International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(5): 233-237
www.biochemjournal.com
Received: 01-02-2024
Accepted: 12-04-2024

Vaishnavi
Research Scholar, Department of Food Science, Nutrition and Technology, CSKHPKV Palampur, Kangra, Himachal Pradesh, India

Dr. Anupama Sandal
Professor, Department of Food Science, Nutrition and Technology, CSKHPKV Palampur, Kangra, Himachal Pradesh, India

Dr. Mamta
Assistant professor Department of Bioengineering and Food Technology, Shoolini University, Solan, India

Corresponding Author:
Vaishnavi
Research Scholar, Department of Food Science, Nutrition and Technology, CSKHPKV Palampur, Kangra, Himachal Pradesh, India

Physical and nutritional evaluation of hulled and hulless barley (*Hordeum vulgare* L.)

Vaishnavi, Dr. Anupama Sandal and Dr. Mamta

DOI: https://doi.org/10.33545/26174693.2024.v8.i5c.1075

Abstract
Barley (*Hordeum vulgare* L.) is a versatile cereal crop with rich nutritional content, making it a valuable food grain. This study evaluated the physical and nutritional properties of hulled and Hulless barley varieties. Physical parameters including size, thousand kernel weight, bulk density, true density, porosity, and specific gravity were measured. Proximate analysis was conducted to determine moisture, ash, crude protein, crude fat, crude fiber, and total carbohydrate content. Results showed that hulled barley had higher length, bulk density, and porosity, while hulless barley exhibited greater width and true density. Hulless barley had higher moisture content (8.01%) than hulled barley (6.33%). Hulless barley had higher fat content (up to 3.25%) compared to hulled barley. Protein content was higher in hulless barley (14.23%) than in hulled barley (12.35%). Hulled barley had higher fiber content (4.17%) compared to hulless barley (2.43%). Carbohydrate content was higher in hulled barley (72.56%) than in hulless barley (69.62%). These findings provide valuable insights into the physical and nutritional characteristics of barley varieties, crucial for developing new food products and optimizing barley use in the food industry.

Keywords: Hulled, hulless, barley, grain, physical, nutrition

Introduction

Barley (*Hordeum vulgare* L.) is a significant cereal crop globally, ranking among the top crops after wheat, rice, and corn (Chen *et al.*, 2020) [4]. Its historical significance is evident from early remains discovered in Aswan, Egypt, dating back 18,000 years (Hamaker, 2008) [7]. Originating in the wild in the Middle East and Ethiopia, barley made its way to India from England and has since become an important coarse cereal in the country. Its ability to thrive in a wide range of environments, suitable for both tropical and subtropical climates, sets it apart from other cereals cereal (Vangool and Vernon, 2006) [16].

In India, barley is predominantly grown in states like Uttar Pradesh, Punjab, Rajasthan, Himachal Pradesh, and Bihar, with a total production of 17,50,000 tonnes across 6,56,000 hectares (FAO, 2017) [5]. In Himachal Pradesh, barley is the most important *rabi* cereal, cultivated in all twelve districts, particularly prevalent in upper temperate areas such as Lahaul and Spiti.

The physical properties of hulled and hulless barley play a significant role in their handling, processing, and storage. Differences in physical properties can impact the design of equipment used in the agricultural industry. For example, the bulk density of hulled and hulless barley affects the design of storage structures like silos and the handling equipment used for transportation. The porosity of barley grains, especially hulled barley, influences airflow during storage, affecting the grain's quality and shelf life. Understanding these physical properties is essential for designing efficient systems for handling, processing, and storing barley grains, ensuring their quality and nutritional value are maintained.

Barley possesses significant potential as a food grain, offering a rich nutritional composition including fiber, antioxidants, vitamins, minerals, and low-fat content (Halland *et al.*, 2016) [6]. The nutritional content of barley varies based on environmental conditions, agricultural practices, and soil conditions (Jadhav *et al.*, 1998) [9]. Its starch content ranges from 60 to 64 percent, with amylase content varying from 20 to 30 percent, and in high amylase barley, it can reach up to 45 percent (Henry, 1988) [8]. Protein content ranges from 8 to 15 percent, with reports of up to 20 percent in certain varieties (Newman and Newman, 1990) [11].

The lipid content ranges from 2 to 3 percent, with most lipids concentrated in the bran and germ portion. Barley also contains dietary fiber ranging from 18.9 to 23.8 percent and ash from 2.3 to 2.6 percent. Whole grain barley flour has been found to contain 18.7 percent total fiber, 2.6 percent soluble fiber, and 16.1 percent insoluble fiber, while dehulled whole barley flour contains 3.5 percent total fiber, 1.9 percent soluble fiber, and 1.6 percent insoluble fiber (Sullivan *et al*., 2010) [14].

Barley has a long history of use in Tibetan foods and is considered a functional food in developed countries. However, its utilization in India, particularly as a hulless type, is limited to tribal areas of Himachal Pradesh and some parts of Bihar. In Himachal Pradesh, barley is used either as a substitute for wheat in making chapatis or in the preparation of various traditional delicacies such *as bhaturu, marchu, pakk, pinni, chhangpa,* and *murjag* across different parts of the state. Despite its nutritional benefits, barley is underutilized in the food industry and is primarily used as fodder in developing countries with limited human consumption, primarily due to a lack of awareness. Other factors include the public perception of barley as a non-food cereal grain, its lack of functional gluten, and the inferior palatability and appearance of barley-based food products compared to those made with wheat and rice.

The popularity of barley in food has increased due to its rich dietary fiber content. Consumers prefer foods rich in functional ingredients due to their awareness of health and nutrition. Beta-glucan, a polysaccharide and soluble dietary fiber found in barley, has significant potential as a nutraceutical, playing a vital role in preventing cardiovascular diseases, controlling diabetes mellitus, and regulating cholesterol levels in the body (Shimizu., *et al*., 2008) [13]. Research in new and novel domains, such as utilizing fiber-rich foods with industrial importance, will broaden the scope of barley utilization in different food systems, including its potential use in beverage manufacturing, thereby enhancing its health benefits. Barley's functional properties make it effective against type-2 diabetes, obesity, and certain cancers.

Materials and Methods

Procurement of Materials

Hulled and hulless barley grains, as shown in Figure 1, were obtained from the Department of Plant Breeding and Genetics, CSKHPKV, Palampur and District Chamba, Himachal Pradesh. The grains were manually cleaned to remove any dust, debris, and foreign particles. Subsequently, the grains were ground into a fine powder using a stainless steel mixer grinder and stored in airtight, food-grade polyethylene terephthalate containers at room temperature for further analysis. All chemicals and reagents used for the analysis were of analytical grade, and the analysis was carried out in triplicate to minimize error.

Physical characteristics of hulled and hulless barley

Size (Length, Breadth and Thickness)

The grains were carefully selected, and ten grains were chosen for measurement. Each grain was measured three times to ensure accuracy. The Vernier Caliper was used to measure the length, breadth, and thickness of each grain. The measurements were recorded for each grain, and the average values for length, breadth, and thickness were calculated from the triplicate measurements.

Thousand kernel weight

A total of three samples, each consisting of one thousand grains, were randomly selected for both hulled and hulless barley. These samples were carefully weighed using an electrical weighing balance. The weighing process was conducted in triplicate to ensure accuracy and reliability of the measurements. The average weight of the grains was then calculated based on the triplicate measurements for each sample of hulled and hulless barley.

Bulk density

To estimate the bulk density of hulled and hulless barley, the grains were poured into measuring cylinders up to a specific height from a constant level, after which they were weighed. The bulk density was then calculated using the following formula:

$$\textit{Bulk density} = \textit{Weight}(g)/\textit{Volume}(ml)$$

True density

The true density of barley grain, which represents the ratio of mass to the volume occupied by the grain, was determined using the toluene displacement method. Initially, the barley grains were carefully weighed. Subsequently, these grains were placed in a graduated cylinder containing a known quantity of toluene, and the resulting increase in the level of toluene was recorded. To calculate the true density, the mass of the barley grains was divided by the volume of toluene displaced by them. This method allows for an accurate measurement of the true density of barley grains by comparing their mass to the volume of toluene they displace.

$$\textit{True density} = \frac{\textit{Weight}(g)}{\textit{Volume of toluene displaced }(ml)}$$

Porosity

Porosity, which quantifies the percentage of air between grains relative to a unit volume of grains, was computed from the bulk and true densities utilizing the relationship established by Jain and Bal (1997).

$$\varepsilon = \left(\frac{\rho_t - \rho_b}{\rho_t}\right) \times 100$$

Where, *E*, is the porosity (%), *Pb* is the bulk density (kg/m3) and *Pt* is the true density (kg/m 3).

Proximate analysis of hulled and hulless barley

Proximate composition

The proximate analysis of both hulled and hulless barley varieties was conducted in triplicate to determine moisture, crude protein, crude fat, crude fiber, and total ash content. These analyses were performed according to the standard methods outlined by the Association of Official Analytical Chemists (AOAC, 2010) [2]. For nitrogen determination, the micro Kjeldahl method was employed, and the nitrogen content was multiplied by a factor of 6.25 to convert it into crude protein. The total carbohydrate content was determined using the difference method. This comprehensive analysis provides a detailed understanding of the nutritional composition of both hulled and hulless barley varieties, essential for evaluating their potential applications in food and feed industries.

Statistical analysis

The experiments were conducted in triplicate, and the data was presented as mean ± standard deviation. Subsequently, the data underwent Analysis of Variance (ANOVA) using OP stat software, which is designed for analyzing commonly used experimental designs. The interpretation of the data was done at a 5% significance level ($p \leq 0.05$), ensuring that any observed differences were statistically significant. This rigorous statistical analysis enhances the credibility and reliability of the research findings.

Results and Discussion

An effort was made to evaluate physical and nutritional properties of hulled and hulless barley. The results thus obtained are present under pertinent Tables.

Physical characteristics and quality evaluation of hulled and hulless barley

The principle dimensions of barley grains, including length, width, and breadth, play a crucial role in seed grading and in the calculation of various modeling kinetics such as drying, cooling, aeration, and equipment design (Varnamkhasti *et al*., 2008) [15]. For quality evaluation of hulled and hulless barley varieties, physical parameters such as length, width, breadth, thousand kernel weight, bulk density, true density, percent porosity, and specific gravity are used. These parameters provide important insights into the characteristics of barley grains.

The relevant data has been summarized in Table 1.

The average length of the test samples was analyzed using a Vernier caliper to the second decimal. The length ranged from 6.88±0.13 to 9.08±0.18 mm, with hulled barley having the maximum length and hulless barley the least. The width was measured as 3.55±0.08 and 3.79±0.10 mm for hulless and hulled barley, respectively. The width of the grain can positively affect the weight, as the weight tends to increase with an increase in width. The total starch concentration positively influenced the thousand kernel weight, with the hulless variety, despite having the lowest length, showing the highest values for width.

The bulk density of hull-less and hulled barley was found to be 0.75±0.08 and 0.68±0.01 g/ml, respectively. The void space between the hull and the caryopsis in hulled barley is filled with air, which could account for its lower bulk density compared to hulless barley.

True density, which is important for separating cereal grains using pneumatic separators, was found to range from about 1.25±0.03 to 1.45±0.03 g/cm³ for both hull-less and hulled barley. True density represents the density of the solid grain material without the voids, and its variation can be attributed to factors such as grain variety and maturity.

Porosity, an important property affecting storage, processing, and quality, was found to be higher in hulled barley (43.6%) compared to hulless barley (46.41%). This difference may be due to the shape and dimension of the grain, as well as the presence of the hull in hulled barley.

Thousand kernel weight (TKW), an indicator of grain size and yield potential, was higher in hulled barley (32.16±0.07g) compared to hull-less barley (30.75±0.08g). TKW is influenced by factors such as cultivar, environmental conditions, and agricultural practices. It is determined by the principle dimensions and length-to-width ratio of seed kernels, making it an essential indicator in crop research programs.

The variations in these physical properties among hulled and hulless barley varieties can be attributed to genetic composition, agro-climatic conditions, and grain development/maturation processes.

Proximate characteristics

Barley grains were analyzed for proximate composition to determine the quality of the raw material for product development and to estimate the nutritional value and overall acceptance of developed food by consumers (Moses *et al*., 2012) [10]. Proximate composition provides an estimation of nutrients and forms the basis for food analysis, including moisture, ash, crude protein, crude fat, crude fiber, and total carbohydrates content. These components are important in the food industry for product development, quality control, or regulatory purposes. Homogeneous and representative samples of the treatments, along with raw hulled and hulless barley, were analyzed for proximate composition, and the results have been reported on a dry weight basis. The relevant data has been summarized in Table 2.

Moisture content: Moisture content influences the weight, appearance, taste, texture, and shelf life of foodstuffs and has a great bearing on the composition of other nutrients. The moisture content of hulled barley was calculated as 6.33% and for hulless barley as 8.01%. The variation in moisture content among different barley varieties could be due to genotypic variations, maturity of samples, and agro-climatic and varietal differences.

A lower moisture content in barley grains can contribute to better storage stability and reduced risk of microbial growth. It also affects the cooking properties and overall quality of barley-based products. Monitoring and controlling moisture content is crucial in food processing to ensure product quality and safety.

Ash content

Ash content gives an index to the mineral content in food material. The ash content of hulled barley was recorded as 2.62% and for hulless barley as 2.56%. These values are consistent with earlier reports. Phosphorus and potassium were found to be major minerals present in barley, while iron and zinc were trace minerals. Ash content is an important indicator of the mineral composition of barley grains. It provides valuable information about the presence of essential minerals that are vital for human health. Phosphorus and potassium are crucial for various physiological functions, including bone health and muscle function. Iron is essential for oxygen transport in the body, and zinc plays a role in immune function and wound healing. Monitoring the ash content helps in assessing the nutritional quality of barley and its potential contribution to a balanced diet.

Crude fat: The crude fat content of barley grains typically falls within the range of 1.97% to 3.25%, with hulless barley exhibiting a higher fat content compared to hulled barley. This variation is influenced by the genetic makeup of the crop and environmental conditions**.**

Protein

The protein content of barley grains varies, with hulless barley typically having a higher protein content compared to hulled barley. The protein content was found to be 14.23 percent in hulless barley and 12.35 percent in hulled barley.

Fiber

Hulled barley has been found to contain the highest crude fiber content at 4.17%, followed by hulless barley at 2.43%. The fiber content in barley, particularly β-glucan, offers several health benefits. β-glucan is a soluble fiber that forms a gel-like substance in the gut, which can help reduce cholesterol levels by binding to bile acids and preventing their reabsorption. This process promotes the excretion of cholesterol from the body, thus lowering blood cholesterol levels (Anderson *et al*., 2009) [1]. Additionally, β-glucan can help regulate blood sugar levels by slowing down the digestion and absorption of carbohydrates, which helps prevent spikes in blood glucose levels. This property is particularly beneficial for individuals with diabetes or those at risk of developing diabetes. The fiber in barley also provides bulk to the diet, which can aid in digestion and promote a feeling of fullness, potentially assisting with weight management. Furthermore, the fiber content in barley helps maintain gut health by promoting the growth of beneficial bacteria in the gut, which can contribute to overall digestive health and immune function. (Shimizu *et al*., 2008) [13].

Carbohydrate: The carbohydrate content in hulled and hulless barley varieties was calculated using the difference method and found to be in the range of 72.56% to 69.62%. The hulled variety contained the highest amount of carbohydrate (72.56%) followed by hulless barley (69.62%). Variations in proximal composition could be attributed to differences in genetic composition and growing environmental conditions. The hulled barley variety was found to have the highest carbohydrate content of 72.56%, followed by hulless barley having 69.62% carbohydrate. These variations in proximal composition, including carbohydrate content, can be attributed to differences in the genetic composition of barley varieties and the environmental conditions in which they are grown.

Table 1: Physical characteristics hulled and hulless barley

Parameters	Hulled barley	Hulless barley
Length (mm)	9.08±0.18	6.88±0.13
Width (mm)	3.79±0.10	3.55±0.08
1000 Kernel weight(g)	32.16±0.07	30.75±0.08
Bulk Density (g/ml)	0.68±0.01	0.75±0.01
True density(g/ml)	1.45±0.03	1.25±0.03
Porosity (%)	43.60±0.43	46.41±0.24

Values are expressed as mean ± standard deviation

Table 2: Proximate composition of hulled and hulless barley

Parameters	Hulled barley	Hulless barley
Moisture (%)	6.33±0.04	2.56±0.05
Total ash (%)	2.62±0.01	2.56±0.05
Crude fat (%)	1.97±0.01	3.25±0.04
Protein content (%)	12.35±0.2	14.23±0.08
Crude fiber (%)	4.17±0.06	2.43±0.08
Carbohydrate (%)	72.57±0.17	69.62±0.18

Values are expressed as mean ± standard deviation

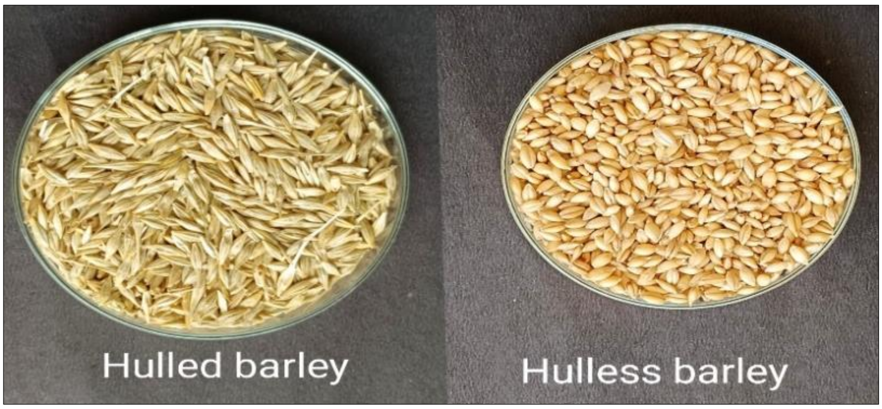

Fig 1: Hulled and Hulless barley grains

Conclusion

The study evaluated the physical and nutritional properties of hulled and hulless barley varieties. Hulled barley exhibited higher length, bulk density, and porosity, while hulless barley had greater width and true density. Hulless barley showed higher moisture content but lower fat, protein, fiber, and carbohydrate content compared to hulled barley. These findings provide valuable insights into the physical and nutritional characteristics of barley varieties, which can inform food product development and enhance the utilization of barley in various food products.

References

1. Anderson JW, Baird P, Davis RH, Ferreri S, Knudtson M, Koraym A, *et al*. Health benefits of dietary fiber. Nutrition reviews. 2009;67(4):188-205.

2. AOAC. Official methods of analysis. Association of Official Analytical Chemist, Washington D.C.UK.14.068, 2057, 2010.
3. Behall KM, Scholfield DJ, Hallfrisch J. Diets containing barley significantly reduce lipids in mildly hypercholesterolemic men and women. The American journal of clinical nutrition. 2004;80(5):1185-1193.
4. Chen J, Sun D, Liu Y, Li Y, Cai L. Comparative transcriptome analysis reveals the regulatory networks of methyl jasmonate-induced resistance to Fusarium head blight in wheat. Scientific Reports. 2020;10(1):1-14.
5. FAO. Food and Agriculture Organization of the United Nations. FAOSTAT, 2017. Retrieved from http://www.fao.org/faostat/en/#data/QC.
6. Halland J, Mage F, Hansen A, Aasen AJ. Grain quality in wheat and barley. Wheat and Barley Grain Quality, 2016, 143-169.
7. Hamaker BR. Biochemical, genetic, and molecular characterization of endosperm resistance to α-amylase and limit dextrinase in barley. Journal of Cereal Science. 2008;48(2):184-195.
8. Henry RJ. Purification and properties of barley endosperm α-amylases. Phytochemistry. 1988;27(9):2713-2716.
9. Jadhav SJ, Agarwal SG, Mujumdar AS. Effect of cultivar and environmental conditions on the distribution of protein and starch in wheat, barley and chickpea. Journal of Food Engineering. 1998;37(4):391-403.
10. Moses M, Amoah RS, Nutsugah SK, Amuzu V. Proximate and mineral composition of mushrooms from Ghana. Journal of Food Technology Research. 2012;4(1):90-98.
11. Newman RK, Newman CW. Barley for food: characteristics, improvement, and renewed interest. Journal of Cereal Science. 1990;11(1):1-16.
12. Sheoran OP, Tonk DS, Kaushik LS, Hasija RC, Pannu RS. Statistical Software Package for Agricultural Research Workers. Department of Mathmetics Statistics, CCS HAU, Hisar, 1998, 139-143.
13. Shimizu C, Kihara M, Aoe S, Araki S, Ito K, Hayashi K. Effect of high β-glucan barley on serum cholesterol concentrations and visceral fat area in Japanese men—a randomized, double-blinded, placebo-controlled trial. Plant Foods for Human Nutrition. 2008;63(1):21-25.
14. Sullivan TW, Lundeen GR, Neuman WL. Differing proportions of soluble and insoluble dietary fibers from cereal grains: their importance in foods for human health. Cereal Foods World, 2010.
15. Varnamkhasti MG, Jafari A, Omid M, Hashemabadi D. Prediction of moisture ratio of barley under different drying conditions using artificial neural networks and mathematical models. Journal of Food Engineering. 2008;89(4):404-411.
16. Vangool D, Vernon L. Potential impacts of climate change on agricultural land use suitability: Barley. Department of Agriculture, Western Australia. 2006, Report No: 302.
17. Yasumatsu K, Sawada K, Maritaka S, Mikasi M, Toda J, Wada T, *et al*. Whipping and emulsifying properties of soybean products. Agric. Biol. Chem. 1972;36:719-727.