

PHYTOCHEMICAL AND PHARMACOLOGY OF *HORDEUM VULGARE* LINN. - A REVIEWDr. Nutan Sharma*¹, Dr. Omprakash Sharma² and Dr. Naresh Garg²¹PG Scholar Department of Dravyaguna Vigyan.²Professor and HOD Department of Dravyaguna Vigyan, SriGanganagar College of Ayurvedic Science and Hospital, Tanta University, SriGanganagar – 335001, India.*Corresponding Author: Dr. Nutan Sharma
PG Scholar Department of Dravyaguna Vigyan.

Article Received on 17/05/2021

Article Revised on 07/06/2021

Article Accepted on 27/06/2021

ABSTRACT

Barley has been cultivated since long in northern India. The important producers of barley are U.S.S.R., China, U.S.A., Canada, India. In India it is found in Uttar Pradesh, Rajasthan, Bihar, Punjab and Madhya Pradesh, West Bengal, Himachal Pradesh, Jammu and Kashmir. The shoots are diuretic. The seed sprouts are demulcent, expectorant. The seed is digestive, emollient, nutritive. It is taken internally as a nutritious food or as barley water (an infusion of the germinated seed in water) and is of special use for babies. Its use is said to reduce excessive lactation. Barley is also used as a poultice for burns and wounds. Recent research has shown that barley may be of aid in the treatment of hepatitis, while other trials have shown that it may help to control diabetes. Barley bran may have the effect of lowering blood cholesterol levels and preventing bowel cancer.

KEYWORDS: Ayurveda, *Hordeum vulgare* Linn. Cancer, Diuretic, Antioxidant, Aphrodisiac.

Taxonomy

Scientific Name

Hordeum Vulgare Linn.Syn.Names- *Hordeum spontaneum* K. Koch, *H. distichum* L., *H. agriocrithon* Åberg.

Vernacular Names

Ayurvedic -Yava, Hayeshtha, Hayapriya, Shuka-Dhaanya, Tikshnashuka.

Unani- Barley, Jao Shaer.

Siddha- Yavam. Saambaluppu (Ash).

Sanskrit- Aksata, Akshata, Dhanyaraja, Divya

English- Barley, Common Barley, Cultivated Barley, Hooded Barley, Malting Barley.

Hindi- Jav, Jau

Urdu- Jao, Jav

Telugu- Barlibiyam, Dhanuabhedam

Marathi- Satu, Jav

Konkani- Sovad

Oriya- Jav, Javadhana, Yava, Bansa

Gujarathi- Jau, Java, Jau

Tamil- Barliarisi

Malayalam- Barli, Yavam

Kannada- Jave-Godhi

Punjabi- Jav, Jau

Spanish- Cebada, Cebada Común, Cebada Cultivada.

French-orge

Nepal- Barli

Taxonomical Classification

Kingdom -: Plantae Plants)

Subkingdom-: Streptophyta

Superdivision-: Spermatophyta (Seed plants)

Division-: Magnoliophyte (Flowering plants)

Class-: Magnoliopsida (Dicotyledons)

Family-: PoaceaeGenus-: HordeolumSpecies-: Hordeum vulgare

DISTRIBUTION

It is used in a wide range in Indian system of medicine (Ayurveda) and described under Shukadhanya Varga. The cereal description is available since times of Vedas and Puranas (Upanishads, Shatapata brahmana), Atharvaveda, Agnipurana. The usage of Yava both as Pathya & Oushadha is established in ancient texts and modern research experiments. In traditional classifications of barley, these morphological differences have led to different forms of barley being classified as different species. Under these classifications, two-row barley with shattering spikes (wild barley) is classified as *Hordeum spontaneum* K. Koch. Two-row barley with nonshattering spikes is classified as *H. distichum* L., six-row barley with nonshattering spikes as *H. vulgare* L. (or *H. hexastichum* L.), and six-row with shattering spikes as *H. agriocrithon* Åberg.

DESCRIPTION

Root – Fibrous, 0.5 to 1 cm thick; cylindrical, glabrous, greyish-brown.

Stem – Cylindrical, 0.4 to 0.6 cm thick; hollow, slightly flattened, smooth; internode long, shining yellow; node short, bearing sheath; fracture, fibrous.

Leaf – Linear-lanceolate, 15 to 25 cm long, upper one dose to the spike; sheath smooth, striate; yellowish-grey. Inflorescence – Spike, terminal, linear-oblong, compressed spikelet sessile, 6 to 8 cm long, 6-rowed type; dark cream.

Fruit – A caryopsis, elliptic, oblong, ovoid and tapering at both ends; smooth, about 1 cm long and 0.2 to 0.3 cm

wide; dorsally compressed and flattened on the sides with a shallow longitudinal furrow; 3 to 5 ridged having shallow depression between them; grains tightly enclosed and adhering to the lemma and palea; a long awn present on the palea; pale greenish-yellow; taste, sweetish acid.



Fig. *Hordeum Vulgare* Linn: (a) plant (b) two row and six row barley (c) stem (d) seeds.

Traditional and Folk Medicinal Uses

Different parts of *Hordeum vulgare* are used as traditional and folk medicines. Hot water extracts of fruit and dried seeds, are taken by females as a contraceptive and hot water extract of dried whole plant for ancylostomiasis, beriberi, cough, influenza, dysentery, jaundice in South Korea. Decoction of dried seeds is used orally for bladder inflammation, diarrhea, enema, gout, hepatitis, externally as an emollient and applied on infected ulcers hemorrhoids and infected ulcers in Iran

and applied to the nose to reduce the internal inflammation in Iran. Decoction of the fruit is taken orally for common cold in Turkey. Hot water extract of dried seeds is also used externally for dermatitis and erysipelas in Guatemala. Decoction of the dried fruit is taken orally for diabetes in China and for diarrhea in Argentina. Infusion of the dried seeds is used as a galactagogue in Italy. Decoction of *Hordeum vulgare* seeds with apples, dried figs and pears is used as anti-cough. Seeds of *Hordeum vulgare* 125 grams are roasted

and mixed with each of 50 gm of *Cicer arietinum* and *Elettaria cardamomum* and used at half teaspoon with water thrice a day to control blood glucose level. *Hordeum vulgare* is used for lowering blood pressure, blood sugar, and cholesterol and applied to the skin for treating boils, also used in diarrhea, stomach pain and inflammatory bowel conditions. Leaf juice is useful for cataract. *Hordeum vulgare* is useful in fever and all inflammatory conditions on account of its soothing properties. Barley flour can be used externally for gout and rheumatism by putting on joints like a plaster. Dry seed powdered mixed with water and sugar is taken orally thrice a day for a month for the treatment of jaundice and hepatitis. According to Hartwell, barley is used in folk remedies for stomach and uterus cancer and abdomen tumors. The seed are used for cancer of the uterus, inflammatory and sclerotic tumors and gatherings, and parotid gland tumors. The seed flour is used for condylomata of the anus, tumors behind the ears, scirrhous of the testicles and spleen, and whitlows. Cataplasms derived from the seed are believed to help breast cancers. Barley is a folk remedy for bronchitis, burns, cancer, catarrh, chest, chilblains, cholecystitis, cholera, cough, debility, diarrhea, dyspepsia, fever, inflammation, measles, phthisis, puerperium, sores, and urogenital ailments.

CHEMISTRY

Seeds- Cyanogenic glycoside characterized as 2- β -D-glucopyranosyloxy - methyl - (2R) - butyronitrile, ubiquinones, proanthocyanidins, glycosides of hordatines A & B, procyanidin B3, trimer of procyanidin C2, prodelfinidin, chrysoeriol, hordeumin, pangamic acid, protein, carbohydrates, calcium, phosphorus, iron.

Leaves- Arabinogalacto (4 - 0 - methylglucurono) - xylan, cyanogenic glucoside, 6'' - sinapolsaponarin, 6''-feruloylsaponarin and 4' - glucosyl - 6'' - sinapolsaponarin, 2''- 0 glycosylisovitexin.

Whole plant- p- coumaroylagmatine, hordenine and its derivative, pyrrolidine, luteolin glycoside, flavones glycosides- orientoside and orientin, cynoglucosides 3-beta- D - glucopyranosyloxy- 2- methylpropene, 4 - beta - D - glucopyranosyloxy -3- hydroxyl -3- hydroxymethyl- butyrobtrile

Pharmacological Activities

Hepatoprotective activity

Methanolic extract of *Hordeum vulgare* seeds showed the hepatoprotective activity against ethanol-induced liver damage.^[41] and acetaminophen-induced liver damage in rats.^[52]

Anti-ulcerative activity

Histopathological examination of the animals treated with barley showed low lesion in stomach compared to ulcerated animals. The highly potential effect of this plant against ulcer in rats recommends the use of barley

grains seeds as potentially protective natural compound as a treatment against ulcer.^[10]

Antioxidant activity

The antioxidant activity of 100% and 80% methanolic extract of seed of three barley varieties like Jou 83, Jou 87 and Haider 93 have been measured by stabilizing sunflower oil with barley seed extract at a concentration of 600 ppm (oil weight basis) and the 80% methanol extract of seeds showed better antioxidant action than the 100% methanol extract. It indicated that antioxidant activity of methanolic extracts of barely seeds can be used to protect vegetable oils from oxidation.^[53] The malt extract showed high antioxidant activities both in vitro and in vivo by its ability to scavenge hydroxyl and superoxide-radicals, high reducing power, and protection against biological macromolecular oxidative damage, the extract also prevented the decrease of antioxidant enzyme activities, decreased liver and brain malondialdehyde levels and carbonyl content, and improved total antioxidant capability in D-galactose-treated mice which indicated the effective antioxidant activities and antiageing effect of malt as an antioxidant for diseases caused by reactive oxygen species.^[54] Antioxidant effects of water extracts of roasted barley (WERB) and unroasted barley (WEUB) have been comparing under different roasting temperatures. Both the extracts showed significant antioxidant activities in linoleic acid and liposome model systems and also possess considerable protection against the damage of deoxyribose and proteins. The antioxidant efficiency of roasted samples found weaker than that of unroasted samples because of the reduction of antioxidant components (catechin, tocopherol, and lutein) with increasing roasting temperature. Unroasted samples were more effective in reducing power, quenching free radical, hydroxyl radical, and chelating iron than the roasted samples.^[55] Barley grass is a powerful antioxidant that kills cancer cells, and overcome a variety of ailments, including acne and ulcers. According to Allan L. Goldstein, an antioxidant called alpha-tocopherol succinate -a potent relative of vitamin E (alpha-tocopherol) may be responsible for inhibit several types of cancer, including leukemia, brain tumors, and prostate cancer.^[56] Microwave oven roasting condition of barley have been optimized to obtain grains with high antioxidant activity measured as the ability to scavenge 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical. The optimum condition for obtaining roasted barley with high antioxidant activity (90.5% DPPH inhibition) was found to be at 600 W microwave powers, 8.5 min roasting time, and 61.5 g or 2 layers of grains. The roasting condition influenced antioxidant activity both individually and interactively. The acetone extract had significantly high inhibition of lipid per oxidation and DPPH radical scavenging activity compared to the aqueous extract and alpha-tocopherol. The reducing power of acetone extracts was not significantly different from alpha-tocopherol. The acetone extract had twice the amount of phenol content compared to the aqueous

extract indicating its high extraction efficiency. The aqueous extract did not contain 3,4-dihydroxybenzaldehyde and 4-hydroxycinnamic acid which are phenol compounds reported to contribute to antioxidant activity in barley grain.^[57] Barley and their corresponding malts extracts contained antioxidants such as carotenoids (lutein and zeaxanthin) and tocopherols (α , δ and γ) beside polyphenols, whose antioxidant activity was measured by various methods. All have high antioxidative properties and tocopherols were found best antioxidants.^[58] Markéta Dvorakova et.al have developed the method to analyze the antioxidant activity of the hot water (45°C) extracts of ten barley varieties and their corresponding malts. The ferric reducing antioxidant power and radical scavenging activity, 2, 2'-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) Diammonium) (ABTS), ranged from 0.23-0.45 mg GAE/g_{dw} for malt and 0.12-0.25 mg GAE/g_{dw} for barley. The hull-less malt KM 1910 was the variety with the best antioxidant properties, whereas the highest antioxidant capacity for barley was detected for the variety Merlin. Total polyphenol content ranged from 0.6-2.9 mg GAE/g_{dw} and correlated positively with all the antioxidant methods used ($p < 0.01$). The major phenolic compound was ferulic acid and its content ranged from 12.5–21.9 and 7.8–56.1 $\mu\text{g/g}_{\text{dw}}$ for barley and malt, respectively. The content of catechin ranged from 11.0–17.0 $\mu\text{g/g}_{\text{dw}}$ in barley and 0.9–12.1 $\mu\text{g/g}_{\text{dw}}$ in malt.^[59]

Anti-proliferative activity

Aqueous methanolic extracts of kernels from six different barley cultivars, namely, Falcon, AC Metcalfe, Tyto, Tercel, Phoenix, and Peregrine, were examined for anti-proliferative activities using Caco-2 colorectal adenocarcinoma cell line. The proliferation of Caco-2 colon cancer cells was significantly ($p < 0.05$) inhibited in a dose-dependent fashion in the presence of all barley extracts tested at the end of the day 4 of incubation, barley extracts rendered 29.3-51.2 and 9.3-15.9% inhibition of cell proliferation at 0.5 and 0.05 mg/ml, respectively.^[60]

Anti-diabetic effect

Ethanol extract of *Hordeum vulgare* seeds demonstrate significant protective effect against diabetic nephropathy and antioxidant activity in streptozotocin induced diabetes in rats, which confirmed the folkloric utilization.^[61]

Antidepressant

Young green barley leaf exhibits a hypolipidemic^[22, 23] and anti-ulcer effects,^[62] via its antioxidative action. Recent studies have indicated that antioxidants such as, α -tocopherol ascorbic acid have an antidepressant-like effect.^[63]

Anti-Urolithic Potential

Ethanol extract of seed have been investigated for anti-urolithic activity in an animal model of urolithiasis. The study demonstrated the anti-urolithic activity

of *seeds* and rationalizes their medicinal use for the treatment of urolithiasis.^[61]

Antifungal activity

The extraction of proteins with antifungal activity from the intercellular washing fluid of barley leaves indicated their possible role in defense against leaf pathogens.^[64]

Hypoglycemic effect

The study carried out to investigate the hypoglycemic effect of barley and its components such as amino acids (L-leucine and L-glutamine) and chromium picolinate on some biochemical and immunological parameters of alloxan induced diabetic rats showed that barley, amino acids and chromium picolinate exerted antihyperglycemic effects and consequently may alleviate liver damage caused by alloxan-induced diabetes. Barley also possesses Hypocholesterolemic, antiprotozoal, antiviral, diuretic, antimutagenic activities.

Ayurvedic Uses and Properties

Rasa of *Hordeum vulgare* is kashaya and madhura; Guna are ruksha, guru, pichchhila, and mridu; Veerya is sheeta; Vipaka is katu; Doshagnata is vaphapittashamaka. Rogagnata properties of *Hordeum vulgare* are Daha, Kshatakshina, Timira, Kantharoga, Charma roga, Visarpa, Pinasa, Shwasa, Kasa, Vatarakta, Urustarnbha, Raktavikara, Pandu, Trisha, Ajeerna, Gulma, Shoola, Atisara, Agnimandya, Chhardi, Mootrakrichchhra, Prameha, Jwara, Shleepada, Vrana, Stanyadosha, and Medoroga. The Karma of *Hordeum vulgare* Linn. are Vatakrit, Medahara, Medhya, Agnivardhaka, Lekhana, Balya, Vrishya, Svarya, Vamya, Sthairyakara, Pureeshakrit.^[1,2]

Important Ayurvedic Formulations and Preparations

The Important Ayurvedic formulations and preparations of *Hordeum vulgare* Linn. are Agastyaharitaki rasayana, Eladya modaka, Dadhika ghrita, Dhanvantara ghrita, Gandharvahasta taila, Dhanvantara taila, Brihatmasha taila, Sarsapadi pralepa, Kayasthadya varti, Yavapatola kvatha, Ratnakara rasa, Yavadya ghrita.^[1,2]

CONCLUSION

The scientific research on *Hordeum vulgare* Linn. suggests a huge biological potential of this plant. It is strongly believed that detailed information as presented in this review on the phytochemical and various biological functions of the extracts might provide detailed evidence for the use of this plant in different medicines. Recent years, ethno-botanical and traditional uses of natural compounds, especially of plant origin received much attention as they are well tested for their efficacy and generally believed to be safe for human use. It is best classical approach in the search of new molecules for management of various diseases. Thorough screening of literature available on *Hordeum vulgare* Linn depicted the fact that it is a popular remedy among the various ethnic groups, Ayurvedic and traditional practitioners for treatment of ailments.

Researchers are exploring the therapeutic potential of this plant as it has more therapeutic properties which are not known.

REFERENCES

- Sharma P C, Yelena M B and Dennis T J. Database on Medicinal Plants Used in Ayurveda: Vol 5, Central Council for Research in Ayurveda & Siddha, Dept. of ISM & H, Min. of Health & Family Welfare, Govt. of India.
- The Ayurvedic pharmacopoeia of India Part- I, Vol.-II, Ministry of health and family welfare, Department of AYUSH., Government of India.
- Chopra R N, Nayar S L, Chopra I C, Glossary of Indian medicinal plants, NISCAIR, New Delhi CSIR, 2006.
- Akar, Avci M, Dusunceli F, Barley: Post-harvest operations, 2004.
- Singh R K and Sharma R P, Relationship of soil chemical composition with the nutritive values of barley grain of Rajasthan and Haryana. Journal of Chemical Biological and Physical Sciences, 2012; 2: 827-831.
- Chand N, Vishwakarma S R, Verma O P and Kumar M, Phenotypic Stability of Elite Barley Lines over Heterogenous Environments. Barley Genetics News Letter, 2008; 38: 14
- Baik B K, Ulrich S E, Barley for food: Characteristics, improvement and renewed interest. Journal of Cereal Science. 2008; 48: 233-242.
- Behall K M, Scholfield D J, Hallfrisch J, Lipids significantly reduced by diets containing barley in moderately hypercholesterolemic men. J Am College of Nutr., 2004; 23: 55-62.
- Food and Drug Administration, FDA, Food labeling: health claims, soluble dietary fiber from certain foods and coronary heart disease. Intl rule Fed Reg, 2002; 67: 61773-61783.
- Sati A D, Mona S, El-kutry and Hoda S I. Inhibitory Effect of Aqueous Extracts of Barley and Fenugreek on Ulcer Induction in Rats. World Applied Sciences Journal, 2008; 5: 332-339.
- FOC, *Hordeum vulgare* L. Flora of China, 22: 396, 398, 399.
- Gehan K and Mohamed a G, Effect of Barley (*Hordeum Vulgare*) on the Liver of Diabetic Rats: Histological and Biochemical Study. Egypt J Histol, 2008; 3: 245- 255.
- Ferreres F, Kršková Z, Gonçalves R, Valentão F, Pereira P, Dušek J A, Martin J, Andrade P B, Free water-soluble phenolics profiling in barley (*Hordeum vulgare* L.). Journal of Agricultural and Food Chemistry, 2009; 57: 2405-2409.
- Gomez-Macpherson, H. 2001. *Hordeum vulgare*. Ecoport Entity 1232, <http://www.ecoport.org>
- Hordeum vulgare*. Retrieved April 18, 2006, from the Integrated Taxonomic Information System on-line database, <http://www.itis.usda.gov>.
- Kling, J. 2004. An Introduction to Barley - Notes from CSS 330 World Foods Class. Accessed April 18, 2006.
- Plants for a Future database. 2004. *Hordeum vulgare* Blagdon Cross, Ashwater, Beaworthy, Devon, EX21 5DF, UK. Website: www.pfaf.org. Accessed April 18, 2006.
- Small, E. 1999. New crops for Canadian agriculture. p. 15-52. In: J. Janick (ed.), Perspectives on new crops and new uses. ASHS Press, Alexandria, VA.
- US Barley genome project. 2005. <http://www.barleyworld.org/northamericanbarley.php> Accessed April 18, 2006.
- U.S. Grains Council (2006) Barley: Genus *Hordeum*, family poaceae, a cereal grain.
- USDA, NRCS, 2006. The PLANTS Database, 6 March 2006. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. <http://plants.usda.gov/java/profile?symbol=HORDE>.
- Wikipedia contributors (2006). Barley. Wikipedia, The Free Encyclopaedia. Retrieved April 14, 2006
- Young, B. 2001. Barley; The Versatile Crop. Southern Illinois University, College of Science, Ethnobotanical Leaflets.
- Hanson A D, Ditz K M, Singletary G W and Leland T J, Gramine accumulation in leaves of barley grown under high-temperature stress. Plant Physiology. 1983; 71: 896-904.
- Hanson A D, Traynor P L, Ditz K M and Reicosky D A, Gramine in barley forage – Effects of genotype and environment. Crop Science. 1981; 21: 726-730.
- Hoult A H C. and Lovett J V, Biologically active secondary metabolites of barley. III. A method for identification and quantification of hordenine and gramine in barley by high-performance liquid chromatography. Journal of Chemical Ecology. 1981; 19: 2245-2254.
- Liu D L and Lovett J V, Biologically active secondary metabolites of barley. II. Phytotoxicity of barley allelochemicals. Journal of Chemical Ecology, 1993b; 19: 2231-2244.
- Lovett J V, Hoult A H C and Christen O, Biologically active secondary metabolites of barley. IV Hordenine production by different barley lines. Journal of Chemical Ecology, 1994; 20: 1945-1954.
- Mann H H and Barnes TW. The competition between barley and certain weeds under controlled conditions. V. Competition with clover considered as a weed. Annals of Applied Biology, 1952; 39: 111-119.
- Baghestani A, Lemieux C, Leroux GD, Baziramakenga R and Simard R R. Determination of allelochemicals in spring cereal cultivars of different competitiveness. Weed Science, 1999; 47: 498-504.
- Chon S U and Kim Y M. Herbicidal potential and quantification of suspected allelochemicals from four grass crop extracts. Journal of Agronomy and Crop Science, 2004; 190: 145-150.
- Yu Y M, Chang W C, Chang C T, Hsieh C L, Tsai C E. Effects of young barley leaf extract and

- antioxidative vitamins on LDL oxidation and free radical scavenging activities in type 2 diabetes. *Diabetes Metab*, 2002; 28: 107–14.
33. Yu Y M, Wu C H, Tseng Y H, Tsai C E, Chang W C. Antioxidative and hypolipidemic effects of barley leaf essence in a rabbit model of atherosclerosis. *Jpn J Pharmacol*, 2002; 89: 142–8.
 34. Borner H. Liberation of organic substances from higher plants and their role in the soil sickness problem. *The Botanical Review*, 1960; 26: 393-424.
 35. Hura T, Dubert F, Dabkowska T, Stupnicka-Rodzynkiewicz E, Stoklosa A and Lepiarczyk A. Quantitative analysis of phenolics in selected crop species and biological activity of these compounds evaluated by sensitivity of *Echinochloa crus-galli*. *Acta Physiologiae Plantarum*, 2006; 28: 537-545.
 36. Ohashi H, Yamamoto E, Lewis N G and Towers G H N. 5-Hydroxyferulic acid in *Zea mays* and *Hordeum vulgare* cell walls. *Phytochemistry*, 1987; 26: 1915-1916.
 37. Oueslati O, Hammouda B M, Ghorbal M H, Gazzeh E M. and Kremer RJ. Role of phenolic acids in expression of barley (*Hordeum vulgare*) autotoxicity. *Allelopathy Journal*, 2009; 23: 157-166.
 38. Yu J, Vasanthan T and Temelli F. Analysis of phenolic acids in barley by high-performance liquid chromatography. *Journal of Agricultural and Food Chemistry*, 2001; 49: 4352-4358.
 39. Batish D R, Singh H P, Kohli R K and Dawra G P. Potential of allelopathy and allelochemicals for weed management. In: *Handbook of Sustainable Weed Management* (Ed., H.P. Singh, D.R. Batish and R.K. Kohli, 2006; 209-256. Food Products Press, Binghamton, NY.
 40. Liu L, Gitz D C III and McClure J W. Effects of UV-B on flavonoids, ferulic acid, growth and photosynthesis in barley primary leaves. *Physiologia Plantarum*, 1995; 93: 725-733.
 41. Harborne J B. *Comparative Biochemistry of the Flavonoids*, Academic Press, London, 1967; 383.
 42. Osawa T, Katsuzaki H, Hagiwara Y, Hagiwara H and Shibamoto T. A novel antioxidant isolated from young green barley leaves. *Journal of Agricultural and Food Chemistry*, 1992; 40: 1135-1138.
 43. Erb N, Zinsmeister H D, Lehmann G and Nahrstedt A. A new cyanogenic glycoside from *Hordeum vulgare*. *Phytochemistry*, 1979; 18: 1515-1517.
 44. Nielsen, K.A., Olsen, C.E., Pontoppidan, K. and Moller, B.L. Leucine-derived cyano glucosides in barley. *Plant Physiology*, 2002; 129: 1066-1075.
 45. Pourmohseni H, Ibenthal W D, Machinek R, Remberg G and Wray V. Cyanoglucosides in the epidermis of *Hordeum vulgare*. *Phytochemistry*, 1993; 33: 295-297.
 46. Smith T A and Best G R. Distribution of the hordatines in barley. *Phytochemistry*, 1978; 17: 1093-1098.
 47. Walter D R and Wylie M A. Polyamines in discrete regions of barley leaves infected with the powdery mildew fungus *Erysiphe graminis*. *Physiologia Plantarum*, 1986; 67: 630-633.
 48. Greenland A J and Lewis D H. Amines in barley leaves infected with brown rust and their possible relevance to formation of 'green islands'. *New Phytologist*, 1984; 96: 283-291.
 49. Barria B N, Copaja S V, Niemeyer H M. Occurrence of DIBOA in wild *Hordeum* species and its relation to aphid resistance. *Phytochemistry*, 1992; 31: 89-91.
 50. Grun S, Frey M, Gierl A. Evolution of the indole alkaloid biosynthesis in the genus *Hordeum*: distribution of gramine and DIBOA and isolation of the benzoxazinoid biosynthesis genes from *Hordeum lechleri*. *Phytochemistry*. 2005; 66: 1264-1272.
 51. Shah P A, Parmar M Y, Thakkar V T, Gandhi T R. Hepatoprotective Activity of *Hordeum Vulgare* Linn. Seeds Against Ethanol-Induced Liver Damage in Rats. *Pharmacologyonline*, 2009; 2: 538-545.
 52. Abbasi A M, Khan M A, Ahmad M, Zafar M, Khan H, Muhammad N, Sultana S. Medicinal plants used for the treatment of jaundice and hepatitis based on socio-economic documentation. *African Journal of Biotechnology*, 2009; 8: 1643-1650.
 53. Prajapati N D, Purohit S S, Sharma A K, Kumar T. A Hand book of Medicinal Plants. 3rd Edition. Agrobios Hindustan Printing Press, Jodhpur, 2006.
 54. Friedrich W and Galinsa R. Identification of a new flavanol glucoside from barley (*Hordeum vulgare* L.) and malt. *European Food Research and Technology*, 2002; 214: 388-393.
 55. Rochester C P, Kjellbom P, Anderson B, Larsson C. Lipid composition of plasma membranes isolated from light-grown barley *Hordeum vulgare* leaves: identification of cerebroside as a major component. *Arch Biochem Biophys*, 1987; 255: 385-91.
 56. The wealth of India, 11 vols. C.S.I.R. (Council of Scientific and Industrial Research), 1948–1976. New Delhi.
 57. Erb N, Zinsmeister H D, Lehmann G, Nahrstedt A. A new cyanogenic glycoside from *Hordeum vulgare*. *Photochemistry*, 1979; 18(9): 1515–1517.
 58. Gupta Mahesh, Abu-Ghannam Nissreen and Eimear Gallagher. Barley for Brewing: Characteristic Changes during Malting, Brewing and Applications of its By-Products. *Comprehensive Reviews in Food Science and Food Safety*, 2010.
 59. Wursch PFX. The role of viscous soluble fiber in the metabolic control of diabetes. A review with special emphasis on cereals rich in α -glucan. *Diabetes Care*, 1997; 20(11): 1774-1780.
 60. Keagy PM, Knuckles BE, Yokoyama WH, Kahlon TS, Hudson CA. Health-promoting properties of a high beta-glucan barley fraction [Grain's symposium, part two]. *Nutr. Today*, 2001; 36(3): 121-123.