Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
https://www.phytojournal.com
JPP 2024; 13(3): 132-139
Received: 04-03-2024
Accepted: 15-04-2024

Dr. Chand Bibi
MD, Department of Tahaffuzi Wa Samaji Tib, National Institute of Unani Medicine, Bengaluru, Karnataka, India

Dr. Safder Husain
Research Associate, Regional Research Institute of Unani Medicine, CCRUM (An autonomous Organization under Ministry of AYUSH), New Delhi, Delhi, India

Corresponding Author:
Dr. Chand Bibi
MD, Department of Tahaffuzi Wa Samaji Tib, National Institute of Unani Medicine, Bengaluru, Karnataka, India

A comprehensive review on medicinal properties, phytochemistry, and pharmacology of *Hordeum vulgare* linn: An important plant origin Unani drug

Dr. Chand Bibi and Dr. Safder Husain

DOI: https://doi.org/10.22271/phyto.2024.v13.i3b.14954

Abstract
Aims and Objectives: *Hordeum vulgare* Linn is an important cereal grain commonly known as *Jao.* It is a common ingredient in Tibetan cuisine and is widely used throughout the Middle East as a whole-grain barley meal in soups, stews, porridges, gruels, biscuits, and bread. Barley has various therapeutic actions too such as it is a good enhancer of intelligence, also used to treat headache, cough, pleurisy, and tuberculosis, inflammation of the breast and axilla, post-auricular swellings, acute swelling of joints and gout, scrofula, chronic swellings, melasma, itching, and so on.
Chemical analysis of it shows that it contains starch, dietary fibers, proteins, essential amino acids, lipids, unsaturated fatty acids, fixed oil, vitamins and minerals, trace elements, phenolic acids, flavonoids, natural polyphenols (Lignans), phytosterols, folates, and various other constituents. Research studies have shown that it possesses antidiabetic, hypolipidemic effects or anticancer, antioxidation, anti-inflammation, immunomodulation, cardioprotection, blood pressure regulation, improve gastrointestinal, hepatoprotection, cardiovascular disease prevention, atopic dermatitis alleviation, and antiaging effects. The aim of this article is to explore different dimensions of barley including botanical, chemical and pharmacological studies of plant besides its traditional uses in Unani Medicine.

Keywords: *Hordeum vulgare*, polyphenols, Phytochemistry, barley, shaeer, Unani medicine

Introduction
Barley is an important cereal grain from the Poaceae family with a botanical name *Hordeum vulgare* L. (Rashid *et al.*, 2017) [1] Barley grain is a common ingredient in Tibetan cuisine and is widely used throughout the Middle East as a whole-grain barley meal in soups, stews, porridges, gruels, biscuits, and bread. (Meyler's Side Effects of Drugs (Sixteenth Edition), 2016). After wheat, rice, and maize, it is the fourth most extensively produced grain. (Waugh *et al.*, 2017; The Worldwide Vegetables., 2015) [3] In the previous century, barley was largely produced and for human consumption however, it is currently widely grown. It is also suitable for animal feed and malt products. (Akar *et al.*, 2004) [5] Barley has been utilized for human and animal feed since prehistoric times. Barley originated in the Near East. The first historical reference belongs to barley dating back to 10,500 BC. Barley appears wildly in ancient Egypt around 8,000 BC. Since 5,000 BC, barley has been grown in Central Europe. It also has been grown in China and used to cure skin, liver, and gastrointestinal diseases since 2000 BC. In classical Greece, it was regarded as the most nutritious cereal grain. (Emilia-Ancuța BO *et al.*, 2019) [6].
Scientific Classification (*Hordeum vulgare* (barley)., 2019; Integrated Taxonomic Information System (ITIS)., 2016).

- **Kingdom:** Plantae.
- **Division:** Tracheophyta.
- **Class:** Magnoliopsida.
- **Order:** Poales.
- **Family:** Poaceae.
- **Genus:** Hordeum.
- **Species:** *Hordeum vulgare* L.

Vernacular names: (Ibn-e-Baitar *et al.*, 1999; UPI., 20109) [9].

- **English:** Barley.

- **Arabic:** Shaeer.
- **Persian:** Jau.
- **Urdu:** Jau.
- **Hindi:** Jav.

Methodology

The data were collected from ancient Unani books, NFUM, as well as other published research papers indexed on PubMed, science direct, Scopus, google scholar, and research gate.

Results and Discussion

Barley is an annual plant with a height of 60-120 cm depending on the type and growth conditions. Typically, barley plants have 1-6 tufted, upright, and strong stems. They contain nodes and internodes, which are solid and hollow, respectively. Barley roots are generated at the seed level. During the growing season, they become extremely branched and active. The roots are highly tough and fibrous, 1.8-2.1 meters deep in the soil, helping to prevent erosion. The leaves grow along the barley stems, which are covered in a waxy chalk-like layer of varied density in most varieties. They are few, alternate, linear-lanceolate, and blades up to 25 cm long and 1.5 cm wide. The leaves vary in shape and size depending on the growth conditions and barley variety. The spike, or flowering structure, is extended upward. The spikes are dense and can reach a length of 10 cm (4 inches). They are made up of a large number of individual blooms known as florets. Although there are variations with two rows (in which just one of the three spikelets on each side of the head develops into a grain) or six rows (two sets of three spikelets form grains), the spikelets (which contain the individual grains) are normally in threes. The total number of spikelets in a spike is about 60 but they vary. A kernel is a grain or seed enclosed in a husk. Barley seeds are about 8mm in length and 50 mg in weight when they are fully matured. The botanical description of barley is given in table 1.

Table 1: Botanical description of barley

S. No.	Description	***Hordeum vulgare* Linn.**
1.	Habit	Plant
2.	Stems and branches	1-6 tufted, upright, and strong stems
3.	Roots	Highly tough and fibrous, 1.8-2.1 meters deep in the soil, helping to prevent erosion. Generated at the seed level.
4.	Leaves	They are few, alternate, linear-lanceolate, and blades up to 25 cm long and 1.5 cm wide, vary in shape and size depending on the growth conditions and barley variety. They grow along the barley stems, which are covered in a waxy chalk-like layer of varied density.
5.	Flowers	Extended upward, dense with length of 10 cm (4 inches) and made up of a large number of individual blooms known as florets. The total number of spikelets in a spike or flowering structure is about 60 but they vary.
6.	Fruit	Caryopsis fruit, smooth, about 1 cm long and 0.2-0.3 cm wide, dorsally compressed and flattened on the sides with a shallow longitudinal furrow, 3-5 ridges with shallow depressions between them, grains tightly enclosed and adhering the lemma and palea; pale-greenish-yellow; odour, not distinct; taste, sweetish-acrid.
7.	Seeds	Seeds are about 8mm in length and 50 mg in weight when they are fully matured. (Waugh *et al.*, 2017; The Worldwide Vegetables., 2015) [3]

Barley is known as shaeer and yoh in Arabic and Sanskrit, respectively. Barley grows in the field before wheat. The barley is grown in cold soil; irrigated by rain, completely ripe, white, large size grains, neither too old nor too new is considered best for use. It exists in two varieties, one of which is taller and has more peel. Another is shorter and has less peel. *Ma'ul shaeer* is more nutritious than *Joe sattu*. The huskless barley is known as *salat*. Unani description of barley is given in table 2.

Table 2: Unani description of barley

Botanical name	***Hordeum vulgare* Linn.** (1999; UPI., 2009)
Mizaj (Temperament)	Cold and dry in first degree (Ghani *et al.*, 1999) [11]
Parts used & *Miqdare Khoorak* (Dose)	Dried grains 100-200 g, Dried plant 10-20g (Khare *et al.*, 2008) [12]
Muzir (Adverse effect)	For urinary bladder, (Jeelani *et al.*, 1996) [13] viscera, (Hakeem *et al.*, 2002) [14] and person with cold temperament & colitis patients. (Razi *et al.*, 1991) [15]
Musleh (Corrective)	Aniseed (*Pimpinella anisum*), *gulqand*, (Jeelani *et al.*, 1996) [16] oil, butter, ghee, sugar, mishri, and meat curry are used as correctives. (Ghani *et al.*, 1999) [11]
Badal (Substitute)	Mung Bean (*Vigna radiata* L.)(Ghani *et al.*, 1999) [11] and Jowar (*Sorghum*) (Jeelani *et al.*, 1996) [13]
Murakkabat (Compound formulation)	*Aash Jao, Maul Shaeer, Zimad e Waram e Unsayain Haad* (UPI., 2007)
Afa'al (actions)	*Mujaffif* (desiccant), *Jaali* (Detergent), *Daf e humma* (Antipyretic), *Mudirre Baul* (Diuretic), *Muwallid e Dam* (Haemotogenic), (UPI., 2009) *Qabiz* (Astringent), *Munzij* sauda (Concoctive of black bile), (Ibn-e-Baitar *et al.*, 1999) [9] *Musakkin*. (Ghani *et al.*, 1999) [11] *Muhallil* (Resolvent), (Hakeem *et al.*, 2002) [14] *Murattab* (Humectant), *Mulyyan* (Laxative) (Kabeeruddin *et al.*, 2007) [14] *Mughazzi* (Nutritive), *Mulattif* (Demulcent), Immune modulation. (Khare *et al.*, 2008) [12]

In the Unani system of Medicine, barley, due to *musakkin* activity, is used to neutralize the heat of humor. Barley paste prepared with vinegar and *ajwain khurasani* or opium is applied on the forehead to relieve headache caused by simple abnormal hot temperament. Because of its antipyretic activity, barley is used to alleviate fever and quench thirst. Due to desiccant, resolvent, and immune modulation activity, barley is used to relieve cough, pleurisy, and tuberculosis. Paste of barley and *tukhme khayarain* in water is used to treat pleurisy and inflammation of the breast, axilla, and ear. Unani Physicians used a paste of barley and *aspghol* in vinegar to treat acute especially post-auricular swellings due to its resolvent activity. The use of paste prepared with barley, *safarjali*, and vinegar is considered a remedy for acute swelling of joints and gout. Unani Physicians also used barley and coriander leaves paste in water to treat scrofula and acute & chronic swellings. Unani Physicians used a paste of barley, figs, rewand chini, and honey water (*Ma'ul asl*) to treat

chronic swellings. *Qairuti* made up of barley, ratiyanj, zift, and wax is also used to resolve chronic swellings. Its lukewarm paste is used to treat melasma and itching due to its detergent activity. Other skin conditions like erysipelas, urticaria, dandruff, and acute swelling are treated by barley paste prepared with vinegar. Scrubbing the body with barley paste removes girt. Barley paste prepared with *ajwain khurasani* is used in orthopedic conditions such as sprains, dislocations, and fractures. Peeled barley paste prepared with *khurfa*, *mako* leaves, and water relieves swelling of the eyes, conjunctivitis, pain, and burning sensation. Mouth wash prepared with boiled barley and wheat husk water relieves toothache. Gargling with soaked barley water improves throat inflammation. Oral use of *zulal* obtained from barley dough soaked overnight in buttermilk relieves bilious vomiting and loose motion. Due to its astringent activity, barley *hareera* is used with some other astringent medicines in loose motion. Barley paste with fenugreek seeds and linseed is applied to the abdomen to relieve severe flatus. Flatus discomfort can also be relieved by hot fomentation with a package of barley husk. In the case of indigestion-related abdominal pain, a semisolid recipe prepared by cooking barley flour in water is used. Barley tree ash solution in water is also used to treat dyspepsia. Barley is used orally to enhance intelligence, strengthen the body and reduce body fat. Main therapeutic uses of barley are given in table 3.

Table 3: Therapeutic uses (*Istemalat*) of crude Barley against Various Ailments

	Ailments	**Approach**
Nervous system	Headache A good enhancer of intelligence	Local application of its paste prepared with vinegar and *ajwain khurasani* or opium on forehead. Used orally.
Respiratory System	Cough, pleurisy, and tuberculosis.	Local application of paste of barley and *tukhme khayarain* prepared in water
Anti-inflammatory	Inflammation of the breast and axilla Post-auricular swellings Acute swelling of joints and gout. Scrofula Chronic swellings	Local application of paste of barley and *tukhme khayarain* in water Local application of paste of barley and *aspghol* prepared in vinegar Local application of paste prepared with barley, *safarjali*, and vinegar Local application of paste of barley and coriander leaves. Local application of paste of barley, figs, *rewand chini*, and honey water (*Ma'ul asl*). *Qairuti* made up of barley, *ratiyanj*, *zift*, and wax is also used for chronic swelling
Skin diseases	Melasma and itching Erysipelas, urticaria, dandruff, and acute swelling	Local application of its lukewarm paste Its paste prepared with vinegar
Eyes, teeth, and throat	Conjunctivitis and burning sensation. Toothache Throat inflammation	Peeled barley paste prepared with *khurfa*, *mako* leaves, and water Mouth wash prepared with boiled barley and wheat husk water Gargling with soaked barley water
Gastrointestinal system	Bilious vomiting and loose motion Flatus Dyspepsia	Oral use of *zulal* obtained from barley dough soaked overnight in buttermilk Local application of barley paste with fenugreek seeds and linseed on abdomen. Hot fomentation with a package of barley husk is also useful. A solution of barley tree ash in water is used. A semisolid recipe prepared by cooking barley flour in water is also used for indigestion-related abdominal pain. (Ghani *et al.*, 1999) [11]

Barley varies widely in chemical composition, due to genotype and environment or interactions between the two. In normal hulled barley, starch is the major constituent, accounting for about 60% of dry matter, followed by total dietary fiber and protein, which comprise about 20 and 11% of dry matter, respectively. The most importantly dietary fiber components in barley are β-glucan and arabinoxylan. A range of different phytochemicals, including tocols, folate, sterols, phenolic acids, and alkylresorcinols (AR), is also found in barley in smaller amounts. Tocotrienols possess antioxidants, and other potential health benefits such as inhibition of cholesterol synthesis, neuroprotection, and anticarcinogenic properties. Phytosterols are added to functional foods to aid in lowering serum cholesterol levels in humans. Phenolic compounds have strong antioxidant activities associated with their ability to scavenge free radicals. Consumption of a high level of phenolic compounds reduces the risk of certain cancers and cardiovascular diseases. Different phytochemical constituents of barley with their therapeutic actions are present in the table 4.

Table 4: Chemical constituents of barley and their therapeutic potential

I Chemical Composition of barley	**Part**	**Therapeutic actions**
1. Starch	Barley grain (Andersson *et al.*, 2008) [18]	Starch enhances the ability of damaged skin to recover. It also enhances skin barrier function in atopic dermatitis. (De Paepe *et al.*, 2002) [19]
2. Dietary fiber Polysaccharides	Grain (De Paepe *et al.*, 2002; Idehen *et al.*, 2017) [19, 20]	Polysaccharides reduce risk factors for chronic diseases, including CVDs and certain types of cancer. (Lovegrove *et al.*, 2017) [21]
β-glucans		B-glucan improves glucose and cholesterol level in blood. It has laxative, anti-cancerous properties against colorectal cancer. It also prevents coronary heart disease, diabetes, and increase gut multiflora. (Ciecierska *et al.*, 2019) [22] It reduces facial fine lines, wrinkles, and roughness (Pillai *et al.*, 2005) [23] by the capability of elastin production. (Ouriel *et al.*, 2014) [24]
Arabinoxylans		It enhances immunity, regulates cholesterol, and diabetes. (Mendis *et al.*, 2014) [25]
Fructans		Fructans possess immunomodulatory activity, stimulate probiotics, improve health, and scavenge "ROS". (Franco-Robles *et al.*, 2015) [26]

Resistant starch		It has anti-cancerous, anti-diabetic, and anti cholesterolemic activity. (Fuentes-Zaragoza *et al.*, 2010) [27]
2. Protein: (Hordeins, glutelins, albumins, and globulins)	Grain (Obadi *et al.*, 2021) [28]	Barley proteins reduce cholesterol, and blood sugar, and have antioxidant activity. (Zeng *et al.*, 2018) [29]
3. Essential amino acids:		They hydrate the skin and protect it from sun damage. (Solano *et al.*, 2020) [30]
Lysine		It has anti-inflammatory, angiogenesis and protein synthesis activity. (Datta *et al.*, 2001; Alagawany *et al.*, 2021) [31, 32]
Threonine		It is good for GIT. (Alagawany *et al.*, 2021) [32]
γ-aminobutyric acid (GABA)		The local application of GABA accelerates skin inhibition recovery when it is damaged and improves epidermal hyperplasia. (Denda *et al.*, 2002) [33]
4. Lipids: Glycolipids (9%)	Grain (Obadi *et al.*, 2021; Nadkarni *et al.*, 1996) [28, 34]	Glycolipids moisturize the skin. (Suanarunsawat*et al.*, 2016) [35]
Phospholipids (20%)		Phospholipids are required for the treatment of inflammatory disorders. (Like arthritis), neurological disorders, tumors, and metastasis inhibition, reducing blood cholesterol and the risk of CVDs. It has immunomodulation and hepatoprotective activities. (Küllenberg *et al.*, 2012) [36]
Unsaturated fatty acids Linoleic acid Linolenic acid		It reduces dermatitis and prevents water loss. (Ahmad *et al.*, 2020) [37]
Fixed oil:		Fixed oil lowers blood glucose levels and serum lipid profile while it increases serum insulin levels and scavenges free radicals. (Suanarunsawat *et al.*, 2016) [35]
Glycerine Lauric acid		Glycerine improves skin hydration and skin barrier function. (Milani *et al.*, 2017) [38] Lauric Acid has antimicrobial activity. (Nakatsuji *et al.*, 2009) [39]
5. Vitamins and minerals Vitamin B1	Barley grain (Obadi *et al.*, 2021) [28]	Vitamin B1 is necessary for energy metabolism and treats beriberi. (Ghosal *et al.*, 2012) [40]
VitaminB2		Vitamin B2 is required for the regular metabolic activity of pancreatic β -cells and protects them from oxidative damage. (Ghosal *et al.*, 2012) [40]
Vitamin C		Vitamin C promotes collagen formation. It is a potent antioxidant and inhibits melanogenesis. Topical and oral use of it prevents photoaging and UV Damage. (Pullar *et al.*, 2017) [41]
Vitamin E		Vitamin C and vitamin E give antiaging and skin lightening properties on the skin. (Rattanawiwatpong *et al.*, 2020) [42]
α-tocopherol β-tocopherol γ-tocopherol		Alpha-tocopherol protects skin surface lipids from photo-oxidative stress, hence maintaining the integrity of the skin barrier. (Ekanayake-Mudiyanselage *et al.*, 2005) [43]
6. Trace elements Cu	Grain (Obadi *et al.*, 2021; Gromkowska-Kępka *et al.*, 2021) [28, 44]	Copper, Zinc, and selenium are antioxidants. (Gromkowska-Kępka *et al.*, 2021) [44]
Zn		Zinc is used orally to treat acne, alopecia, rheumatoid arthritis. Local use of zinc promotes wound healing and reduces inflammation. (Schwartz *et al.*, 2005) [45]
Se		Selenium maintains tissue integrity, antioxidant (Tinggi *et al.*, 2008) [46]
Fe		It is necessary for DNA synthesis. (Abbaspour *et al.*, 2014) [47]
Mg		It promotes skin hydration and reduces inflammation. (Schwalfenberg *et al.*, 2017) [48]
K	Leaves (Khare *et al.*, 2008) [12]	It promotes bone strength and reduces blood pressure, coronary heart disease, and renal stone. (Weaver *et al.*, 2013; Kong *et al.*, 2008) [49, 50]
II. Bioactive compounds 1. Phenolic acid Cinnamic acid	Outer layers of the kernel (Idehen *et al.*, 2017) [20]	It has skin and hair conditioning, skin lightening, antiaging, antioxidant activity. (Gunia-Krzyżak*et al.*, 2018) [51]
Phenolic acid in bound forms Lignin		Lignins reduce serum cholesterol, and blood glucose, prevent tumor development, antioxidant, antiviral, anti-coagulant, and immunomodulatory activity. (Vinardell *et al.*, 2017) [52]
Cellulose		It is used for intestinal health. (Naomi *et al.*, 2020) [53]
Hemicelluloses		Hemicelluloses have radical scavenging and antioxidant activity. (Wu *et al.*, 2019) [54]
Phenolic acid in free forms Ferulic acid (27%)	The outer part of the pericarp (Idehen *et al.*, 2017) [20]	Ferulic acid has anti-inflammatory, antioxidant, anticancer, anti-microbial and antidiabetic activity. It inhibits melanogenesis and enhances angiogenesis. (Zduńska *et al.*, 2018) [55]
Vanillic acid (28%)		Vanillic acid has cardioprotective, hepatoprotective, neuroprotective, antioxidant, anti-inflammatory activity. (Sharma *et al.*, 2020) [56]
Syringic acid (17%)		It has antidiabetic, anticancer, neuroprotective, hepatoprotective, antioxidant, anti-inflammatory activity. (Srinivasulu *et al.*, 2018) [57]
p-coumaric acid (22%)		It inhibits melanogenesis. (Seo *et al.*, 2011) [58]
2. Flavonoids	Barley grain (Idehen *et al.*, 2017) [20]	Flavonoids prevent skin aging by targeting SASP (senescence-associated secretory phenotype). SASPs are pro-inflammatory mediators, secreted by senescent cells. (Rees *et al.*, 2018) [59]
Flavanols		Flavanol- lowers blood pressure. (Rees *et al.*, 2018) [59]
Proanthocyanidis		Proanthocyanidins are powerful scavengers of ROS, antioxidants, anti-inflammatory, immunomodulatory, DNA repair, and antitumor activity. (Yang *et al.*, 2018) [60]
2”-O-glucosyl-isovitexin	Leave (Khare *et al.*, 2008) [12]	2"-O-glycosyl isovitexin has antioxidant, (Arimoto *et al.*, 2000) [61] anti-inflammatory, and antiallergic activity. (Khare *et al.*, 2008) [12]
Anthocyanins are:	Grain (Khare *et al.*, 2008) [12]	Anthocyanins stimulate collagen synthesis, accelerate wound healing by reducing oxidative stress, and have antioxidant and antiaging activity. (Palungwachira *et al.*, 2019) [62]
Cyanidin 3-glucoside		Cyanidin 3-glucoside inhibits UVB-induced epidermal thickness when applied topically. (Pratheeshkumar *et al.*, 2014) [63]
Pelargonidin		It has anti-inflammatory and anticancer activity. (Lee *et al.*, 2019) [64]
3. Lignans (natural polyphenols)	Plant (Idehen *et al.*, 2017) [20]	It has anticancer, antidiabetic, antioxidant, anti-inflammatory, and cardioprotective activity. (Draganescu *et al.*, 2015) [65]
4.Phytosterols β-sitosterol	Barley grain (Obadi *et al.*,	Phytosterols block collagen reduction after UV irradiation and stimulate collagen synthesis. (Beck *et al.*, 2008) [66]

campesterol campestanol	2021) [28]	
5. Folates	Barley grain (Idehen *et al.*, 2017) [20]	Folates prevent cancer in sun-exposed skin (provide precursors for DNA repair and replication). (Williams *et al.*, 2012) [67]
Superoxide dismutase	Leaves (Khare *et al.*, 2008) [12]	It has antiaging property. (Younus *et al.*, 2018) [68]
Indole alkaloid	Leaves (Khare *et al.*, 2008) [12]	It exhibits antibacterial properties. (Khare *et al.*, 2008) [12]

Barely has antioxidant, anti-wrinkle, anti-hyperpigmentation, and inhibitory effects on MMP-2 and MMP-9. In a study, Pin-Der Duh *et al*. (2001) [69] evaluated the antioxidant properties of aqueous extracts of roasted and unroasted barley. They found roasted samples had some low effect compared to unroasted sample. (Duh *et al.*, 2001) [69].

Cheol Park S. *et al*., (2021) [70] evaluated the anti-wrinkle activity of germinated barley by increasing collagen production and inhibiting collagenase. (Park *et al.*, 2021) [70]

Lee J. and Park D. *et al*., (2013) [79] studied the significant inhibition of melanin content, tyrosinase, and tyrosinase related protein (TRP-1 and 2) by hordein, an active compound of germinated barley. (Kim *et al.*, 2013) [71]

Joanna Gromkowska-K, epka K. *et al*., (2021) [44] evaluated the inhibitory impact of barley extract on matrix metalloproteinase (MMP-2 and MMP-9) expression leads to an increase in DNA biosynthesis, which reduces skin damage.

In another study barley was used as an ingredient of a polyherbal formulation for skin aging, in which it is found that barley can reduce skin pigmentation, wrinkles, roughness, and dullness through its different constituents. ($p < 0.001$) (Bibi C, Nigar Z *et al*; 2024) [72]

By scientific studies, it is well known that barley is hepatoprotective, anti-ulcerative, anti-proliferative, anti-diabetic, anti-urolithic, and hypoglycemic. In an animal study on rats, it was found that methanolic extract of *Hordeum vulgare* seeds have hepatoprotective effects against ethanol-induced liver damage and acetaminophen-induced liver damage. (Shah *et al.*, 2009; PA Shah *et al.*, 2009) [73, 74]

In a study, histological analysis of animals treated with barley revealed fewer stomach ulcers than ulcerated animals. (Sati *et al.*, 2008) [75].

In a study, inhibitory impact of aqueous methanolic extract of six different barley cultivars on the proliferation of colon cancer is determined. (Madhujith *et al.*, 2007) [76].

An ethanolic extract of barley seeds was found to have a strong anti-diabetic nephropathy effect. (Shah Jignesh *et al.*, 2012) [77].

A study showed anti-urolithic activity of ethanolic extract of barley seeds. In alloxan-induced diabetic rats, barley and its components have antihyperglycemic actions, which may reduce liver damage. (Mokhtar *et al.*, 2006) [78].

Conclusion

Hordeum vulgare Linn. has been an important ingredient in Tibetan cuisine. Its dried seeds and whole plant have edible, aesthetic as well as medicinal applications. In the present article, authors tried to provide information regarding taxonomy, geographical distribution, morphological description, phytochemistry, and pharmacological properties of barley. Traditionally the barley is used widely for the treatment of various ailments, but scientifically only few of them were demonstrated. Thus, more scientific studies must be conducted to investigate them.

References

1. Rashid K, Kumar CS, Haleel PM. Healthcare Benefits of *Hordeum vulgare* L (Barley): A Phyto-Pharmacological Review. Research Journal of Pharmacology and Pharmacodynamics. 2017 Oct 1;9(4):207-210. DOI: 10.5958/2321-5836.2017.00037.4
2. https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/starch https://doi.org/10.1016/B978-0-444-53717-1.01716-9
3. Waugh R, Snape JW, Powell W. Hordeum Species; c2017, p-1-4 http://dx.doi.org/10.1016/B978-0-12-374984-0.00734-8
4. http://theworldwidevegetables.weebly.com/
5. Akar T, Avci M, Dusunceli F. Barley: Post-harvest operations. Food and Agriculture Organization (FAO) of the United Nations, the Central Research Institute for Field Crops, Ankara, Turkey; c2004 Dec. p. 64.
6. Emilia-Ancuța BO, Muntean L, Russu F, Ona AD, Porumb I, Filip E, *et al*. Barley (*Hordeum vulgare* L.): medicinal and therapeutic uses-review. Hop Med. Plants; c2019. p. 87-95.
7. https://www.cabi.org/isc/datasheet/27662/46796 https://doi.org/10.1079/cabicompendium.27662
8. https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=40865
9. Ibn-e-Baitar. Al-jamiulmufradat al adviawalaghziya [Urdu Translation]. New Delhi: CCRUM. 1999;3:109, 136, 191.
10. Ministry of Health and Family Welfare. Unani Pharmacopoeia of India, Part I, II Vol. I, II, V, VI New Delhi, India; c2009. p. 38-39, 101, 116, 119.
11. Ghani N. Khazain-ul-Advia. New Delhi: IdaraKitab-us-Shifa; c1999. p. 330, 569, 607, 723, 1022, 1242, 1275, 1357.
12. Khare CP. Indian medicinal plants: an illustrated dictionary. Springer Science & Business Media; c2008 Apr 22. p. 101, 145, 187, 367, 537, 703.
13. Jeelani HG. Makhzan-e-Hikmat. Matba SH of set Press, New Delhi. 1996;2:678, 704-705.
14. Hakeem MAH, Mufradat B, Shifa IK. New Delhi; c2002. p. 116, 221, 237, 286, 429, 547, 563, 613.
15. Razi Z. Kitab al-Mansoori. New Delhi: Central Council for Research in Unani Medicine; c1991. p. 196-197.
16. Unani Pharmacopoeia Committee. The Unani Pharmacopoeia of India, Part I, New Delhi, India: Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry of Health & Family Welfare, Government of India, 2007, 6.
17. Kabeeruddin M, IlmulAdviaNafeesi. Ejaz Publishing House, New Delhi; c2007, p. 84, 119, 131, 168, 171, 189, 209, 286.
18. Andersson AA, Lampi AM, Nystrom L, Piironen V, Li L, Ward JL, *et al*. Phytochemical and dietary fiber components in barley varieties in the HEALTH GRAIN diversity screen. Journal of Agricultural and Food Chemistry. 2008 Nov 12;56(21):9767-76. https://doi.org/10.1021/jf802037f
19. De Paepe K, Hachem JP, Vanpee E, Roseeuw D, Rogiers V. Effect of rice starch as a bath additive on the barrier function of healthy but SLS-damaged skin and skin of

atopic patients. Actadermato-venereologica, 2002 May 1, 82(3). https://doi.org/10.1080/00015550260132460
20. Idehen E, Tang Y, Sang S. Bioactive phytochemicals in barley. Journal of food and drug analysis. 2017 Jan 1;25(1):148-161. DOI: 10.1016/j.jfda.2016.08.002.
21. Lovegrove A, Edwards CH, De Noni I, Patel H, El SN, Grassby T, *et al*. Role of polysaccharides in food, digestion, and health. Critical reviews in food science and nutrition. 2017 Jan 22;57(2):237-253. https://doi.org/10.1080/10408398.2014.939263
22. Ciecierska A, Drywien M, Hamulka J, Sadkowski T. Nutraceutical functions of beta-glucans in human nutrition. Roczniki Państwowego ZakładuHigieny, 2019, 70(4). https://doi.org/10.32394/rpzh.2019.0082
23. Pillai R, Redmond M, Röding J. Anti-wrinkle therapy: Significant new findings in the non-invasive cosmetic treatment of skin wrinkles with beta-glucan. International Journal of cosmetic science. 2005 Oct;27(5):292. https://doi.org/10.1111/j.1463-1318.2005.00268_3.x
24. Ouriel, Wendy. The effect of beta-glucan on elastin production in the skin; c2014. www.wendyouriel.com.
25. Mendis M, Simsek S. Arabinoxylans and human health. Food Hydrocolloids. 2014 Dec 15;42:239-243. https://doi.org/10.1016/j.foodhyd.2013.07.022
26. Franco-Robles E, López MG. The implication of fructans in health: immunomodulatory and antioxidant mechanisms. The Scientific World Journal. 2015 Oct; c2015. https://doi.org/10.1155/2015/289267
27. Fuentes-Zaragoza E, Riquelme-Navarrete MJ, Sánchez-Zapata E, Pérez-Álvarez JA. Resistant starch as functional ingredient: A review. Food Research International. 2010 May 1;43(4):931-942. https://doi.org/10.1016/j.foodres.2010.02.004
28. Obadi M, Sun J, Xu B. Highland barley: Chemical composition, bioactive compounds, health effects, and applications. Food Research International. 2021 Feb 1;140:110065. https://doi.org/10.1016/j.foodres.2020.110065
29. Zeng Y, Pu X, Yang J, Du J, Yang X, Li X, *et al*. Preventive and therapeutic role of functional ingredients of barley grass for chronic diseases in human beings. Oxidative medicine and cellular longevity. 2018 Octp. [-p. 2018. https://doi.org/10.1155/2018/3232080
30. Solano F. Metabolism and functions of amino acids in the skin. Amino Acids in Nutrition and Health. 2020:187-99. https://doi.org/10.1007/978-3-030-45328-2_11
31. Datta D, Bhinge A, Chandran V. Lysine: Is it worth more? Cytotechnology. 2001 Jul;36(1):3-12. https://doi.org/10.1023/a:1014097121364
32. Alagawany M, Elnesr SS, Farag MR, Tiwari R, Yatoo MI, Karthik K, *et al*. Nutritional significance of amino acids, vitamins and minerals as nutraceuticals in poultry production and health - A comprehensive review. Veterinary Quarterly. 2021 Dec 15;41(1):1-29. https://doi.org/10.1080%2F01652176.2020.1857887
33. Denda M, Inoue K, Inomata S, Denda S. γ-aminobutyric acid (A) receptor agonists accelerate cutaneous barrier recovery and prevent epidermal hyperplasia induced by barrier disruption. Journal of investigative dermatology. 2002 Nov 1;119(5):1041-1047. https://doi.org/10.1046/j.1523-1747.2002.19504.x
34. KM Nadkarni's Indian materiamedica: with Ayurvedic, Unani-Tibbi, Siddha, allopathic, homeopathic, naturopathic & home remedies, appendices & indexes. 1. Popular Prakashan; c1996. p. 216, 311, 414, 653, 734, 1049, 1272.
35. Suanarunsawat T, Anantasomboon G, Piewbang C. Anti-diabetic and anti-oxidative activity of fixed oil extracted from *Ocimum sanctum* L. leaves in diabetic rats. Experimental and therapeutic medicine. 2016 Mar 1;11(3):832-840. https://doi.org/10.3892%2Fetm.2016.2991
36. Küllenberg D, Taylor LA, Schneider M, Massing U. Health effects of dietary phospholipids. Lipids in health and disease. 2012 Dec;11(1):1-6. DOI:10.1186/1476-511X-11-3
37. Ahmad A, Ahsan H. Lipid-based formulations in cosmeceuticals and biopharmaceuticals. Biomedical Dermatology. 2020 Dec;4(1):1-10. https://doi.org/10.1186/s41702-020-00062-9
38. Milani M, Sparavigna A. The 24-hour skin hydration and barrier function effects of a hyaluronic 1%, glycerin 5%, and Centella asiatica stem cells extract moisturizing fluid: an intra-subject, randomized, assessor-blinded study. Clinical, cosmetic, and investigational dermatology. 2017;10:311. https://doi.org/10.2147/CCID.S144180
39. Nakatsuji T, Kao MC, Fang JY, Zouboulis CC, Zhang L, Gallo RL, *et al*. Antimicrobial property of lauric acid against Propionibacterium acnes: its therapeutic potential for inflammatory acne vulgaris. Journal of investigative dermatology. 2009 Oct 1;129(10):2480-2488. https://doi.org/10.1038/jid.2009.93
40. Ghosal A, Said HM. Mechanism and regulation of vitamin B2 (riboflavin) uptake by mouse and human pancreatic β-cells/islets: physiological and molecular aspects. American Journal of Physiology-Gastrointestinal and Liver Physiology. 2012 Nov 1;303(9):G1052-1058. https://doi.org/10.1152/ajpgi.00314.2012
41. Pullar JM, Carr AC, Vissers M. The roles of vitamin C in skin health. Nutrients. 2017 Aug;9(8):866. https://doi.org/10.3390/nu9080866
42. Rattanawiwatpong P, Wanitphakdeedecha R, Bumrungpert A, Maiprasert M. Anti-aging and brightening effects of a topical treatment containing vitamin C, vitamin E, and raspberry leaf cell culture extract: A split-face, randomized controlled trial. Journal of cosmetic dermatology. 2020 Mar;19(3):671-676. https://doi.org/10.1111/jocd.13305
43. Ekanayake-Mudiyanselage S, Tavakkol A, Polefka TG, Nabi Z, Elsner P, Thiele JJ, *et al*. Vitamin E delivery to human skin by a rinse-off product: penetration of α-tocopherol versus wash-out effects of skin surface lipids. Skin Pharmacology and Physiology. 2005;18(1):20-26. https://doi.org/10.1159/000081682
44. Gromkowska-Kępka KJ, Markiewicz-Żukowska R, Nowakowski P, Naliwajko SK, Moskwa J, Puścion-Jakubik A, *et al*. Chemical Composition and Protective Effect of Young Barley (*Hordeum vulgare* L.) Dietary Supplements Extracts on UV-Treated Human Skin Fibroblasts in *In Vitro* Studies. Antioxidants. 2021 Sep;10(9):1402. https://doi.org/10.3390/antiox10091402
45. Schwartz JR, Marsh RG, Draelos ZD. Zinc and skin health: an overview of physiology and pharmacology. Dermatologic surgery. 2005 Jul;31:837-847. https://doi.org/10.1111/j.1524-4725.2005.31729
46. Tinggi U. Selenium: its role as an antioxidant in human health. Environmental health and preventive medicine. 2008 Mar;13(2):102-108. https://doi.org/10.1007%2Fs12199-007-0019-4

47. Abbaspour N, Hurrell R, Kelishadi R. Review on iron and its importance for human health. Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences. 2014 Feb;19(2):164. PMID: 24778671; PMCID: PMC3999603.
48. Schwalfenberg GK, Genuis SJ. The importance of magnesium in clinical healthcare. Scientifica. 2017 Sep 28;2017. https://doi.org/10.1155/2017/4179326
49. Weaver CM. Potassium and health. Advances in Nutrition. 2013 May;4(3):368S-377S. https://doi.org/10.3945/an.112.003533
50. Kong YH, Jo YO, Cho CW, Son D, Park S, Rho J, *et al*. Inhibitory effects of cinnamic acid on melanin biosynthesis in the skin. Biological and Pharmaceutical Bulletin. 2008 May 1;31(5):946-8. https://doi.org/10.1248/bpb.31.946
51. Gunia-Krzyżak A, Słoczyńska K, Popiół J, Koczurkiewicz P, Marona H, Pękala E, *et al*. Cinnamic acid derivatives in cosmetics: Current use and future prospects. International Journal of Cosmetic Science. 2018 Aug;40(4):356-366. https://doi.org/10.1111/ics.12471
52. Vinardell MP, Mitjans M. Lignins and their derivatives with beneficial effects on human health. International journal of molecular sciences. 2017 Jun;18(6):1219. https://doi.org/10.3390/ijms18061219
53. Naomi R, BtHjIdrus R, Fauzi MB. Plant-vs. Bacterial-derived cellulose for wound healing: A review. International journal of environmental research and public health. 2020 Jan;17(18):6803. https://doi.org/10.3390/ijerph17186803
54. Wu F, Jia X, Yin L, Cheng Y, Miao Y, Zhang X, *et al*. The effect of hemicellulose and lignin on properties of polysaccharides in Lentinus edodes and their antioxidant evaluation. Molecules. 2019 Jan;24(9):1834. https://doi.org/10.3390/molecules24091834
55. Zduńska K, Dana A, Kolodziejczak A, Rotsztejn H. Antioxidant properties of ferulic acid and its possible application. Skin pharmacology and physiology. 2018;31(6):332-6. https://doi.org/10.1159/000491755
56. Sharma N, Tiwari N, Vyas M, Khurana N, Muthuraman A, Utreja P, *et al*. An overview of therapeutic effects of vanillic acid. Plant Archives. 2020;20(Suppl 2):3053-3059.
57. Srinivasulu C, Ramgopal M, Ramanjaneyulu G, Anuradha CM, Kumar CS. Syringic acid (SA) - A review of its occurrence, biosynthesis, pharmacological and industrial importance. Biomedicine & Pharmacotherapy. 2018 Dec 1;108:547-557. https://doi.org/10.1016/j.biopha.2018.09.069
58. Seo YK, Kim SJ, Boo YC, Baek JH, Lee SH, Koh JS, *et al*. Effects of p-coumaric acid on erythema and pigmentation of human skin exposed to ultraviolet radiation. Clinical and Experimental Dermatology: Clinical dermatology. 2011 Apr;36(3):260-266. https://doi.org/10.1111/j.1365-2230.2010.03983.x
59. Rees A, Dodd GF, Spencer JP. The effects of flavonoids on cardiovascular health: a review of human intervention trials and implications for cerebrovascular function. Nutrients. 2018 Dec;10(12):1852. https://doi.org/10.3390/nu10121852
60. Yang L, Xian D, Xiong X, Lai R, Song J, Zhong J, *et al*. Proanthocyanidins against oxidative stress: from molecular mechanisms to clinical applications. BioMed research international. 2018 Mar 12;2018. https://doi.org/10.1155/2018/8584136
61. Arimoto T, Ichinose T, Yoshikawa T, Shibamoto T. Effect of the natural antioxidant 2-O-glycosylisovitexin on superoxide and hydroxyl radical generation. Food and chemical toxicology. 2000 Sep 1;38(9):849-852. https://doi.org/10.1016/S0278-6915(00)00075-2
62. Palungwachira P, Tancharoen S, Phruksaniyom C, Klungsaeng S, Srichan R, Kikuchi K, *et al*. Antioxidant and anti-inflammatory properties of anthocyanins extracted from Oryza sativa L. in primary dermal fibroblasts. Oxidative medicine and cellular longevity. 2019 Jul 31;2019. https://doi.org/10.1155/2019/2089817
63. Pratheeshkumar P, Son YO, Wang X, Divya SP, Joseph B, Hitron JA, *et al*. Cyanidin-3-glucoside inhibits UVB-induced oxidative damage and inflammation by regulating MAP kinase and NF-κBsignaling pathways in SKH-1 hairless mice skin. Toxicology and applied pharmacology. 2014 Oct 1;280(1):127-137. https://doi.org/10.1016/j.taap.2014.06.028
64. Lee BS, Lee C, Yang S, Park EK, Ku SK, Bae JS, *et al*. Suppressive effects of pelargonidin on lipopolysaccharide-induced inflammatory responses. Chemico-biological interactions. 2019 Apr 1; 302:67-73. https://doi.org/10.1016/j.cbi.2019.02.007
65. Draganescu D, Ibanescu C, Tamba BI, Andritoiu CV, Dodi G, Popa MI, *et al*. Flaxseed lignan wound healing formulation: Characterization and *in vivo* therapeutic evaluation. International Journal of Biological Macromolecules. 2015 Jan 1;72:614-623. https://doi.org/10.1016/j.ijbiomac.2014.09.012
66. Beck SG, Mühlberg K, Brenden H, Krutmann J. Topische Applikation von Vitaminen, Phytosterolen und Ceramiden.2008; 59(7):557-562. https://doi.org/10.1111/j.1600-0625.2007.00693.x
67. Williams JD, Jacobson EL, Kim H, Kim M, Jacobson MK. Folate in skin cancer prevention. Water-Soluble Vitamins; c2012. p. 181-197. https://doi.org/10.1007%2F978-94-007-2199-9_10
68. Younus H. Therapeutic potentials of superoxide dismutase. International journal of health sciences. 2018 May;12(3):88. PMID: 29896077
69. Duh PD, Yen GC, Yen WJ, Chang LW. Antioxidant effects of water extracts from barley (*Hordeum vulgare* L.) prepared under different roasting temperatures. Journal of agricultural and food chemistry. 2001 Mar 19;49(3):1455-1463. https://doi.org/10.1021/jf000882l
70. Park SC, Wu Q, Ko EY, Baek JH, Ryu J, Kang S, *et al*. Secondary metabolites changes in germinated barley and its relationship to anti-wrinkle activity. Scientific reports. 2021 Jan 12;11(1):1-9. https://doi.org/10.1038/s41598-020-80322-0
71. Kim SC, Lee JH, Kim MH, Lee JA, Kim YB, Jung E, *et al*. Hordenine, a single compound produced during barley germination, inhibits melanogenesis in human melanocytes. Food chemistry. 2013 Nov 1;141(1):174-81. https://doi.org/10.1016/j.foodchem.2013.03.017
72. Bibi C, Nigar Z. Clinical Evaluation of a Topical Unani Polyherbal Formulation in the Management of Photodamaged Facial Skin: An open- Label Standard Controlled Trial. Altern Ther Health Med. 2024 Mar;30 (3):1623. PMID: 38518171
73. Shah PA, Parmar MY, Thakkar VT, Gandhi TR. Hepatoprotective Activity of *Hordeum vulgare* Linn. Seeds against Ethanol-Induced Liver Damage in Rats. Pharmacologyonline. 2009;2:538-545.

74. PA Shah, Parmar MY, Thakkar VT, Gandhi TR, Protective effect of *Hordeum vulgare* Linn. on acetaminophen-induced liver damage, Pharmacology 1; c2009. p. 336-340. DOI: 10.4103/0975-1483.59324
75. Sati AD, Mona S, El-kutry, Hoda SI. Inhibitory Effect of Aqueous Extracts of Barley and Fenugreek on Ulcer Induction in Rats. World Applied Sciences Journal. 2008;5:332-339,
76. Madhujith T, Shahidi F. Antioxidative and antiproliferative properties of selected barley (*Hordeum vulgare* L.) cultivars and their potential for inhibition of low-density lipoprotein (LDL) cholesterol oxidation. J Agric. Food Chem. 2007 27;55(13):5018-5024. https://doi.org/10.1021/jf070072a
77. Shah Jignesh G, Patel Bharat G, Patel Sandip B, Patel Ravindra K. Protective Effect of *Hordeum vulgare* Linn. Seeds Against Renal Oxidative Stress In Streptozotocin-Induced Diabetic Rats Journal of Pharmacy Research. 2012;5(7):3577-3581. https://doi.org/10.4103/0253-7613.103237
78. Yousef MI, Haroun M, Mohamed H, El-Masry, Reham EA. Ateia, Biochemical and Immunological Study on the Effects of Barley and its Components as Hypoglycemic Agents in Diabetic Rats, American Journal of Biochemistry and Biotechnology 2006;2(1):1-8. https://doi.org/10.3844/ajbbsp.2006.1.8
79. Pethe K, Bifani P, Jang J, Kang S, Park S, Ahn S, *et al*. Discovery of Q203, a potent clinical candidate for the treatment of tuberculosis. Nature medicine. 2013 Sep;19(9):1157-1160.