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NUTRITIONAL PROFILE OF PROMISING GENOTYPES OF BUCKWHEAT GROWN IN DRY TEMPERATE CLIMATIC CONDITIONS OF HIMACHAL PRADESH (INDIA)

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ABSTRACT

Buckwheat is economically important smaller millet grown primarily for carbohydrate and protein content. In this study, biochemical constituents of 15 promising genotypes of buckwheat, grown in Sangla region of Himachal Pradesh (India), were analyzed. The moisture, crude protein, carbohydrate, fat, crude fibre and ash contents in genotypes ranged from 10.0 to 11.7, 1.7 to 2.5, 1.7 to 2.5, 10.2 to 14.8, 1.8 to 2.9, 7.1 to 9.5 and 62.0 to 66.4%, respectively. The K, P, Mg, Ca, Fe and Zn contents in buckwheat grains varied from 423 to 587.5, 248 to 370.2, 200.5 to 308, 43.7 to 58.03, 3.0 to 4.5 and 2.0 to 3.0 mg 100 g^{-1}, respectively. Based on cumulative grading of nutritionally desirable qualities, the genotypes S-B-216 and Kamru followed by S-B-206 and Chini proved superior cultivars.

Key words: Biochemical constituents, buckwheat, genotypes, India, nutritional profile

INTRODUCTION

Buckwheat (*Fagopyrum esculentum* Moench), an important lesser millet crop which originated from Southwest China, is mainly cultivated in China, Japan and North America; and on small scale in Europe, India, Australia, Argentina and Bhutan (Kreft and Germ, 2008). In India, the crop is grown in Western Himalayan states from Jammu and Kashmir in west to Arunachal Pradesh in east. The hilly terrains of Himachal Pradesh represent several diverse eco-geographic pockets which are suitable for the cultivation of hardy crops like small millet type pseudo-cereals like amaranthus, buckwheat and chenopods. In Himachal Pradesh, common buckwheat is grown in Kinnaur, Lahul Spiti and Sirmour districts. Since the crop is adapted to temperate climate; hence, Himachal Pradesh can play an important role in production of this crop. Buckwheat, also called rhubarb or sorrel, is not a cereal but is usually grouped with cereals due to its ways of cultivation and utilization. This herbaceous erect annual meliferous plant in Himachal Pradesh is commonly known as kathu, fafra, ogle or bharesh. This pseudo-cereal crop is grown in higher hills and mountains of the state at an altitude of >1500 to 4500 msl and covers about 1500 ha area (Phogat and Sharma, 2000).

Recent clinical studies on the nutritional and medicinal uses of common buckwheat suggest that it has considerable potential as a functional health-promoting food. It is a rich source of protein, carbohydrates, fibre, essential amino acids and minerals. The grain is used either as human food or

animal/poultry feed, with dehulled groats cooked as porridge and flour used in preparation of pancakes, biscuits, noodles, cereals, etc. Buckwheat is often raised as a leafy vegetable crop in many areas of Indian sub-continent. The leafy tender shoots are used for preparation of dishes. Buckwheat is useful as a green manure crop for renovation of low-productivity land because it grows well on such land and produces a green manure crop in a short time (Marshall and Pomeranz, 1982). Karlubik *et al*. (1997) reported that buckwheat grains contained proteins with favourable essential amino acid make up (2.8-3.5%). Lysine content in buckwheat is higher than cereals. Ikeda *et al*. (1999) reported that buckwheat flour contained higher levels of K, Ca and Mn. Wei *et al*. (2003) during evaluation of various buckwheat genotypes for amino acid profile and mineral content found high amount of soluble protein and very low amount of prolamin in buckwheat kernel. Lal *et al*. (2003) found variation in protein content (8.7 to 13.4%) in 15 buckwheat genotypes grown at Hisar and Sangla centres with genotypes OC-2, IC-10845 and IC-258240 having 13.9, 13.4 and 12.6% protein content, respectively. Gopalan *et al.* (2004) found moisture, protein, minerals, crude fibre and carbohydrate contents of 11.3, 10.3, 2.3, 8.6 and 65.1% and Ca and P contents of 64 and 355 mg 100 g^{-1}, respectively, in buckwheat. Sood *et al.* (1995) observed a good correlation between light brown colour of kernels and high crude protein content than those of black coloured kernels. Crude protein ranged from 10.21 to 18.46%, Ca from 6.39 to 30.75%, Fe from 9.94 to 74.40% and K from 200 to 602 mg 100 g^{-1} flour. Thakur (2008) reported that moisture, protein, fat, crude fibre, ash and carbohydrate content in 14 buckwheat genotypes varied from 10.22 to 12.77, 10.45 to 13.69, 1.72 to 2.60, 5.4 to 7.8, 2.13 to 3.02 and 62.99 to 67.90%, respectively. There is a large pool of promising buckwheat germplasm available in India especially in Sangla region of HP which can be exploited for nutritional security of the vulnerable population groups. The present study was aimed to identify nutritionally superior genotypes especially those with higher protein content which may either serve as parents in future crop improvement programmes.

MATERIALS AND METHODS

The grain samples (200 g) of 15 varieties/genotypes of common buckwheat namely, S-B-203, S-B-206, S-B-208, S-B-216, S-B-217, Chango, Chini, EC-323731, Gaibong, Jangi, Kalpa, Kamru, Kilba, Kuppa and OC-2 were collected from Mountain Agriculture Research and Extension Centre, Sangla (HP) during 2009 and evaluated for various biochemical parameters. The finely ground grain samples of these genotypes were analyzed in triplicate for moisture, crude protein, ash, crude fibre and crude fat by AOAC method (1970) carbohydrate as per Gopalan *et al.* (2004).

The samples were ground and digested in di-acid mixture (nitric acid: perchloric acid in 3:1 v/v) for the determination of mineral elements namely Mg, Ca, Fe and Zn on atomic absorption spectrophotometer (model Perkin Elmer, USA) as per Piper (1966). Potassium was determined by flame photometer [model-129; Systronics (India)] whereas phosphorus was determined colorimetrically in the digested samples as per Olsen (1954). The data was analyzed statistically by using analysis of variance (Panse and Sukhatme, 1984). In order to identify multipurpose versatile cultivars of buckwheat, rating (ranking) of various genotypes was done based on nutritionally desirable traits i.e., protein, carbohydrates,calcium, iron content as adopted by Dogra (2010).

RESULTS AND DISCUSSION

The biochemical analysis of buckwheat grains of various genotypes revealed that moisture content in genotypes varied from 10.04 to 11.7% with maximum in genotype Kuppa and lowest in S-B-216

Table 1: Biochemical composition of promising genotypes of buckwheat grains (% dry wt.)

Genotypes	Moisture	Crude protein	Crude fat	Ash (minerals)	Crude fibre	Carbohydrates
S-B-203	11.2 ± 0.02	11.9 ± 0.04	2.3 ± 0.1	2.6 ± 0.02	8.4 ± 0.10	63.6 ± 0.02
S-B-206	10.9 ± 0.03	13.8 ± 0.40	1.7 ± 0.1	2.3 ± 0.10	7.4 ± 0.03	63.8 ± 0.04
S-B-208	10.9 ± 0.02	11.6 ± 0.02	2.1 ± 0.1	2.3 ± 0.03	8.1 ± 0.02	64.9 ± 0.04
S-B-216	10.0 ± 0.02	12.9 ± 0.10	2.1 ± 0.1	2.2 ± 0.10	7.2 ± 0.10	65.4 ± 0.31
S-B-217	10.9 ± 0.02	10.4 ± 0.03	2.0 ± 0.1	2.5 ± 0.01	7.8 ± 0.04	66.4 ± 0.06
Chango	10.9 ± 0.02	10.4 ± 0.03	2.0 ± 0.1	2.2 ± 0.02	8.8 ± 0.02	65.5 ± 0.30
Chini	11.2 ± 0.04	14.1 ± 0.10	2.3 ± 0.04	1.8 ± 0.20	7.5 ± 0.02	62.9 ± 0.04
EC-323731	11.5 ± 0.20	10.2 ± 0.02	2.5 ± 0.1	2.0 ± 0.20	7.6 ± 0.01	66.2 ± 0.20
Gaibong	10.9 ± 0.20	12.7 ± 0.20	2.3 ± 0.1	2.0 ± 0.10	7.9 ± 0.02	64.2 ± 0.40
Jangi	11.1 ± 0.20	14.1 ± 0.10	1.9 ± 0.1	2.9 ± 0.10	8.0 ± 0.50	62.0 ± 1.00
Kalpa	10.6 ± 0.25	12.0 ± 0.20	2.3 ± 0.1	2.5 ± 0.05	7.8 ± 0.03	64.8 ± 0.30
Kamru	11.4 ± 0.20	13.5 ± 0.10	2.5 ± 0.1	2.2 ± 0.10	7.6 ± 0.02	62.8 ± 0.02
Kilba	11.0 ± 0.03	13.5 ± 0.20	2.0 ± 0.05	2.2 ± 0.10	7.1 ± 0.02	64.2 ± 0.20
Kuppa	11.7 ± 0.20	12.2 ± 0.20	2.0 ± 0.1	2.4 ± 0.20	9.5 ± 0.02	62.2 ± 0.20
OC-2*	10.7 ± 0.10	14.8 ± 0.40	2.1 ± 0.4	1.9 ± 0.40	8.4 ± 0.30	62.2 ± 2.10
Overall mean	10.99	12.54	2.14	2.27	7.94	64.07
$CD_{0.05}$	0.07	0.48	0.06	0.06	0.35	0.54

*Released variety

(Table 1). The moisture content in grains roughly reflects the degree of maturity and accumulation of fibre in the crop plants. The protein content varied significantly from 10.2 to 14.8% with highest content in genotype OC-2, followed by genotypes Chini and Jangi and lowest in genotype EC-323731. The crude fat, an estimate of the total fat content, was highest in genotypes EC-323731 and Kamru and lowest in S-B-206. The genotype Jangi had highest ash content while Chini had lowest ash content with overall range 1.8 to 2.9%. The crude fibre content in genotypes varied from 7.12 to 9.50% with maximum in genotype Kuppa and minimum in Kilba. The carbohydrates form a major part of food which helps in building body strength by generating energy. The carbohydrate content in genotypes varied from 62 to 66.4% with maximum in S-B-217 and minimum in Jangi. The results are in conformation with those of Li and Zhang (2001) and Gupta *et al.* (2002). Bonafaccia *et al*. (2003) reported protein, ash and fat content of 11.70, 2.2 and 2.9% in grains, 21.6, 4.1 and 7.2% in bran and 10.6, 1.8 and 2.3% in flour of buckwheat, respectively.

The mineral analysis of buckwheat genotypes revealed that potassium content ranged from 423 to 587.5 mg 100 g^{-1} with lowest and highest values in genotype S-B-208 and S-B-206, respectively (Table 2). Phosphorus content varied from 248 (in Kamru) to 370.2 (Kuppa); magnesium content from 200.5 (OC-2) to 308 (Chango); calcium content from 43.7 (S-B-216) to 58.03 (OC-2); iron content from 3.0 (S-B-216) to 4.5 (Chango); zinc content from 2 (Jangi) to 3 (S-B-216); mg 100 g g^{-1}, respectively. These findings are in agreement with Kusano *et al*. (1983) who found that calcium, copper, iron, potassium, magnesium, manganese, sodium, zinc and phosphorus content in buckwheat varied from 12.0 to 18.8, 1.2 to 4.3, 18.5 to 19.5, 547.3 to 644.3, 465.0 to 362.1, 1.6 to 3.4, 2.5 to 4.0, 2.7 to 5.9 and 692.0 to 721.0 mg 100 g g^{-1}, respectively, for the tetraploid and two diploid varieties of the original (Kataoka) and the traditional (Ina) grains.

The important minerals, viz., zinc, copper, manganese, calcium, magnesium, potassium and phosphorus analyzed in various buckwheat groats showed that their contents ranged from 1.29 to2.61, 0.31 to 0.63, 0.79 to 2.53, 6.7 to 16.9, 141 to 217, 322 to 518 and 265 to 510 mg 100 g^{-1} dry matter of buckwheat groats, respectively. Similiar variability has been reported by other workers (Amarowicz and Fornal, 1987; Wang *et al.*, 1995; Ikeda *et al.*, 2005). The grading of various genotypes with respect to the prominent desirable quality characters *viz.*, crude protein, oil, ash, crude fibre, calcium, phosphorus and iron contents is presented in Fig. 1. The genotypes S-B-216

Table 2: Variation in mineral composition of promising genotypes of the buckwheat grains (mg 100 g^{-1} on dry wt. basis)

Genotypes	Potassium	Phosphorus	Magnesium	Calcium	Iron	Zinc
S-B-203	437.0 ± 2.0	303.0 ± 1.0	252.5 ± 2.0	45.0 ± 0.07	4.3 ± 0.1	2.2 ± 0.2
S-B-206	587.5 ± 0.5	297.0 ± 1.0	306.0 ± 1.0	45.8 ± 0.20	3.6 ± 0.2	2.4 ± 0.4
S-B-208	423.0 ± 3.0	323.0 ± 1.0	307.0 ± 1.0	48.8 ± 0.02	3.9 ± 0.2	2.5 ± 0.2
S-B-216	545.0 ± 1.0	261.0 ± 1.0	252.0 ± 2.0	43.7 ± 0.20	3.0 ± 0.2	3.0 ± 0.2
S-B-217	498.5 ± 0.7	252.0 ± 1.0	203.0 ± 1.0	49.6 ± 0.05	3.9 ± 0.2	2.3 ± 0.3
Chango	517.5 ± 0.5	360.8 ± 0.4	308.0 ± 1.0	53.8 ± 0.30	4.5 ± 0.2	2.4 ± 0.2
Chini	472.5 ± 0.5	350.0 ± 1.0	217.5 ± 1.0	54.6 ± 0.20	3.2 ± 0.2	2.2 ± 0.2
EC-323731	483.8 ± 0.2	353.0 ± 1.0	302.1 ± 1.0	57.5 ± 0.20	3.8 ± 0.2	2.4 ± 0.4
Gaibong	530.0 ± 2.0	330.0 ± 1.0	280.0 ± 1.0	53.7 ± 0.20	4.1 ± 0.1	2.1 ± 0.3
Jangi	576.3 ± 0.3	367.0 ± 1.0	303.5 ± 1.0	55.4 ± 0.40	4.2 ± 0.2	2.0 ± 0.2
Kalpa	437.5 ± 0.4	266.6 ± 0.5	280.5 ± 0.8	50.5 ± 0.20	4.4 ± 0.3	2.1 ± 0.1
Kamru	517.5 ± 0.5	248.0 ± 1.0	255.5 ± 1.0	46.5 ± 0.20	3.3 ± 0.3	2.4 ± 0.2
Kilba	546.3 ± 0.3	248.3 ± 0.3	215.5 ± 1.0	55.7 ± 0.20	4.1 ± 0.1	2.5 ± 0.3
Kuppa	542.5 ± 0.5	370.2 ± 0.3	285.0 ± 1.0	57.2 ± 0.20	3.8 ± 0.2	2.0 ± 0.2
OC-2	515.0 ± 1.0	300.1 ± 0.8	200.5 ± 1.0	58.0 ± 0.01	3.1 ± 0.1	2.1 ± 0.1
Overall mean	508.6	308.7	264.6	51.7	3.8	2.3
$CD_{0.05}$	0.96	0.96	0.35	0.61	0.28	0.09

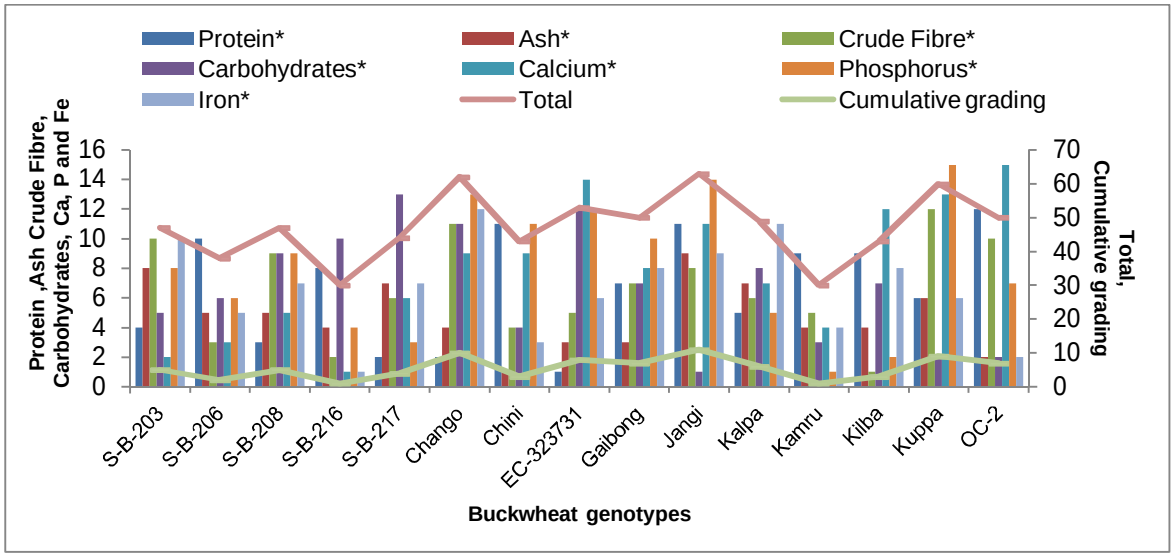

Fig. 1: Varietal grading of buckwheat leaves varieties/genotypes in search of versatile/ multipurpose genotypes (Genotypes graded in the descending order for nutritionally desirable characters)

and Kamru proved most prominent genotypes followed by S-B-206, Chini and Kilba in order of cumulative ranking. The genotypic grading made it possible to identify multipurpose genotypes suited for their direct inclusion in the human diet.

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