

Barley : A Nutritionally Rich Cereal

with Health Benefits

Sneh Narwal¹, Dinesh Kumar² and R.P.S. Verma³

Directorate of Wheat Research, Karnal

Barley, being a good source of protein, is used as a feed and is given in the form of grain, silage, or straw. The by-products of malted barley (dried rootlets, cakes) are also used in the form of animal feed. Straw is also used for animal bedding and also to cover the hut roofs. Barley malt has wider application in the field of brewing, distilleries, confectionaries and pharmaceuticals. It is also used as a raw material for various health and energy drinks, biscuits, chocolates, beer, whiskey, brandy, tonics, health foods, slim diets, baby foods, industrial alcohol and vinegar. Popular health/energy drinks available in the market contain 40-63% of extracted solids of malted barley.

BARLEY is the fourth-largest cereal crop in the world, with a share of 7% of the global cereals production. Most of the barley produced (80-90%) is used for animal feeds and malt. Barley is still used as staple food in many parts of the world like some areas of North and the Near East Africa, the highlands of Central Asia, the Horn of Africa, the Andean countries and in the Baltic States. Morocco is the largest consumer of food barley in the world. In Highlands of Ethiopia, barley accounts for over 60% of the food. In developed countries however, there is very limited use of barley in human food representing less than 5% of the total production.

In India, 75% of total barley produced is used as animal feed, 20% for malt production and only 5% is used directly for food purpose. Out of the total malt produced, 60% is used in brewing for beer production, 8% for distillation, 25% in confectionary and 7% in pharmaceuticals. Direct use of barley

as food in India is restricted to the tribal areas of hills and plains.

Ancient literature throughout the world has stressed the health benefits and medicinal value of barley, which was often called the king of grains. Gladiators in ancient Rome were called *hordearii*, or “barley men,” because of their preference for this highly nutritious grain, which had long held a reputation as being a source of strength and stamina for athletes and labourers. Barley was also awarded to the champions of the Eleusian games. Barley being a nutritionally dense food consists of a balance of complex carbohydrates, proteins and an assortment of vitamins and minerals. Barley is especially an excellent provider of dietary fibre, B vitamins, copper, manganese and selenium.

Why the use of barley is so limited despite being so nutritionally rich? This may be because of the strong taste and “gummy” mouth feeling of whole barley kernels, lack of functionality of barley protein for making leavened bread and other baked products, difficulty in

processing whole barley in comparison to wheat or other grains and the development of grey or other dark colour in the cooked barley products.

The composition of the barley grain and the percentage of macronutrients are similar to those of other cereals, although it is considered to have a poorer nutritive value than wheat because of its higher fiber content. However, the concentration of some other constituents in barley differ appreciably from that in wheat, which may have health implications. In developed countries, people have become more health conscious and are now adopting functional foods that can provide additional health benefits besides the basic nutrition. Barley is one of the top functional food utilized in developed countries in many bakery products and other recipes.

Barley is being used as ready to eat breakfast cereal, barley porridge, *sattu*, barley water and in multigrain atta. Barley is also added to a number of other recipes to enhance

¹ Senior Scientist, ² and ³ Principal Scientists



Hulled Barley



Pearled Barley



Malted Barley

their nutritional value. Barley is recommended to pregnant women in the last trimester to get rid of the excess of water in the body. It is also an excellent remedy for the people suffering from kidney stones as a natural diuretic. Sattu is a common drink in India which is taken in summers to keep the body cool. Pearled barley is mostly preferred for food purposes, but, germ and much of the bran around the endosperm is removed, most of the vitamins and minerals are lost and the nutritional qualities are down about 25%-33% of hulled barley. But, there is a big advantage of pearled barley that it cooks up much quicker.

Barley is a store house of dietary fibres. Fibers are the non-digestible carbohydrates. Barley contains both soluble and insoluble fibre. Total dietary fibre in barley ranges from 11 to 34% and soluble dietary fibre from 3 to 20%. Soluble fibers include beta-glucan, pectins and some hemicelluloses and have many health implications. Insoluble fibers include cellulose, lignins and some hemicelluloses and have laxative effects. Soluble fibre is effective in lowering blood cholesterol and can reduce the risk of heart disease. Soluble fibre is also beneficial in slowing the absorption of sugar and reducing the risk for developing type 2 or non-insulin-dependent diabetes. The insoluble fibre found in barley may be beneficial in helping the body maintain regular bowel function.

Insoluble fibre also help lower the risk for certain cancers such as colon cancer.

The β -glucan content of cereals ranges from 1% in wheat grains, to 3-7% in oats, and 2-10% in barley. Thus, barley grains are a rich source of β -glucans. There is a big advantage with barley β -glucan. In other grains, most of the beta-glucan is removed when the bran layer of the grain is removed, but, in barley, beta-glucan, is found throughout the entire barley kernel and therefore even refined products such as barley flour contain sufficient beta-glucan.

Clinical studies have shown a consistent reduction in total and LDL cholesterol with no change in HDL cholesterol in people with elevated serum cholesterol levels who included beta-glucan containing barley products in their diets. β -glucan and other soluble fibres are believed to bind serum cholesterol and decrease its absorption, resulting in lower total plasma cholesterol levels in humans and animals, thus reducing the risk of cardiovascular disease. Overall, the clinical data indicates that a minimum of 3 g of beta-glucan from specified barley products is effective in lowering elevated cholesterol. The FDA have adopted a recommendation of 3 g per day of β -glucan as having a nutritional affect, this as a component of the recommended 30-35 g of dietary fibre per day as advised by the American Association of Dieticians.

Like all plant foods, barley is naturally cholesterol-free and low in fat. The fat component of barley is rich in tocotrienols which are shown to be potent inhibitors of cholesterol biosynthesis besides having the antioxidant activity.

More than 2800 years ago, the Indian physician Charaka mentioned that 'use of parched barley grains and its flour prevents the development of diabetes'. Charaka advocated, 'use of barley and goose berry powder as the best remedy for obesity'. On average, pearl barleys have an extremely low Glycemic Index (GI) of 25 and a relatively low Glycemic load (GL) of 11, which is an excellent combination and therefore barley is especially effective in the prevention and treatment of diabetes. Eating whole grain barley can control blood sugar for up to 10 hours after the meal which is much longer than either wheat or rice. Making barley a part of the regular diet can cut the risk of developing type II diabetes by as much as 40%.

Barley is rich in amylose compared with other foods. The amylose molecule provides a high fiber source with a low glycemic index. A diet high in amylose may benefit the diabetics because of the slower insulin response, which prevents quick spikes in glucose levels. High amylose leads to the formation of resistance starch, which escapes intestinal digestion and reaches the colon. A lot of research is being conducted on the benefits of a

high amylose diet in the prevention of colon cancer and heart disease.

High-fiber foods induce a greater feeling of satiety than refined and low-fiber foods. Such high-fiber foods can be useful tools for weight loss and weight maintenance. Barley products are high-fiber, low-fat foods that appear to promote satiety. In a study, when the satiety values of four barley based breakfasts were compared to white bread, it was observed that the barley breakfast with the highest beta-glucan and dietary fiber content received the highest satiety score. In another study, a group of diabetics rated the satiety of whole-grain barley bread, pearled barley bread, and white bread and the highest satiety rating was given to the whole-grain barley bread, which contained the highest amount of dietary fiber per serving.

Beta-glucan is also a biologic response modifier, or immunomodulator. It helps in modulating a number of immune functions like activating macrophages, increased resistance against fungal, viral, and parasitic infections, wound healing and also beta-glucan molecules have been recently used in anticancer therapy.

Barley normally contains 8-15% protein in the grain. Major storage proteins are prolamins (hordiens) which have moderate nutritional quality with protein efficiency ratio of 2.04. The prolamins are poor in lysine content. However, the total lysine content of barley (391 mg) is comparatively higher than the wheat (359 mg). High lysine barley mutants like *Hiproly* have been developed which contain 2-3% more lysine than normal types, but these were commercially not very successful. Although barley has a relatively high protein content, it does not have the same baking characteristics as wheat gluten. Therefore, typical barley bread has low bread volumes. Barley flour is primarily used in combination with other flours to make multigrain

Selected nutrient content of different grains (per 100g)

Nutrient	Barley hulled	Brown rice	White rice	Corn yellow	Oats	Rye	Wheat
Energy (Kcal)	354	370	358	365	389	338	342
Protein (g)	12.48	7.94	6.5	9.42	16.89	10.34	11.31
Carbohydrates (g)	73.48	77.24	79.15	74.26	66.27	75.86	75.90
Total Dietary fiber (g)	17.3	3.5	2.8	7.3	10.6	15.1	12.2

Source : USDA National Nutrient Database for Standard Reference, Release 24 (September 2011)

Nutritional analysis of Barley (Per 1 cup cooked pearl barley, 157g)

Calories	193 Kcal	Manganese	0.407 mg
Protein	3.5 g	Selenium	13.5 mcg
Fat	0.7 g	Thiamin	0.13 mg
Carbohydrate	44 g	Riboflavin	0.09 mg
Total dietary fiber	6 g	Niacin	3.239 mg
Calcium	17 mg	Pantothenic acid	0.21 mg
Iron	2.09 mg	Vitamin B6	0.18 mg
Magnesium	35 mg	Folate	25 mg
Phosphorus	85 mg	Vitamin A	11 IU
Potassium	146 mg	Vitamin E	0.02 mg
Sodium	5 mg	Vitamin K	1.3mcg
Zinc	1.29 mg		
Copper	0.165 mg	Water	108.2g

Source: USDA National Nutrient Database for Standard Reference, Release 24 (September 2011)

breads. On average, barley contains about 5% to 8% gluten.

The barley grain is highly concentrated with vitamins like niacin, vitamin B6 and folate, which can help lower the total blood cholesterol. Niacin, a B vitamin provides numerous protective actions against cardiovascular risk factors. Approximately, one cup of barley supplies 14.2% of the daily value for niacin.

By having barley in the diet, we can also get sufficient amount of minerals like selenium and magnesium, both of which are powerful antioxidants and can provide a stronger defense against diseases and cancers. A cup of cooked barley provides 52.0% of the daily value for selenium. Copper, another trace mineral supplied by barley, may also be helpful in reducing the symptoms of rheumatoid arthritis. Copper is also necessary for the activity of *lysyl oxidase*, an enzyme involved in cross-linking collagen and elastin, both of which provide the ground substance and flexibility in blood vessels, bones

and joints. One cup of cooked barley provides 32.0% of the daily value for copper. Barley is also rich source of phosphorus, which, in addition to its role in forming the mineral matrix of bone, is an essential component of numerous other life-critical compounds. A cup of cooked barley gives approximately 23.0% of the daily value for phosphorus.

Some barley based healthy food products

Barley grains contain much greater amounts of phenolic compounds (0.2-0.4%) than other cereal grains. Barley grain phenolics are composed of polyphenols, phenolic acids, proanthocyanidins (PA) and catechins. Phenolic extracts from whole barley kernel possess high antioxidant, antiradical and antiproliferative potentials. One type of phytonutrient especially abundant in whole grains such as barley are plant lignans, which are converted by friendly flora in our intestines into mammalian lignans, including one called enterolactone that is thought to



Some barley based healthy food products

to much attention being paid to wheat as food grain and as a result use of coarse cereals as food had decreased. Now, the time has come that we should pay more attention to barley and its health benefits and instead of a coarse cereal, it may be termed as a quality cereal for human food, medicinal and industrial uses. The changing lifestyles and dietary habits are leading to more and more patients with heart diseases and diabetes. In fact, India is fast becoming the diabetic capital of the world. Therefore, there is a need to include more healthier foods in the diet. Barley is one such cereal which can be integrated in traditional Indian diet to have additional health benefits.

protect against breast and other hormone-dependent cancers as well as heart disease through their antioxidant activity.

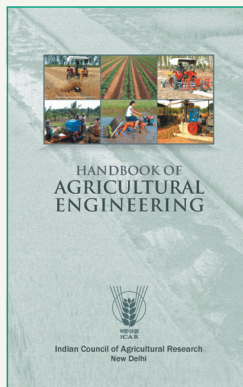
At Directorate of Wheat Research, under barley network programme, efforts are going on to improve the

beta-glucan content of Indian barley varieties which can be used as human food with health benefits.

SUMMARY

Barley has been much neglected in the later half of the 20th century, due

HANDBOOK OF AGRICULTURAL ENGINEERING



Agricultural Engineering interventions have led to significant improvement in agricultural productivity by timeliness of operations, reduction in drudgery, prevention of post-harvest losses and achieving higher cultivation intensity. Timely farm operations with efficient use of inputs, post-harvest processing and value addition to agricultural produce and conservation and sustainable use of natural resources are essential for ensuring higher returns to the cultivators. This is the maiden attempt of the Indian Council of Agricultural Research to publish the *Handbook of Agricultural Engineering*. The handbook comprises 50 chapters under four sections, namely Farm Machinery and Power, Soil and Water Engineering, Energy in Agriculture and Agro-Process Engineering. This publication would be useful to farmers, students, researchers, extension workers, policy makers, entrepreneurs and other stakeholders.

TECHNICAL SPECIFICATIONS

Size	: Royal Octavo (16 cm x 24 cm)
No. of pages	: i-viii + 808
Price	: ₹ 1000
Postage	: ₹ 100
ISBN No.	: 978-81-7164-134-5

For obtaining copies, please contact:

Business Manager

Directorate of Knowledge Management in Agriculture
 Krishi Anusandhan Bhavan-I, Pusa, New Delhi 110 012
 Tel : 011-25843657, Fax 91-11-25841282; e-mail : bmicar@gmail.com

Books you can use: FDCO BOOKS ON SOILS, CROPS, FERTILISERS, MICRONUTRIENTS, BIO-ORGANICS, AND INTEGRATED NUTRIENT MANAGEMENT IN AGRICULTURE, HORTICULTURE & PLANTATIONS

- | | |
|---|---------------|
| 01. Soil Health Management: Physical, chemical, biological, environmental, intensive cropping, dryland farming, management of problem soils, pilot project on SHM. Ed Dr HLS Tandon, 2013. | Rs 600 |
| 02. Compost Handbook: Research-production-application. By MC Manna, A Subba Rao, Asha Sahu and UB Singh. 2012. | Rs 600 |
| 03. Fertiliser Management: Balance-efficiency-profitability. Dr HLS Tandon. 2012. | Rs 500 |
| 04. Biofertiliser Handbook: Research–production-application. Dr P Bhattacharyya, HLS Tandon. 2012. | Rs 600 |
| 05. Biofertilisers & Organic Fertilisers – A sourcebook-cum-directory. Dr HLS Tandon. 2011. | Rs 500 |
| 06. Sulphur in Soils, Crops and Fertilisers – from research to application. Dr HLS Tandon. | Rs 500 |
| 07. Soil Fertility, Fertilisers and INM – A dictionary beyond definitions. Dr. HLS Tandon. 2011. Provides definitions, explanations & examples with tables and illustrations. | Rs 400 |
| 08. Nutrient Uptake, Recycling and Removal by Crops. Dr HLS Tandon & DR Y Muralidharudu. 2010. First book on the subject. Covers over 180 crops & all macro-micro plant nutrients. | Rs 400 |
| 09. Micronutrient Handbook– From research to practical application. Dr HLS Tandon.2009.Covers all micronutrients (B, Cl, Cu, Fe, Mn, Mo, Ni, Zn) and their aspects in soils, crops and fertilisers | Rs 400 |
| 10. Nutrient Management in Horticultural Crops. Dr HLS Tandon & Dr KN Tiwari. 2008.Covers about 100 crops, all plant nutrients(macro and micro), mineral, organic & biofertilisers. | Rs 280 |
| 11. FERTILISERS: Their Composition, Characteristics, Quality, Transformations and Applications. Dr HLSTandon. 2008. Covers about 100 fertilisers(N,P,K,NP,NK,NPK , micronutrients, 100% WS products, speciality fertilisers, liquids, fortified, mixtures, slow release fertilizers, biofertilisers. | Rs 280 |
| 12. Human Factor in Soil and Fertiliser Development. Dr HLS Tandon. 2008. Science in poems. | Rs 100 |
| 13. Fertilizers in Indian Agriculture - From 20th to 21st Century. Dr. HLS Tandon. 2004. A multi-faceted analysis of various aspects of fertilizers incl micronutrients covering past, present & future. | Rs 500 |
| 14. Methods of Analysis of Soils, Plants, Waters, Fertilisers & Organic Manures. Ed. Dr. HLS Tandon. 2nd revised & enlarged edition Covers major & micronutrients. Reprinted 2013. | Rs 500 |
| 15. Integrated Nutrient Management - A Glossary of Terms. Dr. HLS Tandon and Dr. RN Roy. 2004. Provides definitions, explanations & examples of terms. An FAO-FDCO Co-publication. | Rs 400 |
| 16. Dictionary of Biofertilisers & Organic Fertilisers. Dr.P.Bhattacharyya and Dr. HLS Tandon. 2002. Provides definitions, explanations & examples of terms. (Printed Book or CD-ROM). | Rs 350 |
| 17. Dictionary of Secondary & Micronutrients. Dr HLS Tandon. 2002. Covers S, Ca, Mg, B, Cl, Cu, Fe, Mn, Mo, Ni, Zn. Provides definitions, explanations & examples of terms. | Rs 300 |
| 18. Nutrient Management Recommendations for Pulses and Oilseeds. Ed Dr. HLS Tandon. 2002. Covers all important pulses, oilseeds, nutrients, fertilizers, organics, biofertilisers and IPNS. | Rs 200 |
| 19. Organic Recycling and Biofertilisation in South Asia. Ed. Dr. HLS Tandon. 2001. Covers mainly Bangladesh, Bhutan, India, Nepal, Pakistan & Sri Lanka. | Rs 350 |
| 20. Nitrogen Research and Crop Production. Ed. Dr. HLS Tandon. 1996. Covers various aspects of N in soils, crops, fertilizers, INM, BNF and environmental aspects. | Rs 300 |
| 21. Non-Traditional Sectors for Fertiliser Use. Ed. Dr. HLS Tandon. 1992. Covers sectors such as fish ponds, forest plantations, agro forestry, fortification of composts, animal nutrition, pastures, medicinal & aromatic plants, sericulture, drylands etc. | Rs 160 |
| 22. Fertiliser Marketing Systems in India. Ed. Dr. HLS Tandon. 1992. | Rs 220 |

Order with payment by MO/eMO/DD/Cash/at par cheque from the following address.

All cheques/DD payable to Fertiliser Development and Consultation Organisation
(institutions can order on bill basis)

Fertiliser Development and Consultation Organisation

204-204A, Bhanot Corner, Pamposh Enclave, New Delhi 110048, India.

Phone/Fax 11-41633864, e mail: tandonhls@gmail.com, website : www.tandontech.net