Biochemical Evaluation of Tartary Buckwheat (*Fagopyrum tataricum* Gaertn.) genotypes of Cold Desert of Himachal Pradesh

Rishi Thakur[1,2]*, Sunil Kumar[2], Chander P. Awasthi[1] and Madan L. Verma[2]

[1]CSK Himachal Pradesh Krishi Vishvavidyalya, Palampur-176062, (HP), India.
[2]Dr Y S Parmar University of Horticulture & Forestry, Neri Campus, Hamirpur-177001 (HP), India.

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The present investigation reports the details biochemical characterization of tartary buckwheat (*Fagopyrum tataricum* Gaertn.) genotypes. The grain samples of selected thirteen tartary buckwheat varieties/genotypes were evaluated using standard biochemical methods. Values for moisture, fat, ash, crude fibre, carbohydrates, total soluble protein, methionine, tryptophan and *in vitro* protein digestibility evaluated in the grains of tartary buckwheat genotypes showed the range of variation from 10.3-11.5%, 1.9-2.5%, 1.8-2.3%, 7.1-7.9%, 63.8-67.4%, 9.8-11.3 %, 76.0-93.5 mg/g N, 68.2-78.0 mg/g N and 70.7-74.7 %, respectively. Overall superior multipurpose genotypes were identified as Sangla-B-106 followed by Shimla-B-1, Sangla-B-118 and Sangla-B-1 in tartary buckwheat grains based on desirable quality attributes in descending order.

Keywords: crude fibre, carbohydrate, methionine, tryptophan, *in vitro* protein digestibility.

Underutilized crops, being non-competitive with other crops of the same agricultural environment, have been overlooked. Such crops are ignored for a variety of agronomic, genetic, economic and cultural reasons (Pirzadah et al., 2017). Consequently, genetic erosion of gene pools of neglected species has become scarce. Such crops, being adapted to many different agricultural ecosystems, are often grown by small landholders in the marginal areas. They are usually characterized by having local importance in consumption and production systems, requiring relatively low inputs, adapting to specific agro-ecological niches, receiving scarce attention by national agricultural and biodiversity conservation efforts, mainly consisting of local types or landraces, and being cultivated with indigenous knowledge (Zhu, 2016). Various types of underutilized crops such as buckwheat, amaranth, ricebean, faba bean and adzuki bean are grown in all parts of the world. However, buckwheat has recently gained attention as an important supplementary pseudocereal crop. The nutritional quality, high grain yield, nutraceutical attributes and multipurpose usages have generated immense interests (Aarthi *et al.,* 2003).

However, buckwheat production is highly concentrated in China, Japan and North America, it is also produced in Europe, India, Tibet, Tasmania, Australia, Argentina, Bhutan and numerous other countries (Kreft and Germ, 2008). Japan accounts for almost all of the world's Tartary and common buckwheat imports. In India, the crop is grown from Jammu and Kashmir in the west to Arunachal Pradesh in the east. It is becoming popular in the state of Himachal Pradesh,

* To whom all correspondence should be addressed.
Tel.: +91-9418121746;
E-mail: rishu_biochem@rediffmail.com

Uttarakhand and Jammu and Kashmir due to suitable climate. The hilly terrains of Himachal Pradesh represent several diverse eco-geographic cultivation pockets, which are more suitable for cultivation of hardy crops specifically related to small millets along with pseudocereals like amaranthus, buckwheat and chenopods. As per biology of buckwheat, two species of buckwheat are worldwide cultivated. The common buckwheat (*Fagopyrum esculentum*), is an herbaceous annual erect plant with hollow stem having swollen nodes and alternate triangular leaves. The tartary buckwheat (*Fagopyrum tataricum* Gaertn.) is also an herbaceous annual plant but taller and coarser with short internodes and narrow arrow shaped leaves. Flowers are similar and borne on axillary recemes with inconspicuous light green sepals. The species is self-fertile and diploid with chromosome number 2n=16. Tartary buckwheat belongs to genus *Fagopyrum* of the family Polygonaceae. It is grown in higher hills grown more than 4000 msl in the Himalayas and mainly cultivated in the high altitude mountainous areas due to high frost tolerance potential. The economics status of tartary buckwheat is well documented (Zhou et al., 2015). It is rich source of nutraceutical values such as protein, carbohydrates, fibre, essential amino acids and minerals etc. The grain is generally used as human food as well as animal/ poultry feed, with the dehulled groats being cooked as porridge. Its flour is used in the preparation of biscuits, noodles, etc. It is often raised as a leafy vegetable crop in many areas of the Indian sub-continent. It is also useful as a green manure crop for reclamation of low-productivity land because it can grows profusely on such land and produces a massive green manure crop in a short period. The whole grain can be used in poultry scratch feed mixtures. The middlings are high in protein and therefore, are good for livestock feeds, such as hog and chicken feed. Its hull is also sold to make packing material, heating pads, mattresses and light weight hull-filled pillows, which are popular for firm neck support (Lee et al., 2016).

In the Indian state of Himachal Pradesh, tartary buckwheat is grown in Kinnaur and Lahul Spiti districts. Since, the crop is adapted to temperate climate; hence Himachal Pradesh can play an important role in production of this crop. Such a large pool of promising germplasm of tartary buckwheat available in the country in general and in particular to different parts of Himachal Pradesh with special reference to Sangla region of the State, which can be utilized to a greater extent for nutritional and nutraceutical security of the vulnerable population groups. To achieve this objective an organized biochemical approach is essential to select nutritionally superior genotypes either to serve as parents or to isolate and identify well established crop varieties with higher protein content and quality. Therefore, the screening of tartary buckwheat genotypes to harness quality protein potential of germplasm seems to be essential. Since the quality of dietary protein is predominantly governed by the content of the essential amino acids in appropriate quantity and proportion, digestibility and status of anti-nutritional factors (FAO 1990), the present study attempts to fill the research gap by evaluating the limiting amino acids status, in particular to methionine and tryptophan of tartary buckwheat grains.

MATERIALS AND METHODS

The grain samples of thirteen tartary buckwheat varieties/genotypes were collected from Mountain Agriculture Research and Extension Centre (MAREC), Sangla, Himachal Pradesh, India and evaluated for various biochemical parameters by using standard procedures. The finely ground seed samples were stored in air tight containers for avoiding oxidative denaturation and further biochemical analysis. Various genotypes were analyzed in triplicate for moisture, crude protein, ash, crude fibre by following the AOAC,1990 method and crude fat ether extract by (AOAC,1965) method. Carbohydrate content was computed 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; Mertz *et al.* 1975 and Akeson and Stahman, 1964) respectively. The data was analyzed statistically by using analysis of variance as given by Panse and Sukhatme, 1984.

Table 1. Variation in biochemical constituents of tartary buckwheat genotypes

Genotype	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude Fibre (%)	Carbohydrates (%)	Methionine mg/g N	Tryptophan mg/g N	*In Vitro* Protein digestibility (%)
Sangla-B-1	10.5	11.1	2.5	2.3	7.9	63.8	89.1	76.9	74.6
Shimla-B-1	10.4	11.3	2.3	2.2	7.8	64.0	93.5	78.0	73.4
Sangla-B-101	10.5	10.3	2.2	2.1	7.5	66.2	78.4	73.0	74.0
Sangla-B-106	10.4	10.5	2.1	2.0	7.2	66.3	85.3	68.5	74.7
Sangla-B-111	11.5	9.8	2.0	2.1	7.8	65.3	90.7	71.5	72.6
Sangla-B-117	10.4	9.9	2.1	1.8	7.2	67.4	92.4	68.2	73.6
Sangla-B-118	10.4	10.1	1.9	1.8	7.7	66.5	86.8	72.7	74.1
Sangla-B-120	11.2	10.3	2.2	2.2	7.1	65.9	92.1	74.2	73.0
Sangla-B-121	10.3	9.9	2.1	2.0	7.5	66.7	86.6	70.5	73.9
Sangla-B-124	11.2	10.1	2.2	2.1	7.3	65.8	78.5	72.8	70.7
Sangla-B-129	10.3	10.2	2.4	1.9	7.1	66.4	76.0	75.5	72.0
Choling	11.2	10.2	1.9	2.1	7.2	66.1	83.8	71.8	73.5
Kilba	11.2	10.1	2.3	2.0	7.4	65.1	86.1	73.7	73.7
SE (±m)	0.07	0.07	0.05	0.04	0.06	0.12	0.29	0.30	0.31
CD (5%)	0.19	0.20	0.14	0.13	0.17	0.36	0.8	0.8	1.8

Table 2. Varietal grading of tartary buckwheat grain varieties/ genotypes in search of versatile /multipurpose genotypes

Parameters	Sangla-B-1	Shimla-B-1	Sangla-B-101	Sangla-B-106	Sangla-B-111	Sangla-B-117	Sangla-B-118	Sangla-B-120	Sangla-B-121	Sangla-B-124	Sangla-B-129	Choling	Kilba
Protein	2	1	6	3	7	9	5	7	8	7	4	5	6
Crude Fibre	1	2	4	7	2	7	3	8	4	6	8	7	5
Carbohydrates	13	12	6	5	10	1	3	8	2	9	4	7	11
Methionine	5	1	12	9	4	2	6	3	7	11	13	10	8
Tryptophan	2	1	6	12	10	13	8	4	11	7	3	9	5
IVPD	2	9	4	1	11	7	3	10	5	13	12	8	6
Total	25	26	38	37	44	39	28	40	37	53	44	46	41
Cumulative ranking (Biochemical parameters)	1	2	5	4	9	6	3	7	4	11	9	10	8

Genotypes graded in the descending order for nutritionally desirable characters
IVPD *in vitro* protein digestibility

RESULTS AND DISCUSSION

The data on variation in biochemical constituents of various genotypes of tartary buckwheat are shown in Table 1. 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. Values in respect of moisture content in grains of tartary buckwheat genotypes were observed to range from 10.3 to 11.5 per cent. The lowest values for moisture content were demonstrated by the genotypes Sangla-B-121 and Sangla-B-129. The values obtained in the present investigation with regard to released varieties *viz*., Sangla-B-1 and Shimla-B-1 were found as 10.5 and 10.4 per cent, accordingly. The genotypes Sangla-B-121 and Sangla-B-129 were emerged out to be promising for lower values of moisture content suited for storage purposes. The protein content varied from 9.8 to 11.3 per cent. The released varieties Shimla-B-1 and Sangla-B-1 (statistically *at par*) secured first rank and appeared to be promising in this character. The genotypes Sangla-B-106 and Sangla-B-101 stood second in order of preference, which were statistically *at par* when compared with each other. The genotype Sangla-B-111 and Sangla-B-117 (statistically *at par*) scored the lowest value in that order. (Sato *et al*., 2001) estimated the protein content in the tartary buckwheat flour and reported variation from 10.32 to 13.84 per cent.

Values for fat (ether extract) content of different tartary buckwheat genotype(s) are depicted in Table 1. The fat content showed the variation from 1.9 to 2.5 per cent. The values obtained in the present investigation with regard to released varieties *viz*., Sangla-B-1 and Shimla-B-1 were found as 2.5 and 2.3 per cent, accordingly. Ash content of a foodstuff represents inorganic residue remaining after destruction of organic matter. Variation in ash content to range from 1.8 to 2.3 per cent in the grains of tartary buckwheat. The genotypes Sangla-B-1, Sangla-B-120 and Shimla-B-1 emerged promising for this parameter in that order. However, the lowest value was exhibited by Sangla-B-117, which was statistically *at par* with Sangla-B-118.The data indicated that on an average varieties Sangla-B-1 and Shimla-B-1 contained 2.3 and 2.2 per cent ash content. (Bonafaccia *et al*. 2003) analysed the chemical composition of grain, bran and flour of tartary buckwheat. They reported ash 2.81 per cent in grains, 4.97 per cent in the bran and 1.8 per cent in the flour in that order (value given on dry weight basis).

The status of crude fibre content of various tartary buckwheat genotypes is depicted in Table1. The crude fibre showed the range of variation from 7.1 to 7.9 per cent in dry mature grains of tartary buckwheat. Carbohydrate content of tartary buckwheat genotypes ranged significantly from 63.8 to 67.4 per cent. The highest value for carbohydrates content was observed in Sangla-B-117 and the lowest in Sangla-B-1. Methionine content of tartary buckwheat genotypes evaluated showed the range of variation from 76.0 to 93.5 mg/g N g and variety Shimla-B-1 gave the highest value. Tryptophan is an essential amino acid involved in various metabolic processes in the body. Evaluation of genotypes for tryptophan content revealed significant variation from 68.2 to 78.0 mg/g N. Variety Shimla-B-1 showed the highest value closely followed by Sangla-B-1 (statistically *at par*). The genotypes Sangla-B-129, Sangla-B-120 and Kilba exhibited the next higher value for tryptophan content. Chemical composition and amino acid profile give only an approximation of protein quality. Actual biological utilization of the protein must be determined using biological feeding trials or by enzymatic hydrolysis of proteins and evaluation of digestible nitrogen of plant proteins. *In vitro* protein digestibility of tartary buckwheat genotypes showed the significant variation from 70.7 to 74.7 per cent. It was observed that Sangla-B-106 and Sangla-B-1 (statistical *at par*) possessed higher value of protein digestibility followed by Sangla-B-118, and Sangla-B-101 (statistically *at par)*.

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. The cumulative genotypic grading for desirable quality traits taken together showed that Sangla-B-1, Shimla-B-1, Sangla-B-118, Sangla-B-106 and Sangla-B-121 emerged over all superior versatile genotypes for further value addition / quality enrichment.

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