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Biochemical Characterization and Phytochemical Analysis of Different Buckwheat Germplasm in Mid Hill of Sikkim

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ABSTRACT

A study was conducted during November–February of 2021–2022 and 2022–2023 at ICAR RC for NEH Region, Sikkim Centre, Gangtok, Sikkim, India for biochemical characterization, mineral and phytochemical contents of different buckwheat germplasm following standard analysis protocol. The results revealed that accession along with the variety were found to be superior for the desirable nutritional quality parameters in comparison with local variety *Titey*. The protein content was highest in *Titey* (11.2%) followed by Shimla B-1 (11.1%) and lowest in IC49671 and IC108510 (10.4%). Significant variation was estimated for tryptophan content for various genotypes ranges from 66.3 to 76.9 mg g^{-1} N. The crude fibre content showed the range of variation from 3.71 to 4.78% in dry mature grains of tartary buckwheat %. Maximum nitrogen free content was recorded in IC108518 (76.97%) followed by IC202268 (75.37%) and lowest was found in IC36805 (71.41%). Maximum Fe content was found in genotype IC108518 (3.50) followed by IC109549 (3.49) and lowest was recorded in genotype IC49671 (2.50 mg 100 g^{-1}). Similarly, total phenol content ranged from 378.41 to 652.71 mg GAE 100 g^{-1} with an average content of 518.68 mg GAE 100 g^{-1}. Therefore, development and utilization of such functional foods will not only improve the nutritional status of the poor people but also helps those suffering from degenerative diseases. Wide variations among genotypes for quality attributes have shown ample potential to be exploited for further improvement of desirable quality attributes and other properties. This is the first-time study for biochemical and phytochemical analysis of buckwheat in Sikkim condition.

KEYWORDS: Buckwheat, nutritional quality, biochemical characterization, phytochemical analysis

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1. INTRODUCTION

Buckwheat (*Fagopyrum* spp.) belongs to the family polygonaceae, is an herbaceous annual flowering plant growing about 60 cm height with red stems and pink and white flowers resembling those of knotweeds (Das el at., 2015). Buckwheat seed are triangular in shape, which is covered by a hull *i.e.* pericarp. The shape, size, and colour of the seed may vary depending on the species and variety (Gopi et al., 2015). Buckwheat is a pseudocereal cultivated for its nutrient rich grain like seeds and as cover crop (Das et al., 2019). Buckwheat has recently gained attention as an important supplementary pseudocereal crop (Das and Ghosh, 2021). The nutritional quality, high grain yield, nutraceutical attributes and multipurpose usages have generated immense interests. A short crop growing season makes buckwheat a perfect crop for higher altitudes (Das et al., 2020). In spite of its short duration (3–4 months) and better adaptability to low temperatures and moisture stress conditions (Luitel et al., 2022), it thrives well in different cropping patterns. According to Nisar et al. (2022) and Skrabanja et al. (2021), out of the 20 species of Fagopyrum genus only two Common buckwheat (*F. esculentum*) and Tartary buckwheat (*F. tataricum*) are cultivated in India (Das et. al., 2022). Buckwheat grains are mainly used for human consumption and also for livestock, poultry and piggery feeds. According to Alekseyeva (2022) buckwheat can fix atmospheric nitrogen and solubilize native soil phosphorus and potassium (Das et al., 2023). The high lysine level of the protein, which is typically lacking in cereal goods, account for its outstanding quality. Rutin (quercetin-3-rutinosid) and fagopyrin which are known to be used in treating and preventing a variety of human illnesses are also abundant in the crop. Buckwheat flowers, leaves, and seeds are high in rutin and quercetin (Jiang et al., 2019), which have diabetes-protective and anti-inflammatory properties and are also used as medical agents to treat cardiovascular disorders (Brunori and Vegvari, 2020). Further researches should be done to design quality foods using buckwheat and community based research should be under taken to see the effects of these quality foods on the health of the people. Various awareness programs should be done to educate people about their nutritive quality content and their health benefits of buckwheat and its food products.

Buckwheat flour is known as Kuttu ka Atta in northern India and is primarily consumed during religious fasts when cereals and pulses are not permitted to be consumed (Rana et al., 2021). Campbell, reported that (2022) buckwheat grains has high content of minerals, mainly Ca (110 mg 100 g^{-1}), Mg (390 mg 100 g^{-1}), P (330 mg 100 g^{-1}), K (450 mg 100 g^{-1}), Fe (4 mg 100 g^{-1}), Mn (3.37 mg 100 g^{-1}), Cu (0.95 mg 100 g^{-1}) and Zn (0.87 mg 100 g^{-1}). Buckwheat protein consists of 18.2% albumin, 43.3% globulin, 0.8% prolamin, 22.7% glutelin, and 5.0% other nitrogen residue (Gopalan et al., 2019). Buckwheat flour has many flavonoid compounds which is known to effective in reducing the blood cholesterol, it keep capillaries and arteries strong and flexible, and help in prevention of high blood pressure (Santos et al., 2019). Due to high nutritional quality and medicinal value, its production has been increased in recent years (Kontturi et al., 2019). Buckwheat being gluten free and has a medicinal properties, is used in gluten free food preparation for those who have gluten allergy (celiac patients) (Bonafaccia et al., 2023). Present experiment was therefore conducted to study the biochemical characterization and quality attributes to know the importance of this crops and its heaths benefits which can be used as nutritious and energizing foods which contribute food and nutritional security.

2. MATERIALS AND METHODS

2.1. Location and soil type

An experiment was undertaken during November-February of 2021–2022 and 2022–2023 at Research Farm of ICAR Research Complex for NEH Region, Sikkim Centre, Tadong, Sikkim, India (latitude 27°32' N, longitude 88° 60' E, altitude 1300 amsl). The soils of the experimental field were clay loam in texture and had soil pH 5.5.

2.2. Experimental design

The present investigation was designed to evaluate the biochemical characterization of 16 germplasm of tartary buckwheat (*Fagopyrum tataricum*) and common buckwheat (*Fagopyrum esculentum*). The grain sample of buckwheat accession was collected from Himachal Pradesh and ICAR-RC for NEH region, Sikkim Centre. The various biochemical characterizations were carried out at ICAR central laboratory Sikkim Centre by using standard biochemical methods.

2.3. Biochemical analysis

The seed samples were grounded to fine powder and are stored in air tight containers for avoiding oxidative denaturation and further biochemical analysis. Various accessions were analyzed in triplicate for moisture, crude protein, ash, crude fibre by following the Anonymous, 1990 method and crude fat ether extract by (Anonymous, 1965) method. Carbohydrate percentage was calculated as a difference of 100-(moisture+crude protein+crude fat (ether extract)+ash+crude fibre) as given by Gopalan et al., 2004. The essential amino acids methionine and tryptophan and in vitro protein digestibility were estimated by the methods of (Horn et al., 1946 and Mertz et al., 1975) respectively. The starch content was estimated by the method described by Juliano, 1971 and the resistant starch was given by the method of Goni et al., 1996. Sixteen buckwheat genotypes were estimated for five minerals

(Ca, P, Fe, K, and Na). Calcium, potassium and sodium contents were determined by using atomatic absorption spectrophotometer (Chemito, AA203D, Double beam atomatic absorption spectrophotometer). Iron content was determined by the method describe by Javornik and Kreft, 1984 and phosphorous content was estimated by the method described by Fiske and Subbarow (1925) using UV- Visible spectrophotometer (Chemito, UV-2100 model). Total soluble protein was extracted from defatted sample with Tris-CL buffer (pH 7.6) containing β-mercaptoethanol. Albumin, globulin, prolamin and glutelin were extracted by modified Osborne's method as described by Juliano and Boulter (1976). Extracted protein and the different fractions were estimated by the Folin phenol reagent method of Lowry's et al. (1951). Total phenolic content was determined according to the method of Slinkard and Singleton (1977) and expressed in mg gallic acid equivalent (mg GAE)/ 100 g. Total flavonoid content was determined by the method as described by Woisky and Salatino (1998) and expressed as mg quercetin equivalent (mg 100 g^{-1} of sample.

2.4. *Statistical analysis*

The data was analyzed statistically by using analysis of variance as given by Sukhatme and Panse, 1984. The data from all the above biochemical analyses with three replications were statistically analyzed using completely randomized design to interpret the results.

3. RESULTS AND DISCUSSION

3.1. *Variation in biochemical constituents of tartary buckwheat*

The data on variation in biochemical constituents of various genotypes of tartary buckwheat (*Fagopyrum tataricum*) are presented in Table 1. The grain samples of selected sixteen tartary buckwheat genotypes were evaluated using standard biochemical methods. The moisture content roughly indicates the degree of maturity and accumulation of different nutrients in food crops. It is an important criterion contributing towards acceptability of the crop harvest. The moisture percentage of food grains is an important consideration for domestic consumption as well as large scale storage. Among the different tartary buckwheat (*F. tataricum*) accessions it was noticed that IC24301 and VL-7 contributed highest moisture content (11.2%) and lowest in IC108518 (10.4%). Similarly, protein content was highest in Titey (11.2%) followed by Shimla B-1 (11.1%) and lowest in IC49671 and IC108510 (10.4%). The fat content was maximum in Titey, IC49669, IC108510, Shimla B-1 (2.6%) and lowest in IC49671 and IC202268 (1.8%). Similarly, ash content was highest in VL-7 (2.6%) and lowest in IC49669,

Table 1: Variation in biochemical constituents of tartary buckwheat

Sl. No.	*F. tataricum*	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)	Methionine (mg/g N)	Tryptophan (mg/g N)
1.	Titey	10.9	11.2	2.6	1.9	7.2	63.4	90.5	75.1
2.	IC109549	10.5	10.8	2.1	2.5	7.6	63.7	88.5	74.6
3.	IC108518	10.4	10.6	2.4	2.1	7.1	66.9	77.8	66.3
4.	IC49669	10.7	10.7	2.6	1.8	7.1	65.4	85.6	71.6
5.	IC24301	11.2	11.0	2.3	2.3	7.5	61.4	84.9	73.1
6.	IC26600	10.9	10.9	2.2	2.4	7.6	64.5	79.5	67.1
7.	IC49671	10.6	10.4	1.8	1.8	7.8	62.5	90.6	70.9
8.	IC36805	10.8	10.8	1.9	2.5	7.2	63.4	88.4	72.9
9.	IC108510	11.1	10.4	2.6	1.8	7.7	66.9	79.3	68.8
10.	IC243184	11.0	10.6	2.1	2.1	7.2	66.1	80.6	76.9
11.	IC202268	11.1	10.5	1.8	2.2	7.3	61.2	86.5	70.5
12.	IC109728	10.6	10.7	1.9	2.4	7.8	64.5	81.7	69.4
13.	Himpriya	10.9	10.5	2.4	1.8	7.4	63.5	86.7	68.4
14.	PRB-1	10.5	11.0	2.3	2.3	7.6	64.8	88.4	76.7
15.	Shimla B-1	11.1	11.1	2.6	1.9	7.5	65.6	89.6	66.7
16.	VL-7	11.2	10.7	2.1	2.6	7.2	62.3	83.4	69.4
Mean		10.8	10.7	2.2	2.2	7.4	64.1	85.1	71.2
SEm±		0.08	0.07	0.06	0.05	0.06	0.11	0.28	0.03
CD (p=0.05)		0.20	0.21	0.17	0.15	0.17	0.32	0.88	0.86

IC49671, IC108510 and Himpriya (1.8%). Crude fibre was maximum in IC49671 and IC109728 (7.8%), and minimum in IC108518 and IC49669 (7.1%). Carbohydrate content of tartary buckwheat genotypes ranged significantly from 61.2 to 66.9%. The maximum value for carbohydrate content was observed in accession IC108518 and IC108510 (66.9%), and the minimum in IC202268 (61.2%). Raghuvanshi et al. (2021) reported 66.01 to 72.89% carbohydrate in buckwheat flour from India which was in similar conformity with the present study. Tryptophan is an essential amino acid involved in various metabolic processes in the human body. Significant variation was estimated for tryptophan content for various genotypes ranges from 66.3 to 76.9 mg g^{-1} N. The maximum value for the tryptophan content was found in IC243184 (76.9 mg g^{-1} N) followed by PRB-1 (76.7) and minimum in IC108518 (66.3). The values obtained in the present investigation with regard to released varieties viz., VL-7, Shimla B-1, PRB-1 recorded the highest value for moisture content, protein, fat, ash and tryptophan content and lowest value was recorded in Himpriya for ash content. David and Persis (2000) reported the lower moisture content of buckwheat flour justifies the suitability for long term storage without deterioration. Sato et al. (2001) estimated the protein content in the tartary buckwheat flour ranges from 10.32 to 13.84%. The chemical composition of grain, bran and flour of tartary buckwheat was analysed by Bonafaccia et al. (2023) and found 2.81% ash content in grains, 4.97% in bran and 1.8% in the flour. Wide variations among genotypes for quality attributes have shown ample potential to be exploited for further improvement of desirable quality attributes and antioxidant properties. The genotypes superior in individual quality trait i.e., protein, essential amino acids methionine, tryptophan, dietary fibre in grains were identified.

2.2. Nutritional quality of various genotypes of tartary buckwheat

Significant difference was observed for their proximate composition of buckwheat germplasm, *viz.*, moisture content, crude protein, crude fat, crude fibre, ash content and nitrogen free extract, starch, amylose and resistant starch. The data on variation in nutritional quality of various genotypes of tartary buckwheat (*Fagopyrum tataricum*) are presented in Table 2. Value in respect to moisture content in tartary buckwheat genotypes ranges from 7.52 to 9.11%. Shimla B-1 (9.11%) recorded the highest moisture content followed by IC49671 (9.03%) and lowest in PRB-1 (7.52%).

Table 2: Proximate composition, total carbohydrate, starch, amylose and resistant starch content of *F. tataricum* genotypes (% dry weight)

Sl. No.	Germplasm	Moisture	Crude Fat	Crude protein	Ash	Crude fibre	Nitrogen free	Starch	Amylose	Resistant starch
1.	Titey	8.26	2.26	9.38	2.15	4.49	73.44	68.27	22.51	18.70
2.	IC109549	8.05	3.36	8.39	1.87	4.78	73.56	63.18	22.96	18.69
3.	IC108518	7.87	1.98	7.33	1.93	3.90	76.97	70.25	23.57	15.65
4.	IC49669	8.65	3.13	9.11	2.93	3.88	72.29	69.28	23.49	16.40
5.	IC24301	8.27	2.37	8.99	2.75	3.78	73.82	69.44	23.20	15.59
6.	IC26600	7.90	2.89	9.29	1.93	4.60	73.38	68.40	23.04	15.20
7.	IC49671	9.03	1.99	8.38	2.00	4.70	73.89	71.93	23.90	18.32
8.	IC36805	8.50	3.27	9.53	2.67	4.61	71.41	72.61	24.00	15.71
9.	IC108510	7.55	2.33	8.58	1.83	4.56	75.12	72.48	23.02	20.03
10.	IC243184	8.00	2.41	7.98	2.57	4.19	74.84	68.42	23.09	16.99
11.	IC202268	7.88	2.12	8.30	2.23	4.09	75.37	65.62	22.45	20.53
12.	IC109728	8.10	3.40	7.85	2.88	4.30	73.46	68.90	23.73	16.72
13.	Himpriya	8.72	3.62	7.30	1.88	3.71	74.77	69.35	23.26	19.89
14.	PRB-1	7.52	3.41	7.23	2.39	4.74	74.70	70.34	23.60	19.07
15.	Shimla B-1	9.11	1.97	8.09	2.73	3.91	74.17	68.90	22.95	19.27
16.	VL-7	7.59	2.99	8.79	2.32	4.16	74.13	70.55	22.61	15.40
17.	Mean	8.18	2.72	8.40	2.32	4.28	74.08	69.22	23.21	17.64
18.	SEd±	0.084	0.085	0.077	0.095	0.016	0.210	0.119	0.046	0.268
19.	CD (p=0.05)	0.171	0.173	0.156	0.193	0.0325	0.428	0.242	0.0936	0.545

Similarly crude fat content was highest in Himpriya (3.62%) and lowest was recorded in Shimla B-1 (1.97%). The crude protein content varied from 7.23 to 9.53%. Maximum crude protein content was recorded in accession IC36805 (9.53%) and lowest in PRB-1 (7.23%). Ash content was highest in IC49669 (2.93%) followed by IC109728 (2.88%) and lowest was recorded in IC108510 (1.83%). The crude fibre content showed the range of variation from 3.71 to 4.78% in dry mature grains of tartary buckwheat. Highest crude fibre content was found in accession IC109549 (4.78%) and lowest was recorded in Himpriya (3.71%). The buckwheat germplasm under study were found poor in their protein and fibre content then the values reported earlier. Raghuvanshi et al. (2021) reported crude fat, crude protein, total ash and crude fibre in buckwheat flourin the range of 0.75 to 2.33%, 10.43 to 11.23%, 1.82 to 3.10% and 3.53 to 4.80%, respectively. Zheng et al. (1998) dehulled buckwheat groats were found to contain 75% starch, 13.9% protein, and 2.3% lipid. The ash content of buckwheat flour (2.32%) observed in this study is comparable with that reported by Mota et al. (2019). Average ash and crude fibre were comparatively higher in the buckwheat accessions. Crude fibre and ash were found higher than the values obtained in this study. Such variations in the Proximate composition in different germplasm may be attributed to their genetic variation, their stage of maturity, climate and soil conditions from where the samples were collected as well as methods of determination. Nitrogen-free extract (NFE) consist of carbohydrates, sugar, starches, and a major portion of materials classed as hemicelluloses in food and feeds. NFE is calculated by difference. When the sum of crude protein, fat, moisture, ash and fibre is subtracted from 100, the difference is NFE. As NFE is calculated by difference, all the errors associated with proximate analysis are additive in the estimate of nitrogen- free extract. Nitrogen free content of tartary buckwheat genotypes ranged significantly from 71.41 to 76.97%. Maximum nitrogen free content was recorded in IC108518 (76.97%) followed by IC202268 (75.37%) and lowest was found in IC36805 (71.41%). Hussain et al. (2017) reported NFE contents of common buckwheat flour as 68.27%. Average NFE in buckwheat genotype in the present study was 74.08% (Table 2). Starch was the major component of buckwheat endosperm and was composed of 25% amylose and 75% amylopectin (Skrabanja et al., 2021).

Evaluation of genotypes for starch content revealed significant variation from 63.18 to 72.61%. Accession IC36805 (72.61%) recorded the highest starch content followed by IC108510 (72.48%). Soral-Smietana et.al., (2022) reported relatively high amylose content (42–52%) in buckwheat samples. Maximum amylose content was recorded in IC36805 (24.00%). Resistant starch (RS) is a form of starch that is not digested in the small intestine but have unique health benefits that include glycemic control, control of fasting plasma triglyceride and cholesterol levels and absorption of minerals. Similarly resistant starch was recorded highest in accession IC202268 (20.53%) and lowest was recorded in IC26600 (15.20%). Skrabanja et.al., (2021) reported 7–37% of RS in buckwheat seeds. The RS content of sixteen buckwheat genotypes was in the range of 15.20–20.53% with an average content of 17.64% (Table 2). The genotypes differed significantly in RS content in buckwheat genotypes might be attributed to the varietal differences along with other inherent factors such as granular structure, amylose contains amylose retrogradation, amylopectin chain length distribution and amylose-lipid complexes.

2.3. Total soluble protein and its fractions of F. esculentum genotypes

The total soluble protein and its fractions of *F. esculentum* genotypes (% dry weight) were presented in Table 3. From the above data revealed that highest total soluble protein was found in accession IC188701 (7.40%) followed by Shimla B (7.35%) and lowest was recorded in EC18864 (4.58%). Soluble protein level reflects the proteins available in diet. The total soluble protein content ranged from 4.58% to 7.40% with an average of 6.29% for all the sixteen buckwheat genotypes tested. Marshal and Pomeranz (1982) reported protein content in whole buckwheat and buckwheat groates as 13.80 and 16.40%, respectively which was quite higher than the reported value. Such variation might be due to the differences in the varieties, environment and nutrient status of the soil. Value in respect to albumin content in tartary buckwheat genotypes ranges from 17.05 to 21.55%. Maximum albumin content was recorded in accession EC18864 (21.55%) and lowest was found in EC218784 (17.0%) with an average of 18.48%. Globulin was found as the major protein fraction in *F. esculentum* followed by glutelin, albumin and prolamin. Significant variation was estimated for globulin content for various genotypes ranges from 50.47 to 55.30%. Maximum globulin was found in EC218784 (55.30%) followed by EC125937 (54.94%) and variety Shimla B (55.30%) recorded the lowest globulin content. Marshal and Pomeranz (2021) studied that in buckwheat storage globulins account for about 70% of total proteins in the seeds and albumin fraction range from 18 to 32% of total protein depending on cultivar are in agreement with the present study.

Maximum prolamin content was recorded in variety Himpriya (3.95%) followed by accession EC18864 (3.87%) with an average of 3.27%. Significant variation was estimated for glutelin content for various genotypes ranges from 25.94 to 22.20%. Similarly, variety Shimla B (25.94%) recorded the maximum glutelin content followed

Table 3: Total soluble protein and its fractions of *F. esculentum* genotypes (% dry weight)

Germplasm	Total protein	Albumin	Globulin	Prolamin	Glutein	Total	Extraction efficiency (%)
PRB1	7.10	17.96	54.53	3.56	23.95	6.18	87.04
VL7	6.80	18.26	54.78	3.07	23.89	5.86	86.18
IC202226	4.80	17.88	54.12	3.53	24.47	4.25	88.54
EC218784	5.40	17.05	55.30	3.53	24.12	4.81	89.07
EC218742	7.30	17.86	54.81	3.73	23.60	6.44	88.18
EC286936	6.16	18.86	53.66	2.38	25.09	5.46	88.64
EC272442	5.62	17.91	53.92	3.42	24.75	4.97	88.43
IC188701	7.40	17.38	54.82	2.21	25.59	6.33	85.54
EC125937	7.15	17.83	54.94	3.50	23.73	6.28	87.83
EC125935	6.46	20.07	54.35	3.37	22.20	5.63	87.15
EC58332	6.16	17.73	54.30	2.56	25.41	5.47	88.80
EC323730	6.42	17.69	54.64	3.50	24.17	5.71	88.94
EC18864	4.58	21.55	51.33	3.87	23.24	4.13	90.17
EC216631	5.34	19.09	54.56	3.73	22.61	4.82	90.26
Himpriya	6.56	17.32	50.77	3.95	27.96	5.83	88.87
Shimla B	7.35	21.23	50.47	2.36	25.94	6.36	88.53
Mean	6.29	18.48	53.83	3.27	24.42	5.53	88.14
SEd	0.133	0.027	0.087	0.010	0.033	-	-
CD (p=0.05)	02709	0.055	0.178	0.0203	0.067	-	-

by IC188701 (25.59%) and lowest was found in EC125935 (22.20%). Javornik et al. (2022) reported buckwheat protein consists of 18.2% albumin, 43.3% globulin, 0.8% prolamin, 22.7% glutelin, and 5.0% other nitrogen residue are in similar conformity with the present studied and found higher albumin, globulin, prolamin and glutelin content than the reported value. Maximum extraction efficiency was estimated in genotype EC216631 (90.26%) followed by EC18864 (90.17%) and lowest was recorded in IC188701 (85.54%) with an average extraction efficiency of 88.14%.

3.4. Mineral and phytochemical contents of F. tataricum genotypes

In the present investigation, five minerals, Ca, P, Fe, Na, and K were estimated and results are presented in Table 4. Maximum Ca content was found in variety VL-7 (215.33) followed by accession IC26600 (210.32) and lowest was recorded in IC109549 (144.00) with an average of 177.57 mg 100 g^{-1}. Awasthi and Thakur (2010), however, reported lower Ca values, but much higher P values for the released varieties Himprya, PRB-1, Shimla-1 and VL-7. Similarly, P content was found maximum in IC109549 (282.00) followed by Titey (281.00) and lowest was found in variety VL-7 242.61 mg 100 g^{-1} dry weight. Ikeda et al. (2019) reported phosphorous content in buckwheat flour ranges from 265 to 510 mg 100 g^{-1} with an average of 359 mg. Results reported by Mota et al. (2019) also observed similar pattern in mineral contents of buckwheat genotypes. Significant variation was estimated for Fe content for various genotypes ranges from 2.50 to 3.50 mg 100 g^{-1}. Maximum Fe content was found in genotype IC108518 (3.50) followed by IC109549 (3.49) and lowest was recorded in genotype IC49671 (2.50 mg 100 g^{-1}). Similarly, K content was found maximum in IC26600 (298.27) followed by PRB-1 (284.60) and lowest was found in variety IC24301 237.00 mg 100 g^{-1} with an average of 257.68 mg 100 g^{-1} dry weight. Significant variation was estimated for Na content for various genotypes of *F. tataricum*. Maximum Na content was found in genotype Himpriya (4.24) followed by IC108518 (4.07) and lowest was recorded in variety Shimla B-1 (1.56) with an average of 2.55 mg 100 g^{-1}. Buckwheat has varied total phenolic content depending on the method of extraction, and calibration standard used, i.e. gallic acid or ferulic acid. Maximum total phenol content was found in Himpriya (652.71) followed by IC108518 (640.33) and lowest was recorded in genotype IC49671 (378.41). Similarly, total phenol content ranged from 378.41 to 652.71 mg GAE 100 g^{-1} with an average content of 518.68 mg GAE 100 g^{-1} (Table 4). Buckwheat also has high levels of flavonoids. In the present study, total flavonoids content ranged between

Table 4: Mineral and phytochemical contents of *F. tataricum* genotypes (mg 100 g^{-1} dry weight)

Germplasm	Mineral content					Phytochemical content	
	Ca	P	Fe	K	Na	Total phenol content (mg GAE 100 g^{-1})	Total flavonoid content (mg QE 100 g^{-1})
Titey	148.33	281.00	3.31	248.00	2.22	540.19	48.84
IC109549	144.00	282.00	3.49	247.67	2.56	523.15	44.13
IC108518	169.00	243.00	3.50	251.67	4.07	640.33	60.11
IC49669	156.00	263.00	3.29	248.33	1.97	442.61	40.22
IC24301	152.64	265.60	2.80	237.00	1.89	582.10	43.51
IC26600	210.32	274.00	3.14	298.27	3.52	461.33	43.20
IC49671	181.67	271.00	2.50	256.67	2.06	378.41	33.80
IC36805	179.30	265.00	2.84	250.11	2.00	538.19	51.92
IC108510	176.00	261.60	2.93	245.00	1.88	425.77	40.28
IC243184	187.60	260.30	3.43	246.50	1.93	533.00	51.97
IC202268	205.60	262.70	3.28	242.00	1.76	577.81	54.42
IC109728	192.31	259.30	3.30	254.00	2.23	523.08	51.90
Himpriya	174.00	266.00	3.15	267.33	4.24	652.71	49.62
PRB-1	184.00	255.00	2.83	284.60	3.53	546.67	44.91
Shimla B-1	165.00	272.60	3.37	280.33	1.56	554.33	51.30
VL-7	215.33	242.61	3.03	265.33	3.36	379.20	36.06
Mean	177.57	264.07	3.14	257.68	2.55	518.68	46.57
SEd±	3.676	7.140	0.071	3.266	0.150	13.609	2.097
CD (p=0.05)	7.487	14.543	0.145	6.652	0.305	27.721	4.271

33.80 to 60.11 mg QE 100 g^{-1} with an average content of 46.57 mg/100. Maximum flavonoids content was found in accession IC108518 (60.11) followed by IC202268 (54.42) and lowest was recorded in genotype IC49671 (33.80). The flavonoids contents in present study were found to be slightly higher than the value reported by Jiang et al. (2019). Such variations might be mainly because of the methods, solvent and calibration standards used for estimating flavonoid contents and the genetic makeup of the materials. It observed that variation in mineral contents in buckwheat genotypes might be attributed to the varietial differences, stage of maturity, condition of growth, fertilization and the nutrient status of the soil. Buckwheat seeds are good sources of many phenolic compounds, particularly phenolic acids and flavonoids.

4. CONCLUSION

The buckwheat grains were found to have satisfactory nutritional profile of the sixteen buckwheat germplasm used in the study. Buckwheat protein contains well-balanced amino acids with high biological value compared to other cereal proteins. Buckwheat has also abundant source of dietary minerals like calcium, zinc, copper, and manganese. Its leaves are rich source of β-carotene and calcium and can be effectively used for micronutrient deficiencies of the population. Buckwheat flour is a good source for diabetic patients due to low glycemic index.

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