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Review

An Overview of Applications of Medical Barley Water in Gastrointestinal Disorders from the Viewpoint of *Avicenna*

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Abstract

Gastrointestinal disorders are one of the most common conditions among people in many societies. On the other hand, evidence shows that the prevalence of usage of complementary and alternative medicine (CAM) has increased in recent years to treat many chronic and acute conditions, which might be due to testimonies of the safety, effectiveness, and affordability of CAM. In Persian medicine (PM), medical barley water (MBW) has been known as a helpful remedy for treating some digestive illnesses. This study aimed to review the properties of MBW in *Avicenna's Canon of Medicine* for the treatment of gastrointestinal disorders. So, *Avicenna's Canon of Medicine* was reviewed with keywords related to this remedy. Furthermore, various databases, including PubMed, Scopus, Web of Science, Google Scholar, and SID, were searched with the keywords "barley water," "non-alcoholic beer," and "alcohol-free beer." This study showed that *Avicenna's Canon of Medicine* recommends MBW for the treatment of various gastrointestinal disorders. Avicenna prescribed barley water for the treatment of bowel obstruction disease, bowel mass, intestinal ulcers, and jaundice. Oral consumption of MBW was the most frequently used method for disease improvement. Meanwhile, recent studies have also shown the therapeutic effects of non-alcoholic beer in the treatment of various disorders, such as gastrointestinal inflammatory disease, cardiovascular disease, and diabetes, possibly due to its anti-inflammatory effect. Given the high importance of MBW in *Avicenna's Canon of Medicine*, the results of this review and recent clinical studies can introduce MBW as an effective and less harmful gastrointestinal drug. We suggest conducting further clinical trials to assess the effectiveness of MBW in managing gastrointestinal conditions.

Keywords: *Hordeum*; Gastrointestinal disorder; Persian medicine; Complementary therapies; Herbal medicine; Ma'al Sha'ir

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Introduction

Gastrointestinal (GI) and biliary disorders are common abdominal cavity discomforts that affect several aspects of life in those who suffer from these diseases. The common symptoms of GI conditions are nausea, vomiting, abdominal pain, constipation, and diarrhea [1,2]. Increasing the prevalence of GI conditions could be a consequence of modern lifestyles, eating habits, stress, and many other conditions [3], which pose considerable burdens on both individuals and society [4]. GI disorders can be classified as infectious diseases, inflammatory conditions, and food allergies and intolerances [2].

Several classes of pharmacological therapeutic drugs, like proton pump inhibitors (PPIs) and immunomodulators, are used in the treatment of a wide spectrum of GI tract disorders [5]. However, most of these medications have some adverse effects, such as cutaneous manifestations [6]. To reduce the adverse effects of these medications, the use of phytomedicines to treat and manage GI diseases can be an acceptable and available alternative [3].

A notable feature of Persian medicine (PM) as a medical doctrine in Iran [7] is to allocate digestive systems and phytomedicines that are effective for the cure of GI and biliary problems. In this regard, the existence of a separate dosage form named "Juwārish," an arabicized form of "Guwārish," which means digestive medicine, indicates the importance of Iranian sages to this organ. Barley (*Hordeum vulgare* L.), a member of the grass family, is one of the most important plants used in PM and as a drug to treat digestive system disorders [8-11].

Evidence shows that barley was one of the original agricultural crops in the Old World. The domestication of barley occurred around 8000 B.C. (the Neolithic or New Stone Age), according to archaeological remains of the grain discovered in the Occupied Palestinian territory-Jordan region of the Fertile Crescent [12]. This plant is known as "Yava" in Avestan, and its meaning is "life-retentive" [13]. Barley has been used for food and medicine since ancient times. The Roman physician Pliny's notebooks contain hints that barley may be able to treat boils. Most societies have used barley as a primary meal. *Hordearii*, derived from the Latin word for barley, and *hordeum*, were the names given to gladiators who consumed barley for strength and endurance [14].

Currently, barley has emerged as a highly significant cereal crop. The chemical compositions of barley exhibit significant variation as a result of genetic factors and environmental influences encountered during the cultivation process [15,16].

Chemical analysis of barley revealed the presence of starch (50-60%), the albuminoid gene family (9-12%), sugar, and micronutrients including vitamins B and E (6-7%) [13], fat, high fiber content [17-19], beta-Glucan [20,21], carbohydrate, protein [22], minerals [23], amino acid [24], moisture [25], potassium, calcium, sodium, dry matter, ash, pH, iron, caloric density, ferritin, lipid, and sodium [26-29]. A naturally occurring, high-maltose sweetener called malt sugar or barley jelly sugar is also made from barley [14]. According to evidence-based literature, it has been suggested that the consumption of whole grain barley and barley-containing products may have various beneficial effects. These include the potential to reduce total cholesterol and low-density lipoprotein levels in individuals with mild hyperlipidemia, assist in the management of ulcerative colitis and mild constipation, and potentially claim a reduction in the risk of coronary heart disease. Additionally, the consumption of barley may improve glucose tolerance and exhibit positive effects on GI inflammation, colon cancer, diabetes, celiac disease, and hair growth stimulation, among other potential benefits [30].

Barley is sometimes referred to as a functional grain due to its composition of soluble dietary fiber, beta-glucan, and phytochemicals. Barley-containing meals have the potential to be classified as "functional foods," particularly following the approval granted by the U.S. Food and Drug Administration in 2006 [16]. The concept and terminology of functional food started in Japan in 1984, with a resurgence of an old Chinese saying, “Medicine and food are isogenic” [31]. Functional foods can enhance the nutritional quality of major food crops [32,33]. Barley is recognized for its numerous advantageous effects on the human body, owing to its nutritional makeup and its impact on several physiological functions [34,35,36].

Beer is a beverage with a substantial historical and cultural background. Since the Sumerian people invented beer about 5000 BC, alcohol has been the primary factor driving public interest in beer. Alcohol-free beer was only required around the turn of the 20th century, and production technology has evolved significantly since then [37]. Advanced research has broken new ground in the study of the positive effects of alcohol-free beer drinks as alternatives to chemical drugs [38-46].

Barley has also been a prescribed food of PM. In PM sources, there are the various forms of barley, including barley flour (*Daqiq -al ša'ir*) [9,10], thick barley soup (*Kašk-al ša'ir*) [9,47], pealed roasted barley (*Saviq-al ša'ir*) [8,10], and also a common type of drink, barley water (*Ma'al Sha'ir* or *Ab-e-jow*). *Ma'al Sha'ir* is an Arabic word, derived from water (*Ma'*) and barley (*Sha'ir*) [48]. *Ma'al Sha'ir* is a pink to purple colored liquid, prepared through boiling barley. It is made from barley mildly boiled with water (a unit of barley plus twenty units of water) for a short time generating one tenth of the total which gradually discolors

[9,49]. *Ma'al Sha'ir* lexically means barley water and barley extract, and it is different from beer (*Foqā),* which is used as an alcoholic drink. *Foqā* is made of some cereals such as barley, rice, millet, and corn with mint and celery or from some dried fruits such as date plus sugar and a little valerian and pepper synthesized for a long time and fermented. The difference between *Ma'al Sha'ir* as a remedy and *Foqā* because of its very harmful side effects has been absolutely identified, and it generally refers to medication usage. Chemical compounds of *Ma'al Sha'ir* or medical barley water (MBW) show very similar mechanisms of action to functional foods [50], suggesting that they could perhaps be considered to have the same structure in content and effect for treatment. Almost without exception, all Iranian sages accepted the prescription of MBW as a remedy with many medical properties for disorders of the digestive, respiratory, integumentary, and skeletal system [8-10,49,51,52].

Avicenna (980-1037 CE) is one of the main sources of PM who penetrates the underlying principles of medicine. In *The Canon of Medicine*, MBW was commonly prescribed by *Avicenna* as syrup to alleviate GI problems, liver diseases, and intestinal disorders [49]. It can be a fine perspective that opens before us. The new evidence, as it were, proved that alcohol-free beer is guaranteed to cure GI disorders [38,41,42,53]. However, the probable allergen substance of barley demands more careful attention to the formulation of MBW for widespread use [54]. Hereupon, the authors aimed to review *Avicenna's Canon of Medicine* to demonstrate the efficacy and safety of MBW in the treatment of GI conditions. Therefore, MBW may be investigated as an alternative treatment for patients with GI and hepatobiliary diseases.

Ma'al Sha'ir is considered a well-known and useful remedy in PM. Therefore, several studies were conducted to identify and evaluate the properties, formulation, laboratory parameters, mechanism of action [26], and clinical and therapeutic effects of this remedy [55,56]. So, investigating the applications of MBW in GI conditions can be innovative and essential for new research today.

Materials and Methods

In this review study, firstly, the *Avicenna's Canon of Medicine* in both Arabic and Persian versions was searched with keywords related to MBW such as "*Ma'al Sha'ir*" and "*Ab-e-jow.*" Then, the collected content was categorized, where in some cases, for better understanding the concept; other main Persian medicinal texts, including *Kāmil al-ṣinā'a al-ṭibbīya* by *Haly Abbas* [8], *Makhzan al-Adviyeh* by *Aghili Shirazi* [57], *Tibb -e- Akbari* by *Hakim Arzani* [52], *al-Ḥāwī fī al-ṭibb* by *Rhazes* [9], *Firdaws al-Hikmah* by *Ibn Rabban al-Tabari* [10], *Zakhireye Khwarazmshahi* by Isma'il Jorjani [11], and *Almojez Fi-alteb* by *Ibn al-Nafis* [51] were also reviewed. In addition, the major databases, including PubMed, Web of Science, Scopus, Google Scholar, and SID, were searched with the keywords "barley", "barley water," "alcohol-free beer," and "non-alcoholic beer" until 2023. Finally, the results were compared with each other.

Ethical Considerations

This article has been approved by the Research Ethics Committees of the School of Medicine - Shiraz University of Medical Sciences (IR.SUMS.MED.REC.1397.484).

Finding

GI diseases are common clinical diseases belonged to the stomach-related conditions such as chronic gastritis, peptic ulcer, functional dyspepsia, functional bloating [58,59], colon inflammation [60], inflammatory bowel diseases and celiac disease [61-63], causing symptoms such as vomiting, diarrhea, and abdominal pain, or abdominal discomfort [58]. According to PM, these kinds of diseases mostly belong to the category of dystemperament (*Su-e Mizaj*) of liver, stomach, spleen, and intestine. Moreover, evidence showed that the GI problems could be associated with extra organ signs and symptoms, such as dermatologic conditions, sleep disturbance, and vaginal discharge [64,65].

The Material Nature of traditional barley water

According to the theory of Tabi'at (physis) in the PM approach and based on humorism, it is posited that the consumption of foods and medications elicits a *Mizāj* (temperament) within the body [66,67]. The phenomenon encompasses both an active component, characterized by hotness or coldness, and a passive component, characterized by wetness or dryness [49]. Accordingly, MBW is a cold-wet medicine, uretic, and has dissolvent properties [57]. It is a natural detergent (*qassāl*) that cleans waste materials from the human body due to its purity and moisture [47]. Moreover, MBW is a tonic substance that protects and strengthens the heart [68]. It also could clean the stomach from *Ṣafrā'* (yellow bile: hot and dry temperament), and *Dam* (blood: hot and wet temperament) [47,57]. Furthermore, consumption of MBW can be helpful in patients suffering from GI tract dystemperament types (warm, dry, choleric, warm-wet with wet substance) [52,57,69]. But it is important to note that MBW is not a guarantee of wet stomach temperament or cold gut temperament. It is also flatulent [57].

Applications of Traditional Barley Water in The Canon of Medicine

Stomach

MBW is a tonic for the stomach. The use of a combination

of MBW and honey has been mentioned by *Avicenna* as a beneficial remedy for cold dystemperament and dry dystemperament. Moreover, it was suggested that drinking a mixture of MBW and hot oxymel (a syrup of honey and vinegar) purges the stomach, and oral use of MBW with pomegranate juice strengthens the stomach. Additionally, experts recommend using the mixture of tamarind and MBW as an anti-nausea agent. As well, consumption of MBW with *Cucurbita* oil after milk or warmish water is helpful in curing hiccups [49].

Intestine

MBW can improve intestinal function and lower bowel tonic. It is used both orally and as an enema; however, local application of MBW is more common. MBW is helpful in purging the intestine. *The Canon of Medicine* has mentioned it as a beneficial remedy for *Gholonj* (bowel obstruction disease), which is due to bile. If MBW is used in the form of enema with violet oil and water of *Solanum nigrum*, it can be helpful in bowel mass, which obstructs the bowel. MBW improves intestinal ulcers and intestine-inflammatory diseases known as *Sahj* (intestinal scraping) and *Gorhe-e-amaa* (intestinal wounds) in *The Canon of Medicine*. An enema of a mixture of MBW with sweet almond oil, yolk, and water of rice facilitates the healing process of lower intestine ulcers. Patients with bloody diarrhea due to mass of intestine may take advantage of a mix of MBW and water of *Solanum nigrum*, rose water, rose oil, and egg white in the early stages of the disease [49].

Liver

MBW improves patients suffering from hot dystemperament and dry dystemperament. Additionally, experts suggest MBW as a potential therapeutic intervention for individuals with weak liver conditions. MBW is a remedy for hot liver mass, especially if it is mixed with oxymel. In addition, oral use of MBW, either alone or with other cold remedies, is helpful for jaundice [49].

Discussion

The gastrointestinal tract, as the first point of contact for ingested substances, plays a significant role in immunity [70] and contributes to the wellbeing of individuals through the brain-gut-microbiota axis [71]. Currently, medicinal plants and their derived phytochemicals have gained popularity in most diets as prophylactic agents or treatments for several gastrointestinal disorders [72]. Barley, a member of the grass family, is a common cereal. Since ancient times, it has been a significant medicinal herb for hundreds of years [12]. In comparison with other cereal crops, such as wheat and rice, barley has been commonly used in treating various digestive diseases [73], including abdominal problems like vomiting and nausea [74], diarrhea [75], colon inflammation [60], inflammatory bowel diseases and celiac disease [61-63]. Barley includes sizable amounts of protein [22], fat [17], minerals [23], fiber [18], and phytochemicals [76] that are changed to a variety of functional drinks [77]. Globally, beer is the most consumed alcoholic beverage. The nutritional composition of beer includes carbohydrates, amino acids, minerals (particularly fluoride and silicon), vitamins (with notable amounts of folate and choline), and bioactive compounds like polyphenols. However, the presence of alcohol in beer raises health-related concerns [44]. The desire for alcohol-free beer has been present since the onset of the 20th century, and subsequently, advancements in technology have significantly improved the production processes of these beverages. The objective of producing alcohol-free beer is to develop goods that elicit a sensory impression comparable to their alcoholic counterparts [37]. Hence, it is unsurprising that contemporary scientific literature documents numerous advantages linked to the use of non-alcoholic beer. In two distinct investigations, Mateo-Gallego et al. showed that the use of alcohol-free beer, which incorporates the replacement of conventional carbs with small quantities of isomaltulose and the inclusion of maltodextrin in meals, has a notable effect on the gut microbiota of individuals with diabetes who are overweight or obese [38,39]. Two additional studies conducted by Ruiz-Margain et al. (2019) and Macías-Rodríguez et al. (2020) have documented that the intervention involving the consumption of non-alcoholic beer, along with dietary modifications and exercise, appears to be both safe and well received among individuals diagnosed with cirrhosis. Furthermore, these studies have demonstrated that this intervention leads to enhancements in nutritional status, endothelial function, and overall quality of life [41,42]. Trius-Soler et al. (2020) conducted a recent study that examined the impact of non-alcoholic constituents of beer on belly obesity, osteoporosis, and body hydration among female participants. Furthermore, it was understood that the proportion of non-alcoholic beer may perhaps enhance bone health among postmenopausal women [78]. In a recent in vivo study conducted by Akerele et al. (2020), it was reported that the consumption of non-alcoholic wheat beer resulted in decreased blood glucose levels and inhibited the activity of pancreatic α-amylase, lipase, and intestinal α-glucosidase in diabetic rats. These findings suggest that non-alcoholic wheat beer may serve as a viable and beneficial beverage option for individuals with diabetes seeking improved glycemic control [79]. The study conducted by Zhou et al. (2023) showd the potential benefits of non-alcoholic bioactive flavor

compounds found in beer for addressing non-alcoholic fatty liver disease. These compounds were found to have a positive impact on lipid metabolism modulation, the decrease of oxidative stress and associated damages, as well as the alleviation of inflammation [43]. In addition, several interventional studies have conducted comparisons to assess the impact of non-alcoholic beer on various outcomes, including potentially bioactive metabolites [80], metabolic response after meals in individuals without health conditions [46], reduced levels of microRNAs associated with inflammation [40], sustained mood states [45], prevention of oxidative stress to maintain endothelial function and inhibit thrombogenic activity (specifically by lowering oxidized LDL) [44], pancreatic function, osteoporosis, cardiovascular disease, and cancer [81].

The positive findings in recent studies bridge a new way to the effectiveness of alcohol-free beer and MBW, despite the clear-cut difference in their production, in the healing process of organs of the human body, a concept that is in accordance with PM sources. MBW, as discussed earlier, is a beverage that has been appreciated for its medical qualities by almost all Iranian sages and prescribed for common digestive (enterelcosis [82-84], colic [9], dysentery [85], ehpatitis [84], Jaundice [8,49,82-86]), respiratory (tuberculosis [47,52], cough [86-88], pleuropneumonia [49,84], coryza [86], dyspnea [8,9,83]), urinary (cystodynia [89], hydronephrosis [9], cystitis [9,82], dysuria [8,9,89], bladder ulcers [82 ,85]), integumentary (leprosy [84,88], tinea [49], scabies [85,88], eczema [49]), lymphatic (types of fever [8-10,86,87,90]), nervous (simple hot headache [52], trepidation [49], convulsion [8], gout [49,83], paralytic [49], stroke [8,85]), and musculoskeletal systems (sciatica [69], rheumatism [8,49]) disorders and many others.

Evidence showed that consumption of barley water was effective in treatment of hospitalized COVID-19 patients. In this regard, the results showed that Persian barley water had a big effect on lowering the length of stay in the hospital, fever, and levels of erythrocyte sedimentation rate, C-reactive protein (CRP), and creatinine [55,91].

Whereas the parcel of applications of MBW relate to the chief parts of the digestive system and *Avicenna*'s approach to this subject appears to be manifest, the article was formed on the basis of his book. In *the Canon of Medicine,* MBW can play an essential role in improving digestive diseases. It can accelerate the healing process for digestive diseases by affecting inflammatory processes. MBW has an improvement mechanism for nausea and hiccups, which may be due to its vitamin compounds. MBW can also aid in intestinal function. It has the ability to treat bowel obstruction disease, a condition caused by bile accumulation. MBW improves intestinal ulcers and inflammatory diseases. It heals the process of lower intestine ulcers. MBW is helpful for jaundice due to its potassium and vitamin content. It has an effective therapeutic role in bloody diarrhea due to intestinal mass or partial obstruction [49].

It can accelerate the healing process for digestive diseases by affecting inflammatory processes. This remedy has been shown to possess the presence of potassium, calcium, vitamin, carbohydrate, protein, ferritin, lipid, sodium, and β-glucan [50]; therefore, it may also act through these micronutrients and compounds. It includes malignancies of the digestive system as well as malignant masses, GI inflammatory diseases, hepatobiliary disorders, and other chronic digestive diseases. In light of the aforementioned beneficial properties, caution should be exercised while considering the prescription of MBW as a cure, primarily due to its allergenic component, barley (Table 1) [54].

In order to comprehensively examine the various uses of total body water, particularly in relation to the di-

Table1. Different usage forms of MBW for prescription in different GI tract organs in *The Canon of Medicine*

Organ	Disease	Added component	Route
Stomach	Cold dystemperament	Honey	Oral
	Dry dystemperament	Honey	Oral
	Nausea	Tamarind (*Tamarindus indica*)	Oral
	Hiccup	*Cucurbita* oil	Oral
Intestine	Bowel obstruction	*Viola* oil plus water of *Solanum nigrum*	Enema
	Lower intestine ulcers	Sweet almond oil, yolk and water of rice	
	Bloody diarrhea	Water of *Solanum nigrum*, rosewater, rose oil and glair	
Liver	Hot dystemperament	Simple	Oral
	Dry dystemperament	Simple	Oral
	Emaciated liver	Simple	Oral
	Disability of liver	Simple	Oral
	Hepatoma	Oxymel	Oral
	Jaundice	Simple or with cold remedies	Oral

gestive system, it is essential to conduct both in vitro and in vivo studies. These investigations are crucial for elucidating the impact of MBW components on overall health and disease. Furthermore, the findings from these studies have the potential to pave the way for successful preclinical and clinical trials.

Conclusion

The use of MBW as an alternate therapeutic option for many digestive disorders has promise. Multiple experimental studies have substantiated the therapeutic attributes of MBW within the GI tract. It is important to emphasize that conducting empirically planned clinical trials is a crucial initial step in validating previous experimental research and elucidating the beneficial medical benefits of MBW in various disorders. In addition to the healing features of GI inflammatory diseases and anti-inflammatory properties mentioned in *Avicenna's Canon of Medicine*, MBW is a safe and potent remedy for some digestive diseases, including GI mass, GI inflammatory diseases, and hepatobiliary disorders, which can be a broad field for future studies.

Conflict of Interests

There are no conflicts of interest to declare.

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