addition increased weight increase and volume increase values of the erişte samples compared to control erişte sample, and also the highest weight and volume increase values were obtained with 25% RB addition. The cooking loss value of erişte sample with 5% RB substitution level was statistically similar to the control. According to wheat flour, the dark colour of the RB affected the sensory score of erişte negatively especially high addition level, but stickiness values affected positively by RB addition significantly ($P<0.05$) compared to control sample. The sensorial test results indicate that the erişte with an enrichment level of 10% RB was well accepted by the panellist after control sample.

Keywords: colour, cooking quality, erişte, mineral, rice bran, sensory property

1. Introduction

Rice bran (RB), is a by-product of the rice milling process, obtained from outer rice layers (pericarp, aleurone, sub-aleurone, seed coat, nucellus along with the germ and a small part of endosperm) and a good source of protein, minerals, vitamins, fatty acids, dietary fibre and nutraceutical compounds (Hargrove, 1994; Hu *et al.*, 1996; Jue and Vali, 2005; Salunke *et al.*, 1992; Saunders, 1990; Xu, 1998). Rice bran contains various antioxidants that provides beneficial effects for people including the prevention and treatment of diseases, such as cardiovascular diseases, gastrointestinal disease, diverticulosis, diabetes and colon cancer and it also decrease the blood cholesterol (Cara *et al.*, 1992; Chen and Anderson, 1986; Cummings, 1985; Daou and Zhang, 2011; Dukehart *et al.*, 1989; Spiller *et al.*, 1980; Wrick *et al.*, 1983). The presence of minerals, antioxidants and vitamins enables rice bran to be used as nutritional and functional ingredient. Rice bran has two principal uses; as a feedstuffs and in a food systems. Rice bran has been used in food systems as full-fat rice bran, defatted rice bran, rice bran oil and protein concentrates. Rice bran (full-fat and defatted) have been used in bakery products, breakfast cereals, wafers as a protein supplement, binder ingredients for meats and sausages, and in a rice bran based beverages (Bhattacharya, 1988; Prakash, 1996).

Erişte, egg noodle, is a traditional cereal product which is an important part of the diet in many cities of Turkey. Erişte is primarily a home-made dish, and not often found at restaurants or cafes. To prepare erişte; the dough is rolled out into a large thin circle, and left to dry for a while. It's then cutted, and dried. In some regions of Turkey, milk, egg, whey and some additives can be added in erişte formula (Özkaya *et al.*, 2001). In previous studies, legumes (Bilgiçli *et al.*, 2011; Chompreeda *et al.*, 1988; Collins and Pangloli 1997; Goni and Gamazo, 2003; Jeffers *et al.*, 1979; Mahmoud *et al.*, 2012; Osorio-Diaz *et al.*, 2008), different cereals

(Choy *et al.*, 2013; Ge *et al.*, 2011; Handoyo *et al.*, 2006; Kruger *et al.*, 1998; Kulkarni *et al.*, 2012), wheat and oat bran (Chen *et al.* 2011; Fares *et al.*, 2010; Reungmaneepaitoon *et al.*, 2006), and sweetpotato (Collins and Pangloli, 1997; Kaur *et al.*, 2005; Sandhu *et al.*, 2010) have been used for enrichment of erişte/noodle.

The objective of this study was to investigate the effects of RB on erişte quality in an effort to increase nutritional content without adverse effect on technological properties.

2. Materials and methods

Materials

Commercial white wheat flour (WF) was purchased from Hekimoğlu flour mill, Konya, Turkey. Salt and fresh egg were purchased from a local market in Konya, Turkey. RB was obtained from Konya, Turkey. RB was ground in a blender (Moulinex Super Junior S; Moulinex, Paris, France) to use in analysis.

Erişte preparation

Erişte samples were prepared from WF and from different blends of RB. To prepare erişte samples, 200 g, flour, 1 g salt, 60 g whole egg, and water at 30 °C were added in a Hobart N50 mixer (Hobart Canada, North York, ON, Canada) and mixed over 4 min at medium and 4 min slow speed to obtain optimum dough consistency. In RB enriched erişte samples, WF was replaced by different concentrations of RB, as 0, 5, 10, 15, 20 and 25 g/100 g (w/w). The absence of gluten in these flours makes them unsuitable for the production of dough, so vital gluten was added by diminishing gluten amount. The 50 g mixture was kneaded into uniform dough for 3 min which was then placed in a plastic bag for 30 min at room temperature to allow the water to equilibrate evenly. The dough was then sheeted on a Shule laboratory erişte machine (Shule pasta machine, Jiangsu, China P.R.), the dough pieces were firstly passed 2 rollers by mould number 6, then passed by mould number 5. The sheeted erişte dough was cut into strips 2.0 mm thick, 5 mm wide and 40 mm long. The drying took place at 50 °C for 18 h in the drier (FN-500; Nüve, İstanbul, Turkey). The final moisture content of the product after drying was not more than 8-10%. The samples were kept in polyethylene bags and stored at 4 °C until use.

Analytical methods

The approved methods of the American Association of Cereal Chemists were used for the determination of moisture (method 44-19), ash (method 08-01), crude fibre (method 32-10) and crude protein (method 46-12) contents of the raw material and moisture (method 44-19) and crude ash (method 08-01) of erişte samples (AACC, 1990).

Mineral composition

To determine the mineral (calcium (Ca), potassium (K), magnesium (Mg), phosphorus (P), manganese (Mn), iron (Fe) and zinc (Zn)) contents of the erişte samples, microwave assisted extraction was applied (Mars 5, CEM Corporation, Matthews, NC, USA) for sample preparation, which is the direct determination of mineral elements in powdered erişte samples by inductively-coupled plasma spectroscopy, ICP-AES (Vista series; Varian International AG, Zug, Switzerland).

Colour values

Colorimetric measurement of erişte sample was determined using a colorimetre (CR-400; Konica Minolta Sensing Inc., Osaka, Japan). The CIE (Commission Internationale de l'Eclairage) colour values were recorded as L* (lightness), a* (redness), and b* (yellowness). The means were determined from three samples. The hue angle ($h = \arctan(b^*/a^*)$), which describes the hue or colour of erişte sample, and saturation index or chroma ($SI = (a^{*2}+b^{*2})^{½}$), which describes the brightness or vividness of colour of erişte sample, were calculated.

Cooking properties

Weight increase (WI), volume increase (VI) and cooking loss, as cooking quality parameters, were determined according to Oh *et al.* (1985) and Özkaya *et al.* (2001). For determination of WI, VI and cooking loss of erişte samples, 10 g erişte were boiled in 250 ml distilled water for 18 min, and drained. The WI was considered as difference in weight of cooked erişte versus uncooked erişte, expressed as the percentage of weight of uncooked erişte sample. VI was calculated as difference in volume of cooked erişte versus uncooked erişte, expressed as the percentage of volume of uncooked erişte sample. Cooking water was dried to constant weight and cooking loss was determined (AACC, 1990).

Sensory analyses

Sensory evaluation was carried out RB added and control erişte samples. For sample preparation, erişte sample (100 g) was simmered at 95 °C in 500 ml unsalted water for 18 min and drained for 20 s to remove excess water. The 15 panellists (9 women, 6 men) aged 30-55 years old completed the questionnaire. They were selected among researchers of Food Engineering Department at Selcuk University. In sensory analyses, erişte samples were evaluated in terms of surface roughness, firmness, appearance, stickiness, taste-odour, chewiness and overall acceptability. Erişte characteristics were rated on 1 to 5 scale, 5 being the most desirable.

Statistical analyses

A commercial software package (JMP statistical software; SAS, Cary, NC, USA) was used to perform statistical analyses. Data were assessed by analysis of variance. Duncan's multiple-range test was used to separate means. Significance was accepted at $P<0.05$ throughout the analysis.

3. Results and discussion

Properties of wheat flour and rice bran

Chemical composition and colour values of WF and RB are given in Table 1. Crude ash, crude protein and crude fibre content of RB were 7.59, 14.2, and 12.67% respectively. In the study conducted 12 varieties of rice by Sotelo *et al.* (1990) ash, protein and crude fibre contents of rice bran were determined as 7.7 to 13.8%, 12 to 14.7%, and 10 to 15.2%, respectively. These results are similar with this study. The ash, protein, crude fibre and mineral content (Ca, Mg, Mn, P, K, Fe and Zn) of RB were higher than that of WF. High protein and mineral content of RB than WF is important effect on nutritional properties of foods supplemented with RB. In this study Ca, Mg, Mn, P, Fe, K and Zn contents of RB were 307.3; 415.9; 14.86; 1652; 5.71; 886 and 4.83 mg/100 g, respectively. Gerhardt and Gallo (1998) reported that rice bran contains 648.0 mg/100 g Mg, 0.66 mg/100 g Cu, 1,520 mg/100 g K.

RB had low L* (67.95) and high a* (3.62) and b* (18.14) colour values than WF colour values (L*=93.47, a*=-0.48 and b*=9.62) due to the fact that RB had darker colour than WF.

Chemical composition of erişte samples

Chemical composition of enriched erişte samples areshown in Table 2. Apparently, the moisture content of erişte samples containing RB did not show the significant differences as compared with that of erişte samples without RB. As can

Table 1. Some chemical properties and colour values of wheat flour and rice bran.[1,2]

	Wheat flour	Rice bran
Moisture (%)	11.2±0.69^a	9.36±0.51^a
Ash (%)	0.51±0.06^b	7.59±1.53^a
Protein (%)[3]	12.2±0.27^b	14.2±0.17^a
Crude fibre (%)	0.52±0.04^b	12.67±1.65^a
Minerals (mg/100 g)		
Calcium	27.5±0.45^b	307.3± 0.31^a
Magnesium	39.6±2.06^b	415.9±3.45^a
Manganese	0.67±0.03^b	14.86±0.18^a
Phosphorus	134.6±3.56^b	1652±3.18^a
Iron	1.12±0.04^b	5.71±0.51^a
Potassium	162.1±3.83^b	886±3.35^a
Zinc	1.23±0.01^b	4.83±0.04^a
Colour values		
L*	93.47±0.64^a	67.95±1.49^b
a*	-0.48±0.21^b	3.62±0.11^a
b*	9.62±0.09^b	18.14±0.34^a
Hue angle	92.87±1.27^a	78.71±0.13^b
Saturation index	9.63±0.08^b	18.50±0.36^a

[1] Means followed by the same superscript letter within a row are not significantly different ($P>0.05$).
[2] Chemical properties are on dry matter basis.
[3] N × 5.70 for wheat flour; N × 6.25 for rice bran.

Table 2. Some chemical properties and mineral contents of erişte samples.[1,2]

WF:RB[3]	Moisture (%)	Ash (%)	Calcium (mg/100g)	Iron (mg/100g)	Potassium (mg/100g)	Magnesium (mg/100g)	Phosphorus (mg/100g)	Manganese (mg/100g)	Zinc (mg/100g)
100:0 (control)	8.03±0.18^a	1.231±0.04^f	35.8±0.14^f	2.35±0.04^e	178.3±2.49^f	56.2±0.76^f	157.4±3.52^f	0.74±0.03^f	1.54±0.03^e
95:5	8.55±0.17^a	1.461±0.03^e	52.0±0.17^e	2.50±0.03^{de}	206.6±3.66^e	85.0±1.85^e	216.7±2.06^e	1.40±0.04^e	1.67±0.04^{de}
90:10	8.17±0.34^a	1.880±0.01^d	65.6±0.20^d	2.64±0.13^{cd}	227.0±2.01^d	109.3±2.05^d	282.3±1.82^d	2.25±0.08^d	1.82±0.06^{cd}
85:15	8.47±0.37^a	2.012±0.00^c	81.7±0.37^c	2.78±0.10^{bc}	289.1±3.78^c	138.2±0.21^c	351.7±3.44^c	2.86±0.03^c	1.99±0.13^{bc}
80:20	8.42±0.25^a	2.333±0.01^b	95.4±0.41^b	3.02±0.06^b	311.2±2.56^b	164.2±2.09^b	437.3±1.8^b	3.41±0.03^b	2.12±0.10^{ab}
75:25	8.46±0.28^a	2.953±0.00^a	112.9±0.45^a	3.64±0.11^a	394.4±3.15^a	187.5±1.56^a	502.6±2.63^a	4.15±0.01^a	2.28±0.06^a
Mean	8.35±0.28	1.978±0.02	73.9±0.29	2.82±0.08	263.10±2.94	123.40±1.42	324.67±2.55	2.47±0.04	1.90±0.07

[1] Duncan's multiple range test. Means followed by the same superscript letter within a column are not significantly different ($P>0.05$). Values are the average of triplicate measurements of the sample ± standard deviation.
[2] Ash and minerals based on dry matter.
[3] RB = rice bran; WF = wheat flour.

be observed in Table 2, RB addition (25%) increased the ash content of the erişte from 1.231 to 2.953%. It is also observed that higher ash content of RB, directly affected the end product's ash content. Pacheco de Delahaye *et al.* (2005); reported that ash content of storage frozen pizza shows increase with the stabilised rice bran enrichment.

Table 2 shows the mineral content of substituted flours with or without RB (0, 5, 10, 15, 20, and 25%). The ash value is indicative of the presence of high mineral content in erişte samples. The Ca, K, P, Mg, Mn, Fe and Zn values of erişte samples were significantly ($P<0.05$) affected by RB addition levels. Substitution of RB significantly increased the mineral content compared to control erişte. This result in agreement with data given by Sharif *et al.* (2009), who observed a gradual increase of mineral contents of cookie samples supplemented with defatted rice bran.

Ca, Fe, K, Mg, P, Mn and Zn contents of erişte containing RB increased from 35.8, 2.35, 178.3, 56.2, 157.4, 0.74 and 1.54 mg/100 g up to 112.9, 3.64, 394.4, 187.5, 502.6, 4.15 and 2.28 mg/100 g, respectively. It has been reported that rice bran is a good mineral source for food especially phosphorus and potassium (Hamid-Abdul *et al*., 2007).

The dietary reference intakes is a system of nutrient reference values recommendations developed by Institute of Medicine of the US National Academy of Sciences. Recommended dietary allowances (RDA), the daily dietary intake level of a nutrient sufficient to meet the requirements of nearly all (97-98%) healthy people in each life-stage and gender group by the Food and Nutrition Board. The RDAs (Anonymous, 1989) for adult males are 10 mg of Fe, 1.6-2.0 g of K, 350 mg of Mg, 800 mg of P, 2.3 mg of Mn and 15 mg of Zn. When 100 g (dry matter) erişte samples substituted with 25% RB were consumed, 36.4% of RDA for Fe, 21.9% of RDA for K, 53.6% RDA for Mg, 62.8% of RDA for P, 180% of RDA for Mn and 15.2% of RDA for Zn were taken by the human body. Especially high Mn contents of erişte samples substituted with 25% RB are important to overcome the constant fatigue, memory problems, infertility, weight loss, growth retardation, and developmental disorders, especially in children and infants, abnormal formation of bone and cartilages, nausea, vomiting, hair whitening problems which occurs due to Mn deficiency.

Colour values of erişte samples

Colour values of erişte samples are presented in Table 3. High brightness values (lightness) preferred and b* values (yellowness) being variably desirable based on regional and individual consumer preferences (Morris *et al.*, 2000). The differences in lightness (L*), redness (a*), and yellowness (b*) of erişte containing RB were significant ($P<0.05$) (Table 3). L* values, indicating a higher and lower degree of lightness, of the erişte samples decreased with increase in RB substitution. RB has a darker and more yellowish colour compared to WF, as mentioned before in the properties of wheat and RB in Table 1. As expected, RB colour significantly affected the colour of the erişte samples. While the lightness and yellowness of erişte samples decreased, redness increased with increasing levels of RB. Chen *et al.* (2011) reported that lightness (L*) values of wet and dry dough sheet of noodle decreased with the increasing addition of coarse, middle, and fine wheat bran significantly. The highest redness (a*) values of erişte samples were obtained over 20% RB substitution level. And also the lowest yellowish (b*) colour in erişte samples was observed with substitution level of 25% RB. In fact, these erişte samples appeared darker than the control erişte sample. This change observed could be attributed to the natural pigments in brown rice bran such as polyphenols and carotenoids (Choi

Table 3. Colour values and cooking properties of erişte samples.[1]

WF:RB[2]	L*	a*	b*	Hue angle	Saturation index	Cooking properties		
						Weight increase (%)	Volume increase (%)	Cooking loss (%)
100:0 (control)	72.31±0.23[a]	0.99±0.08[c]	23.49±0.33[a]	23.51±0.33[a]	87.59±0.17[a]	194.1±0.64[d]	203.5±0.98[f]	6.61±0.07[c]
95:5	71.62±0.28[a]	1.12±0.08[bc]	21.18±0.23[b]	21.21±0.23[b]	86.97±0.20[ab]	195.3±0.72[d]	206.1±1.33[e]	6.72±0.04[c]
90:10	70.56±0.11[b]	1.19±0.18[bc]	18.21±0.28[c]	18.25±0.29[c]	86.27±0.52[bc]	200.5±0.34[c]	210.5±0.23[d]	7.03±0.07[b]
85:15	69.64±0.38[c]	1.46±0.10[b]	17.67±0.14[c]	17.73±0.15[c]	85.28±0.28[c]	205.7±1.02[b]	212.8±0.52[c]	7.17±0.10[ab]
80:20	64.43±0.35[d]	2.28±0.23[a]	16.48±0.10[d]	16.64±0.13[d]	82.13±0.73[d]	214.2±1.16[a]	225.4±0.41[b]	7.19±0.01[ab]
75:25	63.56±0.38[e]	2.46±0.24[a]	15.03±0.23[e]	15.23±0.26[e]	80.71±0.76[e]	215.6±0.95[a]	237.2±0.24[a]	7.36±0.04[a]
Mean	68.69±0.29	1.58±0.15	18.68±0.22	18.76±0.23	84.82±0.44	204.23±0.80	215.92±0.62	7.00±0.06

[1] Duncan's multiple range test. Means with same superscript letter within a column are not significantly different ($P>0.05$). Values are the average of triplicate measurements of the sample ± standard deviation.
[2] RB = rice bran; WF = wheat flour.

et al., 2007). In the research of Bilgiçli *et al.* (2006), WF was used in tarhana production was replaced with wheat bran up to 50% to improve the nutritional value of tarhana, and the addition of wheat bran resulted in lower L* and b* values. Chillo *et al.* (2008) reported that lightness and yellowness of spaghetti samples significantly decreased with the buckwheat flour and bran. And also with increasing levels of rice bran decreased lightness (L*) and increased redness (a*) in noodles (Chung *et al.*, 2012) compared to the control.

The differences of hue angle and SI of erişte samples showed significant differences in relation to the amount of added RB. Saturation represents 'vividness or dullness of a colour' and hue angle shows how we will perceive an object's colour. As the RB substitution level increased, hue angle and SI values decreased.

Cooking properties

RB substitution level was found statistically significant on WI, VI and cooking loss of the erişte samples. Because of its high fibre content of RB, its substitution level not only increased WI and VI parameters but also increased the cooking loss. The highest WI (215.7%) and VI (237.2%) values of erişte samples were obtained with 25% substitution level of RB. In addition to nutritional effects, RB has functional properties such as water binding capacity. Gluten supplementation which added by diminishing gluten amount in RB supplemented erişte could be caused higher values of weight and volume increase in erişte samples made from rice bran. Vetrimani *et al.* (2005) reported that cooked weight increased with the addition of 2% gluten into vermicelli formulation, while the solid loss remained the same. In contrast to our findings, Bilgiçli *et al.* (2011), Spychaj and Gil (2005) reported that gluten addition into erişte and pasta formulation decreased cooked weight and volume increase.

In Table 3, the cooking loss (the amount of solid substance lost to cooking water) values are presented for all erişte samples. RB substitution level increased the cooking loss of cooked erişte samples. The highest cooking loss value was obtained with 25% RB addition, and RB addition with this level increased cooking loss up to 7.36%. Dick and Youngs (1988) reported that cooking loss of spaghetti cannot be higher than the 7-8% dry weight of the spaghetti. In this study cooking loss value of 25% RB addition (7.36%), is not higher than acceptable value of cooking loss, so 25% RB addition can be acceptable for cooking loss value.

From Table 3 it appears that the cooking loss value of erişte sample with the 5% RB substitution level was statistically similar with respect to the control. So 5% RB substitution level could be considered to have acceptable cooking loss levels. A study on the effects of buckwheat bran flour on extrusion properties and cooking quality of spaghetti by Manthey *et al.* (2004), cooking loss was greater from spaghetti made with semolina-buckwheat bran flour than semolina. And also Kordonowy and Youngs (1985) reported that bran containing spagetthi samples showed higher cooking loss. In an another work, the cooking loss values were equal with respect to the control for the spaghetti samples with the 10% and 20% of buckwheat flour (Chillo *et al.*, 2008).

Sensory properties of erişte samples

Figure 1 shows the mean range values of each attribute evaluated. It can be noted that there are statistically significant differences, among the evaluated seven sample attributes (surface roughness, firmness, appearance, stickiness, taste-odour, chewiness and overall acceptability).

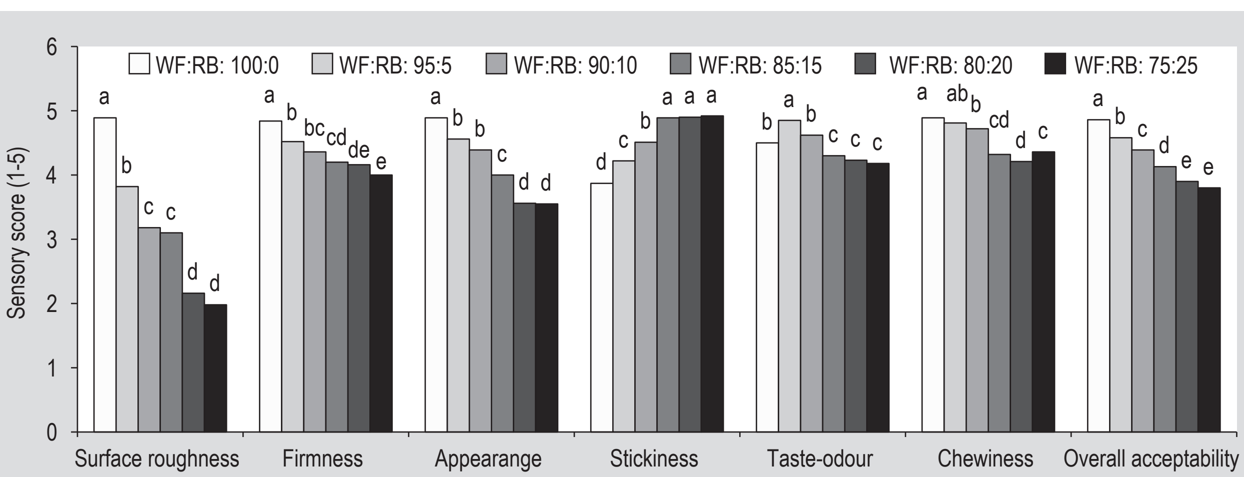

Figure 1. Sensory properties of erişte samples enriched rice bran blends. Bars marked with the same letter are not significantly different for each sensory property (P>0.05). RB = rice bran; WF = wheat flour.

Surface roughness, firmness, appearance, chewiness and overall acceptability scores of erişte samples decreased with RB substitution level. But stickiness values affected positively by RB addition significantly ($P<0.05$) compared to control sample. The highest stickiness scores were obtained with 15, 20 and 25% RB added erişte samples. Bilgiçli *et al*. (2011) reported that in cooked erişte samples containing common bean flours, stickiness was positively affected by gluten addition and also common bean and lentil flour improved the sensory properties of erişte in terms of taste and odour. In this study, in the case of the taste-odour attribute, the range multiple test applied showed a statistically significant preference between enrichment levels with 5% RB and the flour used as control. Therefore, the RB gives a nice aroma making it most attractive. Chillo *et al.* (2008) reported that the increase of bran did not determine an enhancement of bulkiness, adhesiveness and firmness. In another research, Hu *et al.* (2009) reported that; colour, taste, texture and overall acceptability were not found to be significantly different ($P>0.05$) than control bread when 1-3% rice bran fibre preparation was added to the breads. In the study of Hamid-Abdul and Luan (2000), dietary fibre prepared from defatted rice bran was used in bread formulation and determined the functional effects of breads, sensory evaluation revealed that the breads incorporated with dietary fibre extracted from defatted rice bran (both at 5 and 10%) were acceptable for the panellists.

4. Conclusions

These results provide that RB addition into erişte formulation improved the nutritional contents of erişte in terms of ash and mineral (Ca, K, Mg, Mn, P, Fe and Zn) contents. RB gave the erişte samples a darker colour as a result of natural pigmentation and high fibre contents. RB up to 10% substitution level can be used in the erişte formulation to enrich the erişte with minimum adverse effect on technological properties of erişte into consideration.

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