

Effect of pseudocereal flours on some chemical properties and phytic acid content of noodle

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Abstract

Quinoa flour (QF) was used in noodle formulation up to 30% level with and without buckwheat flour (BF). Some chemical properties (ash, protein, cellulose, fat and minerals), phytic acid (PA), colour values, cooking quality and sensory properties of noodles were determined. Ash, fat and PA content of noodle increased with QF or QF:BF blends addition, and the highest values were obtained with 30% QF. PA content increased from 142 mg/100 g to 578 mg/100 g with 30% QF usage. Significant ($P<0.05$) increases were obtained in copper, iron, potassium, magnesium, phosphorus and zinc (Cu, Fe, K, Mg, P and Zn) content of noodle in all addition levels of QF or QF:BF blends compared to control. Increment ratios in Cu, Fe, K, Mg, P and Zn content of noodle containing 30% QF:BF were found as 72.7, 36.9, 54.5, 158.1, 35.3 and 58.6%, respectively. Blends of QF:BF negatively affected L^* values of noodles. The highest cooking loss values were obtained with QF:BF blends over 10% addition levels. The overall acceptability scores of cooked noodle containing 30% QF or 20-30% QF:BF blends were found lower than that of the control.

Keywords: quinoa, buckwheat, noodle, erişte, mineral, phytic acid

1. Introduction

Quinoa (*Chenopodium quinoa* Willd.) and buckwheat (*Fagopyrum esculentum* Moench) are dicotyledonous plants, but since they produce starch-rich seeds like cereals they are called 'pseudocereals' (Schoenlechner *et al.*, 2008). While, quinoa belongs to the *Chenopodiaceae* family, genus *Chenopodium*, buckwheat belongs to the family *Polygonaceae* (Jancurova *et al.*, 2009; Marshall and Pomeranz, 1982). The most striking features of these pseudocereals are balanced amino acid contents, gluten free compositions and some phytochemicals.

The protein content of quinoa seeds varies from 13.8% to 16.5%, and the quality of the protein is very good (Koziol, 1992; Schoenlechner *et al.*, 2008). The quinoa proteins are mainly globulins and albumins. The amino acid profile of quinoa proteins shows a balanced essential amino acid content with a high level of lysine (4.5-7.0%) (Watanabe *et al.*, 2003). Quinoa protein is close to the FAO recommended

pattern in essential amino acids (Prakash and Pal, 1998). Oil content in quinoa ranges from 1.8% to 9.5% with an average of 5.0-7.2% (Koziol, 1992). Quinoa has a high content of mineral (calcium, magnesium, iron, copper and zinc) and vitamin (A, B₂ and E). Mineral content of quinoa seeds is generally higher than that found in cereal (Koziol, 1992; Repo-Carrasco *et al.*, 2003; Schoenlechner *et al.*, 2008). The dietary fibre content of quinoa (12.88%) is comparable to that of other cereals, and the proportion of soluble fibre is only 13.5% of total dietary fibre (Ranhorta *et al.*, 1993; Schoenlechner *et al.*, 2008). Quinoa contains also several antinutritional substances such as, saponins, phytic acid (PA), tannins and protease inhibitors (Vega-Galvez *et al.*, 2010). Quinoa seed is used to make flour, soup, breakfast cereal and alcohol, while the flour is utilised in making sweet biscuits (60% quinoa flour; QF), bread (10-13% QF), noodles and pasta (30-40% QF) and processed food (Bhargava *et al.*, 2006; Valencia-Chamorro, 2003).

Buckwheat is a valuable raw material for improvement nutritional quality and functional properties of food products with balanced amino acid composition, high contents of vitamins (thiamine, riboflavin, pyridoxine and vitamin E), minerals (phosphorus, iron, zinc, potassium and magnesium), polyunsaturated essential fatty acids, sterols, rutin, quercetin, quercitrin, fagopyratol, resistant starch and gluten free proteins (Marshall and Pomeranz, 1982; Steadman *et al.*, 2001; Wijngaard and Arendt, 2006). Average contents of protein, lipids, and ash in buckwheat have been reported as 13.0, 2.9 and 2.7%, respectively (Shim *et al.*, 1998). Resistant starch content was 33.5% of total starch in buckwheat, which is important for preparation of low glycemic index food (Skrabanja and Kreft, 1998). Buckwheat is a rich mineral source (except for calcium; Ca) than many cereals such as rice, sorghum, millet and maize (Steadman *et al.*, 2001). Rutin and quercetin (polyphenols with antioxidant activity) contents of buckwheat hull are 0.84-4.41 and 0.009-0.029 mg/g, respectively (Oomah and Mazza, 1996). Buckwheat milling products (white flour, whole flour and bran) can be used in different bakery products, pasta-noodle, cookie, cake, crepe, breakfast cereal and soap formulations (Bilgiçli, 2009a,b; Bonafaccia and Kreft, 1994; Kim *et al.*, 1999; Levent and Bilgiçli, 2011, 2012).

PA has been considered to be an antinutrient due to its ability to bind minerals (Rickard and Thompson, 1997). PA is found in cereal, pseudocereal, legume and oily seeds. PA is present in the outer layer and endosperm of the quinoa seed, and ranges between 1,050 and 1,350 mg/100 g (Kozioł, 1992). According to Chauhan *et al.* (1992) and Ruales and Nair (1993) PA content of quinoa ranged between 100 and 1000 mg/100 g. While Varriano-Marston and DeFrancisco (1984) found that the PA concentrated in the embryo of quinoa seed, Chauhan *et al.* (1992) and Ruales and Nair (1993) reported that PA is distributed uniformly in the seed. PA contents of buckwheat groat have been reported between 1,170 mg/100 g and 1,510 mg/100 g by some researchers (Bilgiçli, 2009a; Steadman *et al.*, 2001). Bran is concentrated source of PA (3,500-3,800 mg/100 g), and 60-90% of phosphorus is stored as PA (Schoenlechner *et al.*, 2008; Steadman *et al.*, 2001).

The purpose of this research was to determine the effect of the addition of QF and blends of QF with buckwheat flour (BF) (QF:BF) into noodle by measuring some physical, chemical and sensory properties of these products.

2. Material and method

Materials

Commercial wheat flour, whole egg and salt used for noodle preparation were obtained from local markets in Konya, Turkey. Quinoa was purchased local marked in Istanbul, Turkey. Buckwheat was obtained from Yar Gıda,

Antalya, Turkey. Buckwheat and quinoa were ground in a hammer mill (Falling Number-3100 Laboratory Mill; Perten Instruments AB, Huddinge, Sweden) as whole flour.

Methods

For Turkish egg noodle preparation, the method given by Özkaya *et al.* (2001) was used with some modification. Control sample was made with wheat flour (200.0 g), whole egg (40.0 g), salt (1.0 g) and water. QF or QF:BF (50:50, w/w) blends replaced wheat flours at levels of 10, 20 and 30% in noodle formulation. Noodle ingredients were kneaded in a Hobart-N50 mixer (Canada Inc., North York, ON, Canada), dough was rested for 20 min and the dough pieces were thinned and cut into long stripes using the noodle machine (Shule Pasta Machine, Changzhou, China P.R.). The drying of noodle samples below 10% moisture content took place at 55 °C in a dryer (Nüve FN-500, Ankara, Turkey). The water uptake (WU) and volume increase (VI) of noodle samples were determined according to Oh *et al.* (1985) and Özkaya *et al.* (2001). WU values were calculated by differences of dry and cooked noodle weights. For the VI determination, dry and cooked noodle samples were put into the water-full graduated cylinders. The VI was calculated by the volume difference of water overflow by dry and cooked noodle. Cooking loss (CL), the weight of total solids expressed as a percentage, was measured by evaporating the noodle cooking water to dryness in an oven, as described by the AACC method (AACC, 1990).

Chemical analysis

AACC methods were followed for determinations of ash, protein, cellulose and fat content of the samples (AACC, 1990). Colorimetric method was used for measuring of phytate phosphorus (PP) and PA content of the samples (Haugh and Lantzsch, 1983). For analysing the mineral contents of the raw materials and noodle samples, about 0.5 g of ground samples were put into a burning cup and pure HNO₃ were added. The sample was incinerated in a microwave oven (MARS-5™ Cem Corp., Matthews, NC, USA) and dissolved ash was diluted to a certain volume with water. Concentrations were determined with an inductively coupled plasma atomic-emission spectrometer (Varian Vista Model, Mulgrave, Australia) (Bubert and Hagenah, 1987).

Colour values

Colour measurements were made by measuring L* (light/dark), a* (red/green), and b* (yellow/blue) parameters with a chromo meter (model CR 400, Minolta Camera, Co. Ltd., Osaka, Japan). Saturation index (SI) was calculated as $(a^{*2} + b^{*2})^{1/2}$ (Francis, 1998).

Sensory properties

Raw and cooked noodle samples were subjected to sensory analyses. For cooked noodle preparation, raw noodle samples (100 g wet basis) were simmered in 500 ml water for 18 min and drained for 20 sec to remove excess water. Cooked noodle samples were served to panellist at 35–40 °C. The sensory analyses were conducted by 14 panellists (male and female). While ‘raw noodles’ were evaluated in terms of surface smoothness, speck, crack, appearance and overall acceptability, ‘cooked noodles’ were evaluated on the basis of taste, odour, stickiness, chewiness and overall acceptability using a five-point scale.

Statistical analysis

The means, which were statistically different from each other, were compared using Duncan’s multiple comparison tests at 5% confidence interval. The TARIST (version 4.0; Ege University, İzmir, Turkey) software was used to perform the statistical analyses.

3. Results and discussion

Chemical composition and phytic acid content

Chemical compositions of raw materials and noodle samples are given in Table 1. Compared to wheat flour, QF and BF (obtained as whole flours) had higher ash, cellulose, fat, PA and PP content. The chemical composition of wheat flour, QF and BF were within the ranges reported by Ajo (2013), Elgün and Ertugay (1995), Jancurová *et al.* (2009), Marshall and Pomeranz (1982), and Wijngaard and Arendt

(2006). Increasing amount of QF in noodle formulation, increased the ash, fat, PP and PA content of the noodles significantly ($P<0.05$). In QF:BF (50/50, w/w) blends, the high addition levels (20–30%) also increased the same chemical components significantly ($P<0.05$) compared to control noodle. Similarly, Bilgiçli (2009a) reported that BF in noodle formulation above 20% addition level increased the ash, cellulose, fat and PA content when compared with a control made by wheat flour. While the increment in ash and fat improved the nutritional value of noodles, high PA and PP values which obtained with high addition levels of QF or QF:BF blends had negative effect in terms of decreasing mineral bioavailability. In our previous studies, the PA loss in fermented cereal products as tarhana increased up to 98% (Bilgiçli *et al.*, 2006), but in unfermented product as noodle and cookie the losses was found low levels (Bilgiçli, 2009a) compared to raw material used in its preparations.

Mineral contents of the wheat flour, QF, BF and noodle samples are summarised in Table 2. Compared to wheat flour, QF and BF had richer mineral content except Ca. Similar values for mineral content of wheat flour, QF and BF have been reported by Elgün and Ertugay (1995), Bilgiçli (2009a), Steadman *et al.* (2001) and Vega-Gálvez *et al.* (2010). Ca contents of the noodles changed between 30.7 and 34.1 mg/100 g, the highest value obtained with 30% QF usage. Copper (Cu) is a significant trace element for the central nervous system development, and low concentrations of Cu may result in incomplete development (Desai and Kaler, 2008). Cu contents of the QF and BF was found similar, and higher than wheat flour about 2.5 times. This difference in Cu content of raw material was affected to final product, and the Cu content of the noodles increased from 0.22

Table 1. Chemical composition of raw material and noodle samples.^{1,2}

	Ash (%)	Protein (%)	Cellulose (%)	Fat (%)	Phytate phosphorus (mg/100 g)	Phytic acid (mg/100 g)
Raw materials						
Wheat flour	0.46±0.01 ^j	11.2±0.14 ^d	0.51±0.14 ^e	0.6±0.14 ^h	44±1.41 ^g	156±1.41 ^h
Quinoa flour (QF)	2.30±0.03 ^a	12.5±0.14 ^c	2.50±0.14 ^a	5.5±0.14 ^a	442±2.83 ^a	1567±2.83 ^a
Buckwheat flour (BF)	1.91±0.03 ^b	11.5±0.21 ^d	1.20±0.14 ^b	2.3±0.14 ^g	375±2.83 ^b	1330±2.83 ^b
Noodle samples						
Control	1.15±0.03 ⁱ	13.0±0.14 ^b	0.65±0.04 ^{de}	2.1±0.07 ^g	40±2.83 ^g	142±2.12 ⁱ
QF 10%	1.29±0.01 ^g	13.1±0.07 ^{ab}	0.82±0.04 ^{cd}	2.4±0.14 ^{ef}	75±1.41 ^f	266±1.41 ^g
QF 20%	1.49±0.01 ^e	13.2±0.14 ^{ab}	0.93±0.03 ^{bcd}	2.9±0.07 ^{cd}	110±1.41 ^e	390±2.83 ^e
QF 30%	1.68±0.01 ^c	13.4±0.14 ^a	1.21±0.14 ^b	3.4±0.14 ^b	163±2.83 ^c	578±2.12 ^c
QF:BF ³ 10%	1.27±0.03 ^h	13.1±0.14 ^{ab}	0.81±0.08 ^{cd}	2.3±0.07 ^g	75±2.83 ^f	266±2.55 ^g
QF:BF 20%	1.43±0.01 ^f	13.2±0.14 ^{ab}	0.90±0.14 ^{cd}	2.6±0.07 ^{de}	108±2.83 ^e	383±1.41 ^f
QF:BF 30%	1.61±0.03 ^d	13.2±0.14 ^{ab}	1.00±0.14 ^{bc}	3.0±0.07 ^c	150±2.83 ^d	532±2.83 ^d

¹ Means with same letter within column are not significantly different (Duncan’s multiple range test, $P>0.05$).

² Based on dry matter.

³ QF:BF blend 50:50 (w/w), replaced wheat flours at levels of 10, 20 and 30%.

Table 2. Mineral contents (mg/100 g) of raw material and noodle samples.^{1,2}

	Calcium	Copper	Iron	Potassium	Magnesium	Manganese	Phosphorus	Zinc
Raw materials								
Wheat flour	20.1±0.28 ^g	0.33±0.03 ^{bc}	1.35±0.03 ^e	195±0.71 ^j	34±0.71 ⁱ	0.35±0.03 ⁱ	210±0.71 ⁱ	1.22±0.01 ^g
Quinoa flour (QF)	30.9±0.28 ^{ef}	0.83±0.03 ^a	3.90±0.06 ^a	685±0.71 ^a	175±0.71 ^b	1.51±0.03 ^a	510±0.85 ^a	4.02±0.03 ^a
Buckwheat flour(BF)	19.2±0.28 ^h	0.80±0.01 ^a	2.85±0.06 ^b	483±0.57 ^b	195±1.41 ^a	1.22±0.01 ^b	450±0.71 ^b	3.12±0.03 ^b
Noodle samples								
Control	30.7±0.14 ^f	0.22±0.01 ^e	1.68±0.04 ^g	220±0.85 ^j	31±1.41 ^j	0.42±0.01 ^h	224±0.71 ^h	1.33±0.04 ^f
QF 10%	31.6±0.14 ^{cd}	0.28±0.04 ^{cd}	1.98±0.04 ^e	272±1.27 ^g	46±1.13 ^h	0.51±0.03 ^{fg}	256±0.42 ^g	1.62±0.03 ^e
QF 20%	32.9±0.28 ^b	0.35±0.01 ^{bc}	2.22±0.03 ^d	318±1.27 ^e	60±1.41 ^f	0.61±0.01 ^{de}	286±0.71 ^e	1.85±0.04 ^d
QF 30%	34.1±0.14 ^a	0.39±0.04 ^b	2.48±0.04 ^c	365±0.71 ^c	74±0.71 ^d	0.71±0.01 ^c	318±0.57 ^c	2.16±0.06 ^c
QF:BF ³ 10%	31.1±0.14 ^{def}	0.28±0.01 ^{cd}	1.85±0.03 ^f	261±0.71 ^h	47±0.71 ^g	0.47±0.03 ^{gh}	255±0.85 ^g	1.59±0.06 ^e
QF:BF 20%	31.4±0.28 ^{cde}	0.33±0.03 ^{bc}	2.05±0.04 ^e	301±0.71 ^f	63±1.13 ^e	0.56±0.01 ^{ef}	274±0.85 ^f	1.82±0.04 ^d
QF:BF 30%	31.9±0.28 ^c	0.38±0.04 ^b	2.30±0.03 ^d	340±1.41 ^d	80±0.71 ^c	0.65±0.04 ^{cd}	303±0.57 ^d	2.11±0.01 ^c

¹ Means with same letter within column are not significantly different (Duncan's multiple range test, $P>0.05$).

² Based on dry matter.

³ QF:BF blend 50:50 (w/w), replaced wheat flours at levels of 10, 20 and 30%.

mg/100 g up to 0.39 mg/100 g with 30% QF addition level. Iron (Fe) is another important mineral in human nutrition. Fe deficiency is one of the widespread nutritional disorder in the world. A lot of people are iron-deficient or anaemic (Zeng *et al.*, 2010). In present study, significant ($P<0.05$) increase was obtained in Fe content of noodles with QF or QF:BF addition. This increment ratio reached up to 47.6% with QF (30%) addition. Low potassium (K) intake with high sodium consumption increases the cardiovascular diseases (Umesawa *et al.*, 2008). Magnesium (Mg) deficiency also increases the risk of cardiovascular disease, hypertension, diabetes mellitus, osteoporosis and headaches (Altura and Altura, 2001; Cappuccio, 2000; Kao *et al.*, 1999; Mizushima *et al.*, 1998). As the QF and BF rich source of K and Mg (Table 2), significant ($P<0.05$) increase was also observed in noodles containing QF and QF:BF blends. Like other minerals, manganese (Mn) and phosphorus (P) content of the noodle increased with QF or QF:BF addition. Zinc (Zn) plays a central role in cellular growth due to it is associated with more than 50 distinct metalloenzymes (Brown *et al.*, 2001). Zn deficiency causes hyperammonemia, neurosensory disorders and decreases serum testosterone level and lean body mass (Prasad, 2008). Zn content of the noodles changed between 1.33 and 2.16 mg/100 g. When 100 g (dry matter) noodle containing 30% QF or 30% QF:BF blends was consumed by male adults, 18.9-20.3%, 21.1-22.9%, 37.9-39.8 and 14.1-14.4% of the recommended dietary allowances (RDA) for K, Mg, P and Zn respectively, was taken into the body. Control noodle contains only 12.2, 8.9, 28.0 and 8.9% of the RDA for K, Mg, P and Zn, respectively. Bilgiçli (2009a) found that noodle with 40% BF contains, 13.8, 40.9, 37.7, 25.3 and 12.8% of RDA for K, Mg, P, Fe and Zn, respectively.

Colour values

Colour values of some raw materials and the raw noodle samples are given in Table 3. Compared to control noodle, QF increased lightness (L^*) but BF decreased L^* values of the noodle. Bilgiçli (2009a) reported that BF significantly ($P<0.05$) affected colour values of noodle by leading to darker colours. There are a lot of studies on decreasing L^* values of different cereal products when substituted with BF especially when used as whole flour or dark flour (Atalay *et al.*, 2013; Bilgiçli, 2009b; Duarte *et al.*, 1996; Yıldız and Bilgiçli, 2012). In contrast to L^* value, redness (a^* value) of the noodles increased with the addition of BF. The increment in a^* values of noodles may have been affected by natural pigment characteristic of whole BF flour which is more reddish than other main ingredients (QF and wheat flour) of noodle (Table 3). In our previous studies, higher a^* values were found in bread (Levent and Bilgiçli, 2012) and noodle (Bilgiçli, 2008) samples prepared with BF substitution, compared to control samples without BF. 20% QF or 30% QF:BF blend gave the most yellowish colour to noodle surface. A yellow colour and bright appearance is preferred in Turkish noodle which is called *erişte* (Özkaya *et al.*, 2001). SI values were affected significantly ($P<0.05$) by QF or QF:BF blend addition into noodle formulation, and the lowest SI values obtained in noodle sample containing 10% QF.

Cooking properties

Cooking properties of noodles as WU, VI and CL are given in Table 4. All of the QF or QF:BF addition levels decreased WU and VI of the noodles. Generally high addition level

Table 3. Colour values of raw material and noodle samples.¹

	L*	a*	b*	SI
Raw materials				
Wheat flour	96.11±0.14 ^a	-0.85±0.07 ⁱ	9.75±0.07 ⁱ	9.78±0.08 ^h
Quinoa flour (QF)	91.52±0.07 ^b	-0.97±0.06 ^j	12.67±0.03 ^h	12.71±0.06 ^g
Buckwheat flour (BF)	79.31±0.14 ⁱ	3.57±0.03 ^a	15.32±0.03 ^a	15.73±0.04 ^a
Noodle samples				
Control	87.84±0.08 ^e	0.64±0.07 ^e	13.91±0.06 ^c	13.93±0.04 ^{cd}
QF 10%	90.88±0.14 ^c	0.03±0.01 ^g	13.15±0.08 ^g	13.15±0.04 ^f
QF 20%	90.02±0.14 ^d	0.10±0.03 ^f	14.19±0.03 ^b	14.19±0.06 ^b
QF 30%	90.73±0.03 ^c	-0.08±0.01 ^h	13.47±0.06 ^f	13.47±0.03 ^e
QF:BF ² 10%	87.30±0.11 ^f	1.18±0.04 ^d	13.91±0.06 ^d	13.96±0.08 ^c
QF:BF 20%	85.60±0.14 ^g	1.60±0.07 ^c	13.70±0.06 ^e	13.81±0.07 ^d
QF:BF 30%	85.06±0.08 ^h	2.01±0.07 ^b	14.08±0.06 ^b	14.23±0.04 ^b

¹ Means with same letter within column are not significantly different (Duncan's multiple range test, $P>0.05$).

² QF:BF blend 50:50 (w/w), replaced wheat flours at levels of 10, 20 and 30%.

a* = green (negative values)/red (positive values); b* = blue (negative values)/yellow (positive values); L* = light/dark; SI = saturation index.

Table 4. Cooking properties of noodle samples.¹

Noodle samples	Water uptake (%)	Volume increase (%)	Cooking loss (%)
Control	237±2.83 ^a	244±1.41 ^a	5.7±0.14 ^d
QF 10%	223±4.24 ^{bcd}	228±4.41 ^c	6.9±0.28 ^c
QF 20%	220±1.41 ^{cd}	227±1.41 ^c	7.3±0.28 ^c
QF 30%	211±1.41 ^e	215±2.83 ^c	7.4±0.28 ^c
QF:BF ² 10%	228±4.24 ^b	235±2.83 ^b	8.2±0.14 ^b
QF:BF 20%	225±2.83 ^{bc}	230±2.83 ^{bc}	9.3±0.14 ^a
QF:BF 30%	217±1.41 ^{de}	225±1.84 ^c	9.8±0.28 ^a

¹ Means with same letter within column are not significantly different (Duncan's multiple range test, $P>0.05$).

² QF:BF blend 50:50 (w/w), replaced wheat flours at levels of 10, 20 and 30%.

of QF or QF:BF gave lower WU and VI values. CL values increased from 5.7% (control) up to 7.4% (with usage of 30% QF) and up to 9.8% (with usage of 30% QF:BF). Chillo *et al.* (2008) also reported CL increment in gluten free spaghetti samples (CL = 11.4%) with usage of QF in formulation compared to control sample containing gluten (CL = 7.8%). Bilgiçli (2009a) reported the CL values of noodle containing BF (5-40%) between 6.41% and 9.53%. Absence or dilution of gluten content in noodle formulation with usage of pseudocereal flours may cause leaching of more solids into cooking water due to weakening the structure of the noodle (Bilgiçli, 2008, 2009a; Duarte *et al.*, 1996).

Sensory properties

Sensory properties of raw and cooked noodle samples are given in Table 5 and 6. 30% level of QF or all addition

Table 5. Sensory properties of raw noodle samples.¹

Noodle samples	Surface smoothness	Speck	Crack	Appearance	Overall acceptability
Control	4.9±0.14 ^a	4.5±0.00 ^a	4.7±0.28 ^a	4.9±0.14 ^a	4.7±0.28 ^a
QF 10%	4.0±0.14 ^{bc}	4.4±0.14 ^a	4.1±0.14 ^{ab}	4.8±0.00 ^a	4.5±0.14 ^{ab}
QF 20%	4.2±0.28 ^{ab}	4.1±0.14 ^a	4.0±0.00 ^{bc}	4.5±0.14 ^a	4.2±0.14 ^{ab}
QF 30%	3.6±0.14 ^{cd}	4.0±0.14 ^{ab}	3.5±0.14 ^{cd}	4.0±0.28 ^b	4.0±0.00 ^{bc}
QF:BF ² 10%	4.0±0.14 ^{bc}	4.0±0.14 ^{ab}	4.0±0.14 ^{bc}	4.0±0.14 ^b	4.1±0.14 ^{bc}
QF:BF 20%	3.5±0.14 ^{de}	3.6±0.28 ^b	3.0±0.28 ^e	3.6±0.14 ^{bc}	3.7±0.14 ^c
QF:BF 30%	3.1±0.14 ^e	3.1±0.28 ^c	3.2±0.14 ^{de}	3.5±0.14 ^c	3.0±0.28 ^d

¹ Means with same letter within column are not significantly different (Duncan's multiple range test, $P>0.05$).

² QF:BF blend 50:50 (w/w), replaced wheat flours at levels of 10, 20 and 30%.

Table 6. Sensory properties of cooked noodle samples.¹

Noodle samples	Taste	Odour	Stickiness	Chewiness	Overall acceptability
Control	4.8±0.14 ^a	4.5±0.00 ^a	4.5±0.14 ^{ab}	4.0±0.00 ^c	4.8±0.14 ^{ab}
QF 10%	4.7±0.14 ^a	4.8±0.14 ^a	4.5±0.14 ^{ab}	4.2±0.00 ^{bc}	5.0±0.14 ^a
QF 20%	4.3±0.28 ^b	4.7±0.14 ^a	4.6±0.28 ^a	4.0±0.14 ^c	4.4±0.14 ^{bc}
QF 30%	3.6±0.14 ^c	4.5±0.14 ^a	4.6±0.28 ^a	3.5±0.14 ^d	3.5±0.14 ^d
QF:BF ² 10%	4.8±0.14 ^a	4.6±0.28 ^a	4.0±0.14 ^b	4.8±0.14 ^a	4.6±0.00 ^{bc}
QF:BF 20%	4.0±0.28 ^b	4.5±0.14 ^a	4.0±0.14 ^b	4.5±0.28 ^{ab}	4.3±0.00 ^c
QF:BF 30%	3.5±0.14 ^c	3.5±0.28 ^b	3.5±0.14 ^c	4.5±0.14 ^{ab}	3.3±0.14 ^d

¹ Means with same letter within column are not significantly different (Duncan's multiple range test, $P>0.05$).

² QF:BF blend 50:50 (w/w), replaced wheat flours at levels of 10, 20 and 30%.

level of QF:BF usage in noodle formulation decreased surface smoothness and crack scores of raw noodles. The appearance and overall acceptability scores of the raw noodle containing QF up to 20% level and control prepared with wheat flour were found similar. All addition level of QF:BF blend decreased the overall acceptability scores of raw noodles. The high level (20-30%) of QF or QF:BF blend decreased the taste score of the cooked noodles (Table 6). No differences in the odour score of the cooked noodle were observed except the highest addition ratio of QF:BF blend. The overall acceptability score of cooked noodle containing 30% QF or 20-30% QF:BF blend were found lower than the control. Similarly, Bilgiçli (2009a) reported that noodle containing BF above 30% addition level had lower overall acceptability scores than control.

4. Conclusions

Quinoa and buckwheat are rich source of mineral, essential amino acid some phytochemical compared to wheat. They can be used for nutritional enrichment of some cereal products. On the other hand PP and PA acid content of these pseudocereals are also high level. In present study, QF was used in Turkish noodle formulation up to 30% level with and without BF. Ash, fat, PA, Cu, Fe, K, Mg, P and Zn content increased with QF or QF:BF blend addition. High addition level of QF:BF blends negatively affected CL values of the noodles, and gave dark colour to noodle surface. The overall acceptability score of cooked noodle containing 30% QF or 20-30% QF:BF blends were found lower than the control.

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