Journal of Cereal Research

13(2): 215-219

Homepage: http://epubs.icar.org.in/ejournal/index.php/JWR

Short Communication

Identification of promising sources of hulless barley (*Hordeum vulgare* L.) for important quality traits

Dinesh Kumar[1], Ramesh Pal Singh Verma[1], Sneh Narwal[2], Jogendra Singh, Rekha Malik[1], Ajit Singh Kharub[1] and Gyanendra Pratap Singh[1]

[1]*ICAR-Indian Institute of Wheat and Barley Research, Karnal – 132001, India*
[2]*ICAR-Indian Agricultural Research Institute, New Delhi – 110 012, India*

Article history: Received: 4 May, 2021 Revised: 17 July, 2021 Accepted: 11 Aug., 2021

Citation:
Kumar D, RPS Verma, S Narwal, J Singh, R Malik, AS Kharub and GP Singh. 2021. Identification of promising sources of hulless barley (*Hordeum vulgare* L.) for important quality traits. *Journal of Cereal Research* ***13(2):*** *215-219. http://doi.org/10.25174/2582-2675/2021/111226*

****Corresponding author:*** *dinesh.kumar3@icar.gov.in*

Key words: Barley, Beta glucans, protein, TCW, amylose

Barley is one of the oldest domesticated crops by human being and used as staple food for quite a long time (Haas *et al.,* 2018). Over the period of time wheat and rice replaced barley from regular diets and this led to significant decrease in its area and production. However, in last two decades barley has made its place among the nutraceutical grains especially because of relatively higher content of soluble dietary fibres as compared to other cereal grains except oats (Derakhshani *et al.,* 2020). Barley contains significantly higher levels of a soluble fibre called mixed linkage β-1-3;1-4 glucans (popularly known as beta glucans) *vis-à-vis* wheat and rice. Beta glucans have been shown to reduce low density lipoprotein cholesterol (LDL Cholesterol) and thus providing protective role against cardiovascular diseases (Ames *et al.,* 2008). Regular consumption of beta glucan is also reported to reduce the blood sugar and thus helpful in prevention and management of type-II diabetes (Ames *et al.,* 2008). Consumption of soluble fibre rich diet has been shown to protect against certain kinds of colon cancer (Madhujith *et al.,* 2005). The health benefits of barley were probably known to ancient civilizations and some studies suggest the use of barley in management of type-II diabetes in Indo-Vedic Civilization (Sarkar *et al.,* 2015 there in). Barley has very low glycemic index among the cereal grains. The lower glycemic index foods are considered healthy option especially in case of type-II diabetes management. Soluble dietary fibres, by increasing the viscosity of stomach and intestinal contents, is believed to reduce the overall intestinal enzymatic activity, and to decrease post-prandial plasma glucose levels. Besides the beta glucans, the amylose percentage is also important parameter as higher amylose content starches are degraded slowly in the human gut (Aldughpassi *et al.,* 2012).

At present majority of the barley production is consumed as animal feed (65-70%), next major use is for malting (25-30%) and very lesser amount is used directly as food (2-5%). Barley as a food is mainly consumed in some African countries and higher Himalayas' especially Tibet region (Ullrich, 2011). With the changing food habits and life styles, the importance of nutraceuticals or healthy foods is on rise and expected to be a part of the regular diet in urban population of developed and developing countries (Narwal *et al.,* 2015). Barley, Oats and Millets are the Grains of Future and hence need to have high yielding varieties with good quality and tolerance to biotic and abiotic stresses. In case of barley most of the varieties developed in India are hulled ones and cater to the need of feed and malt barley segment. The hulless varieties are preferred over the hulled ones for direct consumption as barley-based foods, since the adhered hull led to poor texture, mouth feel and undesirable colour to the processed products (Narwal *et al.,* 2017). The removal of hull needs extra efforts and may also lead to loss of nutrients from upper layers of the grain. The hulless varieties are available, but have lower yields as compared to the hulled varieties. The hulless breeding programme is focussed on increasing the yield with better tolerance to biotic and abiotic stresses. However, the quality component is equally important as for higher flour recovery and better health promoting activities the grains must possess certain quality parameters. In the present study, four exotic germplasm introductions, 19 hulless indigenous landraces, and six released hulless barley cultivars were screened for grain physical and biochemical quality parameters to identify sources of better quality for their potential use in hull less barley improvement programme of the country.

A set of 29 genotypes were grown in three replications at ICAR-IIWBR, Karnal during 2017-18 in rabi season following the recommended cultural practices of feed barley for North Western Plains Zone. The cleaned grains were analysed for thousand kernel weight, plump grain percentage, grain protein, beta glucans content, amylose percentage and test weight using standard EBC procedures. Thousand kernel weight was estimated by counting thousand grains on Pfeuffer make grain counting machine and then weighing the grains on electronic weighing machine. Grain plumpness was determined using Pfeuffer make Sortimat machine where 100 g grains were separated over 2.8 mm, 2.5 mm and 2.2 mm screens; the grains retained over 2.8 and 2.5 mm were considered plump ones. Protein content was measured using Foss make NIR machine. Beta glucans and Amylose content were quantified using Megazyme make enzymatic kits. Test weight was estimated using ICAR-IIWBR developed hectolitre apparatus.

The hullless barley genotypes have normally lesser yields and one of the reasons for this is relatively lower values of thousand grain/kernel weight as compared to hulled ones. Therefore, it is of paramount importance to identify the hulless genotypes with higher thousand grain weight. Three genotypes, BCU 8038, BCU 7998 and BCU 8023 had significantly higher thousand grain weight as compared to the best Indian check Geetanjali and comparable to exotic check Atahualpa (Table 1). The rate of grain filling and grain filling duration are important determinants of thousand kernel weight and genetic variation is available for these features. However, both rate and duration of grain filling are greatly affected by genotypic and environmental interaction (Sakuma and Schnurbusch, 2019). In this study, three sources have been identified under the similar growing conditions indicating the genetic variation in the thousand kernel weight.

Another important grain physical trait related with flour recovery is percentage of bold or plump grains. In this study, the grains retained on 2.5 mm screen were considered as percentage of total plump grains. In case of malt barley, the minimum desirable percentage of plump grains is 90 %, though no such standard is available for food barley, however higher the value more will be the flour recovery. Three genotypes, BCU 8041, DWR 62 and DWR 80 had bold grain percentage of more than 70 %. The major contributor to the grain dry matter are polysaccharides especially starch and normally plump grains result from higher starch deposition in the endosperm. For increasing the grain plumpness source-sink dynamics are very important as more deliverance of photosynthates to grain and its conversion to storage molecules decides the grain size/weight (Dreccer *et al.,* 1997). However, besides several other quality parameters genotype x environment interaction and cultural practices are also very important (Mckenzie *et al.,* 2005). Though the present study has been conducted only for one year at one location, however it has provided important preliminary insight into relative performance of promising sources for further detailed study.

Grain protein content varied from 9.2 to 14.3 per cent, though higher protein content is desirable in food barley provided it is not because of reduced starch or lesser plump grains. In this study, no such genotype could be identified having higher protein content coupled with higher plump grain percentage. In barley, the major storage proteins are hordeins (prolamines), therefore identification of better sources of hordein content and better nutritional composition is required for hulless barley. There are four major types of hordeins based upon the amino acid composition and molecular weight and at molecular level the hordein protein families are coded by *Hor-1, Hor-2, Hor-3, and Hor-4* located on chromosome 1H (Tanner *et al.,* 2019). Though genotype is the major determinant of grain protein content (Kumar *et al.,* 2012), the content is also significantly affected by the cultural practices especially nitrogen fertilization and growing environment.

The hulless barley grain is considered a good source of mixed-linkage (1 → 3), (1 → 4)-β-D-glucans (β-glucans) which contribute to the major portion of soluble fibres. The beta glucan content varied from 4.6 to 7.3 per cent in the genotypes tested, with the highest content in BCU 8028 (7.3 % dwb). Three other genotypes had beta glucan content of more than 6 percent besides the checks. The genotype BCU 8028 was found to contain highest grain beta glucan content in preliminary screening done during 2014-15 (Fig. 1). The genotypes were also screened for beta glucan polymorphism molicular level using CAPS marker HvCslF6, however no significant differences were discernible in this study (Fig. 2). Barley contains approximately 2–11% of β-glucans and content is affected by genetic and environmental factors (Al-Ansi *et al.,* 2020). The soluble dietary fibre content is relatively higher in hulless barley as hull causes dilution effect on most of the nutrients except the insoluble fibres in hulled barley. The higher content of grain beta glucans in barley is the major reason for labelling barley as health promoting grain. β-glucans lower plasma cholesterol (mainly LDL cholesterol), bring down post-prandial blood glucose, lower glycemic index of barley and reduce the risk of colon cancer. Health benefitting effects of β-glucans are mainly due to their property of making viscous mass in the gut (Peckz *et al.,* 2017).

Amylose content also contributes in increasing the resistant starch content and the percentage is mainly genotypically determined however, in this one-year study no significant differences could be inferred from the data.

There is a positive correlation (0.48) between protein and beta glucan content; and between thousand grain weight and plump/bold grains. This correlation may help in better understanding of the food quality traits in future.

Table 1: Grain physical and biochemical trait values in hulless barley grains

Genotype	Origin	TGW (g)	Bold grain (%)	Thin grain (%)	Protein (% dwb)	Beta glucan (% dwb)	Amylose (%)	Test wt (kg/hl)
BCU 8023	I	45.1	53.0	14.7	12.2	6.0	26.3	76.9
BCU 8024	I	37.9	31.9	21.7	11.1	5.3	25.7	75.8
BCU 8025	I	42.7	36.8	17.1	9.4	5.3	24.3	76.2
BCU 8026	I	38.4	55.9	12.0	10.0	5.5	26.3	76.2
BCU 8027	I	38.3	52.2	11.1	11.5	6.3	21.5	77.3
BCU 8028	I	36.3	48.6	13.7	11.1	7.3	27.6	78.4
BCU 8029	I	36.7	27.5	22.9	9.5	4.6	23.5	78.2
BCU 8030	I	39.9	40.0	14.6	10.7	5.5	24.5	77.4
BCU 8031	I	40.9	44.6	14.6	11.9	5.5	26.8	77.4
BCU 8032	I	39.9	27.0	20.6	10.7	5.8	30.7	77.2
BCU 8033	I	38.4	24.1	25.0	11.0	5.5	28.1	76.6
BCU 8034	I	40.3	62.3	14.7	11.0	5.9	28.1	75.9
BCU 8035	I	39.1	50.2	17.1	10.6	5.0	28.3	74.5
BCU 8036	I	39.5	22.9	25.9	10.1	5.6	22.3	77.6
BCU 8037	I	44.1	51.4	11.4	10.8	5.6	22.9	77.5
BCU 8038	I	49.1	61.3	7.6	10.4	5.9	24.2	78.8
BCU 8039	I	42.9	40.4	16.4	10.6	5.7	26.9	77.1
BCU 8040	I	40.1	32.8	21.1	10.5	5.3	27.2	76.9
BCU 8041	I	44.7	73.6	5.6	9.2	4.9	23.6	65.6
BCU 7998	E	47.1	65.5	6.1	10.1	6.1	23.5	78.4
DWR 62	E	37.5	72.3	3.7	10.2	4.9	24.8	78.7
DWR80	E	41.5	71.9	4.1	9.8	5.5	26.5	75.9
DOLMA	C	36.0	9.9	45.3	10.2	6.5	26.2	75.6

NDB943	C	39.3	46.5	9.3	10.9	5.8	22.2	79.1
KARAN16	C	37.9	33.3	21.8	10.0	5.3	29.8	75.2
BHS352	C	37.6	20.6	34.0	10.3	6.6	29.7	76.4
GEETANJALI	C	40.8	64.2	4.6	9.7	5.3	32.8	79.6
HBL 276	C	32.5	12.7	43.1	11.1	6.0	26.1	75.4
ATAHULAPA	E	46.7	56.5	7.4	14.3	6.5	30.8	66.5
LSD (5%)		4.2	10.7	6.1	0.8	0.9	NS	1.4

I= Indigenous landrace, E= Exotic, C= Released Cultivar, LSD= Least Significant Differences

In this preliminary study genetic differences among different genotypes were noticed and BCU 8028 for higher grain beta glucan content; BCU 8038, BCU 7998 and BCU 8023 for higher thousand grain weight and BCU 8041, DWR 62 and DWR 80 for higher bold grain percentage were identified. These genotypes may provide important clues at biochemical and molecular level to assist breeders in development of improved hulless barley genotypes for food purposes.

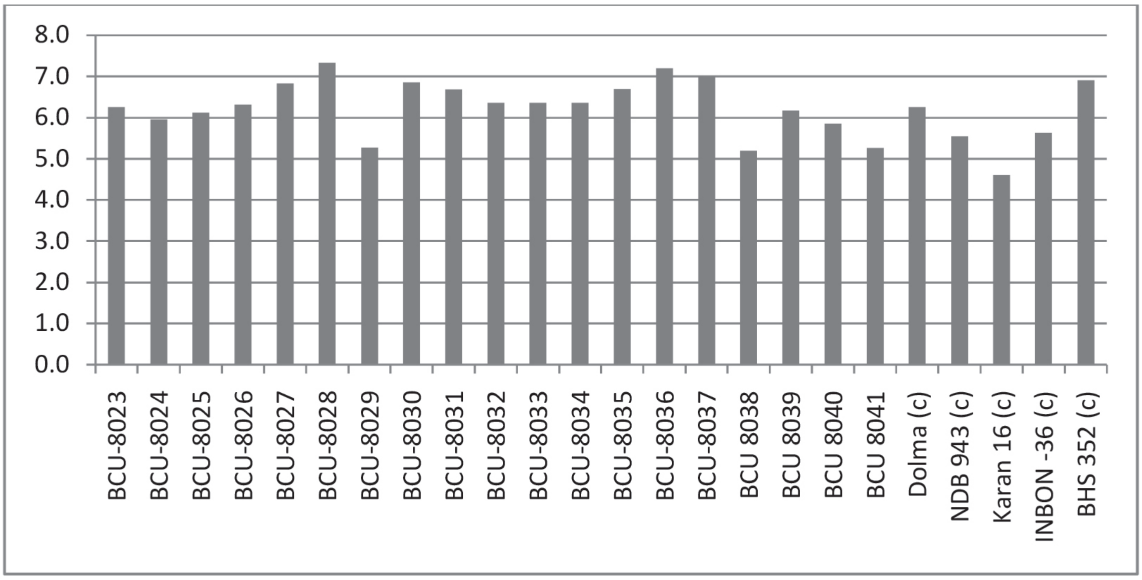

Fig. 1: Beta glucan content (% dry weight basis) in barley genotypes (2014-15)

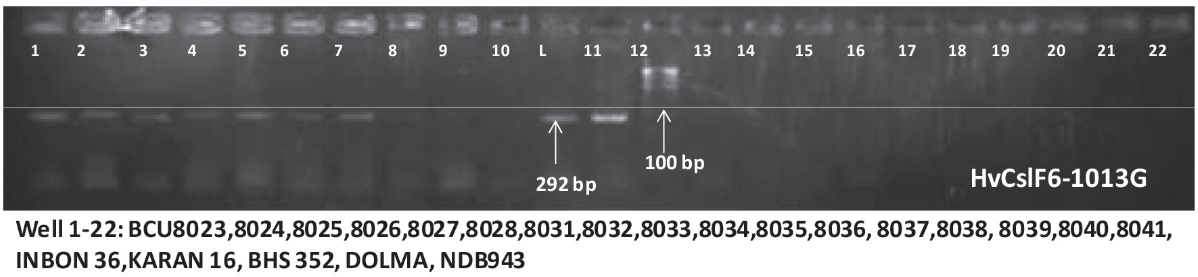

Fig. 2: Agarose gel showing the polymorphism for the marker HvCslF6 with respect to beta glucan in Hulless landraces and checks

Acknowledgement: Funding of in-house project "Biochemical and molecular approaches to understand nutritional and industrial quality in barley" is thankfully acknowledged. Special thanks to Sh. Rampal for providing excellent technical assistance during the study.

Conclusion

Barley is one of the unique cereals having health promoting properties in its grains. There is a renewed interest in food barley in past few years and need is being felt for high yielding hulless genotypes with superior food quality parameters. In this study 19 land races collected from Leh and Ladakh region, four exotic germplasm introductions, breeding lines and six released hulless cultivars were evaluated in 2017-18 for seven grain quality parameters. Promising genotypes for grain beta glucan content and thousand kernel weight have been identified. A positive correlation has been observed between grain beta glucan content and protein content.

Compliance with ethical standards: NA

Conflict of Interest: Authors declare that they have no conflict of interest

Author's Contribution: D Kumar (Planning, execution and writing of MS); RPS Verma (Major Editing of MS); J Singh (Selection & Supply of Genotypes); R Malik (Molecular Studies); ASKharub (Editing); GP Singh (Planning, Guidance and Editing)

References

1. Ames NP and CR Rhymer. 2008. Issues surrounding health claims for barley. *The Journal of Nutrition* **138**: 1237S–1243S. doi:10.1093/jn/138.6.1237s
2. Aldughpassi A, E-S M Abdel-Aal and TMS Wolever. 2012. Barley cultivar, kernel composition, and processing affect the glycemic Index. *The Journal of Nutrition* **142**: 1666–1671. doi:10.3945/jn.112.161372
3. Dreccer MF, C Grashoff and R Rabbinge. 1997. Source-sink ratio in barley (*Hordeum vulgare* L.) during grain filling: effects on senescence and grain protein concentration. *Field Crops Research* **49**: 269–277.
4. Derakhshani Z, F Malherbe, JF Panozzo and M Bhave. 2020. Evaluation of diverse barley Cultivars and landraces for contents of four Multifunctional biomolecules with nutraceutical potential. *Current Research in Nutrition Food Science* **8**: doi : http://dx.doi.org/10.12944/CRNFSJ.8.2.03
5. Haas M, M Schreiber and M Mascher. 2018. Domestication and crop evolution of wheat and barley: Genes, genomics, and future directions. *Journal of Integrative Plant Biology* **61**: 204-225. doi:10.1111/jipb.12737
6. Kumar D, S Narwal, RPS Verma, AS Kharub, V Kumar and I Sharma. 2012. Genotypic variability in β-glucan and crude protein contents in barley genotypes. *Journal of Wheat Research* **4:** 61-68.
7. Madhujith T and F Shahidi. 2007. Antioxidative and antiproliferative properties of selected barley (*Hordeum vulgarae* L.) cultivars and their potential for inhibition of low-density lipoprotein (LDL) cholesterol oxidation. *Journal of Agricultural and Food Chemistry* **55**: 5018–5024.
8. McKenzie R, AB Middleton and E Bremer. 2005. Fertilization, seeding date, and seeding rate for malting barley yield and quality in southern Alberta. *Canadian Journal of Plant Science* **85:** 603-614.
9. Narwal S, D Kumar and RPS Verma. 2015. Effect of Genotype, Environment and Malting on the Antioxidant Activity and Phenolic Content of Indian Barley. *Journal of Food Biochemistry* **40**: 91–99.
10. Narwal S, D Kumar, S Sheoran, RPS Verma and RK Gupta. 2017. Hulless barley as a promising source to improve the nutritional quality of wheat products. *Journal of Food Science & Technology* **54**: 2638-2644.
11. Pejcz E, A Czaja, A Wojciechowicz-Budzisz, Z Gil and R Spychaj. 2017. The potential of naked barley sourdough to improve the quality and dietary fibre content of barley enriched wheat bread. *Journal of Cereal Science* **77**: 97–101
12. Sarkar P, DH Lohith Kumar, C Dhumal, SS Panigrahi and R Choudhary. 2015. Traditional and ayurvedic foods of Indian origin. *Journal of Ethnic Foods* **2:** 97–109.
13. Tanner GJ, ML Colgrave, MJ Blundell, CA Howitt and A Bacic. 2019. Hordein accumulation in developing barley grains. *Frontiers in Plant Science* **10**: 649.
14. Ullrich SE. 2011. Significance, adaptation, production, and trade of barley. In: Ullrich SE, editor. *Barley: Production, Improvement, and Uses.* Oxford: Wiley-Blackwell. pp. 3-13.