Nutritional and phytochemical composition of improved varieties of buckwheat grains (*Fagopyrum esculentum* Moench) in India

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ABSTRACT : The study was undertaken to analyze the nutrient and phytochemical composition of seven cultivars of buckwheat grains. Six indigenous cultivars of buckwheat viz. PRB 9001-I, IC-3141, IC-8819, IC-8869, Himpriya, VL Ugal and a local variety of buckwheat grains were processed to obtain whole flour and 40 mesh sieved flour. Proximate constituents in different cultivars of sieved buckwheat flour (SBF) were found tobe in the range of 0.75 to 2.33, 10.43 to 11.23, 1.82 to 3.10, 3.53 to 4.80 and 66.01 to 72.89 per cent for crude fat, crude protein, total ash, crude fibre and carbohydrate respectively. SBF was also observed to be an excellent source of fibre with total dietary fibre observed in the range of 14.52 to 17.77 per cent and soluble dietary fibre 5.11 to 6.84 per cent. VL Ugal cultivar was found to be significantly better than other varieties in terms of its protein, calorific value and iron content. Buckwheat grains were also found to be a good source of calcium, which ranges from 56.60 to 94.34 mg/100gm in SBF. Phytochemical analysis revealed that different cultivars of buckwheat contain negligible amounts of tannins, oxalates and glucosinolates. Phytate content was found to be high in different cultivars of SBF i.e. ranging between 184 to 339.7 mg/100gm.

Key words: Buckwheat, *Fagopyrum esculentum* Moench, nutrient, anti-nutrient, phytochemicals, grains.

Buckwheat (*Fagopyrum esculentum* Moench) is a herbaceous plant of the Polygonaceae family. Being a pseudocereal, it is typically associated with the grain family due to its similar use and chemical composition. It is grown as minor grain crop in Indian Himalayas especially in the high altitude areas (1600-4000 m above mean sea level) and is cultivated in the hilly states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Manipur and Arunachal Pradesh under low input conditions and harsh environment (Gupta *et al*., 2004). Moreover, buckwheat does not have particular soil or fertilization requirements and has the ability to correct growth without the use of artificial fertilizers or pesticides (Kreft *et al.,* 1996). Furthermore, it absorbs less water and lower amounts of nutrients from soil than other main crops (Li and Zhang, 2001) and thus, it can prove as an imminent and forthcoming nutritional source for the "Starving World" (Leder I, 2009). Among various varieties of buckwheat, two buckwheat species are commonly cultivated: Common buckwheat or sweet buckwheat (*Fagopyrum esculentum* Moench) and Tartary buckwheat (*Fagopyrum tartaricum*) (Baljeet *et al*., 2010). It is called as "kuttu" in Hindi and is a traditional underutilized crop, being generally eaten during fasting Hindu months. The structure and characteristics of buckwheat grain are quite different from those of wheat grain.

Primary antioxidant components present in buckwheat are rutin, quercetin, hyperin, catechins, and polyphenols have demonstrated many health benefits including antimutagenic and anticarcinogenic effects (Kim *et al*, 2007). These functional components of buckwheat have additional health benefits like reducing high blood pressure, lowering cholesterol, controlling blood sugar and preventing cancer risk (Kim *et al*., 2004). Furthermore, buckwheat is gluten-free, which makes it an important ingredient of foods formulated for people suffering from celiac disease (Petr *et al*., 2003). Keeping in view such vast functional and nutraceutical benefits of buckwheat, the present study was undertaken to evaluate the nutritional, mineral and phytochemical composition of seven cultivars of buckwheat.

MATERIALS AND METHODS

Sample collection and preparation: Indigenous cultivars of buckwheat viz. PRB 9001-I, IC-3141, IC-8819, IC-8869, Himpriya were procured from G.B. Pant University of Agriculture and Technology, Hill Campus, Ranichauri, Tehri Garhwal; VL Ugal cultivar was obtained from Vivekanand Parvatiya Krishi Anusandhan

Shala, Almora, whereas local variety of buckwheat grains was procured from the local market of Haldwani, Uttarakhand. All the grain samples were cleaned, dried in oven at 40°C for 6 hours and grounded to obtain whole buckwheat flour (WBF) while part of whole flour was sieved through a 40 mesh sieve to obtain 40 mesh sieved buckwheat flour (SBF).

Nutritional composition: WBF and SBF samples were analyzed in triplicates for their proximate composition viz. moisture, crude protein, crude fat, crude fibre and total ash as per the AOAC (1984) method. The carbohydrate content was calculated by subtraction method. Total dietary fibre (TDF) content in the flour samples was estimated by the method of Asp and Johanson (1981). Calcium was analyzed by titrirmetric method given by AOAC (1984) whereas iron was estimated colorimetrically by Wong's method.

***Anti-nutritional characteristics*:** Glucosinolate content in the flour samples was analyzed using the procedure given by Nasirullah and Krishnamurthy (1996), tannins by Follin-Denis method, phytate content by Haug and Lantzceh (1983) and oxalate content by the method given by Abaza *et al.*, 1968.

***Statistical analysis*:** One way ANOVA was used to find significant differences in the nutrient composition of different cultivars of buckwheat. A p-value of less than 0.05 was considered to be statistically significant.

RESULTS AND DISCUSSION

Nutritional composition: Moisture in WBF and SBF from different cultivars ranged from 10.25 to 13.92 per cent and 9.53 to 13.08 per cent respectively. Crude fat ranged from 1.70 to 4.05 per cent in WBF and 0.75 to 2.33 per cent in SBF. An average loss of 52.19±8.79 per cent fat in different cultivars was observed during sieving. Loss of fat during sieving is attributable to the loss of bran and detachment of germ which contain highest amount of lipids in a grain. Whole flour of cultivars VL Ugal and IC 8869 were found to have significantly ($p \leqslant 0.05$) high level of fat as shown in Table 1.

Protein content of WBF ranged from 11.30 to 12.32 per cent. Flours obtained by sieving showed a slight decrease in protein content with values ranging from 10.43 to 11.23 per cent and average loss in different cultivars was found to be 7.83±1.37 per cent. Buckwheat proteins have been reported as having a high biological

Table 1: Nutritional content of different cultivars of whole buckwheat (WBF) and 40 mesh sieved flour (SBF)

NUTRIENTS	Flour	VARIETIES							CD at 5%
		IC 3141	IC 8869	IC 8819	PRB 9001-I	HIMPRIYA	VL Ugal	Market variety	
Moisture (%)	WBF	10.54±0.20	10.63±0.13	11.05±0.28	10.44±0.15	10.30±0.14	10.25±0.06	13.92±0.15	0.54
	SBF	10.16±0.07	9.53±0.11	11.33±0.23	12.00±0.00	11.92±0.11	9.8±0.14	13.08±0.11	0.28
Crude fat (%)	WBF	1.73±0.09	2.50±0.00	3.98±0.14	1.70±0.21	2.00±0.00	4.05±0.71	4.05±0.07	0.23
	SBF	0.75±0.03	0.75±0.00	2.16±0.00	0.75±0.00	1.05±0.00	2.16±0.00	2.33±0.04	0.04
Crude protein	WBF	11.41±0.05	11.30±0.10	12.32±0.13	11.34±0.05	11.52±0.10	12.25±0.17	12.14±0.32	0.33
(%)	SBF	10.43±0.10	10.43±0.10	11.12±0.13	10.46±0.05	10.86±0.10	11.05±0.15	11.23±0.05	0.24
Crude fibre (%)	WBF	10.81±0.26	9.14±0.26	12.65±0.20	8.42±0.30	10.37±0.26	9.83±0.23	9.33±0.23	0.54
	SBF	4.80±0.25	4.58±0.06	4.86±0.42	3.53±0.29	3.73±0.02	4.63±0.01	4.72±0.16	0.48
Total dietary	WBF	31.29±0.03	29.94±0.06	31.59±0.09	31.10±0.00	29.45±0.13	31.41±0.04	30.84±0.49	0.19
fibre (%)	SBF	16.82±0.47	17.16±0.03	17.50±0.03	14.52±0.07	17.77±0.23	16.08±0.00	15.60±0.00	0.43
Soluble dietary	WBF	6.25±0.01	7.57±0.00	6.08±0.01	6.77±0.02	6.50±0.00	7.02±0.16	8.60±0.00	0.35
fibre (%)	SBF	5.39±0.01	6.37±0.79	5.11±0.37	5.77±0.33	6.58±0.04	6.54±0.01	6.84±0.05	0.30
Insoluble dietary	WBF	25.04±0.48	22.07±0.05	25.57±0.23	24.33±0.32	22.65±0.36	23.48±0.01	22.24±0.00	0.39
fibre (%)	SBF	11.13±0.00	10.79±0.29	12.39±0.11	8.75±0.00	11.62±0.00	9.54±0.02	8.76±0.00	0.58
Carbohydrate	WBF	61.73±0.99	64.03±0.11	56.73±0.60	65.37±0.47	63.06±0.40	60.44±0.45	57.70±0.33	7.01
(%)	SBF	70.76±0.42	72.89±0.18	67.72±0.92	70.70±0.60	70.00±0.41	69.74±0.12	66.01±0.27	9.18
Energy	WBF	311±2.26	326±0.68	312±1.05	322±1.63	316±1.60	327±1.78	316±0.46	3.23
(kcal)	SBF	228±0.92	337±2.37	335±2.84	331±2.60	333±0.96	342±0.46	331±0.99	3.92
Total ash (%)	WBF	3.78±0.04	2.40±0.00	3.27±0.11	2.73±0.12	2.75±0.08	3.18±0.16	2.86±0.11	0.18
	SBF	3.10±0.08	1.82±0.17	2.99±0.33	2.11±0.19	2.44±0.19	2.63±0.03	2.63±0.00	0.32
Calcium	WBF	90.56±0.06	75.47±0.00	139.62±5.33	94.34±5.33	105.66±0.00	96.73±1.96	105.66±0.00	6.96
(mg/100g)	SBF	60.30±0.00	56.60±5.33	94.34±5.33	79.25±5.33	75.47±0.00	79.21±5.33	75.47±0.00	9.53
Iron (mg/100g)	WBF	5.80±0.01	2.86±0.018	5.81±0.00	5.29±0.04	5.08±0.00	5.91±0.02	3.89±0.018	0.09
	SBF	2.40±0.04	0.82±0.3	2.31±0.09	1.85±0.03	1.83±0.08	2.90±0.13	0.93±0.05	0.04

value of 90.5 to 93.1 as compared to 53.0 and 55.0 of wheat flour and rice respectively. Apparently digestibility of buckwheat protein is relatively low. The amino acids in buckwheat protein are also well balanced; with its lysine content, which is generally the first limiting amino acid in other plant proteins, approximately twice than found in wheat flour and similar in its content with egg white (Pomeranz and Robbins, 1972 and Wei *et al.,* 1995).

Crude fibre in WBF of different varieties ranged from 8.42 to 12.65 per cent whereas in SBF, it ranged from 3.53 to 4.86 per cent. An average loss of 55.59±6.61 per cent fibre was observed due to the loss of bran and husk during sieving. Nevertheless, buckwheat grains were found to be an excellent source of fibre as compared to wheat and rice which contain 1.9 and 0.2 per cent crude fibre respectively. TDF ranged between 29.45 to 31.59 percent in WBF and from 14.52 to 17.77 percent in SBF, showing an average loss of about 48.06±55.87 percent in different cultivars. TDF was significantly found to be higher in VL Ugal and IC 8819 cultivars of WBF and in Himpriya and IC 8819 cultivars of SBF. Soluble dietary fibre (SDF) was estimated to be in the range of 6.08 to 8.60 per cent and 5.11 to 6.84 percent in WBF and SBF respectively. Insoluble dietary fibre (IDF) ranged from 22.07 to 25.57 per cent in WBF and from 8.75 to 12.39 percent in SBF. SDF are of clinical importance since these are potent in lowering plasma cholesterol and delay the uptake of carbohydrate and lead to a reduced rate of entry into the circulation (Blackburn *et al*., 1984) whereas IDF, present in bran, helps in relieving constipation by increasing fecal weight and in shortening the transit time (Truswell, 1993). Since buckwheat grains were found to be a rich source of TDF and SDF so they can be applied in the prevention of obesity, diabetes and in lowering of plasma cholesterol (Brennan, 2005).

Carbohydrate by difference in WBF ranged from 56.73 to 65.37 per cent. Non-significant differences existed between carbohydrate content of SBF with values ranging from 66.01 to 72.89 per cent. An average increase of 13.31±33.08 per cent in carbohydrate content was found in different cultivars on sieving. Calorific value of WBF and SBF was found to be 311 to 327 kcal/100 gm and 228 to 342 kcal/100 gm respectively. Calorific value of buckwheat flour is comparable to wheat and rice (341 and 345 kcal/100 gm respectively). Besides, its protein and fat content is also higher than wheat (6.8 and 1.7 per cent respectively).

Buckwheat grains contain numerous nutraceutical compounds (Li and Zhang, 2001) and are rich in vitamins, especially those of B group (Fabjan *et al*., 2003). Ash content in WBF and SBF ranged from 2.40 to 3.78 and 1.82 to 3.10 per cent respectively with cultivar IC 3141 having significantly higher ash content than other cultivars. An average loss of 15.76 to 16.07 per cent in ash content was observed during sieving in different cultivars. Calcium content of WBF and SBF ranged from 75.47 to 139.62 mg/100 gm and 56.60 to 94.34 mg/100gm respectively with cultivar IC 8819 having significantly higher values. Iron in whole and sieved buckwheat flours ranged from 3.89 to 5.80 mg/100gm and 0.82 to 2.90 mg/100gm respectively with VL Ugal having significantly higher amounts of iron than other varieties. Therefore, it can be observed that buckwheat is a better source of calcium than wheat and rice having calcium content of 48 mg/ 100 gm and 10 mg/ 100 gm respectively.

Phytochemical composition: Literature on the phytochemical composition of buckwheat is scanty. Results revealed that WBF contains negligible amount of tannin i.e. 1.46 to 3.76 µg/100g which was even further reduced by an average of 21.66±7.42 per cent on sieving. Among whole flour cultivars PRB 9001-1 and in SBF, variety IC 8819 contained significantly high tannin content than other cultivars. Nonetheless, tannins possess anti-carcinogenic, gastro-protective, anti-ulcerogenic and cholesterol lowering properties (Dykes and Rooney, 2006). Cereals are, usually, found to be a poor source of oxalate with rice and wheat containing negligible amounts of oxalate (3 and 8 mg/100 gm). Values for oxalate content of SBF ranged from 8.13 to 15.00 mg/100gm which is higher than wheat and rice. Glucosinolates ranged from 15.20 to 33.60 mg/100g in WBF and 5.70 to 19.40 mg/100 gm in SBF. An average loss of 51.46±9.75 per cent glucosinolate in different cultivars of buckwheat was observed on sieving. Cultivar IC-8869 contained significantly high levels of glucosinolate than other cultivars.

Dietary phytate has been reported to have beneficial effect on lowering blood glucose and lipids. In addition, they have also demonstrated antioxidative and anti-carcinogenic activities (Schlemmer *et al*., 2009). Phytate content in whole flour ranged from 623.93 to 995.91 mg/100g while in sieved flour it was reduced by 68.45±2.66 per cent with values ranging from 184.51 to 339.46 mg/100gm in different cultivars as shown in Table 2.

Table 2: Phytochemical composition of different cultivars of whole buckwheat (WBF) and 40 mesh sieved flour (SBF)

Phyto chemicals	Flour	VARIETIES							CD at 5%
		IC 3141	IC 8869	IC 8819	PRB 9001-I	HIMPRIYA	VL Ugal	Market variety	
Tannin (µg/100g)	WBF	2.36×10-³± 0.04X10-³	2.6×10-³± 0.16 ×10-³	1.96 ×10-³± 0.47 ×10-³	3.76×10-³± 0.28 ×10-³	1.46×10-³± 0.18 ×10-³	3.03×10-³± 0.04 ×10-³	1.57 ×10-³± 0.21 ×10-³	0.34× 10-³
	SBF	1.63 ×10-³± 1.24 ×10-³	2.23 ×10-³± 0.12 ×10-³	1.66 ×10-³± 0.02 ×10-³	2.96 ×10-³± 0.12 ×10-³	1.2 ×10-³± 0.08 ×10-³	2.46×10-³± 0.09 ×10-³	1.00 ×10-³± 0.00	0.26× 10-³
Oxalates (mg/100g)	WBF	23.75±0.88	21.25±1.76	25.63±0.88	22.50±1.00	20.00±0.88	18.75±0.00	19.38±0.88	2.02
	SBF	15.00±1.53	14.38±0.88	15.00±1.53	11.88±1.53	8.13±0.88	10.00±0.88	8.13±0.88	2.37
Gluco-sinolates (mg/100g)	WBF	29.6±0.00	33.6±0.00	29.5±0.00	15.2±0.00	17.3±0.00	21.1±0.005	15.6±0.00	0.36 × 10-³
	SBF	12.0±0.00	19.4±0.00	10.9±0.00	7.6±0.00	10.8±0.00	11.7±0.00	5.7±0.02	0.23× 10-³
Phytates (mg/100g)	WBF	827.10± 16.44	761.1± 22.39	883.9± 6.10	771.2± 13.57	623.93± 13.94	852.76± 3.17	995.91± 5.53	28.94
	SBF	287.88± 4.36	235.75± 0.98	293.23± 3.74	206.16± 2.25	184.51± 4.17	271.03± 1.94	339.46± 6.88	8.40

CONCLUSION

Results implicate that sieved buckwheat flour was found to be a better source of calcium than wheat and rice. Flour from variety VL Ugal has maximum calorific value, protein content, soluble fibre and mineral bioavailability stands better than other cultivars and can be utilized to alleviate micronutrient deficiencies.

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