

UTILIZATION OF WATER CHESTNUT AND BARLEY AS POTENTIAL INGREDIENT IN BAKERY PRODUCTS

Abstract

Diabetes, one of the most prevalent non-communicable diseases, affects a sizeable section of the global population. As bakery products have a high GI and cause blood sugar levels to rise, diabetic people are unable to consume them. Few underutilised crops, such as water chestnut and barley, for the can be used for production of low glycemic index (GI) bakery products. Water chestnut and barley flour can be used to create low GI baked items because they have low GI values (Water Chestnut GI value - 54; Barley GI value – 28). Water chestnut and barley flour Product may prove to be an effective diet for those with hyperglycemia. Jaggery and Honey, which are natural sweeteners, are used in place of table sugar in the baking process to further reduce GI and increase their commercial viability in therapeutic diets. Moreover, There are some other health benefits and essential properties which help the human body from many chronic diseases Some properties are antidiabetic properties, antiobesity, cardiovascular disease prevention, anticancer effect, antioxidation, anti-inflammation,immunomodulation, cardioprotection, hypocholesterolaemic effects etc.

Keywords: Water Chestnut, Barley, low Glycemic Index, Bakery, Diabetes.

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I. INTRODUCTION

Due to their widespread availability and practicality, customers today enjoy bakery goods like cakes and muffins. Muffins are little fast breads that can be sweet or savoury and resemble cakes. People favour them mostly for their flavour and soft texture. The primary ingredient in all bakery goods, wheat flour, has a medium to high GI. When additions like sugar are added, the GI of bakery goods increases even more, making them unsuitable for people with Diabetes.

With 415 million cases worldwide, Diabetes is the third most common non-communicable disease. According to the *World Health Organisation*, In India only, there are number of Diabetic Patients compare to all over the world, 134.5 million Indians are expected to be at higher risk till year 2030 (*International Diabetic Federation, Atlas, 2015*). In light of this, low GI bakery items may prove to be a viable meal option for persons who have hyperglycemia or are at risk for developing the condition.

The development of diabetic bakeries, or low GI bakeries, can move forward by investigating low GI food sources and changing the baking technique as well as the ingredients. A simple technique to lower the GI of bakery products is to substitute non-nutritive sweeteners for sugar. According to many researchers and authors' reports, freezing baked goods both before and after baking is a successful way to lower their glycemic response (*Borcza, Pisulewski, Sikora, & Krawontka, 2008; Rosin, Lajolo, & Menezes, 2002*). More research must be done in this area because the production of low GI bread products is a relatively new topic in food processing. Furthermore, the worrying diabetic situation and consumer knowledge of health and diet have prompted a quest for unconventional low GI food sources as raw materials for bakery product creation. Due to its low GI, water chestnut (*Trapanatans*) can be investigated as a basis material for the creation of low GI baking products. However, the nut lacks certain proteins (gluten) that are required to provide baked products acceptable sensory and textural qualities. In order to create low GI bread items, water chestnut must be combined with a low GI gluten source. In addition to having a low GI, barley contains 5-8% gluten, which is sufficient for the creation of baked goods like muffins. According to several researches, barley and water chestnut flour (Barley Flour) are combined with other grains to create baked goods. *Krishnaiya, Kasar, and Gupta (2016)* investigated the impact of water chestnut on the chemical, sensory, and nutritive properties of muffins made with wheat. The antioxidant activity and starch digestibility of muffins made from several flours (wheat, rice, oat, corn and barley) were tested by *Soong, Tan, Leong and Henry (2014)*. In a 2017 study, *Gao, Brennan, Mason, and Brennan* examined how sugar replacement affected the sensory qualities of muffins. *Romjaun and Prakash (2013)* created muffins with added fibre. However, there hasn't been a documented comprehensive investigation on the use of water chestnut flour (WCF) and Barley Flour blends for making muffins. The best method for creating muffins for diabetes patients appears to be blending Barley Flour and WCF, altering the prebaking and post baking methods, and replacing additives like sugar with non-nutritive sweeteners.

II. WATER CHESTNUT

Water chestnut (*Trapanatans*) is an aquatic plant which is indigenous to Asia and Europe. Due to its capacity to create thick monocultures that outcompete native plants and change aquatic ecosystems, it is regarded as an invasive species in many other regions of the world, including North America and Australia. Water chestnut is a floating plant that can grow as tall as 2 metres. It has triangular leaves and pink or white blooms. The plant creates a hard-shelled fruit with a solitary seed inside of it. The fruit can last up to three years before it sinks to the bottom of the body of water.



Figure 1: (a) Unpeeled Water Chestnut (b) Peeled Water Chestnut

Water chestnut is a highly versatile plant and can may grow in a variety of aquatic environments, including lakes, ponds, rivers, and marshes. It can grow in water up to 4 metres deep and can withstand a broad variety of salinities and temperatures.

The plant is a major problem in freshwater ecosystems, as it can form dense monocultures that out compete native aquatic plants. This can lead to a decline in biodiversity and negatively impact fish and wildlife that rely on native plants for food and habitat. The plant also impairs recreational uses of water bodies, including swimming, boating and fishing.

Control of water chestnut populations is difficult due to its ability to reproduce rapidly. Mechanical and chemical methods have been used to control the plant, but they are often expensive and can have negative impacts on native species.

Biological control methods, such as introducing a plant-eating insect that feeds only on water chest (*Trapa natans L.*) chestnut, have shown some promise as a way to control the plant. The most promising insect species that feeds on water chestnut is the water chestnut weevil (*Euhrychiopsis lecontei*).

1. Composition: Water chestnut (Trapanatans) is a high nutrient food that is low in calories content and high in vitamins and minerals content . It is a good source of carbohydrates, dietary fibres, and protein.

Water chestnut contains various vitamins such as Vitamin C, Vitamin B complex (especially B1, B2, B3, B5, B6, and B9). It is also rich in minerals such as Calcium, Iron, Magnesium, Manganese, Phosphorus, Potassium and Zinc.



Figure 2: Harvesting of Water Chestnut (Source- Agrifarming.com)

Water chestnut also contains antioxidants, including flavonoids and polyphenols, which have anti-inflammatory and anti-cancer properties. Additionally, it contains phytosterols, by which they have been demonstrated to reduce cholesterol and improve heart health.

Water chestnut is also a good source of dietary fiber, with approximately 3.3 grams of fiber per 100 grams of fresh water chestnut. Fiber is important for maintaining healthy digestion and preventing constipation.

Water chestnut also contains a moderate amount of protein, with about 2 grams of protein per 100 grams of fresh water chestnut. It's worth noting that the composition of water chestnut can vary depending on the stage of maturity, location and growing conditions.

- Nutritional Value:** Here is a summary of nutritional value per 100 grams of fresh water chestnut:

Table 1: Nutritional value of Water Chestnut (Source- G.M. Barros & AG)

Components	Proportions
Energy	95 calories
Carbohydrates	22.1 g
Fiber	3.3 g
Protein	2 g
Fat	0.5 g
Vitamin C	11.8 mg
Vitamin B1	0.13 mg
Vitamin B2	0.04 mg
Vitamin B3	0.7 mg
Vitamin B5	0.3 mg

Vitamin B6	0.04 mg
Vitamin B9	11 mg
Calcium	33 mg
Iron	0.7 mg
Magnesium	31 mg
Manganese	0.1 mg
Phosphorus	44 mg
Potassium	260 mg
Zinc	0.2 mg

3. Health Benefits: There are some of the potential health benefits of water chestnut:

- **Lower blood pressure:** The potassium in water chestnut can help to lower the blood pressure by acting as a vasodilator and reducing the resistance in the blood vessels.
- **Improve heart health:** The phytosterols in water chestnut have been shown to lower cholesterol levels, which may help to improve heart health.
- **Anti-inflammatory and anti-cancer properties:** Water chestnut contains antioxidants, including flavonoids and polyphenols, which have anti-inflammatory and anti-cancer properties.
- **Improve digestion:** Dietary fibre, which can aid in promoting healthy digestion and preventing constipation, is also included in water chestnuts.
- **Aid in weight management:** Water chestnut is low in calories content and high in fiber content, which may play vital role in weight management.
- **Beneficial for diabetes:** Water chestnut has been traditionally used in the treatment of diabetes; it contains low glycemic index which means it can help to maintain blood sugar levels.

It's worth noting that more research is needed to confirm the health benefits of water chestnut, and that it should not replace any conventional medical treatment without consulting a doctor.

III. BARLEY

One of the top 10 crops in the world and the fourth-ranked cereal is barley (*Hordeum vulgare* L.). Human meals, malt products, and animal feed all use barley as a major component of the global food supply. Regarding its potential use as a component in processed meals for humans, the barley crop may be thought of as being rather underutilised. A member of the *Hordeum* genus, barley is one of the oldest types of plants.

- 1. Classification:** The tribe Triticeae of the family Poaceae includes the grass known as barley. The one-flowered spikelet of *Hordeum* is the main taxonomic feature. At each node of the flat rachis of the spike or head, three spikelets alternate on opposite sides. At each node, a triplet of spikelets—the centre and the two laterals—are thereby created. Two glumes support each spikelet. The spike is referred to as six-rowed when all three spikelets are viable. The spike is two-rowed if only the centre spikelet is fertile.

The palea and lemma of the floret attach to the outside of the grain in the majority of barley crops cultivated for commercial purposes. Huskless barley are not suitable for malting, but they are used for human foods as their digestibility is higher than the hulled type. Although huskless barley cannot be used for malting, it is utilised for human consumption because it is more easily digestible than hulled barley.

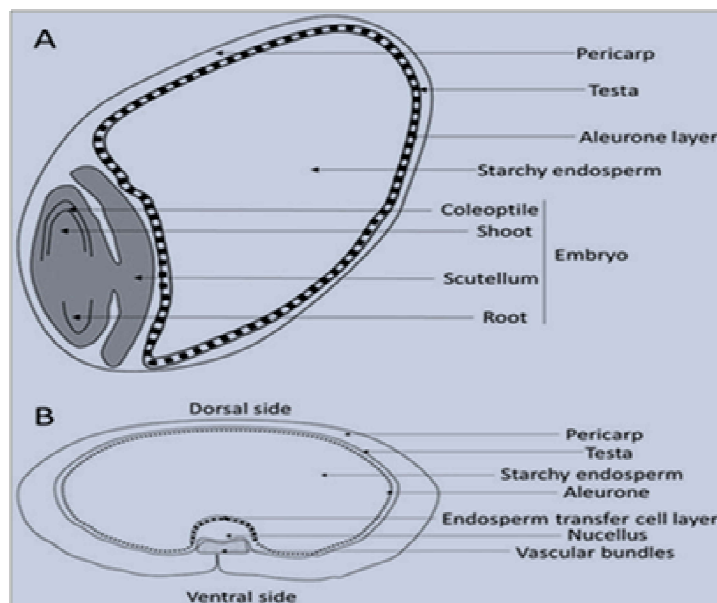


Figure 3: Parts of Barley (Source- www.intechopen.com)

2. **Chemical Composition:** About 80% of the weight of barley grain is made up of carbohydrates. Starch is the most prevalent single component in grains, making up to 65% of the total weight. However, polysaccharides derived from cell walls are also quantitatively significant and may account for more than 10% of grain weight. A regulated steeping and germination schedule is used to create barley malt. The breakdown of reserve compounds is ultimately responsible for the significant chemical alterations seen during malting.

Table 2: Nutritional value of Barley (Source- Researchgate.com)

Components	Proportions (Dry weight %)
Starch	63-65 %
Sucrose	1-2 %
Other sugars	1 %
Water soluble polysaccharides	1-1.5 %
Alkali soluble polysaccharides	8-10 %
Cellulose	4-5 %
Lipids	2-3 %
Protein	10-12 %

Albumin and Globulin	3.5 %
Hordeins	3-4 %
Glutelin's	3-4 %
Nucleic acids	0.2-0.3 %
Minerals	2 %
Others	5-6 %

- 3. Processing of Barley:** For human use, barley is frequently milled to create products including blocked barley, pearled barley, barley groats, barley flakes, and barley flour. Preliminary cleaning, conditioning or tempering, bleaching (blue aleurone barley), shelling or blocking, aspiration, size grading by sifting, groat cutting, pearling of blocked barley or large barley groats, grading and sifting, and polishing may be the order of steps in the milling of barley. The following is a description of a few of the commercially available barley products.



Figure 4: Barley Kernel

By gradually removing the hull, bran, and germ by abrasive action in a stone mill, pot and pearled barley are made. The first stage of pearling, which may remove 7–14% of the grain's weight, is the production of pot barley. The seed coat (testa and pericarp), aleurone, sub-aleurone layers, and the germ are all removed by further abrasion, leaving a core endosperm that is a source of carbohydrates and proteins.

Roller milling pearled or obstructed barley produces barley flour. Pre-dampening the barley groat, steam heating the groats or pearled barley, flaking, and hot air drying the flakes are the steps used to make barley flakes. Testa and pericarp, germ, the tricellular aleurone and sub-aleurone layers, and the hulls are absent from barley bran.

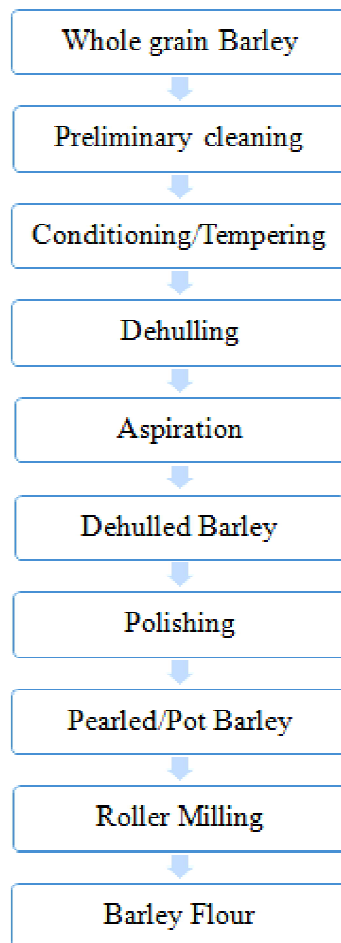


Figure 5: Processing of Barley Flour

4. Health Benefits of Barley: There are some Health Benefits of Barley

- **Use of Barley for Sleep:** Gamma-aminobutyric acid, a brain chemical, calcium, potassium, and the amino acid tryptophan are all abundant in barley grass powder. It is an excellent functional meal and may also help with sleep. Gamma-aminobutyric acid, calcium, and potassium are all present in greater concentrations in barley grass powder than in polished rice. Foods for improved sleep-in persons may include polished rice, wheat flour, barley, and their byproducts. However, additional study is needed to substantiate it.
- **Use of Barley for Diabetes:** Barley and its extract may be useful for treating diabetes because they may scavenge oxygen free radicals. Because of its dietary fibre, it may help reduce blood glucose and fasting blood sugar levels. People with diabetes may benefit from the flavonoids in barley by lowering their post-meal blood glucose levels.

- **Use of Barley for Immunity:** Young barley leaves contain a high amount of polysaccharides, which may have immunomodulatory and macrophage (a kind of white blood cell) stimulatory effects. These effects, however, require scientific validation. So please refrain from using self-medication.
- **Use of Barley for Cancer:** Barley's potent antioxidant, high alkalinity, phytochemicals, flavonoids, and chlorophyll content might all work together to prevent the growth of cancer cells. Barley's phytochemical mixtures may be effective in the fight against breast cancer.
- **Use of Barley as an Antioxidant:** One of the most stress-resistant crops is barley, which produces succinate, glutathione, and tocopherol in its flag leaf. Barley grass flavonoids contain strong antioxidant qualities that may benefit conditions brought on by oxidative stress, such as inflammation, cancer, and cardiovascular disease.

IV. USE IN BAKERY PRODUCTS

Here are some use or application of Low GI Food Product in Bakery Products :

1. **Bread:** One of the most important sources of carbs in the diet is bread. Because diabetes patients frequently require multiple meals throughout their treatment life, bread is recognised as one of the diet components that cannot be overlooked (Izydorczyk, et al., 2008). Making bread at home with specially formulated diabetes-friendly components may also help to decrease the potential negative impact that bread may have on blood sugar levels. Examples of these include Barley flaxseed meal, chia seeds, wheat bran, barley, and other ingredients (Holtekjolen, et al., 2008).

Barley is a cereal that is farmed for human use. People are becoming more and more interested in producing food products. Bread is a common component of many peoples' diets. The bread's antioxidant properties will increase if barley flour is used in place of wheat flour, provided the barley variety is stable and acceptable during baking (Gill et al., 2002). Additionally, they claimed that employing natural ingredients in the baking process enhanced the bread's sensory qualities and that the phenolic content of the barley had an impact on organoleptic properties of bread made with barley. When barley flour is added to wheat flour in a precise ratio, beta-glucan levels rise, which also enhances the baked good's appearance and flavour.

In one slice, there are 103 calories, 20 grams of carbohydrates, 2 grams of fat, 2 grams of protein, and 1 gram of fibre. Beta-glucans and beta glucose, which reduce plasma cholesterol, enhance lipid metabolism, and lower food's glycaemic index, are the most prevalent fibre components in barley. Both soluble and insoluble dietary fibre can be found in abundance in Barley Glenn. All goods made with barley are believed to reduce the incidence of coronary heart disease, according to Wani et al. (2016).

2. **Muffins:** Muffins are tiny pieces of sweet and savoury fast bread that resemble cake. They are adored primarily for their delicate texture and mild flavour. Wheat flour is the main ingredient in all bakery goods, however because of its high glycemic index rating; it is unhealthy and can cause a variety of diseases, including diabetes (Shafi et al., 2017).

As a result, it is believed to be a secure and wholesome practise to replace wheat flour with low GI grain flour, such as water chestnut (Trapanatans), while making low GI bread products. However, it lacks gluten, which is necessary for the textural characteristics of baked goods. Therefore, bakery goods need a supply of low GI gluten.

- 3. Biscuits:** Low GI foods will make living a better life simpler and will be especially beneficial to diabetics. When formulating the recipe for the biscuits, the ingredient that will contribute to the glycemic index is determined. This will help us prevent any health difficulties caused by hereditary conditions, including diabetes-related disorders, and it will help create a healthy society (Brand et al., 1997).

V. CONCLUSION

Diabetes is the third most common non-communicable disease, affecting a significant portion of the world's population. Bakery products with high glycemic index (GI) are unsuitable for diabetic people. Water chestnut and barley can be used to create low GI baked items, as they have low GI values (54 and 28 GI). These products may prove to be an effective diet for those with hyperglycemia. Natural sweeteners like jaggery and honey can be used to further reduce GI and increase their commercial viability in therapeutic diets. Low GI bakery items may prove to be a viable meal option for those with hyperglycemia or at risk for developing the condition. Further research is needed to develop low GI bakeries and explore alternative low GI food sources.

Water chestnut, an aquatic plant native to Asia and Europe, is an invasive species that forms dense monocultures, impacting freshwater ecosystems and affecting biodiversity. It is a low-calorie, high-vitamin-dense food with a low GI content. Controlling water chestnut populations is challenging due to its rapid reproduction. Biological control methods, such as water chestnut weevils, have shown promise in controlling the plant.

A significant crop in the globe, barley is seen to be underutilised in terms of its potential usage as a component in prepared foods for people. It belongs to the genus *Hordeum* and is classified as a grass belonging to the tribe Triticeae. Barley grain contains carbohydrates, with starch being the most abundant component. A planned timetable for germination and steeping produces barley malt. For human use, barley is frequently milled to create products including blocked barley, pearled barley, barley groats, barley flakes, and barley flour.

Barley has potential health benefits, including potential use for sleep, diabetes, immunity, cancer, and antioxidant properties. Barley grass powder contains gamma-aminobutyric acid, calcium, potassium, and tryptophan, making it a good functional food and sleep promoter. Barley can also be used in baking products, such as bread, muffins, and biscuits. Bread's antioxidant properties increase if barley flour is used in place of wheat flour, provided the barley variety is stable and acceptable during baking.

Breads are a common component of many people's diets, and using barley flour in place of wheat flour can enhance the sensory qualities of baked goods. Muffins, small pieces of sweet and savoury fast bread, are a popular choice due to their delicate texture and mild

flavor. However, low GI flour, such as water chestnut, is necessary for the textural characteristics of baked goods.

Low GI ingredients like Water Chestnut & Barley offers potential health benefits, including sleep, diabetes, immunity, cancer, and antioxidant properties. Its high alkalinity, antioxidant properties, and high concentration of flavonoids may help reduce blood sugar and glucose levels. Barley's potential for cancer treatment and antioxidant properties make it a promising crop for various health concerns.

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