Pharmacological And Biomedical Effects of Malting on Cereal Grains

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Abstract: Health is an asset to be treasured. Diet is a medium through which health is maintained. Diet including Cereals like Rice, Wheat, Barley, Oats, Millets, etc., are global staple foods for millions of people. Cereals are known as the largest source of energy, now-a-days, cereals are known for their various functional properties. Various methods are followed to improve these properties. Malting is one of a process by which the cereal grains are enriched with functional properties that gained its use in pharmacological and biomedical fields. Malting is a traditional and simple method that has potential of increasing iron content, amino acid content, sugar content of cereals and provides enhanced digestibility of cereals. Malting of cereals finds its applications in food, beverage and cosmetics industry due to its bio-active properties. In this review, the importance of healthy lifestyle through diets including cereals, the process of malting and its effects, pharmacological and biomedical properties and its applications were presented.

Keywords: Malting, Biomedical effects, Beverages, Diet, Cereals

Introduction
By definition and realisation, health is a natural aspect of life. Staying healthy is dependent on one's way of life. We have placed overall health in our bodies, and we come diligently and constantly to keep our physical condition. When it comes to our food, we realise the critical components of overall health. Eating natural, complete foods and making a commitment to avoiding foods heavy in fat and oil (Kumar, 2017). Health extends people's lives and minimises newborn and maternal mortality. A healthy diet, personal hygiene, and regular exercise are essential for optimal health (Shridhar et al., 2015). A healthy lifestyle that includes a good food, physical activity, no smoking, a healthy weight, and no to low alcohol use will help prevent heart failure. These findings highlight the need of emphasising overall healthy lifestyle in public health programmes aimed at preventing heart failure and increasing healthy life years at all ages. (Limpens, 2022).

Advocating for a healthy lifestyle from a young age will lessen both the disease's occurrence and its long-term repercussions (Kaundal et al., 2022 and Lie Fong et al., 2021). Starting a healthy lifestyle requires a change in food as well as regular physical activity and exercise (diabetes). Diet and physical activity are two of the most important aspects of diabetes self-management (Spandana, 2022).

Building a healthy lifestyle, regardless of age, has been shown to minimise the risk of cardiovascular disease, the incidence of obesity and diabetes, the risk of malignancy, psychiatric problems, and cognitive dysfunction (Lee et al., 2010 and Willoughby et al., 2008; Cojocaru et al., 2014). Cereal grains account for almost half of global calorie intake, with higher proportions in low and middle-income nations, particularly in Africa and South Asia. Cereal grains account for over 70% of daily caloric consumption in these regions (Keamy, 2010). According to FAO STAT 2021, global cereal food consumption is 176 kg per capita per year, or around 480 g per capita per day. Wheat and maize are the most abundant crops (766 and 1148 million metric tonnes, respectively), followed by rice (755 million metric tons). Other globally important cereal crops include barley, sorghum, and oats (FAO STAT, 2021).

Grains are an important source of energy (30 percent of intake), proteins (25 percent –30 percent), carbohydrates (40 –45 percent), fibre (40 –60 percent), and vitamins and minerals such as thiamine (25 –35 percent), folate (30–35 percent), iron (40 –45 percent), calcium (10 –30 percent), and selenium, depending on the amount and quality of grains consumed by adult populations (20 percent) (Mckevith, 2004 and Valsta et al., 2021).

In addition to being major sources of nutritional energy, most cereals contain variable amounts of proteins, lipids, minerals, and vitamins. Wheat accounts for around 20% of total dietary calories and proteins worldwide (Shiferaw et al., 2013), while rice accounts for 20% of total calories and contains key minerals, vitamins, and bioactive phytochemicals, along with other essential food components found in rice bran (Fukagawa and Ziska, 2019). Whole maize grain is high in anthocyanins and has several nutritional benefits that can be increased by the traditional 'nixtamalization' method (Rosales et al. 2016; Bañuelos-Pineda et al. 2018).

Some cereals, particularly coloured rice, wheat, maize, and millets, include useful bioactive components such as polyphenols, tocopherol, oryzanol (antioxidants), and vitamins. These grains have functional features that help fight diseases and prevent or regulate some diseases in the body, such as cardiovascular risk, cancer risk, type 2 diabetes, hypertension, high blood pressure, and so on (Baniwal et al., 2021, Bartlomiej et al., 2012) (Klopcic et al., 2020).

Cereals have unique traits that go beyond their nutritional value, such as biomedical properties. Wheat bioactive components such as phenolic acids (hydroxycinnamic acids and hydroxybenzoic acids), flavonoids, benzoazinoids (BXs), carotenoids, alkyl resorcinols, and others have numerous therapeutic applications in the treatment and prevention of obesity, cardiovascular disease
CVD, type-2 diabetes, anti-colorectal cancer, and others (Liu et al., 2020). Rice is a popular diet for new-borns due to the presence of lysine (Baniwal et al., 2021). Brown rice is a whole grain product that is low in calories but high in fibre, vitamins, particularly vitamin B, iron, and manganese. Brown rice has been shown to help reduce heart problems by lowering cholesterol levels, as well as to be important for cleaning the digestive tract and preventing the formation of blood clots. When crushed rice powder is applied to the skin, it has a medicinal effect on skin disorders (Lavanya et al., 2017).

Rice is well-known for its anti-oxidant and chemoreceptive characteristics, and its red colour is due to the presence of the pigment "proanthocyanin" (Mehra et al., 2020). Barley is a non-gluten grain. The hull-less barley has been discovered to have a high glucan content that aids in the prevention of induced colon cancer (Idehen et al., 2017 and Baniwal et al., 2021). Quinoa is a pseudo-grain that can be used to induce hunger in persons who do not have an appetite. Quinoa's reduced Glycemic Index is responsible for this feature (Lopes et al., 2019).

According to a study (Lattimer & Haub, 2010), fibres in oats have the ability to lower LDL cholesterol levels, which is especially relevant for patients with diabetes. Oats include beta-glucan, which helps to keep blood sugar levels stable (Chen & Raymond, 2008).

Malting process:
Malting and fermentation are significant unit procedures used to improve food quality during processing. Malting is the process of modifying the biochemical alterations that increase the nutritional and bioactive qualities of cereal grains during controlled germination (Dahiya et al., 2018).

Steps involved in malting process
The malting process consists of three major phases. The first step is to soak the barley, commonly known as steeping, in order to awaken the dormant grain. The grain is then allowed to germinate and sprout. Finally, the barley is heated or kilned to obtain its final colour and flavour.

Step 1: Steeping
Steeping is the first and most important process in producing high-quality malt. This is accomplished by submerging or "steeping" the grain in water, followed by an air rest period that allows the grain's water content to grow. Under optimal growth conditions, the absorbed water activates naturally occurring enzymes and promotes the grain to generate new enzymes. The steeping procedure varies depending on grain type and size, but it usually takes 24-48 hours. When the barley has attained a moisture level that allows for a consistent breakdown of starches and proteins, the steeping process is complete.

Step 2: Germination
The second stage is to carry on the germination process that began with steeping. Grain growth and alteration take place here. Rootlets develop from the kernel from the outside of the grain. This process usually takes 4-6 days and produces what is known as "Green Malt." The grains are separated with occasional rotation to avoid grain clumping, non-uniform heating, and different rates of germination.

Step 3: Kilning
Kilning is the third and last step in the malting process. The green malt is dried by convection heat treatment to prevent further germination. Most malts begin by removing moisture from the germinated grain, a process known as withering. Additional drying decreases the moisture level of the malt for flavour and colour development.

Malting increases total sugar and free fatty acids due to protease and amylase enzymes, which break down the complex structure of protein and carbs in cereals into simple and soluble components (Sandberg & Andlit, 2002). Fermentation is a process in which microbe enzymes operate on a substrate, most commonly a carbohydrate, to produce energy, acids, gas, and alcohol (Kohajdova and Karovicova, 2007). (Olamiti et al., 2020). Fermentation is crucial for increasing the nutritional contents of food and preserving it. This approach aids in the preservation of food products while also improving the flavour, colour, and nutritional content of raw materials (Chinenye et al., 2017; Saleh et al., 2013). (Olamiti et al., 2020).

Endopeptidases degrade proteins into polypeptides with reduced molecular weight during the malting process, while exopeptidases degrade breakdown products into amino acids such as lysine, -aminobutyric acid, and asparagine (Ding et al., 2018; Grassi et al., 2018; Xie et al., 2014; Belcar et al., 2021). The protein level of the composite flour improved after fermentation (Gawande et al., 2018). Fermentation can also boost mineral availability and vitamin B levels, especially thiamine (Gawande et al., 2018; Mungula et al., 2003). Grain malt flour is utilised in the manufacturing of newborn and geriatric diets, as well as as a popular diabetic food supplement (Kumar et al., 2016; Udeh et al., 2018). The process of malting is done in almost all the cereals like wheat, barley, oats, quinoa, maize, rice for the preparation of malted beverages which are alcoholic and non-alcoholic in nature. Beers are the fermented beverages prepared from malted rice and malted barley. Malting of grain sprouts enhances the anti-oxidant activity of the cereals. The effect of malting on cereal grains is depicted in Table 1.
<table>
<thead>
<tr>
<th>S.no</th>
<th>Cereal Grains</th>
<th>Malting Process</th>
<th>Time of Malting</th>
<th>Benefits</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Wheat</td>
<td>Germination</td>
<td>5 days</td>
<td>Reduction of undesired Cinnamic Acid</td>
<td>Langos et al., (2015)</td>
</tr>
<tr>
<td>2.</td>
<td>Fox Tail Millet</td>
<td>Germination</td>
<td>3 days</td>
<td>Concentration of minerals.</td>
<td>Coulibaly and Chen(2011)</td>
</tr>
<tr>
<td>3.</td>
<td>Pearl millet</td>
<td>Soaking</td>
<td>24 hrs</td>
<td>Enhanced Protein</td>
<td>Iyabo et al. (2018)</td>
</tr>
<tr>
<td>4.</td>
<td>Barley</td>
<td>Mashing</td>
<td>10 mins at 4°C</td>
<td>Degradation of protein into Amino Acids</td>
<td>Torres et al. (2022)</td>
</tr>
<tr>
<td>5.</td>
<td>Black Rice</td>
<td>Germination</td>
<td>8 days</td>
<td>High intensity of colour of rice wort could be achieved.</td>
<td>Usansa et al. (2011)</td>
</tr>
</tbody>
</table>

Table 1: Effect of malting on various cereals

Phytochemistry of various cereals:
Malting of cereals have considerable effect on the phytochemical parameters of the grains. The phytochemical parameters include moisture content, crude protein, crude fat, total carbohydrates (Hingade et al., 2019). The crude protein in wheat and barley grains after malting were increased substantially whereas moisture content, crude fat and crude fibre content were reduced after malting (Hingade et al., 2019).

There are many phytochemicals present in the cereals. The levels of phytochemicals increase during malting of the grains. These phytochemicals help in preventing many diseases like Type-2 Diabetes, cardiovascular problems, obesity problems (Belobrajdic et al., 2013)

Wheat: Wheat's antioxidant qualities are mostly related to its high phenolic content, including alkyl resorcinols and hydroxycinnamic acids (ferulic, sinapic, and coumaric acids) concentrated in the bran portion (Adom et al., 2005; Belobrajdic et al., 2013). Following the malting process, the concentration of flavonoids such as catechin and tocopherols in the bound fraction of wheat cultivars increased.

Barley: The most important phytochemicals found in barley are phenolics, tocopherols, and folate. Tocopherol levels in barley have grown about fivefold over normal levels. (Ward et al., 2008; Belobrajdic et al., 2013).

Rice: Although the quantities of these phytochemicals vary greatly amongst rice kinds, brown rice is a good source of lipid-soluble antioxidants such as ferulated phytosterols (γ-oryzanol), tocopherols, and tocotrienols. (Bruce et al., 2010; Belobrajdic et al., 2013). The total phenolic contents of the grains and anti-oxidant capacity increased after malting of the grains.

Rye: Rye has a higher concentration of alkyl resorcinols (568 to 3220 g/g) than the other major cereal kinds (0 to 750 g/g). The high amount of folate in the grain (0.55 to 0.80 mg/100 g) [64] is associated to the quantity of alkyl resorcinol in rye (Ross et al., 2004; Belobrajdic et al., 2013). Some rye varieties possess relatively high amounts of total phenolics (up to 1080 g/g), however the free phenolic content is quite modest (between 10 and 35 g/g). (Nystorm et al., 2008) Other phytochemicals, such as tocopherols and polyphenols, are found in modest concentrations in rye (Nystorm et al., 2008).

Oats: Tocopherols and tocotrienols, phenolic acids, sterols, selenium, and avenanthramides (a type of N-cinnamoyl anthranilate alkaloids found only in oats) are the most important phytochemicals found in oats (Peterson et al., 2001). The total phenolic levels in oats are similar to those in wheat and rye, but oats contain up to ten times freer and more conjugated phenolics. Other phytochemicals found in oats include folate, polyphenols, ferulic acid, and flavonoids at low quantities. (Belobrajdic et al., 2013). Different anti-oxidant activity along of the malted cereals along with extraction method is shown in the Table 2.
Pharmacology of malted cereal grains:
Malting finger millet increases its digestibility, sensory and nutritional quality, and has a significant influence on antinutrient reduction. Finger millet malting properties are superior to other millets and rank second only to barley malt (Pawar et al., 2007). When three different types of malted barley were utilised to make cookies, the antioxidant research and total phenolic content were found to be higher than in regular wheat cookies (Jukic et al., 2022).

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Cereals</th>
<th>Component</th>
<th>Effect</th>
<th>Mechanism</th>
<th>Health benefits</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pearl Millet</td>
<td>Iron</td>
<td>Increased in malts</td>
<td>Breakdown of complex compounds to simple nutrients by Germination</td>
<td>Prevent Anaemic conditions</td>
<td>Vijay et al., 2021.</td>
</tr>
<tr>
<td>4.</td>
<td>Wheat</td>
<td>Starch</td>
<td>Decreases in malts</td>
<td>Action of amylolytic enzymes on starch reserves.</td>
<td>Sugars obtained are the basic source of energy metabolism.</td>
<td>Byeon et al., 2022.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Phenol Content</td>
<td>Increased during malting</td>
<td>Decomposition of cell wall components and Bio-Synthesis of phenols</td>
<td>Antioxidant property</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Barely</td>
<td>Anti-inflammatory agents like Vanillic Acid</td>
<td>Increased during malting</td>
<td>Formation of Short Chain Fatty Acids</td>
<td>Anti-inflammatory properties</td>
<td>Zeng et al., 2020</td>
</tr>
</tbody>
</table>

Table 2: Anti-oxidant activity of different cereal grains
Applications of Malting

Food Applications

When wheat flour is partially substituted with malted barley flour, the texture of the cookies improves and the amount of sugar used in cookie baking is reduced. These cookies have a lot of sensory appeal (Alka et al., 2017). Malted Millet flour was created as a healthier alternative to gluten-containing flour while baking cookies. Malted millet flour had favourable sensory, aroma, and flavour characteristics, as well as an increased amino acid profile (Adebiyi et al., 2017).

The addition of malted raw ingredients to goods has also been found to improve their sensory characteristics. Extrudates made from malted millet and soybean performed better in terms of flavour and texture than unmalted equivalents, and the malted flavour masks the disagreeable beany flavour derived from soybean (Obatolu, 2002). The use of native or malted amaranth looks to be a promising method for producing high-quality breads with much higher dietary fibre content than the reference wheat bread (Onyango et al., 2022).

Traditionally, either malting or fermentation is used to process finger millet (Ragi) (Rao et al., 2001). A preparation known as 'ragi malt' that can be used as a health drink or energy drink and is popular in Indian states (Verma et al., 2013).

Industrial Applications

Wisconsin Mellin Company created the first malt-based feeding product given to infants with sterilised milk in 1850. (Hunziker, 1949). James and William Horlicks created Horlicks in 1887 using malted barley and wheat (Dhillon, 2005). Many items based on malted grains have been introduced in the business since then.

A malt beverage is a fermented drink manufactured from malted cereal grain such as barley, which includes germinating the grain in water and drying it (Chettri et al., 2002). Malt extract is a concentrated syrup made from barley that contains 70%--80% sugar (Aghel et al., 2016). Malt drinks are classified as alcoholic (containing more than 1.2 percent alcohol), low alcoholic (containing 0.5 percent to 1.2 percent alcohol), or nonalcoholic (containing less than 0.5 percent alcohol) (Briggs et al., 2004). Barely Malt, in conjunction with rice malt, is an essential component of the brewing industry for beverage production.

Rice malt beer can also be manufactured in a typical manner, resulting in well-fermented beers with no off-flavor equivalent to barley malt bottom fermented beer (Marconi et al., 2017).

Because of the product's high nutrient density, beverage drinks made from tiger nut milk and malted yellow maize in an 80:20 ratio can be utilised as a beverage food for both young and old people (Ogori et al., 2022). Several patents have been obtained for barely rootlets, a product obtained in the brewing industry following malting (Neylon et al., 2020). A patent has been obtained in the United States, where the rootlets can be utilised to extract functional chemicals for use in the beauty sector (Kihara et al., 2007). The nutritional quality of wheat-malted sorghum-soybean composite flour is improved by malting. Composite flour with up to 20% malted sorghum could find use in the candy industry (Aluge et al., 2016).

Medicinal Applications of Malting

In humans, a probiotic drink comprised of wheat, barely, or oats enhanced gut microbial equilibrium (Arya et al., 2018). Malted beverages immediately scavenge free radicals in the body, slowing the ageing process (Kim et al., 2014 and Yazhen et al., 2022). Malt-derived antioxidants suppress oxidative processes and can recover oxygen-free radicals (Vanderhaegen et al., 2006).

Germination boosts calcium, copper, manganese, zinc, riboflavin, niacin, and ascorbic acid levels, according to Kaushik et al. (2010). Badau et al. (2005) discovered that malting decreases the phytic acid level of pearl millet varieties. Wheat polyphenols are well-documented for their ability to efficiently regulate oxidative stress and have anti-inflammatory, anti-diabetic, and anti-cholesterol properties (Martn-Diana et al., 2021).

Conclusion:

Malted beverages and malted items made from cereal grains are becoming more popular due to their numerous health benefits. The by-products of grain malting have numerous applications in food, industry, and medicine. Malting is the process of altering the biochemical properties of cereals in order to improve their nutritional and bioactive properties. Malted grains and malted beverages reduce the risk of cardiovascular disease and help avoid diabetes. Gluten-intolerant people can ingest malted flour since the malting process converts gluten to a soluble form. Malted plant-based milks and cheese can be utilised as an alternative source of dairy goods. Malted grain phytochemicals are utilised to make medications, and the by-products are employed in the cosmetic industry.

References


