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Nutraceutical Rich Buckwheat *upma* Formulation for Nutrition Security

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ABSTRACT: Buckwheat (*Fagopyrum esculentum*) an annual crop, is a pseudo cereal and member of polygonaceae family. Upma is a traditional Indian breakfast dish, cooked as a thick porridge from dry roasted semolina. Buckwheat varieties PRB-1, Nelagiri along with bread wheat variety as control were procured from Agricultural University, Dharwad. The buckwheat varieties were analyzed for nutraceutical content and utilization of buckwheat in upma. Buckwheat groats were cleaned and milled by scientific miller to obtain dehusked grain. Further grains made into semolina to develop buckwheat incorporated Upma. Upma was prepared from semolina with incorporation of buckwheat semolina at 25, 50, 75 and 100 per cent in bread wheat semolina. Buckwheat and bread wheat semolina were roasted. Seasoning was done along with cut vegetables and other ingredients. Two hundred ml of water added 100 gm of upma preparation. Contents were cooked for 8-10 min and 15 trained panel members for sensory parameters evaluated upma. Among the proximate composition Nelageri, variety semolina had highest fat (1.87), protein (18.78) and ash (3.66) g/100 g contents compare to control. Analysis of nutraceutical contents revealed that PRB-1 variety had significantly highest polyphenol (614.19 mg/100 g) and vit-E (54.53 µg/100 g). Total dietary fiber found to be highest in Nelagiri variety (14.44 g %). Sensory scores of upma with 25 per cent buckwheat semolina had significantly higher scores of appearance, color, flavor, taste; texture overall acceptability and acceptability index. Computed nutritive value of highly accepted 25 per cent buckwheat incorporated upma had protein, fat, crude fiber and minerals. This could be new product development from Buckwheat semolina, which contributes health benefits for general health and particular to celiac patients.

Keywords: Upma, Buckwheat, Nelagiri, Nutraceutical, Sensory scores.

INTRODUCTION

Buckwheat (*Fagopyrum esculentum*) an annum crop, is a gluten free pseudo cereal and member of polygonaceae family. This ancient crop was first cultivated in China. It is widely produced in Russia and Poland. Buckwheat is commercially cultivated in United States, Canada and France. About 2.11 million ha of buckwheat was sown worldwide in 2010-11. Its world production is 2.4 million tons in 2016, led by Russia with 50 per cent of the world total and China with 17 per cent (Alviola *et al.,* 2018). Among the identified nine different varieties of buckwheat species, two buckwheat species *viz.,* common buckwheat (*F. esculentum*) and tartary buckwheat (*F. tartaricum*) are commonly cultivated and used for food preparation around the world (Li and Zhang 2001). The characteristics and structure of buckwheat grains are quite different from wheat grain. In spite of its name, buckwheat does not contain any wheat or the protein-gluten. It contains 67-75% starch, 7-21% protein, 1.2-4.3% lipids, and appreciable amount of dietary fiber and minerals (Przybylski and Gruczynska 2009). Compared to other grains, the major benefit of buckwheat is, it is gluten free and has unique amino acid composition, which gives special biological activities including cholesterol-lowering, anti-hypertensive and improving digestion by relieving constipation. Today, buckwheat is a favored amongst plant-based and gluten-free grain. It could therefore be used as an alternative for wheat in gluten-free diets for celiac patients (Thakur, 2011).

Upma is a traditional Indian breakfast dish, cooked as a thick porridge from dry roasted semolina. Various seasonings and vegetables are often added during cooking depending on individual preferences. The indigenous instant food products are prepared at home since ages, but due to the availability of wide range of instant food products in recent years, the consumers are more keen to use the products available in the market using convenient packages at reasonable rate (Yadav and Sharma, 2008). Though the physiological importance of pseudo cereal is laid since ancient times, the proximate principles, antioxidant activity and nutraceutical content of buckwheat studies are in vague and also utilization of buckwheat in traditional and convenience food products are rare. Hence, the present study has been carried out to examine the nutraceutical content of buckwheat and its utilization in *upma* preparation

MATERIAL AND METHODS

The experiment was conducted at department of Food Science and Nutrition, University of Agricultural Sciences, Dharwad. Buckwheat grains were procured from AICRP Wheat scheme, MARS, UAS, and Dharwad. Buckwheat varieties namely Nelageri, PRB-1 and along with bread wheat as control were taken for the study. Grains were cleaned for extraneous matter and milled to obtain semolina. Particle size of 212 µm used to obtain semolina and used in the preparation of *upma*. Whole buckwheat plant, flower, Grain, Husk, edible seed were represented in Fig. 1.

Proximate principles. Buckwheat semolina will be analyzed for proximate principles *viz*, moisture, protein, fat, crude fiber and ash by standard AOAC methods (Anon., 2005). Moisture was determined by oven dehydration method at 105°C up to the constant weight. Crude protein was determined by using Kjeldhal method, crude fat was determined by ether extraction method using sohxlet. Crude fiber was determined by acid digestion and alkali digestion method. Ash content was determined in mufflefurnace at 550°C for 6 hours. The carbohydrate content was calculated by difference method and energy value was computed using factor 4, 4 and9 for carbohydrate, protein and fat respectively. Gluten content was also analyzed.

Nutraceutical content. Nutraceutical *viz.*, antioxidant activity, polyphenol, Vitamin-E and total dietary fiber were analyzed by standard procedures.

Antioxidant activity: Antioxidant activity determined by DPPH method (Sridevi *et al.,* 2010).

Total polyphenols: Total Polyphenols in sorghum samples was analyzed by Follin-Ciocalteau Reagent method (Sadasivam and Manickam 2008) using catechol as the standard.

Dietary fiber (g/100g): Soluble, insoluble and total components of dietary fibre were estimated from defatted sorghum samples by enzymatic–gravimetric method (Amerine *et al.,* 1965).

$$\frac{\text{SDF}}{\text{IDF}} = \frac{\text{Weight of crucible with fi} \quad \text{containing ash (b)} - \text{Weight of the crucible after ashing (c)}}{\text{Weight of sample (a)}} \times 100$$

TDF = SDF + IDF

Vitamin E: vitamin E determined by spectrophotometric method (Zhang *et al.,* 2017)

Buckwheat upma: Buckwheat groats were cleaned and milled by to obtain dehusked grain. Further grains made into semolina to develop buckwheat incorporated *Upma. Upma* was prepared from semolina with incorporation of buckwheat semolina at 25, 50, 75 and 100 per cent in bread wheat semolina. Buckwheat and bread wheat semolina were roasted. Seasoning was done along with cut vegetables and other ingredients. Water was added to seasoning. Mix roasted semolina in boiling water. Cook the contents for 8-10 min and upma.

Sensory evaluation: By trained panelists using 9-point hedonic scale. Statistical analysis: The mean ± standard deviation and one-way ANOVA (Fisher *et al.,* 1963).

Nutritive value computation: Nutritive value of buckwheat upma was computed by using Indian Food Composition Table (Gopalan *et al.,* 2017)

RESULTS

The moisture, fat, protein, ash, crude fiber, carbohydrates and energy values of buckwheat varieties constitute the proximate principles Table 1.When buckwheat varieties were compared to bread wheat variety: PRB-1 with bread wheat, the bread wheat had higher moisture (16.54 g %) while PRB-1 variety had high protein (15.28 g), ash (3.12 g) and energy (348 Kcal). Compared with bread wheat, Nelagiri variety had significantly ($p<0.01$) high protein (18.78 g %), ash (3.66 g %) and crude fiber (1.37 g %), while bread wheat had higher carbohydrates (68.26 g %). The difference in proximate composition might be associated with varietal differences, variation in agronomical practices and fertilizer application. The composition of seeds also vary depending on the source of seed material, genetic and environmental factors, processing of the seed, laboratory conditions, reagents, modification of the method, pesticides used etc (Jindal, 2016).

Nutraceutical content buckwheat semolina is represented in the Table 2. The antioxidant activity of buckwheat varieties ranged from (85.36 to 95.69 %). Bread wheat had lowest polyphenol content (252.95 mg/100 g) compared to buckwheat varieties, the results differ significantly ($p<0.01$). PRB-1 variety had highest vit-E content of (54.53 µg/100 g). Insoluble dietary fiber content of buckwheat varieties and bread wheat ranged from 9.71 to 11.56 per cent while 9.71 per cent

in bread wheat. Nelagiri had highest soluble dietary fiber content (2.88 %) compared to PRB-1 variety (2.13 %). Total dietary fiber content was found to be highest in Nelagiri variety (14.44 %) and PRB-1 (12.94 %) and least was to be found in bread wheat (11.78 %).

Characteristics of buckwheat upma Table 3 revealed that water required to cook 100 g buckwheat upma was 190 ml, which is lesser, compared to 100 per cent bread wheat upma. This might be due to lack of gluten in the buckwheat grains. Increment in buckwheat semolina proportions turned upma to slight sticky and mushy granules with light brown color, which may be attributed for absence of gluten and presence of polyphenol content that imparted change in color. Sensory scores of upma Table 4 with 25 per cent buckwheat semolina had significantly higher scores of appearance, color, flavor, taste, texture overall acceptability and acceptability index 8.20, 8.00, 7.80, 7.60, 7.50, 7.60 and 86.48 respectively. Decreased sensory scores with increased addition of buckwheat semolina may be due to change in color of the buckwheat semolina, bland taste which is attributed to high ash content and presence of rutin content in buckwheat (Jan *et al.*, 2015).

The nutrient composition of buckwheat-incorporated upma is presented in Table 5. The protein, fat, crude fiber and carbohydrate content of 25 per cent buckwheat incorporated upma, which was highly accepted, is depicted in Fig. 2. As the incorporation level of buckwheat semolina in upma increased, the nutrients viz., protein, fat, crude fiber, calcium sodium, potassium, iron, zinc, manganese, copper, thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, histidine, lysine, methionine, cysteine, threonine and tryptophan contents increased, whereas carbohydrates, energy, isoleucine, leucine, phenylalanine and valine contents decreased. Highly accepted 25 per cent buckwheat incorporated upma had protein (16.62), fat (29.67), crude fiber (2.32) g/100 g, minerals viz., calcium (77.63), sodium (20.95), potassium (450), iron (4.24), zinc (3.37), manganese (1.55) and copper (0.95) mg/100 g. vitamin content of buckwheat incorporated upma had thiamine (1.46), riboflavin (0.52), niacin (6.44), pyridoxine (2.27), pantothenic acid (3.49) mg/ 100 g and amino acids viz., histidine (3.88), isoleucine (6.63), leucine (11.55), lysine (6.5), methionine (2.85), cysteine (2.90), phenylalanine (8.62) threonine (6.10), tryptophan (2.06) and valine (8.05) g/ 100 g.

Table 1: Proximate principles (g %) of buckwheat varieties.

Varieties	Moisture	Fat	Protein	Ash	Crude fiber	CHO	Energy (Kcal)
PRB-1	11.19 ±0.88	1.29±0.04	15.28±0.53	3.12±0.01	0.45±0.10	68.65±1.27	348±3.6
Nelagiri	15.73±0.12	1.87±0.28	18.78±0.72	3.66±0.01	1.37±0.56	58.58±1.02	326±3.26
BRW (UAS-304)	16.54±0.99	1.79±0.40	10.1±0.35	2.66±0.01	0.65±0.001	68.26±0.83	329±5.77
t value							
a) PRB-1 X Nelagiri	8.76*	3.40^{NS}	6.70**	80.50**	2.79*	10.64**	7.76**
b) PRB-1 X Bread wheat	6.928**	2.12^{NS}	2.21*	69.50**	3.28^{NS}	7.77^{NS}	4.75*
c) Nelagiri X Bread wheat	1.38^{NS}	0.28^{NS}	5.75**	65.8**	2.21*	5.26**	7.86^{NS}

PRB-1, Nelagiri- Buckwheat varieties, BRW- Bread wheat
Note: ** - Significant at 0.01 per cent level, *- Significant at 0.05 per cent, NS- Non significant

Table 2: Nutraceutical content of buckwheat varieties.

Variety	Antioxidants (%)	Polyphenols (mg/100 g)	Vitamin E (µg/100g)
PRB-1	95.69 ± 1.44^{a}	614.19 ± 5.73^{a}	54.53±1.56^{a}
Nelagiri	91.95 ± 1.34^{a}	552.99 ± 44.18a^{b}	50.33±0.90^{b}
BW	33.01 ± 4.79^{c}	252.95 ± 44.72^{c}	10.82±0.68^{c}
F value	258.015**	35.907**	1053.01**
S Em ±	1.82	26.57	0.63
CD	5.94	86.66	2.06

Note: S.Em: Standard Error of mean, C.D: Critical Difference, ** - Significant at 0.01 per cent level,
*- Significant at 0.05 per cent, Different super scripts within a column indicate significant difference at 0.05 level by DMRT

Table 3: Characteristics of buck wheat *upma.*

Characteristics	Proportions (BRWS:BWS)				
	100:00	**75:25**	**50:50**	**25:75**	**00:100**
Water absorption for cooking (ml)	220	220	200	200	190
Texture	Smooth and separable granules	Smooth and separable granules	Smooth but not separable granules	Slight sticky	Sticky and mushy
Cooking time (min)	25	25	23	20	20
Color	Creamish	Light creamish	Light creamish	Slight brown	Slight brown

BRWS- Bread wheat semolina, BWS- Buckwheat semolina
Particle size- 210 µm

Table 4: Sensory scores of buckwheat upma.

Proportions BRWS: BWS	Appearance	Color	Flavor	Taste	Texture	Overall acceptability	Acceptability index	Ranking
100:00	8.10±0.58[a]	8.20±0.42[a]	7.70±0.48[a]	7.60±0.52[a]	8.10±.32[a]	7.80±.42[a]	87.96	I
75:25	8.20±0.42[a]	8.00±0.47[ab]	7.80±0.63[a]	7.60±0.84[a]	7.50±.53[b]	7.60±.52[ab]	86.48	II
50:50	7.70±0.67[ab]	7.50±0.53[b]	6.80±0.63[b]	7.00±0.47[b]	7.20±.63[b]	7.40±.69[ab]	80.74	III
25:75	6.90±0.52[b]	7.60±0.52[b]	7.40±0.97[a]	6.50±0.47[b]	6.70±.74[b]	7.10±.74[b]	78.14	IV
0:100	6.30±0.48[c]	6.60±0.84[c]	6.30±0.48[b]	5.90±0.57[c]	5.90±.57[c]	5.80±.63[c]	68.14	V
S. Em ±	0.171	0.182	0.209	0.187	0.181	0.194	-	
F value	20.027**	11.537**	9.205**	13.815**	19.703**	16.722**	-	

BRWS- Bread wheat semolina, BWS- Buckwheat semolina
Note: ** - Significant at 0.01 per cent level, *- Significant at 0.05 per cent, NS- Non significant
Different super scripts within a column indicate significant difference at 0.05 level by DMR

Table 5: Nutrient composition of buckwheat upma.

Nutrients / 100 g	Proportions (BRWS:BWS)				
	100:00	75:25	50:50	25:75	00:100
Proximate principles					
Energy (Kcal)	666	660	655	649	644
Protein (g)	14.53	16.62	18.72	20.81	22.91
Fat (g)	29.66	29.67	29.69	29.71	29.74
Crude fiber (g)	2.03	2.32	2.61	2.91	3.20
Carbohydrate (g)	87.35	83.35	79.24	75.18	71.13
Minerals					
Calcium (mg)	72.3	77.63	84.97	90.31	97.65
Sodium (mg)	20.79	20.95	21.10	21.26	21.43
Potassium (mg)	410	450	490	530	570
Iron (mg)	3.53	4.24	4.92	5.60	6.28
Zinc (mg)	2.9	3.37	3.86	4.34	4.83
Manganese (mg)	1.06	1.55	2.04	2.54	3.03
Copper (mg)	0.89	0.95	0.99	1.05	1.11
Vitamins					
Thiamine (mg)	0.39	1.46	2.54	3.62	4.69
Riboflavin (mg)	0.18	0.52	0.86	1.20	1.54
Niacin (mg)	2.22	6.44	10.66	14.88	19.09
Pyridoxine (mg)	0.47	2.27	4.07	5.86	7.66
Pantothenic acid (mg)	1.06	3.49	5.93	8.37	10.81
Amino acid					
Histidine (g)	3.85	3.88	3.93	3.95	3.99
Isoleucine (g)	6.70	6.63	6.55	6.47	6.40
Leucine (g)	11.74	11.55	11.35	11.15	10.97
Lysine (g)	5.72	6.5	7.29	8.07	8.86
Methionine (g)	2.66	2.85	3.03	3.20	3.40
Cysteine (g)	2.83	2.90	2.98	3.05	3.14
Phenylalanine (g)	8.74	8.62	8.50	8.38	8.27
Threonine (g)	5.91	6.10	6.30	6.49	6.70
Tryptophan (g)	1.82	2.06	2.30	2.54	2.78
Valine (g)	8.11	8.05	8.00	7.95	7.90

BRWS- Bread wheat semolina, BWS- Buckwheat semolina; *Computed nutritive value (Gopalan, *et al.*, 2017)

Fig. 1 (a) Whole plant (b) Flower (c) Grain (d) Husk (e) Buckwheat edible seed.

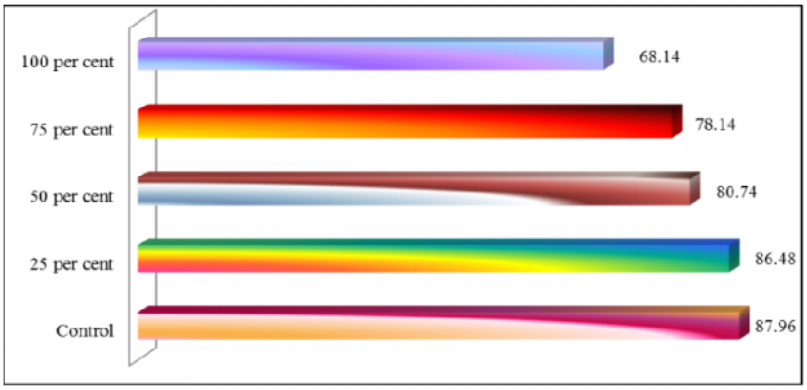

Fig. 2. Acceptability indices of upma with various buckwheat proportions.

CONCLUSION

Buckwheat semolina had better physical and functional characteristics and are gluten free. They were found to be rich in protein, carbohydrates, energy, micro and macro minerals and nutraceutical compared to bread wheat. The Nelagiri variety had better cooking quality and acceptability. Utilization of buckwheat @ 25 per cent in upma had better sensory scores and nutrient composition. Thus, the utilization of buckwheat can be promoted in different food products. Apart from this, the comparison data of buckwheat varieties with bread wheat is useful in convincing the farmers to produce neutracetically rich and highly acceptable buckwheat among wheat growing farmers.

FUTURE SCOPE

As the buckwheat is gluten free and it had good amount of protein and nutraceutical content this can be used in the preparation of many traditional and convenience food products. Daily utilization of buckwheat helps to improve the nutritional status and health of the individual. Further clinical research needed in the subject area to prove health benefits of buckwheat.

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Conflict of Interest. None.

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