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Barley Foods and Health: Opportunities Ahead

Alka Vasan[+], Manisha Mani, and Pinky Boora

CCS Haryana Agricultural University, Hisar, India

Abstract Barley, basically an annual grass crop, consumed as a major food and feed, belongs to the family of Poaceae. It is considered as the fourth most-important crop in the world after corn, wheat and rice; has been commercially grown for 10,000 years now. Using various processing or milling techniques like blocking and pearling, grinding, roller milling, flaking, etc. a lot of food products can be produced from barley. Known for its varied use, the crop also has health benefits attached to its consumption. Barley has attracted health professionals for its fiber content, particularly β-glucan, which has been shown to reduce blood cholesterol and to produce a flattened glucose response. 80% of the barley production comes from Uttar Pradesh, Rajasthan and Madhya Pradesh, India is self sufficient, besides exporting 0.1-0.2 million tonnes of barley annually. This paper throws light on the various techniques of barley processing and the need for the enhancement of its consumption considering its health related advantages over other crops due to its low fat and high fiber content.

Keywords: Barley Processing, Barley Foods, Food Processing Opportunities, Poaceae

1. Introduction

Barley (Hordeum vulgare) is one of the important cereal crops in the world. It is a winter season (rabi) cereal crop grown in Uttar Pradesh, Punjab, Rajasthan, Madhya Pradesh, Haryana and Bihar. In India, area under barley is 7.7 lakh hectares and production is 4.72 lakh tones. Barley is a major food & animal feed crop, belonging to the grass family Poaceae. The nutrient content of barley compares favorably with that of corn, oats, wheat, milo and field peas.

Barley contains eight essential amino acids. According to a recent study, eating whole grain barley can regulate bold sugar (i.e. reduce blood glucose response to a meal) for up to 10 hours after consumption compared to white or even whole-grain wheat, which has a similar glycemic index. Barley has many uses, for instance it can be served as animal fodder, as base malt for beer and certain distilled beverages, and as a component of various health foods. It is used in soups and stews, and in barley bread of various cultures. Like wheat and rye, barley contains gluten that makes it an unsuitable grain for consumption by those with celiac disease. In a 2007 ranking of cereal crops in the world, barley was fourth both in terms of quantity produced (136 millions tons) and in area of cultivation.

2. Barley History

The exact origin of barley is not exactly known, presumed to be originated either in Egypt, Ethiopia, the Near East or Tibet. There is, however, compelling evidence of the possibilities of multicenters of origin of barley, initiating in the Iberian Peninsula, extending across North Africa. But it can be surely said that it was one of the earliest cultivated grains. Barley was grown in the Middle East prior to 10,000 BC, but barley's cultivation in China and India probably occurred later. Barley was grown on the Korean Peninsula by 1500-850 BC along with millet, wheat, and legumes. Six-rowed barley did not come about until after 6000 BC. In ancient Egypt (3200 BC to 30 BC) barley bread and beer (made from malt) constituted a

+ Corresponding author.
E-mail address: alkavasan@yahoo.com

complete diet. Barley (Hordeum vulgare) has been used as food by man since time immemorial. Its use in the religious ritual of ancient Hindus as well as ancient Greeks furnishes strong argument in favour of the great antiquity of its cultivation. Locating the origin of cultivated barley has not been without controversy. Remains of barley grains found at archeological sites in the Fertile Crescent of the Middle East indicated that about 10,000 years ago the crop was domesticated there from a wild species H. spontaneum. Indeed, the archeological data gathered from the large project where 367 barley accessions were obtained from the FAO's Middle Eastern International Center for Agricultural Research in Dry Areas (ICARDA), Aleppo, Syria and from similar national centers in the Old and New World allowed researchers to conclude that the Fertile Crescent is the place of origin of cultivated barley. This is the most prominent and accepted theory regarding origin of cultivated barley.

3. Types of Barley and Barley as a Food

Barley has a lot of varieties which can be clubbed to form different types of classification. For instance, one way of classification is to identify it by whether there are two, four or six rows of grains on the head which makes it tow row, four row or six row barley. The six row barley can produce 25-60 grains, while two-row barley produces 25-30 grains and the four-row barley is actually loose six-row barley. The wild barley is two-row and the six-row type barley is the most cultivated. Spikelets are arranged in triplets which alternate along the rachis. In wild barley, only the central spikelet is fertile, while the other two are reduced. This condition is retained in certain cultivars known as two-row barleys. Two-row barley has a lower protein content than six-row barley and thus more fermentable sugar content. High protein barley is best suited for animal feed and malting barley is usually lower protein. In Western countries, barley is increasing in popularity as a food grain and is used in flours for bread making or other specialties such as baby foods, health foods and thickeners (Akar et al. 2012). The barley can also be classified by describing its beards (awns) which cover the kernels. In the barley germplasm database awns are described along the following morphology:

1. Long awned
2. Short awned
3. (Normal) hooded
4. Elevated hooded,
5. Subjacent hooded
6. Long awned in central row, and awnletted or awnless in lateral rows
7. Short awned in central row, and awnletted or awnless in lateral rows
8. Awnless or awnletted in central and lateral rows
9. Elevated hoods in central row, and awnless in lateral rows

Barley can also be described as:

1. hulled (naked) or hulless,
2. feed type or malt type,
3. height (dwarf),
4. seed color (colorless, white, yellow, blue)

3.1. Whole Grain Barley

Whole grain barley refers to barley that has been minimally processed or cleaned so that most of the bran and endosperm is left intact and the germ is present. Whole grain barley may also be called hulled or hulless barley.

Hulled barley refers to covered barley that has been minimally processed to remove only the tough inedible outer hull. Hulled barley may be purchased in several forms including kernels (berries), cut (grits), flaked or ground (meal or flour)

Hulless barley refers to a type of barley in which the tough inedible outer hull is loosely adhered to the kernel. The outer hull is so loose, that when this barley is harvested in the field, the outer hull usually falls off. Processors often refer to this type of barley as 'naked' barley. Hulless barley requires little to no processing to remove the tough inedible outer hull. Because this product requires minimal cleaning, most of the brand and endosperm is left intact and the germ is present.

3.2. Barley Malt

Barley Malt is made by soaking and drying barley kernels. The kernels are then allowed to germinate or sprout in a controlled environment. Barley malt is an important for beer production. It is also used in extracts and syrups for adding flavor, colour or sweetness to commercially prepared foods such as cereals, baked goods, confections and beverages. Malting barley is used to produce malt for the brewing and food industries. The major quality that buyers look for are varietal purity, high germination, high malt extract, high diastatic power, large kernel size, good hectoliter weight and bright grain, free mould or weather staining and an intact husk. Malt can be processed into non-brewing consumer products, mainly in the form of sweetener extracts. The Table.1 shows the proportionate utility of Barley globally explaining its major utility rests in brewing and secondly the increased use for food and feed purpose, i.e. 25%

Table.1: Proportionate Utility of Barley

Brewing Purpose:	50%
Food and Feed Purpose:	25%
Distilled and Whisky:	20%
Syrup, Vinegar, Diuretics:	5%

Barley originally was mainly cultivated and used for human food, but it is now used for various reasons like mainly for animal feed. It is estimated that about two-thirds of the barley crop has been used for feed, malting, food, production of starch, either for food or for the chemical industry, finishing beef cattle in the United States and is also used in swine diets particularly in geographic regions where maize cannot be economically produced, thus it competes with wheat as a feed in those climates. In some countries, such as Morocco, India, China and Ethiopia, barley is used as an important food crop in daily diets. Table 2 shows the various potential use of barley:

Table.2: Potential use of Barley

S. No.	**Type of Barley**	**Potential Uses**
1.	Feed Barley	Livestock and poultry
2.	Pearl Barley	Soups, dressing flour
3.	Milling Barley	Sattu, grits, baby food, balahar, bread and biscuits
4.	Malt Barley	Green malt, dry malt, milk based beverage 1. Malt grains for dairy feeds 2. Distiller's alcohols, spirits, whiskies 3. Infant baby food, chocolate from malt 4. Malted syrups, textile use, baking uses, candles 5. Dextrin for breakfast cream, coffee substitute 6. Milk based beverage and Malt milk 7. Malted sprouts, vinegars, non-beverage products 8. Health tonics, Chocolate

On the basis of scientific research barley is also known for being quite useful as medicine. Being easily digestible as compared to wheat, so, it can be called as the best diet for patients or recovering ones.

4. Barley and Health

Evidence from observational studies indicates that diets rich in whole grains like barley reduce risk of obesity and other diseases related to the metabolic syndrome e.g. type 2 diabetes and cardio-vascular disease. The mechanisms involved are only partially elucidated.

4.1 Chemical Constituents

Barley grain is an excellent source of soluble and insoluble dietary fiber (DF) and other bioactive constituents, such as vitamin E (including toco-tri-enols), B-complex vitamins, minerals and phenolic compounds. Barley is also a rich source of tocols, including tocophenols and toco-tri-enols. Barley contains 3-11% dietary fibers made up of pentosans, beta-glucan and cellulose. Barley has an attractive nutrient make-up which makes it an excellent food for health conscious people. The Table 3 shows the nutritional composition of hundred gm of edible portion of barley:

Table.3: Nutrient Composition of Barley

Proteins	11.6 g
Fat	2g
Crude fibre	6g
Neutral detergent fibre	16.9g
Acid detergent fibre	6.2 g

(Source: Brady *et al.*, 2005)

Whole grain barley contains high levels of minerals and important vitamins like calcium, magnesium, phosphorous, potassium, Vitamin A, Vitamin E, niacin and folate. Barley products rich in indigestible carbohydrates (dietary fibre and resistant starch), facilitated glycaemic regulation through a mechanism involving fermentation by gut micro-organisms. Fermentation was associated with release of specific gut hormones (GLP-1), with acknowledged benefits on a variety of parameters associated with reduced risk of the metabolic syndrome, including benefits on perceived satiety. GLP-1 is currently investigated for use as an antidiabetic, antiobesity drug, but appears to be produced endogenously in healthy subjects after intake of certain whole grain barley products rich in indigestible carbohydrates. Addition of whole grain barley products with slow glycemic response and rich in dietary fibre and resistant starch in test meals significantly improved insulin sensitivity in type 2 diabetic subjects as compared with whole grain wheat or white wheat. The medicinal uses of barley have been summarized in Table 4:

Table.4: Medical application of Hordeum vulgare

Disease	Application
Anti-cough	Decoction of H. vulgare seeds with apples, dried figs and pears.
Bladder Inflammation	A decoction of dried seeds is used orally for bladder inflammation in Iran
Blood glucose level	Seeds of H. vulgare 125 gram are roasted and mixed with each of 50 gm of Cicer arietinum and Elettaria cardamomum and used half teaspoon with water thrice a day to control blood glucose level
Cholera	Powdered flower of Calotropisprocera, fruits of Piper nigrum, seed ash of H. vulgare and rose water are taken orally for cholera in India
Dermatitis	Hot water extract of dried seeds is also used externally for Dermatitis in Guatemala
Diabetes	This remedy is used as dietary supplement to control diabetes
Inflammations	Hot water extract of dried seeds is used externally for inflammations

(Source: Mohammad A. Jebor 2013)

5. Methodology

Just like other cereal grains, barley has to be treated with one or more processing methods to make it edible and so the barley varieties were treated with various techniques of barley processing, like blocking and pearling, grinding, roller milling and flaking to determine the nutritional composition of barley. Blocking is designed to remove the tough, fibrous, and largely indigestible hull that adheres strongly to the kernel (Yeung and Vasanthan 2001). The pearling process that follows blocking is commonly done in three or more stages to remove pearling flour, fines, or pearling (Edney et al. 2002). Grinding is done to produce whole-grain flour using a hammer/pin mill designed to shred grain into fine particles. Roller milling is done to fractionate wheat into ‘white’ flour for baking purposes. Flaking is accomplished by passing hot, moist grains through flaking rollers, which flatten the kernel, producing flakes of various thicknesses. After rolling, the flakes are cooled and dried before storage or packaging (Kent and Evers 1994).

6. Results & Conclusion and the Way Ahead

Starch, fiber, and protein make up the largest portion of the kernel, and variation in one of these components will influence the amounts of the other two. Starch level varies inversely with protein ($r = -0.81$) and fiber ($r = -0.64$) (Aman and Newman 1986). The level of protein in barley is highly variable, ranging from 7 to 25% according to a large USDA study involving over 10,000 genotypes (Ullrich 2010), although the level in typical barley is more commonly reported between 9 and 13% (Duffus and Cochrane 1993; Newman and Newman 2004). Starch-type β-glucan interaction was clearly demonstrated by Bhatty (1992), who studied 15 diverse barleys and their roller-milled products, flour and bran. The barleys included in the study were hulled, hulless, and waxy hulless genotypes.

Whereas, relatively little barley is used directly for food today, it has great potential to reclaim some of its prominence as a food grain, largely due to its high nutritional value. Barley grain provides low fat, complex carbohydrates (mainly starch) for energy, relatively well-balanced protein to meet amino acid requirements, minerals, vitamins, especially vitamin E and other antioxidants, primarily polyphenolics, and insoluble and soluble fibre with general (rapid food passage in the colon) and specific health benefits. A thorough knowledge of cereal processing and the impact of barley genotype on such processes is an absolutely necessary requisite to the manufacture of appealing, tasty, and acceptable as well as healthy food products. At the present time, the general public recognizes barley as a food primarily as pearled barley, an ingredient in soups and stews.

Over the last 15 years, research efforts associated with food barley have increased significantly, revealing a number of unique cultivar-specific functional characteristics that affect both human health and functionality in food processing. New barley cultivars have been generated specifically for food use, possessing increased β-glucan, desirable starch composition profiles and improved milling/processing traits.

Whereas much is known about the nutritional and health benefits of barley consumption, much less is known about the functionality of barley grain components in terms of processing and food product/ingredient development. Although there is much to learn about barley food quality traits, there is enough information to significantly improve barley for food use through breeding. Barley is secure in uses for feed, malting, and food, and the potential is great to improve barley for all these uses. Given the state of knowledge about the positive traits of barley and barley's current and future attributes, the future for barley use in food products is improving and very promising. The health claim will help the food barley industry a great deal, by increasing the interest of health conscious consumers and by providing information for nutritional educators. Researchers are continuing to evaluate barley's other health effects and are conducting clinical trials on the role of barley in lowering glycemic response and in providing a sense of fullness after eating. Keeping in current and future attributes of barley, all these facts will be very significant in improving the future for barley use in food products and the results look very promising.

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