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A Review on the Potential of Barley to Produce Healthy Food Products

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***Abstract*-- Barley (*Hordium vulgare L.*) is a common cereal which is being produced in various countries for different uses such as for animal feed, brewing industries and to some extent for human consumption. Barley is identified as a source of good nutrients and bioactive compounds that are beneficial for health. The present review paper discusses about the qualities, composition and potential of barley to develop healthy food products. Barley has high fibre content, antioxidants, and micronutrients and phytochemicals etc. After analysis of various studies it is found that barley is a ideal grain for peoples who have or not have any non-communicable diseases. Barley has been found suitable for peoples with diabetes mellitus, heart diseases, cancer, obesity etc. From past years, barley is used to produce range of products which are part of daily diets such as chapattis in India. The paper also describes that barley is also being utilised to produce biscuits, crackers, sattu etc. Barley can be used to formulate variety of healthy food products. The products developed with barley showed excellent properties for health.**

***Keywords*-- Antioxidants, Barley, β-glucan, Food products, Health benefits**

I. Introduction

Barley (*Hordium vulgare L.*) commonly known as "Jau" belong to family poaceae. Barley is cultivated for malting and brewing industrial purposes. Afresh barley is identified as a good source of functional foods ingredients such as minerals, antioxidants and high fibre contents and gives positive effect on wellbeing of the consumer and lowers the risk of various diseases. [2]

In many countries such as Japan, China, Korea etc. barley tea is used as traditional cold beverage. Barley tea is known as oriental coffee and it has pleasing aroma. Various therapeutic effects of this barley tea are described in a Chinese medical dictionary e.g. it aids in digestion, gas removal. [5]

Barley is majorly used for animal feeding. It is also used for food and malt production. Around 70% barley used for feed and 30% of barley grains are used for producing malt. The use of malted barley is done in malting beer and food substitutes.

Because of many good properties of barley such as low density lipoprotein and high soluble fibre content, the manufacturers prefer barley over wheat and other cereals. Low density lipoprotein (LDL) is associated with risk of heart diseases whereas the soluble fibre in barley has the cholesterol lowering effect. In most countries, the majority portion of the barley is used as animal feed, particularly for cattle and pigs, and the use of barley as human food is more limited. During the past decade, of the total global barley consumption, about 65% is used as feed, followed by industrial at about 20%, which includes malting. A smaller percentage is used for food (5%) as well as some for other uses (7%).[6]

It has been recognised for decades that dietary fibre is important for health and as part of a balanced diet. Soluble fibre such as β-glucan has been shown effects on the glycaemic, insulin, and cholesterol responses to foods. Cereals like barley and oats are good sources for these functional ingredients. Studies have also demonstrated their potential nutritional benefits. [8] Total barley grain contains from 2 to 11% of the beta-glucan. Beta-glucan of barley has been shown to decrease the risk of heart disease. Barley contains various essential amino acids such as threonine, valine, lysine and arginine. Cereals like barley and oats have been shown to reduce the instances of developing type-2 diabetes mellitus. [30]

The first meta-analysis of randomized clinical trials provides information on the effect of barley b-glucan on lipid profile. The meta-analysis showed that consumption of barley beta-glucan reduced blood cholesterol concentrations in subjects with different dietary backgrounds. Barley intake had no effect on HDL cholesterol and tryglycerol consumption.[2]

Barley has a classification of phytochemicals to impact the human health potentially. Due to inherent properties of barley advantages like these are present in phytochemicals. Few of them are: high anti-inflammatory, anti-oxidative activity and immune-stimulus or also has the ability to prohibit low density lipoprotein, whereas increases levels of HDL cholesterol. [19]

Barley contains phenol compounds which possess antioxidant activity.[22]

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Barley has been recognized as a functional grain because it contains high amounts of β-glucan (4–11%). In addition, it is good source of phenolic compounds and antioxidants among the cereals. The unique bioactive composition of barley makes it different from other cereals, fruits, and vegetables. Since barley and other cereals are consumed after processing, this greatly affects the composition of phytochemicals and antioxidants. [26]

Belobrajdic and Bird (2013) in their review concluded that diet rich in whole cereals and grains attributed with various healthy compounds such as vitamins, minerals, dietary fibres and phytochemicals reduce the risk of type 2 diabetes development. For centuries, barley has been utilised for human as food and medicinal use. Various uses of barley in food, medicine and drink formulations for good health are mentioned in studies. Many researches find out that barley kernel has bioactive compounds that have positive effects on human health and help in management and prevention of diseases. Barley contains tocols, vitamins, minerals, beta-glucan and phytochemicals which causes high antioxidant activity, low glycaemic response and cholesterol profile. Hence it is proved that barley helps with the disorders such as obesity, heart diseases, type 2 diabetes and cancer etc.[7]

II. Potential Of Barley In Food Product Development

Barley is a simple grain, which grows in India such as wheat, rai and maize. Scientists have identified it as nutritious crop. Barley is being consumed all over the world after researches find out the health benefits of barley. Barley flour, barley bread, barley flakes, roasted barley and many preparations of barley are available in market today. Daily intake of barley reduces the risk of constipation. It is recommended to take barley in daily diet.

Nirupama gangoupadhyaya in her study prepared four types of crackers with barley four and bran by replacing wheat flour. When these preparations were compared with the wheat cracker, that was a control sample, found to be enriched in β-glucan, bioactive compounds, antioxidants and polyphenols. Hence on the basis of qualities, barley crackers can be served as health supporting food.[13] A drink prepared with yogurt was supplemented with roasted barley powder with different levels such as 0%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3%. The effects on rheological properties, sensory properties, and physicochemical properties were evaluated. Addition of barley flour into drink increased antioxidant capacity, yogurt acidity, and water binding capacity, phenolic compounds content.

The interest in barley benefits for human health got reawakened and substituting barely bread for wheat bread has been traditionally used by diabetic people in lraq as a means of combating their diabetic condition, especially in rural areas where access to modern medicine is limited (Mahdi and Naismith, 1991).[1]

Sharma and Gujral in their study replaced wheat flour with barley flour for making chapattis. Antioxidant properties of chapattis were assessed before the baking process and after that. Total phenolic content of barley chapattis found to be increased as ferulic acid increased by 57.1 %, total flavonoid content as cathechin increased by 101% and antioxidant activity was increased by 22.6%. Research concluded that barley chapattis can be consumed to avail bioactive compounds of barley. Gujral and Gaur(2005) in their study evaluated the properties of fresh made and stored barley chapattis. In these chapattis the use of wet gluten and barley flour improved the quality of chapattis (both stored and fresh).[27]

In their study Frost et al. explored the possibility (potential) of barley flour to be used as a source of soluble fibre in cookies. The objective of the study was to analyse the sensory and physical qualities of chocolate chip cookies after the use of barley flour. In cookies preparation barley flour was added or substituted at different level as 0, 30, 40, 50, 60, and 70 % in all-purpose flour. By increasing barley flour level, there was an increase in aroma and flavour, thickness, dryness, colour intensity, graininess.[12] Ahmad et al. 2021, prepared biscuits with barley and wheat flour 20 and 40%. Whole baley flour was added to wheat flour for preparation of different mixtures. Water was added to prepare the dough. The addition of barley flour resulted in protein, fibre and ash contents. The antioxidant activity in barley (41.5%) was more than wheat flour (2.03%). The higher level of barley incorporation in flour (40%) found to have higher acceptance rate and decreased microbial load during the storage time.[4]

Gupta et al carried out study on prepration of cookies by adding barley flour into the wheat flour. Cookies which incorporated with barley flour (10, 20, 30, 40%) showed high fibre, protein and mineral content in comparison to cookies made from 100% wheat flour. Also the colour of cookies was changed with the addition of barley flour. Incorporation of 30% barley flour was found to be ideal for cookies in context of colour, flavour, taste, appearance etc. cookies contained 1.7% β-glucan, 31.8 ppm calcium, 36.6 ppm iron, 22.9 ppm zinc whereas barley incorporated cookies had lower breaking strength than wheat flour cookies. Overall the barley flour incorporated cookies were rich in nutrients in comparison to 100% wheat flour cookies.[15]

Shakeb et al. (2022) formulated a sattu mix for their study. Canadian peas, maize and chick pea were used and soaked in water for 4 hours and 2 hours respectively. The water drained and grains were roasted individually around at 100 to 120°c for 45 minutes approximately. Then grains were cool down till the room temperature and crushed with hammer mill. Other ingredients such as wheat, oats and barley were crushed after dry roasting. All powdered ingredients were siewed and mixed in different proportions for two formulations. First formulation was based on wheat, which included chickpea, barley, oats, wheat and Canadian pea flour in ratio of 3:3:1:2:1. Second formulation was based on maize in which mixed chickpea, barley, oats, maize and Canadian peas flour were into ratio of 3:3:1:2:1. These flour were mixed thoroughly and packed in packets of 100 g. The developed product had 6-7% of moisture and could be stored for 60 days at room temperature. They formulated two variations of sattu, in which one was based on wheat and other was based on barley. Wheat based sattu powder was had found to have higher digestibility and lower glycaemic index in comparison to maize based variety. The prepared sattu powder was found convenient and easy to prepare by mixing with hot or cold water.[25]

D Mridula et al (2009) in their research prepared three variation of fortified sattu with bengal gram and barley. Sattu was fortified with vitamins such as thiamine, riboflavin and niacin and minerals such as calcium and iron as per FDA guidelines for fortification of flour. Bengal gram and barley proportions in sattu samples was 100:0, 50:50 and 75:25. [10] The fortified sattu based on Bengal gram provided 27.68% digestible protein, 3.21% ash, 1.03% dietary fibre, 5.23% fat, 170 mg calcium, 12.5 mg iron per 100 g. Sattu powder with 50:50 bengal gram and barley 19.49% digestible protien, 3.31% fat, 2.57% ash, 1.45% dietary fibre, 387 kcal, 130.78 mg calcium, 8.39 mg iron. Sattu powder with 75:25 ratio of Bengal gram and barley provided 23.58 % digestible protein, 4.21% fat, 2.93% ash, 1.11% dietary fibre, 391 kcal, 144.58 mg calcium and 10.4 mg iron per 100 g. sattu samples which were stored in safe and acceptable limit were stored in safe and acceptable limit were good but low deterioration was in the sample stored at 25°c (65% RH) in laminated aluminium foil pouches.[25]

Anwar Hussain and Rajkumari Kaul, 2018, biscuits incorporated with barley and buckwheat flour (10, 20, 30, 40 & 50%) into wheat flour. Biscuits with barley and buckwheat flour had high fibre, fat, ash, carbohydrate and mineral content in comparison to biscuits made with only wheat flour.[17]

Sneh narwal et al. (2017) in their study tried to enrich wheat chapatti and biscuit with the goodness of hulless barley. Barley flour used with wheat flour in different proportions from 5 to 30%. Evaluation resulted in significant increase in antioxidant activity and beta glucan amount at 30% blending of flour. Total phenolic content was also increased in both biscuits and chapattis.[21] Holtekjolen et al. (2008) researched on the sensory and antioxidant properties of the breads containing barley. The study findings reported increased antioxidant activity in comparison with control sample. Free phenolic content decreased and bound phenolic content increased during baking process. Sensory evaluation of bread showed that the differences are dependent on the variety of barley.[16]

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