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Research Article

PHYSIOCHEMICAL AND NUTRITIONAL PROPERTIES OF BUCK WHEAT FLOUR AND IT'S PRODUCTS

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ABSTRACT

Fagopyrum esculantum (Family: Polygonaceae) commonly known as Buckwheat has variety of beneficial properties and its gluten free nature plays an important role in prevention of celiac diseases. Other health benefits of buckwheat include antihypertensive, antihyperlipidemic, anti-diabetic, anticancer and anti-inflammatory properties. In the present study, the water absorption capacity of buckwheat flour was found lower than that of refined wheat flour, whereas oil absorption capacity of buckwheat flour was found higher than that of refined wheat flour. From proximate analysis, the content of moisture, ash, carbohydrates, fats, proteins, crude-fiber, iron, magnesium were recorded in terms of percentage as 11.5, 1.85, 70.8, 5.31, 10.43, 5.23, 1.85 and 1.62 respectively. The energy content of buckwheat flour was calculated to be around 373 kJ. Statistical analysis showed that bread prepared with 70 % buckwheat flour, biscuits prepared with 25 % buckwheat flour and idly prepared with 50 % buckwheat flour has maximum scores in overall acceptability.

INTRODUCTION

As a prelude to identify antihypertensive food rather than antihypertensive drug because of less or no side effects, Buckwheat (Fagopyrum esculatum) from the family Polygonaceae, was considered as one of the ingredient as potential antihypertensive food. There are considerable number of reports concerning its blood pressure lowering effect of Buckwheat has been reported (Guang *et al*.2009; Chen *et al* 2009). Buckwheat seeds are commonly eaten in Asia and Western countries in the form of groats. The leaves and stems of the buckwheat are also edible and have been used as a traditional medicine in eastern Asia (Ushida *et al*. 2008).

Bread is most important, affordable and easy snacking food which came into existence thousands of years ago. It was introduced as a bakery product by Egyptians over 12000 BC. It is known to be the most convenient and accepted food in the world (Ijah *et al*. 2014). The texture of the bread is generally soft and color of the loaf is generally light brown, shiny, indicating even baking. Strains of the yeast i.e. Saccharomyces cerevisiae are being used, which reproduce by budding and raise the dough. This is brought about by the action of enzymes called amylase, which act on starch to form maltose. Yeast use the maltose for their own growth and reproduction and release carbon dioxide, which raises the dough. In the past, many of the experiments were conducted to improve the nutritional value of bread like rich in fiber, sugar free, antioxidant rich bread and fat free breads. The renewed costumer's interest in the consumption of nutritional value is the key lead to health benefit. The use of white flour derived from the processing of whole wheat grain aimed at improving the aesthetic value of white bread, has led to drastic reduction in the nutritional density and fiber content of white bread (Jain *et al*. 2017). Therefore in the present study, buckwheat flour has been tried in making few of the edible products like bread, biscuits, and idly with an aim to increase nutritional and therapeutic benefits

MATERIALS AND METHODS

Raw Material

Wheat flour, buckwheat grains, salt, sugar, refined wheat flour, samolina and oil (Dhara) were procured from local markets of Lucknow, UP. Buckwheat grains was washed many times with tap water to remove all the rodents adhered on it, then powdered into fine flour. The presence of larvae, grit, rodents & weevils in buckwheat flour are checked by (FSSAI 2016 manual method) whereas the presence of synthetic color is tested according to (Brazeau *et al*.2018).

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Formulation of Bread

The common ingredients used for making bread (milk powder, oil, sugar and yeast powder) were the same in all the bread preparations unless and until specified (Table 1). The wheat flour was partially replaced by buckwheat flour by adding 30, 50 70 and 100 %, respectively. Each batch of the prepared bread was tested on hedonic scale and analyzed for various nutrients and energy value.

Table 1 Different combination of bread

Batch	Wheat Flour (g)	Buckwheat Flour (g)	Vegetable Oil (g)	Yeast (g)	Salt (g)	Sugar (g)	Milk Powder (g)
BWB1	100	-	6	3	1	5	5
BWB2	70	30	6	3	1	5	5
BWB3	50	50	6	3	1	5	5
BWB4	30	70	6	3	1	5	5
BWB5	-	100	6	3	1	5	5

The ingredients used for the preparation were analyzed for both physical and chemical properties. Five breads have been prepared containing 30%, 50%, 70%, 100% and 0% of buckwheat flour in combination with refined wheat flour. All the prepared breads were subjected to sensory evaluation to optimize different sensory attributes (color, texture, taste, flavor and overall acceptability) and based on sensory evaluation the best combination was selected, the final bread was prepared and was subjected to further analyses.

Formation of Biscuits

The biscuits were prepared with incorporation of refined wheat flour and buckwheat flour in various proportions i.e. 3:1, 2:2 and 1:3 keeping sugar (30 g), milk (10g) and oil (20 g) amount constant in a total of 100 g powder. Fat and ground sugar were creamed in a mixer with a flat beater for 2 min at low speed. The biscuits were cut to desired diameter of 50 mm and transferred to a lightly greased aluminum baking tray. The biscuits were baked at 190 degree centigrade for 12 min a baking oven. The baked biscuits were cooled and stored in an air tight contained for further use.

Table 2 Different combination of biscuits

Ingredients	Refined Wheat flour (g)	Buckwheat Flour (g)	Sugar (g)	Oil (g)	Milk powder (g)
BWBS1	100	-	30	20	10
BWBS2	75	25	30	2	10
BWBS3	50	50	30	2	10
BWBS4	25	75	30	20	10

Formation of idly

Idly were prepared by incorporation of semolina and buckwheat in the same proportions as biscuits. Idly dough were prepared by adding semolina and buckwheat flours with curd and water. This batter is soaked for 6 hours after fermentation was spooned onto well-greased idly moulds. The idlys were than steamed in an idly cooker for 20 min.

Table 3 Different combination of idly

Ingredients	Semolina (g)	Buck wheat (g)	Curd (g)
BWI_1	100	Nil	30
BWI_2	75	25	30
BWI_3	50	50	30
BWI_4	25	75	30

Proximate Analysis of buckwheat

Moisture Content

5.0 gram of the bread sample was oven dried at 110 C for 4 to 5 hrs. The oven dried samples were cooled in desiccators and reweighed; this drying process was continued until the constant weight were obtained. The resultant loss in weight was calculated as percent moisture content. (A.O.A.C., 2005).
Moisture (%) = (Loss in weight)/ (Weight of sample) x 100

Crude Fat content

5.0 gram of sample was taken and defatted with n-hexane (boiling point 68- 72^o C) in Soxhlet apparatus for 8 hrs. The resultant extract was evaporated to dryness and crude fat content was calculated as per A.O.A.C. 2005) method.

Crude protein content

Protein was estimated by Microkjeldhal method. Moisture free deflated 0.5 gram of sample was digested with concentrated Sulphuric acid at 130-140˚C. After that it was distilled with 40% sodium hydroxide solution, ammonia liberated was trapped in 4.0 % boric acid and then titrated with 0.1 N hydrochloric acid. The percent nitrogen was estimated and Protein content in the sample was calculated by multiplying per cent nitrogen by a factor of 6.25.(A.O.A.C.,2005)

Total ash

5.0 gram of the sample was kept in crucible and burnt to low flame till all the material became smokeless. It was kept in muffle furnace for 6.0 hrs at 600° C then cooled in desiccators and weighed. The sample was again put in muffle furnace till two consecutive weights were constant and the percent ash was calculated (A.O.A.C 2005).

Total carbohydrate content

The total carbohydrate content in the 5.0 gram sample was calculated by the following calculation method of AOAC (1995).

Total carbohydrate (%) = 100 – (Crude protein %+Crude fiber % + Crude fat % + Total ash %)

Mineral contents

The minerals such as iron, magnesium were estimated according to the standard methods as described in AOAC (2005) using Atomic Absorption Spectrophotometer (Varian, AA240, Victoria, Australia). 0.5 gram of sample was digested with 10 ml nitric acid at a temperature of 60-70°C for 20 min and then digested with HCl at a temperature of 190°C till the solution became clear. The digested sample was transferred to 250 ml volumetric flask and volume was raised with distilled water and then filtered and loaded into Atomic Absorption Spectrophotometer apparatus. The standard curve was prepared by running samples of known strength through atomic absorption spectrophotometer. The mineral contents of unknown samples were estimated by using the respective standard curve prepared for each mineral.

Functional Properties of flour

Water Absorption Capacity

One gram of sample with 10 ml of water was mixed in 25 ml graduated conical flask. The suspension was allowed to stand at room temperature (30 ± 2 °C) for 1 hr. The suspension was centrifuged at 200 g (2000 rpm) for 30 min. The water

absorption capacity (WAC) was examined as percent water bound per gram flour (Beuchat *et al* 1977).

WAC (ml per g buckwheat flour) = Volume of water absorbed/weight of sample.

Oil Absorption Capacity

One gram of sample was taken with 10 ml of refined vegetable oil was mixed into 25 ml graduated conical flask. The suspension was centrifuged at 200 g (2000 rpm) for 30 min. The volume of the oil on the sediment was measured and the oil absorbed expressed as percent oil absorption based on the original sample weight (Beuchat *et al* 1977).

OAC (ml per g flour) =Volume of fat absorbed/weight of sample

Hedonic Analysis

Sensory evaluation of bread samples was evaluated by nine point hedonic scale.

A semi-trained panel of 20 members was drawn from Era Lucknow Medical College & Hospital for sensory evaluation.

RESULTS AND DISCUSSION

Table 4 depicts that the moisture content and energy value of buckwheat flour (BWF) are slightly higher than that of refined wheat flour (RWF.). The moisture content of buckwheat flour reported here i.e. 11.53 % is in accordance to the earlier studies done by (Bhavsar *et al*. 2013) and Baljeet *et al* 2010)[11] who have reported nearly 11.35 % and 11.60 % respectively. The carbohydrate content of RWF is slightly higher than that of BWF i.e. 76.96 % in RWF as compared to 70.85 % in BWF. The carbohydrate content of buckwheat flour found in the present study i.e. 70.85 % was, however, slightly lower than that obtained by (Baljeet *et al* 2010) i.e.75.74 % but the same as i.e. 70.40% as reported by (Ganesh *et al* 2013).The protein content has been found same in RWF & BWF.i.e.10.43 %. However, the fat, ash, iron, magnesium and crude fiber contents of BWF are found several folds higher than that of RWF. The fat content of buckwheat flour was 5.31% (Table 3). The value is comparable to value of 2.20% reported by (Ganesh *et al* 2013). Fat content of 1.81% was also reported by (Baljeet *et al* 2010).The percent protein of Buckwheat flour was 10.43% (Table 4). This result is comparable to those reported by (Ganesh *et al* 2013) 10.41% and (Baljeet *et al* 2010) 8.73%. The percent Ash content of flour was 1.85% (Table 3). Ash content of 1.42% has been reported by (Baljeet *et al* 2010) and 2.67% has been reported by (Ganesh *et al* 2013). The calorie value (energy) of buckwheat flour was 372.91 kcal/100gm (Table -3). This value is higher than that obtained by (Costantini *et al* 2014) i.e.255% and near about same as i.e.368% as obtained by (Hager *et al* 2012). The percent fiber of buckwheat flour 5.23% (Table 3). The value obtained was higher than that obtained by (Ganesh *et al* 2013), reported value of 1.68%. (Baljeet *et al* 2010) also reported fiber content of 0.70% for buckwheat flour. The iron content of buckwheat flour was 1.85% (Table 3). This value is comparable to value of 2.67% reported by (Ganesh *et al* 2013). Mineral magnesium content of buckwheat flour was 162.5mg/100gm (Table 3) while magnesium content was 252.9 mg/100gm was reported by (Steadman *et al* 2001).

Table 4 Proximate analysis of Refined Wheat Flour (RWF) and Buck Wheat Flour (BWF)

Nutrients	RWF (%)	BWF (%)
Moisture	8.93	11.53
Carbohydrate	76.96	70.85
Fat	1.39	5.31
Protein	10.43	10.43
Ash	0.50	1.85
Energy	343.00	372.91
Crude fiber	1.78	5.23
Iron	0.78	1.85
Magnesium	0.48	162.5

Functional properties of flour

The functional properties of flours play important role in the manufacturing of products & explain how ingredients behave during preparation & cooking. The buckwheat flour (BWF) and refined wheat flour (RWF) were also analyzed for their functional properties. Table 5 presents the water and oil absorption capacities of RWF and BWF. The water absorption capacity of RWF has been found lower for buckwheat flour whereas the fat absorption shows reverse which is found to be higher in RWF compared to BWF.

Table 5 Water and Oil absorption capacity of RWF and BWF

Absorption capacity	RWF(ml/gm)	BWF (ml/gm)
Water absorption (%)	7.90	2.03
Oil absorption (%)	1.69	1.79

The lower water absorption capacity of BWF could be attributed to the presence of lower amounts of hydrophilic constituents in BWF (Akubor *et al*, 2004). The oil absorption capacity of BWF was significantly higher than that of RWF that may be responsible to the mouth feel and longer retainment of the flavor. BWF has higher oil absorption capacity which indicates the presence of more polar amino acid then refined wheat flour (Taira *et. al* 1974)

Functional property

Water absorbtioncapasity –The WAC of BWF was 2.03ml/g (table 2). This value is higher than that obtained by (Bhavsar *et al* 2013) i.e. 1.37.Water absorbtion capacity of buckwheat flour was 1.32ml/g has been reported by (Kaur *et al* 2015) and 1.15 ml/g has been reported by (Sindhu *et al* 2016).

Oil absorption capacity-The OAC of BWF was 1.79 ml/g (table 2). This result is comparable to those reportedby (Maninder *et al* 2014) 1.80 ml/g and (Bhansar *et al* 2013) 1.87ml/g. This result is higher than that optained by (Ritu *et al* 2016) i.e.0.82 ml/g.

Hedonic evaluation

Table 6 presents the hedonic evaluation results of breads containing 0 to 100 % BWF It has been observed that bread prepared with 30 % wheat flour and 70% of buckwheat flour has maximum score.

Considering differences between the groups less than $p<0.005$ as significant, there was found significant difference in bread having various composition of buckwheat flour in refined wheat flour like in appearance ($p<0.023$), color ($p<0.014$), texture ($p<0.012$), odor ($p<0.039$) and taste ($p<0.018$), however there was not found any significance with regard to overall acceptability ($p>0.063$) (Table 7)

Table 6 Statistical evaluation of prepared breads

Properties	BWB1		BWB2		BWB3		BWB4		BWB5		Kruskal Wallis Test	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	chi sq	p-value
Appearance	8.00	0.00	8.00	0.00	7.00	0.00	7.33	0.58	6.67	0.58	11.29	0.023
Color	8.00	0.00	7.00	0.00	6.00	0.00	7.33	0.58	7.00	0.00	12.55	0.014
Texture	8.00	1.00	7.00	0.00	6.00	0.00	8.00	0.00	6.00	0.00	12.81	0.012
Odor	7.33	0.58	7.00	0.00	6.67	0.58	7.67	0.58	6.00	0.00	10.10	0.039
Taste	8.33	0.58	7.67	0.58	7.00	0.00	8.33	0.58	6.00	0.00	11.91	0.018
Overall Acceptability	8.33	0.58	7.67	0.58	6.67	0.58	8.00	1.00	6.67	0.58	8.94	0.063

Table 7 Statistical evaluation of control & buckwheat bread

Properties	BWB1 (Control)		BWB4		Mann Whitney Test	
	Mean	SD	Mean	SD	U-value	p-value
Appearance	8.00	0.00	7.33	0.58	1.50	0.200
Color	8.00	0.00	7.33	0.58	1.50	0.200
Texture	8.00	1.00	8.00	0.00	4.50	1.000
Odor	7.33	0.58	7.67	0.58	3.00	0.700
Taste	8.33	0.58	8.33	0.58	4.50	1.000
Overall Acceptability	8.33	0.58	8.00	1.00	3.50	0.700

There was found significant difference in any of the properties like appearance, color, texture, odor, taste or in overall acceptability between BWB1 and BWB4 ($p>0.05$).

There was found significant differences among various batches of idly containing buck wheat flour. The most notable changes in color ($p<0.001$), taste ($p<0.001$), flavor ($p<0.001$) texture (p,0.002) and overall acceptability ($p<0.001$).

There was found significant difference in the color of control BWI3, BWI4, Where in taste significant difference was observed between control & BWI2, BWI4, in flavor significant difference were found between control, BWI2 & BWI4, in texture the significant difference were found among all the batches of idly. However, in overall acceptability the significant difference were found between control & BWI2, BWI4.only.

Table 8 Statistical evaluation of control and buck wheat flour containing biscuits

Properties	Color		Taste		Flavor		Texture		Overall acceptability	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
BWBS1	8.00	0.00	8.00	0.00	8.00	0.00	8.00	0.00	8.00	0.00
BWBS2	7.80	0.45	7.40	0.89	7.20	0.84	6.60	0.89	7.40	0.89
BWBS3	7.00	0.71	6.40	1.14	6.40	0.89	6.80	0.84	6.80	1.30
BWBS4	6.20	0.84	5.80	1.30	6.00	1.41	5.80	1.64	6.20	1.64
Kruskal Wallis Test	13.34		10.54		11.45		9.76		6.59	
p-value	0.004		0.014		0.010		0.021		0.086	

There was found significant differences between various types of buckwheat biscuits compared to control biscuits containing refined wheat flour only like in color ($p <0.004$), taste ($p<0.014$), flavor ($p<0.010$) and texture ($p<0.021$) but not in overall acceptability ($p<0.086$) (Table 8)

Table 9 Statistical evaluation of control & other buckwheat biscuits

Properties	Batch	Mean	SD	U-value!	p-value
Color	BWBS1	8.00	0.00	Ref.	
	BWBS2	7.80	0.45	10.00	0.690
	BWBS3	7.00	0.71	2.50	0.032
	BWBS4	6.20	0.84	0.00	0.008
Taste	BWBS1	8.00	0.00	Ref.	
	BWBS2	7.40	0.89	7.50	0.310
	BWBS3	6.40	1.14	2.50	0.032
	BWBS4	5.80	1.30	0.00	0.008
Flavor	BWBS1	8.00	0.00	Ref.	
	BWBS2	7.20	0.84	5.00	0.151
	BWBS3	6.40	0.89	0.00	0.008
	BWBS4	6.00	1.41	0.00	0.008
Texture	BWBS1	8.00	0.00	Ref.	
	BWBS2	6.60	0.89	2.50	0.032
	BWBS3	6.80	0.84	2.50	0.032
	BWBS4	5.80	1.64	0.00	0.008
Overall acceptability	BWBS1	8.00	0.00	Ref.	
	BWBS2	7.40	0.89	7.50	0.310
	BWBS3	6.80	1.30	5.00	0.151
	BWBS4	6.20	1.64	2.50	0.032

There was found significant difference in color, taste and flavor between control and BWBS3,and BWBS4. However considering texture there was found significant difference among each biscuits. The overall acceptability of control & BWBS4 as also found significant. (Table 9).

Table 10 Statistical evaluation of various batches of Idly

Batch	Color		Taste		Flavor		Texture		Overall acceptability	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
BWI 1	8.00	0.00	8.00	0.00	8.00	0.00	8.00	0.00	8.00	0.00
BWI 2	7.00	1.00	6.57	0.53	6.71	0.76	7.00	0.58	6.71	0.49
BWI 3	6.86	0.69	7.43	0.98	7.43	0.53	7.29	0.49	7.71	0.49
BWI 4	5.29	0.49	6.14	0.90	5.57	0.79	6.14	1.07	5.71	0.49
Kruskal Wallis Test	19.24		16.39		19.49		15.07		23.22	
p-value	<0.001		0.001		<0.001		0.002		<0.001	

Table 11 Statistical evaluation of various batches of idly

Properties	Batch	Mean	SD	U-value	p-value
Color	BWI 1	8.00	0.00	Ref.	
	BWI 2	7.00	1.00	10.50	0.073
	BWI 3	6.86	0.69	3.50	0.004
	BWI 4	5.29	0.49	0.00	0.001
Taste	BWI 1	8.00	0.00	Ref.	
	BWI 2	6.57	0.53	0.00	0.001
	BWI 3	7.43	0.98	17.50	0.383
	BWI 4	6.14	0.90	0.00	0.001
Flavor	BWI 1	8.00	0.00	Ref.	
	BWI 2	6.71	0.76	3.50	0.004
	BWI 3	7.43	0.53	10.50	0.073
	BWI 4	5.57	0.79	0.00	0.001
Texture	BWI 1	8.00	0.00	Ref.	
	BWI 2	7.00	0.58	3.50	0.004
	BWI 3	7.29	0.49	7.00	0.026
	BWI 4	6.14	1.07	3.50	0.004
Overall acceptability	BWI 1	8.00	0.00	Ref.	
	BWI 2	6.71	0.49	0.00	0.001
	BWI 3	7.71	0.49	17.50	0.383
	BWI 4	5.71	0.49	0.00	0.001

SUMMARY AND CONCLUSION

Sensory evaluation was done with each concentration of the bread, biscuits and idly to know the better product among them and the points included for evaluation are Appearance, odor, taste, flavor, texture and overall acceptability by 20 panelists. From the analysis it is concluded that the incorporation of 70%,25%,50% of buckwheat for bread ,biscuits and idly will be more acceptable by the consumers and will have nutritional properties.

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