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Fortified buckwheat noodles as a potential replacement of locally produced noodles

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Abstract

The present study explored the possibility of formulating noodles with improved nutritious value and acceptable sensory properties using buckwheat (*Fagopyrum esculentum*) flour in supplementation of wheat flour and compared the developed noodles with locally available branded noodles in Bangladesh. Wheat flour was substituted with 10%, 20%, 30% and 40% whole buckwheat flour. Ash (1.95-2.16%), protein (13.45-17.04%), fat (0.55-0.78%), fiber (0.23-0.55%) and mineral contents increased with the increasing content of buckwheat flour in noodles preparation. On sensory evaluation, noodles formulated with 30% buckwheat flour were found to be acceptable and were characterized with higher mineral content along with the accession in ash, protein and fiber content up to 2.08%, 16.13% and 0.46% respectively, which outran the values of other locally available noodles. On sensory evaluation and nutritional point of view, buckwheat noodles is a potential replacement of other available noodles in the local market of Bangladesh.

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Introduction

In some parts of the world, common buckwheat *(Fagopyrum esculentum)* of the family Polyganaceae draws attention as an essential crop (Kim *et al.,* 2008). It is a gluten free pseudocereal that has received increasing importance as a source of potential functional food in many countries of the world (Zhang *et al*., 2012).Among many other countries, China, Japan, India, Russia, Poland, Hungary, Italy, Canada, USA, and Brazil share the majority production of buckwheat plant (Popović *et al.*, 2014). On the other hand, Bangladesh produces buckwheat in a very limited area, particularly in the greater Panchagar district located near the Himalayan Mountain region (Debnath *et al*., 2008). Buckwheat flour is contemplated as a potentially healthy ingredient in preparing different food items such as pasta, noodles, pancakes, bread, biscuits, etc. (Torbica *et al*., 2010).

Recently, there is an increasing interest revolve globally for buckwheat products as a nutritious food and as a substitute for gluten-allergic person (Giménez-Bastida *et al.,*2015).It contains higher protein content compared to rice, wheat, millet, sorghum, maize and other cereals. Study reviews that buckwheat protein consists of 18.2% albumin, 43.3% globulin, 0.8% prolamin, 22.7% glutenin and 5% other nitrogen residue (Jacquemart *et al*., 2012).The amino acids in buckwheat proteins are well balanced and rich in lysine, which is recognized as the first limiting amino acid in wheat and barley (DVOŘÁČEK *et al*.,2006). Buckwheat flour is also a rich source of many essential minerals (Fe, Se, Cr, Zn, Mg, P, K. Na, Ca, B, Cu, Sn, Pb), vitamins (whole vitamin complex, B, B1, B2, B3, B4, B5, B7, vitamin E, K) and antioxidants (rutin, quercetin, isovitexin, orientin, phenols, etc.) (Giménez-Bastidae *et al,* 2015). Buckwheat starch is

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slowly digestible which also gives it a special nutritional importance compared to wheat starch (Acquistucci *et al*., 1997).

Buckwheat noodles are consumed as traditional foods in many parts of the world due to their non glutinous nature and higher nutritional value. In Japan, expensive restaurants serve it as Soba noodles. Noodles are one of the popular foods in many parts of the Asian countries (Bangladesh, India, China, Japan, Thailand, etc.) for its high nutritional quality and for having enjoyable flavor. Besides, it is ready to eat food, cost effective and highly available. However, locally available noodles are not nutritionally rich as it is mainly prepared from wheat. Wheat is not considered as a good source of nutrients as it is not a source of complete protein (De Francischi *et al*., 1994). Therefore, buckwheat flour can be applied in the production of protein rich buckwheat noodles by combining with wheat flour in different ratios. Several studies have affirmed that the incorporation of buckwheat flour in the preparation of noodles not only increased nutritional value but also enhanced sensory quality (De Francischi *et al*., 1994). Buckwheat possesses many health benefits like plasma cholesterol level reduction, neuro protection, anticancer, anti-inflammatory, anti-diabetic effects and improvement of hypertension conditions (Zhu, 2016).

In this study, a substantial percentage of wheat flour was substituted with buckwheat flour in formulating noodles and compared to locally available noodles in terms of nutritional value along with acceptable sensory properties for consumption.

Materials and methods

The study was accomplished in the laboratory of Quality Control Research Section of Food Science and Technology, Bangladesh Council of Scientific and Industrial Research (BCSIR), Dr. Kudrat -i- Khuda Road, Dhanmondi, Dhaka, Bangladesh.

Sample collection

Common buckwheat groats (*Fagopyrum esculentum*) were collected from the greater Panchagar district of Bangladesh. Eight different brands of locally available noodles and other raw materials such as wheat flour, table salt (NaCl), soybean oil, chicken egg, etc. which were used for the preparation of buckwheat noodles were collected from the local market. All chemicals and materials were also purchased from the local market.

Preparation of raw materials

Buckwheat groats were dried in a hot drier at 50°C for 6h and were ground into flour in a grinder. Finally, the flour was sieved using 0.25mm sieves to pass the powder.

Design of experiment

The experiment was designed to formulate a high percentage of buckwheat supplemented noodles without affecting noodles texture significantly. Wheat flour was replaced with buckwheat flour by four different proportions (10%,20%,30% and 40% respectively) and was designed as N1, N2, N3 and N4 respectively, whereas N0 (without buckwheat flour) was kept as a control. The formulation and preparation of biscuit is shown in Table I and Figure I, respectively.

N0= 100% Wheat flour (WF)
N1= 90% WF + 10% Buckwheat flour (BF)
N2= 80% WF + 20% BWF
N3= 70% WF + 30% BWF
N4= 60% WF + 20% BWF

Table I. Formulation of experimental noodles with different composition

Sample	Wheat flour (g)	Buckwheat flour (g)	Carboxymethylcellulose (CMC) (g)	Salt (g)	Corn starch (g)
Control	100	0	0.15	0.75	1.65
N1	90	10	0.15	0.75	1.65
N2	80	20	0.15	0.75	1.65
N3	70	30	0.15	0.75	1.65
N4	60	40	0.15	0.75	1.65

Preparation of buckwheat noodles

Buckwheat noodles were developed by mixing buckwheat powder in four different percentages (10%, 20%, 30% and 40%) and other ingredients like iodized salt (NaCl), starch and carboxymethyl cellulose (CMC) were kept constant for all formulations. The composition of experimental noodles is mentioned in Table I. Firstly, all the dry ingredients were mixed properly. Then, 27.5 ml water was added to the mixture to make dough. The dough was kept for 10 minutes at room temperature. Pasta sheets from the dough were made by using a noodle machine and subsequently these sheets

were cut into the noodles shape. The noodles were dried at <40°C for 6 h and prepared for cooking. The preparation and formulation of buckwheat noodles have been depicted in Fig. 1.

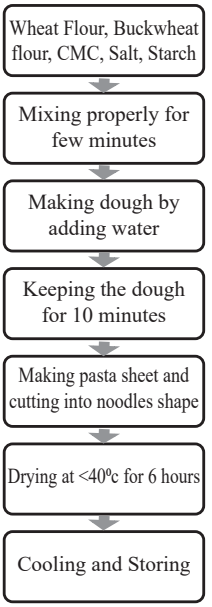

Fig. 1. Flow chart of buckwheat noodles preparation

Proximate nutrient analysis of buckwheat and locally available noodles

The nutrient content of the newly developed buckwheat noodles and locally available branded noodles were estimated according to the standard analytical methods (AOAC, 2005). The carbohydrate content was measured by the calculated difference method [100-(moisture+ash+ protein+fat+fiber)] and energy value was estimated by multiplying the amount of fat, protein, and carbohydrate by their respective physiological energy value (9 kcal for fat, 4 kcal for protein and carbohydrates each) and taking the sum of products (Bonafaccia *et al*., 1994).

The four essential minerals (Na, K, Fe and Ca) were assayed in this study. Iron (Fe) was determined by spectrophotometric thiocyanate method (Vogel, 1978) while sodium (Na) and potassium (K) were determined by flame photometric method (Jahan *et al*, 2011). Calcium content was measured by potassium permanganate titrimetric method (Egan *et al*, 1981) with minor modification.

Sensory analysis

Sensory analysis of the developed buckwheat noodles was done using nine -point hedonic –scale (9= like extremely, 8= like very much, 7= like moderately, 6= like slightly, 5= neither like or dislike, 4= dislike slightly, 3= dislike moderately, 2= dislike very much, 1= dislike extremely) (Lim, 2011). The sensory analysis of the buckwheat noodles was performed by the trained 10 (ten) panel judges, Selected from the staff members of the Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR). The experimental noodles were served to the panel judges for the evaluation of taste, color, texture, flavor and overall acceptability based on the nine point hedonic scale.

Statistical analysis

All experiments were carried out in triplicate. The results were analyzed using Statistical Package for the Social Sciences (SPSS version 15.0 SPSS Inc. Chicago, Illinois, USA). Values were expressed as percentage and mean ± SD. One-way ANOVA was used for determining the significance/non significance of results. Means were separated using t-test.

Results and discussion

Proximate composition and mineral analysis of developed buckwheat noodles

The nutritional composition of buckwheat noodles using four different percentages of buckwheat flour was shown in Table II.It was found that the moisture (between 11.37% and 10.91%) and carbohydrate content (between 74.1% and 68.60%) of the newly developed buckwheat noodles were decreased while the ash (between 1.89% and 2.16%), protein (between12.04% and 17.04%), fat (between 0.46% and 0.78%) and fiber (between 0.16% and 0.55%) content were gradually augmented with the increasing percentage of buckwheat flour (Table II). The highest ash, protein, fat and fiber content was found for treatment N4 (2.16%, 17.04%, 0.78% and 0.55% respectively) while least for control N0 (1.89%, 12.04%,0.46% and 0.16% respectively).

The highest moisture content was found for control N0 (11.37%) while least for treatment N4 (10.91%). The moisture content for other treatments N1, N2, N3 were found to be 11.26%, 11.14% and 10.94% respectively. The moisture content was gradually decreased by increasing the buckwheat flour concentration in noodles. According to Baljeet *et al.* (2010), the lower moisture content of buckwheat noodles could be attributed to the presence of lower amount of hydrophilic constituents in buckwheat flour. The highest fat content was found for treatment N4 (0.55%) and least for control N0 (0.46%). Increasing the substitution of wheat flour by buckwheat flour slightly increased the total

fat content of noodles sample. The highest fiber content was found for treatment N4 (0.55%) while least for control N0 (0.16%). The fiber content for other treatments N1, N2 and N3 were found to be 0.23%, 0.35% and 0.46% respectively. The carbohydrate content was found to be highest for control N0 (74.10%) while least for treatment N4 (68.60 %). The carbohydrate content for other treatments N1, N2 and N3 were found to be 72.60%, 70.60% and 69.70 % respectively. The decreased value of this parameter was due to the gradual incorporation of buckwheat flour into the noodles which contains higher amounts of protein, fat and fiber than wheat flour supported by the studies of Costantini *et al.* (2014). Energy value was almost similar among the experimentally developed noodles as shown in Table II.

Table II. Proximate analysis and mineral contents of buckwheat flour (BWF) fortified noodles

Sample	Moist. %	Ash %	Prot. %	Fat %	Fiber %	Carbohydrate %	Energy Kcal/100g	Na (mg/100g)	K (mg/100g)	Ca (mg/100g)	Fe (mg/100g)
Control	11.37 ±0.02^{a}	1.89 ±0.10^{e}	12.04 ±0.04^{e}	0.46 ±0.02^{e}	0.16 ±0.01^{e}	74.1 ±0.05^{a}	349.0 ±0.1^{a}	353.8 ±1.23^{e}	83.4 ±0.73^{e}	31.5 ±0.33^{d}	3.32 ±0.29^{b}
N1	11.26 ±0.03^{b}	1.95 ±0.01^{d}	13.45 ±0.02^{d}	0.55 ±0.01^{d}	0.23 ±0.02^{d}	72.6 ±0.04^{b}	349.2 ±0.24^{a}	488.9 ±1.03^{d}	140.1 ±0.93^{d}	32.61 ±0.46^{c}	4.31 ±0.55^{a}
N2	11.14 ±0.03^{c}	1.99 ±0.02^{c}	15.28 ±0.02^{c}	0.61 ±0.02^{c}	0.35 ±0.03^{c}	70.6 ±0.07^{c}	349.5 ±0.46^{a}	531.0 ±1.0^{c}	175.7 ±2.0^{c}	32.93 ±1.34^{b}	5.59 ±0.41^{a}
N3	10.94 ±0.01^{d}	2.08 ±0.03^{b}	16.13 ±0.02^{b}	0.67 ±0.01^{b}	0.46 ±0.02^{b}	69.7 ±0.05^{d}	349.3 ±0.58^{a}	622.9 ±1.64^{b}	265.6 ±2.0^{b}	34.71 ±0.49^{a}	6.34 ±0.29^{a}
N4	10.91 ±0.01^{d}	2.16 ±0.02^{a}	17.04 ±0.04^{a}	0.78 ±0.02^{a}	0.55 ±0.02^{a}	68.6 ±0.05^{e}	349.3 ±0.58^{a}	735.9 ±0.32^{a}	363.7 ±1.81^{a}	35.79 ±0.30^{a}	6.56 ±0.39^{a}

Control (N0) = WF, N1=10% BWF; N2= 20% BWF; N3=30% BWF; N4= 40% BWF
Values are means of triplicates± standard deviation. Values with the same superscript in a column are not significantly different (p> 0.05)

The mineral contents (Na, K, Ca and Fe) were concurrently increased with the gradual substitution of wheat flour by buckwheat flour (up to 40%) in noodles preparation (Table-II). The highest sodium (Na) content was found for treatment N4 (735.9mg/100g) while least for control N0 (353.80mg/100g). The sodium content for other treatments N1, N2 and N3 were found to be 488.9mg/100g, 531mg/100g and 622.9mg/100g respectively. The highest potassium content was found for treatment N4 (363.70mg/1000g) while least for control N0 (83.40mg/100g). The potassium content for other treatments N1, N2 and N3 were found to be 140.10mg/100g, 175.70mg/100g and 265.60mg/100g respectively. The highest calcium (Ca) content was found for treatment N4 (35.79mg/100g) while least for control N0 (31.50mg/100g). The calcium content for other treatments N1, N2 and N3 were found to be 32.61mg/100g, 32.93mg/100g and 34.71mg/100g respectively. The highest iron (Fe) content was found for treatment N4 (6.56mg/100g) while least for control N0 (3.32mg/100g). The iron content for other treatments N1, N2 and N3 were found to be 4.31mg/100g, 5.59mg/100g and 6.34mg/100g respectively. These findings showed that the nutritional quality of buckwheat noodles was increased by increasing the percentage of buckwheat flour and lowering the percentage of wheat flour.

Sensory evaluation of developed buckwheat noodles

Sensory analysis is an integral part of the development of products that fulfill consumer expectations. Table IV depicts the effects of buckwheat flour incorporation on the sensory characteristics of noodles.

The color and appearance is one of the most essential sensory attributes which affects consumer's perception of other parameters such as taste, flavor, texture, etc. In the present study, the mean score for color and appearance was ranged

from 8.0 to 8.85 and highest score was found in control N0 (8.85) while least in treatment N4 (8.00). The gradual addition of buckwheat flour by 10%, 20%, 30% and 40% concentration in noodles preparation caused reducing the mean score for color and appearance as the flour had lower lightness and higher yellowness and redness value compared to control sample also supported by the studies of Rayas-Duarte *et al. (*1996). For other treatments, N1, N2 and N3 it was found to be 8.70, 8.65 and 8.50 respectively.

Table III. Comparison of nutritional composition of developed buckwheat noodles (N3) with locally available different branded noodles

Sample	Moist. %	Ash, %	Prot. %	Fat, %	Fiber, %	Carbohydrate, %	Energy, Kcal/100g	Na (mg/100g)	K (mg/100g)	Fe (mg/100g)	Ca (mg/100g)
N3	10.94 ±0.10^{b}	2.08 ±0.026^{c}	16.13 ±0.0.02^{a}	0.67 ±0.010^{f}	0.46± 0.021^{a}	69.72 ±0.49^{e}	349.3 ±0.58^{f}	622.9 ±1.64^{a}	265.6 ±2.0^{a}	6.34 ±0.29^{a}	34.71 ±0.49^{a}
S1	10.64 ±0.15^{c}	1.92 ±0.025^{e}	12.44 ±0.015^{f}	1.74 ±0.015^{b}	0.090 ±0.010^{e}	73.17 ±0.061^{d}	358.0 ±1.0^{d}	493.7 ±2.36^{d}	140.9 ±0.29^{g}	2.85 ±0.27^{c}	16.55 ±0.44^{c}
S2	9.80 ±0.015^{d}	1.69 ±0.006^{f}	12.19 ±0.015^{g}	1.90 ±0.010^{a}	0.15 ±0.015^{d}	74.27 ±0.072^{c}	362.7 ±0.58^{b}	487.5 ±0.45^{e}	181.2 ±0.33^{d}	3.08 ±0.17^{c}	14.87 ±0.25^{d}
S3	9.78 ±0.02^{d}	1.71 ±0.010^{f}	13.7 ±0.010^{b}	1.39 ±0.01^{c}	0.28 ±0.010^{b}	73.14 ±0.06^{d}	360.0 ±1.0^{c}	554.6 ±4.72^{b}	188.3 ±1.09^{b}	3.35 ±0.05^{b}	11.15 ±0.04^{f}
S4	7.20 ±0.01^{f}	1.40 ±0.010^{g}	11.31 ±0.015^{i}	1.38 ±0.010^{c}	0.29 ±0.015^{b}	78.42 ±0.015^{a}	371.0 ±1.0^{a}	471.5 ±0.55^{f}	183.0 ±0.71^{c}	3.38 ±0.03^{b}	11.16 ±0.04^{f}
S5	6.63 ±0.15^{g}	0.85 ±0.010^{h}	13.49 ±0.015^{c}	0.77 ±0.010^{e}	0.18 ±0.020^{c}	78.08 ±0.066^{a}	373.0 ±1.0^{a}	389.4 ±0.61^{h}	103.2 ±1.77^{i}	2.87 ±0.24^{c}	20.06 ±0.02^{b}
S6	9.54 ±0.031^{a}	1.76 ±0.015^{a}	11.95 ±0.025^{h}	0.76 ±0.021^{e}	0.13 ±0.020^{d}	75.86 ±0.047^{b}	358.08 ±0.58^{a}	387.7 ±0.46^{h}	117.2 ±0.29^{h}	1.77 ±0.02^{e}	20.23 ±0.02^{b}
S7	6.13 ±0.020^{h}	1.96 ±0.031^{d}	13.06 ±0.020^{e}	0.85 ±0.042^{d}	0.14 ±0.021^{d}	77.86 ±0.047^{b}	371.3 ±0.5^{a}	535.5 ±0.36^{c}	153.8 ±0.31^{f}	3.45 ±0.04^{b}	12.18 ±0.02^{e}
S8	9.39 ±0.010^{e}	1.72 ±0.010^{b}	13.32 ±0.025^{d}	0.82 ±0.010^{d}	0.12 ±0.010^{d}	74.63 ±0.065^{d}	359.18 ±1.0^{e}	435.1 ±0.02^{g}	167.1 ±0.06^{e}	2.15 ±0.14^{d}	12.25 ±0.025^{e}

Here, S1, S2, S3, S4, S5, S6, S7 and S8 are specified as locally available different branded noodles.
Values are means of triplicates± standard deviation. Values with the same superscript in a column are not significantly different (p> 0.05)

Table IV. Sensory attributes of developed noodles prepared with different levels of buckwheat flour (BWF)

Treatments	Color and appearance	Texture	Taste	Flavor	Overall acceptance
Control (N0)	8.85 ±0.04^{a}	8.80 ±0.05^{a}	8.00 ±0.05^{a}	7.80 ±0.04^{a}	8.37 ±0.05^{a}
N1	8.70 ±0.02^{b}	8.63 ±0.08^{b}	8.10 ±0.04^{b}	7.90 ±0.04^{b}	8.10 ±0.04^{b}
N2	8.65 ±0.03^{c}	8.30 ±0.05^{c}	8.35 ±0.05^{c}	8.10 ±0.03^{c}	8.00 ±0.05^{c}
N3	8.50 ±0.03^{d}	8.28 ±0.05^{d}	8.50 ±0.03^{d}	8.25 ±0.04^{d}	8.27 ±0.06^{d}
N4	8.00 ±0.03^{e}	7.50 ±0.03^{e}	7.80 ±0.03^{e}	8.40 ±0.02^{e}	7.90 ±0.04^{e}

(N0) = WF, N1=10% BWF; N2= 20% BWF; N3=30% BWF; N4= 40% BWF
Values are means of triplicates± standard deviation. Values with the same superscript in a column are not significantly different (p> 0.05)

Food texture is also a key factor in the sensory evaluation of food quality, which is often used to determine the freshness of food. In the present study, the textural properties of the buckwheat flour fortified noodles were found decreasing with the increasing amount of buckwheat flour and highest score for textural properties was found for control, N0 (8.80) while least for treatment N4 (7.50). It was due to the formation of cracks with the gradual addition of gluten free buckwheat flour into the formulation of noodles. The use of less glutinous composite flours in noodle preparation reduced the textural strength of noodles where such strength is dependent upon approximate levels of gluten development. The mean score for texture of other treatments N1, N2 and N3 were found to be 8.63, 8.30 and 8.28 respectively (Table IV).

Taste is also an important factor which determines the acceptability of any product. In the present investigation, the mean score of taste was found highest for treatment N3 (8.50) and was reduced significantly to 7.80 for treatment N4, possibly due to presence of flavonoid compound (rutin) having bitter taste in buckwheat flour (Christa *et al*., 2008). For other treatments , N0, N1 and N2 , the mean scores were found to be 8.00, 8.10 and 8.35 respectively.

The flavor of the noodles samples varied significantly between 7.80 and 8.40. Highest mean score for flavor was reported for N4 (8.40) while least for control N0 (7.8). The mean scores for other treatments, N1, N2 and N3 were found to be 7.90, 8.10 and 8.25 respectively.

In terms of overall acceptability, control N0 (8.37) and treatment N3 (8.27) showed a significantly higher mean score compared to treatment N1 (8.10), N2 (8.00) and N4 (7.90). Based on organoleptic evaluation, the developed buckwheat noodles formulated with 30% buckwheat flour (N3) was acceptable over the higher level buckwheat flour fortified noodles.

Comparison of nutritional composition of newly developed buckwheat noodles (N3) with locally available noodles

Moisture content

A comparative study of nutritional analysis of 30% buckwheat noodles (N3) and locally available eight branded noodles is shown in Table III. It revealed the moisture content of newly developed buckwheat flour fortified noodles (N3) was higher (10.94%) compared to other local noodles used in the study (Table III). Dried buckwheat flour contains higher fiber content compared to wheat flour, which contributed to the higher water absorption properties of buckwheat fortified noodles.

Ash

Ash content of local noodles was ranged from 0.85% to 1.96% whereas 2.08% was present in the buckwheat flour fortified noodles (N3). This is due to a higher ash percentage of the buckwheat flour compared to wheat flour supported by the studies of Bal jeet *et al.* (2010). As ash is considered as an important indicator of the minerals in food, this study further strengthens the suitability of the developed noodles as a source of micronutrient.

Protein

In this study, the protein content of the buckwheat flour fortified noodles (N3) was found significantly higher (16.13%) than all the locally available noodles used in the study (Table III). The results obtained are in accordance with the findings of Wei *et al*. (1995) where it shows that buckwheat flours contain a large amount of residual protein (average 43%) compared to wheat flour protein (2.7%). The high protein content of buckwheat noodles can make it the most preferable choice for the undernourished people and school going children of the country.

Fat

The fat content of the all local noodles ranged between 0.76% and 1.90% (Table III). It was shown that buckwheat flour fortified noodles (N3) contained lower fat contents (0.67%) compared to eight of the local noodles used in the study. The results obtained are in contradiction with the studies of Bilgiçli (2009), may be due to use of some other ingredients, which contributed to the increase of fat contents of the local noodles in the study.

Fiber

The crude fiber content of the buckwheat supplemented noodles was found to be 0.46% where fiber content of the local noodles was between 0.09% and 0.18% (Table III). Buckwheat flour contains a higher amount of fiber compared to wheat flour which contributes to the higher content of fiber in buckwheat noodles found from the studies of Bilgiçli *et al. (*2009). It was found that dietary fiber from buckwheat flour contains many health benefits such as prevention of diabetics, cardiovascular diseases, constipation, irritable colon cancer etc.

Carbohydrate

The carbohydrate content of eight of the local noodles used in the study ranged between 73.14% and 78.42% which was higher compared to the carbohydrate content of newly

developed 30% buckwheat fortified noodles, N3 (69.72%) (Table III). The lower carbohydrate content of the buckwheat noodles was possibly as a result of less carbohydrate content of buckwheat flour used in the preparation of noodles. Thus, a lower percentage of carbohydrate in buckwheat noodles will be beneficial to health for adults and diabetic patients.

Energy value

The energy value of the newly developed buckwheat fortified noodles (N3) was found 349 Kcal/100g which was slightly lower than the locally available noodles that ranged from 355-373 Kcal/100g. This is because of the lower fat content of the buckwheat flour which contributed to the decreased energy value of buckwheat noodles compared to the local noodles used in the study.

Comparison of minerals content of developed buckwheat and locally available noodles

Buckwheat noodles (N3) contained higher minerals content (sodium, potassium, calcium and iron) compared to other local varieties of noodles used in the study (Table-III). The sodium (Na), potassium (K), iron (Fe) and calcium (Ca) content of buckwheat noodles were 622.9 mg/100g, 265.60 mg/100g, 6.34 mg/100g and 34.71 mg/100g respectively. Among the local varieties, S3 and S7 contained higher sodium (Na) contents (554.60 mg/100g and 535.50 mg/100g respectively) compared to other samples of noodles. The potassium content of local noodles (S1-S8) were ranged from 103.20 mg/100g to 188.30 mg/100g which was lower than the potassium (K) content of 30% buckwheat supplemented noodles (265.60 mg/100g). The iron content of buckwheat noodles was also found higher (6.34mg/100g) than the local noodles (S1-S8) which were ranged from 1.77 mg/100g to 3.45 mg/100g. Calcium contents of local noodles were ranged between 11.15 mg/100g and 16.55mg/100g which was lower compared to the calcium content of 30% buckwheat supplemented noodles (34.71mg/100g). The comparative study of four essential mineral contents (Na, K, Ca and Fe) between 30% buckwheat noodles and eight of the local noodles indicates that buckwheat flour contains higher amount of minerals compared to other local flour used for noodles preparation.

Conclusion

The incorporation of buckwheat flour in noodles formation augmented the nutritional and sensory properties of this product. Gradual addition of buckwheat flour by 10%, 20%, 30% and 40% concentration increased the ash, protein, fiber and mineral (Na, K, Fe and Ca) contents and decreased the moisture and carbohydrate contents of noodles. Based on the biochemical and sensory analysis, it can be concluded that noodles formulated with 30% substitution of wheat flour with buckwheat flour is acceptable in quality and it is nutritionally superior over locally available noodles. These findings of the present study may help in developing commercial processing technology for effective utilization of buckwheat flour specially in the manufacturing of noodles.

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