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Effect of soaking and malting on the selected nutrient profile of barley

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Abstract: The locally purchased barley grains were soaked for 48 hrs at low temperature (10-18^{0}C) to 40-45% moisture and germinated for 2 days. The germinated grains were dried in a cabinet drier at 65^{0}C for 16 hrs. Once dried, grains were manually derooted and were ground by pin grinder. The raw, soaked and malted barley were analyzed for moisture, ash, crude protein, crude fat, crude fiber, starch, reducing sugar, phytic acid and for total iron. Analysis of the malted barley showed increase in reducing sugar and crude fiber while decrease in ash, crude protein, starch and crude fat was observed. Phytic acid, known for restriction of bioavailability of minerals, was drastically reduced. Total iron was also observed to reduce during malting.

Keywords: Barley, soaking, malting, proximate composition, phytic acid.
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INTRODUCTION

The barley occupies 94 thousand hectare in Pakistan in 2006-07 and the production of barley was 92.7 ton in Pakistan during 2006-07. In NWFP barley occupies an area of 32.1 thousand hectare and the production in NWFP was 32.7 thousand ton[1].

Barley (*Hordeum vulgare* L.) is grown as a commercial crop in some one-hundred countries world-wide and is one of the most important cereal crops in the world. Barley assumes the fourth position in total cereal production in the world after wheat, rice, and maize, each of which covers nearly 30% of the world's total cereal production[2].

It is estimated that about 85% of the world's barley production is destined for feeding animals, while the rest is used for malt production, seed production and food consumption. It is used for production of starch either for food or for the chemical industry[3]. Some 140 million ton of barley is produced annually worldwide[1]. In industrialized countries the consumption of barley as food has lost most of its earlier importance in human nutrition[4].

The predominant food product of barley is malt that is primarily used in the brewing industry. Barley, malt extracts and syrups are used in small amounts in food products to give better flavour and colour, for example, in breakfast cereals and baked goods. The largest use is in fermented bakery products. Malt extract is a source of soluble sugars, protein and amylases in the dough and promotes the activity of yeast resulting in good bread texture and bigger loaf volume, good flavour and colour to the finished baked products. Further applications of malt products are for non-fermented bakery products, for example, crackers, cookies and muffins. Malted barley is rich in enzymes and is also used for bakery products as a source of amylases to compensate the low alpha amylase activity in bread wheat flours[5].

Moreover, this millet is a rich source of protein (11.2%), mineral (1.2%) and iron (0.0023%)[6]. It contains antinutrients, phytate phosphorus and polyphenols being major among them. Phytate is known to interact with proteins and minerals and reduces the availability to human beings[7]. Germination is an important intermediate step in the preparation of malted barley. Malt is produced by the controlled germination of barley grains (*Hordeum vulgare* L.), which is initiated by steeping barley grains in water, followed by germination and kilning periods. The major objectives of the malting process are to hydrolyze barleys endosperm cell walls (predominantly (1→3, 1→4)-β-glucan), hydrolyze a portion of endosperm protein, produce a quantity of enzymes within the grain that are further utilized during brewing (e.g. α-amylase), and to develop desirable malt colour and flavour[8]. Several reports showed that germination alters the availability of minerals. Many simple processing techniques such as dehulling, soaking, malting, fermentation, and autoclaving are used to minimize the interactions between phytate and divalent cations especially Fe^{++}, Zn^{++}, and Cu^{++}. Barley is an important cereal crop used not only for malting but also in the production of variety of products so it was considered worthwhile to study the effect of soaking and malting on the different nutrient profile of barley.

MATERIALS AND METHODS

Malting

Barley was purchased from the local market and cleaned for extraneous matter. This raw cleaned barley was retained for analysis. Cleaned barley was then steeped for 48 hrs at low temperature (10-18^{0}C) to 40-45% moisture. During steeping, water was changed every 8 hrs. The grain was constantly aerated to provide dissolved oxygen for the respiration of barley kernels. This soaked barley was dried in oven and retained for analysis. After steeping was complete, the grains were removed from water and placed on wet sacks in stainless steel

trays to germinate for 2 days. Water was sprayed on the grains three times per day. After germination; the grains were dried in a cabinet drier at 65^0C for 16 hrs. Once dried, grains were manually derooted and were ground by pin grinder. The grounded malt, raw barley and dried soaked barley were packed in polyethylene bags for analysis.

Nutrients analysis

Samples were analyzed in triplicates by standard A.O.A.C procedures[9] for moisture, crude protein, ether extract, crude fiber, and ash. The factor 6.25 was used to convert the Kjeldhal nitrogen to crude protein. Crude fat was determined by ether extraction method using soxhlet apparatus. Crude fiber was determined by acid digestion and alkali digestion method. Ash content was determined in muffle furnace at 550°C for 6 hours. Starch content was calculated from the amount of reducing sugar hydrolyzed from starch by hydrochloric acid[10]. Reducing sugar was determined by following the method of Lane and Eynon mentioned by Pearson's chemical analysis of foods[10]**.**

Phytic acid was determined by following the method of Ranghana**[11]** while Iron was estimated by following standard A.O.A.C method[9] on Hitachi Zeeman Japan Z-8000, Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

Proximate composition of raw, soaked and malted barley is shown in table 1. The proximate composition of barley changes during its processing. The moisture content of raw, soaked and malted barley observed was 10.42%, 8.82% and 7.05% respectively. While ash content of raw, soaked and malted barley was 2.45%, 2.16% and 1.95% respectively. There was a maximum decrease in the ash content of malted barley grains. Sankara Rao and Deosthale (1980)[12] also reported similar results in sorghum during pearling.

Table 1: Changes in proximate composition during barley processing.

Sample	Moisture (%)	Ash (%)	Crude Protein (%)	Crude Fat (%)	Crude Fiber (%)
Raw	10.42 ±0.78	2.45 ±0.05	12.28 ±0.04	1.70 ±0.03	5.90 ±0.09
Soaked	8.82 ±0.67	2.16±0.03	12.01 ±0.04	1.05 ±0.04	5.73 ±0.05
Malted	7.05 ±0.98	1.95±0.02	11.90 ±0.02	1.20 ±0.06	8.15 ±0.05

*Mean of triplicate determinations±SD (standard deviation)

Pawar and Machewad (2006)[16] also observed decrease in ash content and stated that the decrease in ash content of barley on soaking, germinating and malting could be due to solubility in water and subsequent loss on leaching during these processing methods. The losses could also have been due to redistribution of ash from barley seeds, roots and shoots developed during malting. The crude protein content observed was 12.28% in raw, 12.01% in soaked and 11.90% in malted barley. Slight variations in protein content were observed. These results are supported by the findings of Pawar and Machewad (2006)[16] that attributed these changes to leaching losses and translocation of protein from seeds to roots and shoots. The data is in agreement with the study of Taylor (1983) [13] who reported transfer of much of the nitrogen to the roots and shoots in sorghum during malting. The raw seed contained crude fat 1.70 %, soaked 1.05% and malted 1.20%.The crude fiber content in raw, soaked and malted barley was 5.90%, 5.73% and 8.15% respectively. In case of crude fat content no marked change was observed, while considerable increase in crude fiber was observed. The high fiber content of germinated barley could be of dietary importance, if incorporated in fiber supplements.

Table 2 represents the starch and reducing sugar content of barley samples. The starch content observed in raw, soaked and malted barley was 38.50%, 37.53% and 25.70 %, while reducing sugar content was 1.09%, 0.76% and 5.23% respectively. During malting decrease was recorded in starch content with a marked increase in reducing sugar content. These changes probably were caused, in part, by the increased enzyme activity during germination, which hydrolyze the starch and protein. These results are supported by the observations of MacLeod (1967)[14] and Macgregor and Balance (1980)[15] who reported that during germination, barley produces many enzymes that hydrolyze starch and protein, such as α-amylase, β -amylase and protease.

Table 2: Changes in Starch and Reducing Sugar during barley processing.

Sample	Starch (%)	Reducing Sugar (%)
Raw	38.50±1.01	1.09±0.99
Soaked	37.53±0.98	0.76±0.76
Malted	25.70±1.12	5.23±0.09

*Mean of triplicate determinations±SD (standard deviation)

Table 3 depicts the phytic acid and iron level of barley during processing. The phytic acid observed was 156.72mg/100g in raw, 133.45mg/100g in soaked and 104.20 mg/100g in malted barley. The phytic acid was drastically reduced both during soaking (14.84%) and malting (33.50%). These results are in agreement with the findings of Pawar and Machewad (2006)[16] who also reported maximum

reduction during soaking (41.4%), germination (33.5%) and malting (28.9%). They further argued that the reduction in phytic acid content during malting and germination might have been due to its degradation and phytase synthesized during these processes. These results are also supported by the observations of Pawar et al (1986)[17] and Rao and Deosthale (1988)[18].

The data as shown in Table-3 indicates the iron content during barley processing. The iron level observed was 2.10mg/100g, 1.81mg/100g and 1.11mg/100g in raw, soaked and malted barley. Contrary to the findings of Muhammad Rauf Khan (1990)[19] who reported increase in the calcium and iron content during light germination, a drastic decrease in the present study was observed both in soaked (13.81%) and malted barley (47.14%). However, the present findings are in agreement with the observations of Pawar and Machewad (2006)[16] who reported maximum reduction during soaking (47.90%), germination (58.68%) and malting (62.28%). These results are also supported by the observations of Sangita and Sarita (2000)[20] who reported that during malting process calcium and phosphorus content increases whereas iron content decreases.

Barley is one of the major millet crops of the world which is a staple in the diets of Asian and African people. Because of its high diastatic power, it is used in malting and for the production of malted products, so it was considered worthwhile to study the effect of malting on the different nutrient profile of barley. From the study it can be concluded that malting of barley be an efficient means of reduction of phytic acid that otherwise hinders the bioavailability of several minerals to human body. Further studies targeting the bioavailability of minerals from malted barley specifically iron, zinc and calcium are suggested.

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Table 3: Changes in Phytic acid and Iron level during barley processing.

Sample	Phytic Acid (mg/100 g)	%) Reduction in Phytic Acid	Total Iron mg/100 g	(% Reduction in iron content
Raw	156.72±0.87	-	2.10±0.17	-
Soaked	133.45±0.91	14.84	1.81±0.09	13.81
Malted	104.20±0.67	33.50	1.11±0.11	47.14

*Mean of triplicate determinations±SD (standard deviation)