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## Essential mineral composition of buckwheat (*Fagopyrum esculentum*) varieties for nutrition security

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### Abstract

Buckwheat varieties PBR-1, Nelageri, IC-79147 along with one bread wheat variety as a control were procured from Wheat scheme, MARS, Agricultural University, Dharwad during *kharif* season. The varieties were analyzed for proximate principles *viz.*, moisture, fat, protein, ash, crude fiber, carbohydrates and energy. Macro and micro mineral contents *viz.*, Calcium, sodium, potassium, iron, zinc, copper and manganese. Analysis of the proximate results revealed that Nelageri variety had higher moisture- 15.73, fat- 1.87, protein- 18.78, ash- 3.66 gm/100 gm. IC-79147 variety showed maximum crude fiber- 1.46, carbohydrates - 67.78 g percent and energy 346 Kcal. Analysis of the macro mineral content revealed that Nelageri variety had highest sodium (2.45 mg) and potassium (444.00 mg) compared to control. IC-79147 variety had lowest calcium (40.00 mg) compared to control. Among the micro minerals, manganese and copper ranged between 2.60 to 2.80 mg/100 g, 0.55 to 0.67 mg/ 100 g respectively. IC-79147 variety had highest Zn (4.25 mg) and Fe (5.57 mg). PBR-1 variety had lowest Zn (3.32 mg) content among the varieties. Results concluded that buckwheat varieties had good macronutrients and mineral composition. These minerals especially iron helps to improve hemoglobin level, zinc to improve immunity, sodium to maintain water and mineral balance, potassium to maintain normal blood pressure level. These minerals found to be good amount in buckwheat varieties compared to bread wheat. Hence, buckwheat can be used in different food recipes to overcome micro and macro mineral deficiency. Buckwheat is gluten free as mentioned in the literature and current study observation hence it can be useful for celiac patients as these patients are gluten intolerance in nature.

**Keywords:** Buckwheat, proximate principles, mineral analysis

### 1. Introduction

Buckwheat (*Fagopyrum esculentum*) an annual crop, is a pseudo cereal and member of polygonaceae family. This ancient crop was first cultivated in China. Buckwheat is widely produced in Russia and Poland. Other countries where buckwheat is cultivated commercially include 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 percent of the world total and China with 17 percent ([www.buckwheatwikipedia.com](http://www.buckwheatwikipedia.com)). 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) [8]. The structure and characteristics of buckwheat grain are quite different from those of wheat grain. Despite its name, buckwheat actually does not contain any wheat or the protein- gluten. Today, buckwheat is a favorite amongst plant-based and gluten-free grain. It could therefore be used as a substitute for wheat in gluten-free diets for celiac patients.

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) [10]. Buckwheat grains contain a wide variety of micro and macronutrients (Kim *et al.*, 2004) [7]. As compare to other cereal crops it has more crude protein and lysine content (Hussain *et al.*, 2017) [4]. Among them essential amino acids like lysine, threonine and tryptophan are in high value (Li *et al.*, 2001) [8]. Buckwheat contain good amount of macro minerals *viz.*, calcium, sodium, potassium and micro minerals *viz.*, zinc, iron, manganese and copper (Bonafaccia *et al.*, 2003) [3].

The present research was conducted to study the proximate principles and mineral content of buckwheat varieties.

### 2. Material and Method

The experiment was conducted in the department of Food Science and Nutrition, University of Agricultural Sciences, Dharwad.

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Buckwheat grains were procured from AICRP Wheat scheme, MARS, UAS, and Dharwad. Buckwheat varieties namely Nelageri, PBR-1 and IC-79147 along with bread wheat as control were taken for the study. Represented Fig. 1 Grains were cleaned for extraneous matter and flour was prepared for further analysis.

## 2.1 Proximate principles

Buckwheat varieties were analyzed for proximate principles viz., moisture, protein, fat, crude fiber and ash by standard AOAC methods (Anon., 2005) [1]. 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 muffle furnace at 550 °C for 6 hours. The carbohydrate content calculated by difference method and energy value was computed using factor 4, 4 and 9 for carbohydrate, protein and fat respectively. Gluten content was also analyzed.

## 2.2 Mineral analysis

Macro minerals viz., calcium, sodium, potassium, micro minerals viz., iron, copper zinc and manganese were analyzed by atomic absorption spectroscopy using standard AOAC methods. (Anon., 2005) [1].

### 2.2.1 Preparation of mineral solution

The mineral solution of samples was prepared by using standard wet ashing method (Anon., 2005) [1]. The sample was treated with a mixture of mineral acid (tri acids) and heated for rapid decomposition. The volatile constituents disappear and non - volatile mineral elements retain in the solution. Heating is continued until contents were reduced to few ml of clear yellow residue. The residue is dissolved in HCL (6N), filtered and made to a known volume with triple distilled water for various elemental analyses.

## 2.3 Statistical analysis

The data of current research work were statistically analyzed and results were presented as mean±standard deviation. Difference between the variables was tested for significance by one-way ANOVA using SPSS version 16.1.

## 3. Result and Discussion

### 3.1 Proximate principles

Table 1 shows that the proximate principles of buckwheat samples along with bread wheat. Moisture, fat, protein and ash content found to be highest in Nelageri variety 15.73 g/100 g, 1.87 g/100 g, 18.78 g/100 g and 3.66 g/100 g respectively. Fat content ranges from (1.29 – 1.87 g/100 g) among the buckwheat varieties. Least amount of protein 15.28 g/100 g reported in PBR-1 and highest in Nelageri variety (18.78 g/100 g). Crude fiber ranges from (1.37 – 1.46). Carbohydrates and energy found maximum in PBR-1 variety 69.65 g/100 g, 348 Kcal. Buckwheat varieties are gluten free. The results achieved are in close conformation with findings of (Khan *et al.*, 2013) [6].

### 3.2 Macro minerals

The macro minerals viz., calcium, sodium, potassium of buckwheat varieties and bread wheat were presented in Table 2.

### 3.2.1 Calcium

Buckwheat varieties had calcium contents that ranged from 44.54 to 41.35 mg per 100 g. PRB-1 variety had highest calcium (44.54 mg/100 g) followed by Nelagiri variety (41.35 mg/ 100 g) that differed significantly ( $p<0.05$ ). The calcium content of buckwheat varieties were higher than that of bread wheat, which differed significantly ( $p<0.01$ ) when compared with bread wheat which had lower calcium content (21.31 mg/ 100 g).

### 3.2.2 Sodium

Among the buckwheat varieties, both Nelagiri variety and PRB-1 had high contents of sodium- 2.95 mg 2.13 mg per 100 g respectively, which did not differ significantly. Compared to PRB-1 and Nelagiri varieties, bread wheat had significant ( $p<0.01$ ) low sodium content (85 mg/100 g).

### 3.2.3 Potassium

The potassium content of buckwheat varieties were ranged between 444 to 371.66 mg per 100 g. The PRB-1 had highest potassium content (444.0 mg/100 g) compared to Nelagiri (371.66 mg/100 g). When buckwheat varieties were compared with bread wheat, bread wheat had lower potassium content (223.00 mg/100 g) and results were found to be highly significant ( $p<0.01$ ). Potassium content of buckwheat varieties represented in Fig. 2

The calcium content of buckwheat 41 mg reported by Pryzybyski *et al.* 2009 [10] were closer results in present study. Potassium and sodium content of buckwheat flour was reported by Pryzybyski *et al.* 2009 [10] were higher than the present study 577 mg and 11 mg/100 g.

## 3.3 Micro minerals

The micro minerals viz., zinc, iron, manganese and copper buckwheat varieties and bread wheat were presented in Table 3 and Fig. 3

### 3.3.1 Zinc

Buckwheat varieties had significantly ( $p<0.01$ ) high zinc content. Nelagiri variety had highest zinc content of 4.05 mg followed by PRB-1 with 3.32 mg per 100 g and the results were found to be statistically significant ( $p<0.01$ ). Bread wheat had significantly ( $p<0.01$ ) lower zinc (2.43 mg/100 g) content compared to buckwheat varieties.

### 3.3.2 Iron

The iron content of buckwheat varieties ranged from 4.31 to 4.34 mg per 100 g. There was no significant ( $p>0.05$ ) difference in iron contents between the two buckwheat varieties. Highly significant difference was observed in iron contents of buckwheat varieties and bread wheat. Bread wheat had significantly ( $p<0.01$ ) lower iron content (3.96 mg/ 100 g) compared to buckwheat varieties.

### 3.3.3 Manganese

Among the buckwheat varieties, the manganese content ranged from 2.64- 2.80 mg per 100 g. Though bread wheat had higher manganese content (3.27 mg/100 g) compared to buckwheat varieties, the results did not differ significantly ( $p>0.05$ ).

### 3.3.4 Copper

The copper content of buckwheat varieties were 0.56 and 0.67

mg per 100 g for PRB-1 and Nelagiri. There was highly significant difference ( $p < 0.01$ ) found in copper content among the two buckwheat varieties. Nelagiri variety had higher copper content (0.67 mg/100 g) followed by PRB-1 (0.56 mg/100 g). Bread wheat had higher copper content (0.73 mg/100 g) which differed significantly ( $p < 0.05$ ). The results

present in the study was close conformation with Pryzybylski *et al.* (2009) [10] and Hsu *et al.* (2008) [5].

Mineral content of buckwheat variety *i.e.*, Nelagiri variety had higher sodium, potassium, zinc and copper, whereas PRB-1 variety was high in calcium, iron and manganese.

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

Variety	Moisture	Fat	Protein	Ash	Crude fiber	Carbohyd-rates	Energy (kcal)	Gluten (%)
PBR-1	11.19±0.88 <sup>b</sup>	1.29±0.04 <sup>b</sup>	15.28±0.53 <sup>b</sup>	3.12±0.01 <sup>b</sup>	1.45±0.10 <sup>a</sup>	69.65±1.27 <sup>a</sup>	348±3.60 <sup>a</sup>	Nil
Nelageri	15.73±0.12 <sup>a</sup>	1.87±0.28 <sup>a</sup>	18.78±0.72 <sup>a</sup>	3.66±0.01 <sup>a</sup>	1.37±0.56 <sup>b</sup>	58.58±1.02 <sup>c</sup>	326±3.21 <sup>b</sup>	Nil
IC-79147	10.49±0.43 <sup>b</sup>	1.28±0.15 <sup>b</sup>	15.98±0.55 <sup>b</sup>	2.98±0.15 <sup>b</sup>	1.46±0.15 <sup>a</sup>	67.78±0.74 <sup>a</sup>	346±2.51 <sup>a</sup>	Nil
Bread wheat	16.54±0.99 <sup>a</sup>	1.79±0.40 <sup>ab</sup>	16.1±0.35 <sup>b</sup>	2.66±0.01 <sup>c</sup>	0.65±0.01 <sup>b</sup>	62.25±0.83 <sup>b</sup>	329±5.77 <sup>b</sup>	14.16±0.76 <sup>a</sup>
Mean±SD	13.49±2.86	1.56±0.36	16.53±1.47	3.11±0.38	0.98±0.52	64.32±4.38	337±1.73	3.86±6.62
F Value	57.44**	4.37*	22.82**	85.46**	8.83**	74.68**	24.106**	875.75**
S. Em±	0.41	0.15	0.32	0.04	0.17	0.55	2.29	0.23
CD	1.33	0.49	1.05	0.14	0.55	1.80	7.47	0.78

**Note:** Mean ± S.D, S.Em: Standard Error of mean, C.D: Critical Difference,

\*\* - Significant at 0.01 percent level, \* - Significant at 0.05 percent level, Different super scripts within a column indicate significant difference at 0.05 level by DMRT

**Table 2:** Macro mineral content (mg/ 100 g) of buckwheat varieties

Si. No	Varieties	Calcium	Sodium	Potassium
1	PBR-1	44.54±0.58 <sup>b</sup>	2.13±0.01 <sup>c</sup>	371.66±2.08 <sup>c</sup>
2	Nelageri	41.35±1.37 <sup>c</sup>	2.45±0.01 <sup>a</sup>	444.00±1.00 <sup>a</sup>
3	IC-79147	40.00±0.90 <sup>c</sup>	2.33±0.01 <sup>b</sup>	395.00±1.00 <sup>b</sup>
4	Bread wheat	81.31±1.09 <sup>a</sup>	0.85±0.04 <sup>d</sup>	323.00±1.00 <sup>d</sup>
	Mean±SD	51.80±17.89	1.94±0.66	383.42±45.52
	S. Em±	0.59	0.58	2.55
	F value	1105**	3370**	4141**
	CD	1.94	1.88	2.54

**Note:** Mean ± S.D, S.Em: Standard Error of mean, C.D: Critical Difference,

\*\* - Significant at 0.01 percent level, \* - Significant at 0.05 percent level, Different super scripts within a column indicate significant difference at 0.05 level by DMRT

**Table 3:** Micro mineral content (mg/ 100 g) of buckwheat

Si. No	Varieties	Zinc	Iron	Manganese	Copper
1	PBR-1	3.33±0.04 <sup>c</sup>	4.34±0.01 <sup>b</sup>	2.80±0.08 <sup>b</sup>	0.55±0.01 <sup>c</sup>
2	Nelageri	4.05±0.03 <sup>b</sup>	4.30±0.01 <sup>b</sup>	2.64±0.03 <sup>b</sup>	0.67±0.02 <sup>ab</sup>
3	IC-79147	4.25±0.07 <sup>a</sup>	5.57±0.20 <sup>a</sup>	2.60±0.08 <sup>b</sup>	0.62±0.06 <sup>b</sup>
4	Bread wheat	2.43±0.11 <sup>d</sup>	3.96±0.01 <sup>c</sup>	3.27±0.33 <sup>a</sup>	0.73±0.01 <sup>a</sup>
	Mean±SD	3.51±0.74	4.54±0.64	2.83±0.31	0.65±0.07
	S. Em±	0.04	0.06	0.10	0.01
	F value	413.59**	138.48**	8.81**	14.31**
	CD	0.13	0.20	0.34	0.06

**Note:** Mean±S.D, S.Em: Standard Error of mean, C.D: Critical Difference,

\*\* - Significant at 0.01 percent level, \* - Significant at 0.05 percent level, Different super scripts within a column indicate significant difference at 0.05 level by DMRT



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

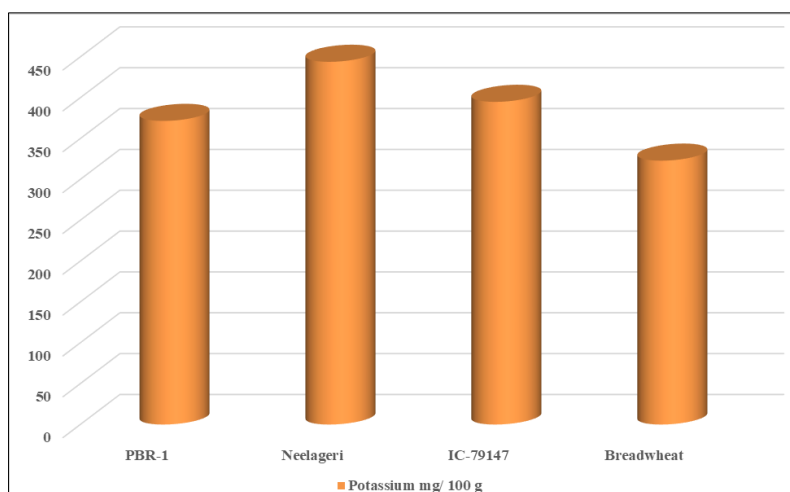


Fig 2: Potassium content of buckwheat varieties

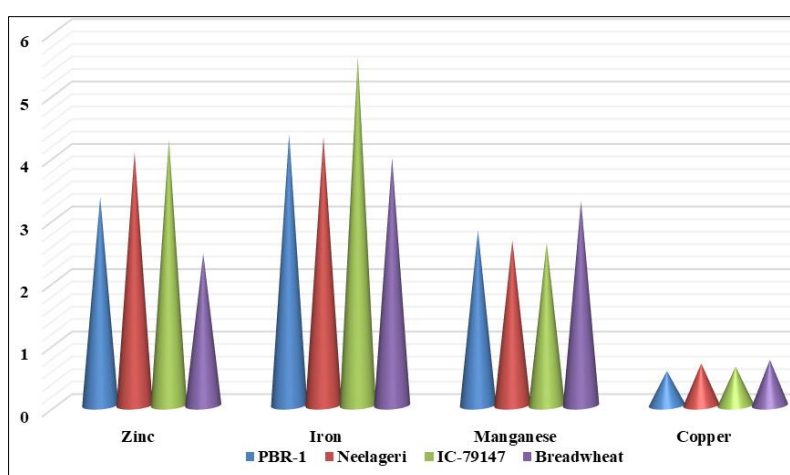


Fig 3: Micro mineral content (mg/ 100 g) of buckwheat

### Conclusion

The results of the present investigation revealed that buckwheat is high in protein, fat, and ash content and low in fiber. Rich in macro and micro minerals. Thus based on our findings the buckwheat is ideal for incorporation in diet formulations. The results in this research confirm that buckwheat is a good source of many important nutrients that appear to have very positive effect on human health. Apart from this, the comparison data of buckwheat varieties with bread wheat is useful in convincing the farmers to produce nutraceutically rich and highly acceptable buckwheat among wheat growing farmers of North Karnataka.

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