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Effect of Germination process on Chemical Composition of barley Grains, Nutritional Value

Nadia Sh. Alshamlan*

Department of Food and Nutritional Sciences, College of Health Sciences, Public Authority for Applied Education and Training, Shuwaikh 70654, Kuwait

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ABSTRACT

The current study aimed to evaluate the properties of common and germinated barley by estimating the effect of germination on the chemical composition content and nutritional value. Barley is considered a functionally key food due to being a good source of antioxidants and dietary fiber, such as β-glucan **and** some minerals. Results indicated an improvement in the chemical composition of barley after germination. Results of protein and fiber content also reflected a genuine difference. Average value of barley was 9.91 to 12.81% for germinated barley and crude fiber is being 4.75%, while crude fiber in germinated barley was 5.15%. Results of minerals, such as calcium, magnesium, potassium, chromium, and manganese, were at the normal levels of 2.69, 29.25, 208.05, 0.75, and 0.64 mg/100g, respectively, while observed increased after germination to amount to 4.72, 30.78, 268.15 and 0.91 mg/100g, respectively, in compared with 0.78 mg/100g after germination. Results also indicated that a significant increase in bioactive compounds namely flavonoids and phenols contents, along with antioxidant activity in germinated barley compared to with common Type. This research recommended promoting and encouraging the consumption of germinated barley products in different food types.

Keywords: barley; germinated barley; antioxidants; minerals; nutritional value.

INTRODUCTION

An ancient grain called Hordeum vulgare L. barley has been utilized for a very long time as both an animal feed and a source of raw materials for the food industry. Barley still has lately obtained enormous usage in several Asian and North African civilizations due to its nutritional significance and high concentration of physiologically active chemicals. The use of barley as a component in food products has gained popularity.Considering how β-glucan lowers blood cholesterol and the glycemic index , as well as in creating a new trend in unique barley foods, β-glucan has been linked to lower cholesterol through health claims approved by the European Commission. Foods with β-glucan levels ≥1g can utilize this claim (European Commission, 2012). Additionally,the biologically active components of barley (phenolic compounds, tocols, and sterols) have positive benefits that are currently the topic of extensive investigation Barley's germination is a process of alteration and change that results in new compounds with high bioactivity and can improve the grain's stability and nutritional value (Nonogaki et al. 2010). Germinated barley grain is a vital and fresh source of protein, enzymes, vitamins, and minerals due to its importance in healthy and sound diets. It is simple food, easy to digest, and contains a high biological value that leads to the release of enzymes, germination of barley seeds, and the doubling of vitamins, minerals, and amino acids . When barley grain is exposed to moisture, (alpha-amylase) enzyme emerges, which breaks down the starch in barley grain in a saturated form into simple sugars, thus turning the complex protein into simple protein, composing easily digestible amino acids. Storage compounds (proteins and starch) are divided according to enzyme activity during germination. In addition, some useful substances are now produced, such as polyphenols and vitamins. Functional and sensory qualities of the rare are also affected by germination. All changes that occur during reproduction turn into seeds that germinate a useful component that is increased by biologically and organically active compounds. Its application in the foodstuff field would yield significant nutritional value. Today, markets offer foodstuff with health-promoting qualities as evidenced by the expanding market of nutritionally valuable meals that can control various bodily processes and enhance the health of consumers (Vicentini *et al*. 2016).

MATERIALS AND METHODS

Chemicals:

All Chemical in this study were purchased from chemical Company in Kuwait

.**Barley Grains:**

barley grain (*Hordeum Vulgare*) was purchased from the farm Public Authority for Agriculture Affairs and Fish Resources - Kuwait City

Methods:

Preparation of Germinated barley:

The grains washed with 0.7% sodium hypochlorite before soaking for 12 hours in distilled water at room temperature with the ratio of 1 part grain to 4 parts water, the grains were put on trays covered in gauze after draining the

* **Corresponding author.**
E-mail address: Nalshamlan244@gmail.com
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water. Gauze cloths reduce contamination and allow oxygen to reach the grains starting to germinate. After the grains are germinated at 25±3°C for 72 hours. Germinated Grains were sprayed regularly with distilled water to keep them adequately moist before and after soaking. Finally Grains were weighed before germination as mentioned by (Frias *et al*. 2005).

Chemical Analysis:

Chemical composition of raw and germinated barley, includes measures of the(crude protein, crude fiber, ash, and moisture content), according to the method described in [AOAC] (2000). Total fats are determined by the procedure outlined by (Folch *et al* .1957). Estimation of β-17glucan was performed according to the method of (McCleary and Codd, 1991), at the laboratory of the College of Health Science.

Bioactive Compounds and Free Radical Scavenging assay:

Free radical scavenging assay DPPH method, of (Brand-Williams *et al*.1995), has been adopted. Total flavonoids were extracted using the method of (Siddhuraju and Becker, 2003). Total phenolic content was measured by the method of (Makkar *et al*. 1997). Phenols were extracted from bakery products, with modifications, following the method reported by(Siddhuraju and Becker, 2003).

Determination of minerals content :

1. Weighing 2g then heat the samples at 550 °C.
2. 100 mL of 1M HCl was used to dissolve the ash.
3. Using the procedures of AOAC (2005), melted ash was examined to trace zinc, iron, calcium, potassium, sodium, and magnesium.

Statistical analysis:

IBM SPSS, version 20.0, was used to check computerized data. (IBM Corp., Armonk, New York).

F-test (ANOVA) was used for paired comparisons and then the least significant difference (LSD) test was conducted for comparisons involving more than two groups. Student t-test was also adopted to compare two groups under study for quantitative variables normally distributed.

RESULTS AND DISCUSSION

Physical properties of barley grain:

Barley grains physical properties were illustrated and the results are included in Table 1.

Table 1.physical properties of barley grains :

Physical Parameters	Results
Color	Tan
Appearance	Horseshoe
Length (mm)	9.95
Width (mm)	3.35
Thickness (mm)	2.58
Weight of 1000 seeds (g)	42.08
True Density (kg/m3)	940
Bulk Density (g/ml)	0.62
Porosity (%)	44

***Each value represents the average of three decisions**

Results in Table (1) indicate that barley has a number of physical properties. A primary factor influencing visual acceptance is color. Barley grains were detected to be horseshoe-shaped and of brown color. Measurements of multi-dimensional characteristics, such as length, width, and thickness, revealed values of 9.95, 3.35, and 2.58 (mm) respectively. Core weight at 1000 was recorded as 42.08 g, actual density as 940 kg/m3, bulk density as 0.62 g/ml, and porosity as 44 percent.

Chemical composition of germinated barley grains and germinated barley:

Results in Table (2): showed chemical composition for barley grains and germinated ones, comparison between barley and germinated ones barley and total chemical composition.

The average protein of barley was 9.91% and germinated barley was 12.81%. Protein is an important component and an essential compound for living cells. Therefore, barley grains contain a higher protein content than other crops. During the germination process, several elements are converted into essential nutrients, which increases nutrition value (Sangronis *et al*. 2006).

The average fat content of barley was (2.53%), while that of germinated barley was (2.10%). These results are consistent with several reports that the fat content of barley growing grains ranges from 1 to 3 percent. Fats are essential for regulating the physical and chemical properties of growing grains because they provide the seeds with essential nutrients during germination and are essential for protein transport (Youssef *et al*. 2012; Cozzolino and Degner, 2016).

Upon germination prosses, the ash level decreased from 3.24 to 2.81%. Ash concentration in barley before and after germination was (2.33%) and (2.16%), respectively. On the other hand, ash concentration remained stable during the first 36 hours after germination. Current results indicate that the amount of ash is insufficient to be considered an important food source.

According to the results, barley included a crude fiber content of 4.75%, while germinated barley had a crude fiber content of 5.15%. Fibers are important biologically active ingredients. They are prebiotics, representing an important category of functional foods.

Prebiotics are polysaccharides and oligosaccharides that can be selectively fermented by probiotic bacteria native to the large intestine. They have several positive health effects due to their anti-cancer, anti-microbial, anti-hyperglycemic, and anti-osteoporotic properties, as well as their tonic activity. (Abu Bakr *et al*. 2014).

N-free extract value of barley was 80.43%, while the mean value of germinated barley was 76.27% for common barley, according to the results indicated in Table (2). It was found that there are significant differences in the mean values of the samples for protein and N-free extract, while there were no significant differences in the mean values of fat, ash, and crude fiber in germinated barley.

According to Table (2), the concentration of barley was β-glucan (6.50%), while that of germinated barley was (7%). These results contradict the results (Chandra *et al*. 1999). The main reason for the decrease of β-glucan during the germination process is that β-glucans exist in Androsperm.

Androsperm walls are destroyed during germination, rendering β-glucans free and mostly soluble due to hydrolysis of β-glucinase, which is known as (Lichenase and 4glucano Hydrolase). It is responsible for reducing the β-glucan content.

Table 2. Chemical properties of barley and germinated barley

Chemical properties (g/ 100g dry weight)	Barley grains	Germinated grains Barley	% change	T	P
Crude Protein (%)	9.91 ± 0.26	12.81 ± 0.26	29.3	7.881*	0.001*
Fat content (%)	2.53 ± 0.09	2.10 ± 0.46	-17.0	0.927	0.406
Ash content (%)	3.24 ± 0.27	2.81 ± 0.18	-13.3	1.338	0.252
Crude fibers (%)	4.75 ± 0.03	5.15 ± 0.16	8.4	2.423	0.073
N-free extract (%)	80.43 ± 0.23	76.27 ± 0.18	-5.1	14.233*	0.001*
β- Glucan (%)	6.50 ± 0.36	7.0 ± 0.22	7.7	1.194	0.299

Data was expressed using Mean ± SE. t: Student t-test
***: Statistically significant at p ≤ 0.05**

Antioxidant activity phenols and flavonoids content in barley and germinated barley Grains:-

Table (3) indicates DPPH scavenging activity ,flavonoids and total phenolic content in mg/100g for barley and germinated barley.

Total antioxidant activity, as determined by DPPH, indicated that after germination, DPPH value were increased to 56.60% for barley to 82.12%. In addition, it was observed that, after germinations process , DPPH value increased by 45.1%. The ability of different samples to produce free roots using free DPPH compound has been frequently assessed. Antioxidants are chemicals that can reduce or prevent oxidation (Amarowicz *et al*. 2004). while the level of flavonoids increased to 102.0 mg/100g in germinated barley, the mean value of total flavonoids was 54.38 mg/100g in barley. According to several studies, flavonoids show antioxidant, anti-carcinogenic, anti-allergic, anti-inflammatory, anti-carcinogenic, and gastric-protective properties (Harborne and Williams, 2000; Yao *et al*. 2004; Fardet, 2010).

The maximum result for total phenol was 86.1 mg / 100g after barley germination. The mean value of that compound was only 76.5 mg/100g under normal conditions. After germination, there was a significant rise in total phenols and total flavonoids. These results are consistent with the results of (Sharma and Gujral.2010 and El-Ashaal, 2013), who found that phenolic content increased after germination as a result of Enzyme hydrolysis releasing phenolic components along with lignin and arabinoxylase. After germination, it can be noted that the value of total phenols and total flavonoids increased to 11.1, 87.6%.

Table 3. Antioxidant activity, phenols, and flavonoids content in barley and germinated barley grains :

Bioactive compounds	Barley grains	Germinated Barley	% change	T	P
DPPH scavenging activity (%)	56.60 ± 0.44	82.12 ± 0.47	45.1	39.332*	<0.001*
Total phenols (mg/100g)	76.5 ± 0.05	86.1 ± 0. 48	11.1	19.935*	<0.001*
Total flavonoids (mg/100g)	54.38 ± 0.40	102.0 ± 0.48	87.6	76.025*	<0.001*

Data was expressed using Mean ± SE. t: Student t-test
***: Statistically significant at p ≤ 0.05**

Mineral content of barley and germinated barley:

Results in Table (4) showed the mineral content in barley and germinated barley grains depicts a comparison of mineral content in barley and germinated.

Minerals are an important source of biological processes and metabolic functions and are available in grains (Demirbas, 2005). It can be noted that the various minerals such as calcium, magnesium, potassium, chromium, and manganese, had normal levels of 2.69, 29.25, 208.05, 0.75, and 0.64 mg/100g, respectively. However, they increased after the germination process to 4.72, 30.78, 268.15, and 0.91 mg/100g, respectively, corresponding to 0.78 mg/100g. After the germination process, Ca, Mg, K, Cr, and Mn increased by 75.5, 5.0, 28.8, 21.3, and 21.9 %, respectively. Fe decreased after the germination process by 17.4% and 0.78 mg/100g, respectively. After germination process, Ca, K, and Fe indicated significant changes, while Mg, Cr, and Mn did not show such differences (Al-Rdaddi, 2008). These results are consistent with those who reported that Mg content was increased by 3-day germination in barely detectable amounts. Magnesium was slightly increased after germination process , which is important for heart activity and maintaining blood pressure (Hübner *et al*. 2010). Potassium (K) is essential for maintaining acid-alkali balance in the body, maintaining cell fluid volume, transmitting nerve impulses from one cell to another, supporting heart function, and maintaining blood pressure (Nawar, 2004). Calcium is very important for bones and teeth, blood clotting, and reducing colon cancer. Calcium also increased in germinated barley, compared to a few regular grains. The iron percentage decreased in germinated barley due to the combination of iron and phenolic substances in the soaking water. Iron is important in creating hemoglobin and activating the enzyme to create neural stimuli . Mn has slightly increased after barley germination. Cr and Mn are important components of insulin formation; insulin is used to treat diabetic patients.

Table 4. Some mineral content of barley and germinated barley grains :

Minerals (mg/100g)	Barley Grains	Germinated Barley grains	% change	T	P
Ca	2.69 ± 0.14	4.72 ± 0.47	75.5	4.156*	0.014*
Mg	29.25 ± 0.38	30.78 ± 0.49	5.0	2.489	0.068
K	208.05 ± 0.26	268.15 ± 0.26	28.8	163.320*	<0.001*
Fe	5.93 ± 0.12	4.90 ± 0.06	17.4	7.879*	0.001*
Cr	0.75 ± 0.30	0.91 ± 0.37	21.3	0.336	0.754
Mn	0.64 ±0.13	0.78 ± 0.47	21.9	0.643	0.555

Data was expressed using Mean ± SE. t: Student t-test
***: Statistically significant at p ≤ 0.05**

CONCLUSION

Germination has improved chemical composition and nutritional value. Results indicated that the germination process had a significant impact on the chemical, mineral, and nutritional properties, with the increase of several essential substances during germination, such as phenols, flavonoids, antioxidant activity, and fiber, especially β-glucan, along with a significant decrease in crude fat and ash in germinated barley. The crude fat and ash are significantly reduced in bread barley. Moreover, the germination process raises metal content, Ca, Mg, K, Cr, and Mn, to improve human health. It is recommended to encourage and promote the consumption of germinated barley and its inclusion in various food products.

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تأثير عملية الاستنبات على الصفات الكيمائية والقيمه الغذائيه لحبوب نبات الشعير

نادية شاهين الشملان

قسم علوم الغذاء والتغذية ، كلية العلوم الصحية ، الهيئة العامة للتعليم التطبيقي والتدريب ، الشويخ 70654 ، الكويت

الملخص

تهدف الدراسة الحالية إلى دراسة خصائص حبوب الشعير وحبوب الشعير المستنبت. تم دراسة تأثير عملية الإنبات على التركيبة الكيميائية والقيمتة الغذائية، و يعتبر الشعير غذاء مهم وظيفياً لأنه مصدر جيد لمضادات الأكسدة والألياف الغذائية مثل β الجلوكان ، وبعض المعادن. أوضحت النتائج إلى تحسن في صفات التركيب الكيميائي للشعير بعد الإنبات. أظهرت النتائج اختلافات واضحة في محتوى البروتينات والالياف و كانت القيمة المتوسطة لبروتين 9.91 و للشعير المستنبت 12.8 %. واعطت نتائج تقدير الالياف الخام 4.75 ووصلت في الشعير المستنبت 5.15%. و اظهرت تقدير المعادن الكالسيوم و المغنيسيوم والبوتاسيوم و الكروم ز المنجنيز قيم 2.69, 29.25 , 208.05 , 0.75 , 0.64 ملجم / 100 جرام و ارتفعت بعد عملية الانبات الى ولكنها زادت بعد الإنبات لتصل إلى 4.72 و 30.78 و 268.15 و 0.91 ملغ / 100 غرام بالمقابل 0.78 ملغ / 100 غرام بعد الإنبات ، كما أظهرت النتائج زيادة كبيرة في محتوى flavonoids ومحتويات phenols إلى جانب النشاط المضاد للأكسدة في الشعير المنبت مقارنة بالشعير, توصي الدراسة بتعزيز وتشجيع استهلاك منتجات الشعير المستنبت في صفات الغذائية المختلفة .

كلمات داله: شعير , شعير المستنبت ,مضادات الأكسدة ,المعادن , القيمة الغذائية .