Antioxidant Activity, Antinutritional Factors and Technological Studies on Raw and Germinated Barley Grains (Hordeum vulgare. L)

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ABSTRACT

This study was revealed for investigate the effect of germination on physical, chemical, mineral composition, vitamins content and nutritional characteristics of each variety of Egyptian barley grains (Hordeum vulgare L.) Giza128 (hull- less barley), and Giza134 (hulled barley) were obtained from Agricultural Research Center, Giza, Egypt. Raw barley grains were soaked in water for (12hr.), then germinated for 24, 48, 72 hr. In addition, sensory evaluation was carried out for Talbina prepared from raw barley and germinated (72hr.) barley flours for both varieties (Giza 128, Giza 134) was evaluated.

The results showed that the mean weight and volume of the thousand grains were 50.73± 0.19 (g) and 85 ± 5 (ml). Also, the density was 0.60± 0.02 (g/ml) for Giza 128, while the mean weight and volume and density for Giza 134 were 52.72± 1.78 (g), 85 ± 5 (ml), 0.62 ± 0.02 (g/ml), respectively. Moreover, the highest moisture content for both Giza 128 and Giza 134 was noticed during the germination period for 72hr. (11.6% and 12.4%), respectively. Also, the crude protein content was decreased significantly due to soaking treatment, and there were no significant differences for the three germinated treatments compared to the raw sample for Giza128 variety. On the other hand, there were a significant differences between the germinated samples compared with raw and soaked samples. The ash content for soaked barley (12hr.) was decreased for the three germinated samples compared to the raw sample for both varieties. Also, there were no significant differences between the five treatments for the mineral composition, there was a decrease in the content of the calcium, magnesium, iron, zinc and manganese in the germinated grains for 72hr. compared with raw grains for both varieties under study. Moreover, there was an increase in vitamin (A, D, Niacin and C) for both Giza 128, Giza 134 varieties in germinated grains (72hr.) compared with the raw grains. Also, Giza 128 variety exhibited higher content of the minerals and vitamins in the raw and the germinated grains (72hr.) compared with Giza 134 variety. On the other hand, the nutritional compounds (total phenol, flavonoids, antioxidant activity (DPPH) and the antinutritional factors (phytic acid, tannic acid and oxalic acid) were decrease in the germinated barley. The decrease in the total phenols, flavonoids antioxidants activity (DPPH) content in Giza 128 variety was more pronounced (20.3%, 44.4%, 12.8%) than that the in Giza 134 variety (7.5%, 11.1%, 9.8%), respectively.

Also, sensory evaluation for Talbina prepared from raw and germinated (72hr.) barley flours for Giza 128 and 134 varieties was studied. The data revealed that, there were significant differences in case of the color, taste and the overall acceptability between the Talbina prepared from the raw barley flour for Giza 128 and Giza 134 variety, although there were no significant differences in case of the texture and odor for both varieties.

Key words: Barley, Germination, Chemical Composition, Minerals, Vitamins, Antinutritional Factors, Talbina.

INTRODUCTION

Cereal grains constitute a major source of energy and nutrients in the world. The benefits of cereals to human health are the subject of extensive research and epidemiological studies, which have linked whole grain intake to the prevention of metabolic syndrome, obesity, and associated chronic diseases such as cardiovascular disease and two types of diabetes. The health benefits of cereals are primarily caused by their phytochemicals including phenolic acids, flavonoids, vitamins, fiber, and minerals, which act together to combat oxidative stress, inflammation, hyperglycaemia, and carcinogenesis (Poutanen, 2012; Wang, Wu, &Shyu, 2013).

Barley (Hordeum vulgare L.) is an ancient cereal which has been traditionally used for animal feeding and as raw material in melting industry (Madakemohekar, et al., 2018). Today, barley remains an important grain in some cultures of Asia and Northern Africa, and in recent years, there has been an increasing interest in using barley as an ingredient in food products due to its nutritional value and high content of biologically active compounds (Martínez, et al., 2018). Most barley varieties are hulled, although several hull-less varieties are also cultivated. Hull-less barley, known as ‘naked’ barley, requires minimal cleaning compared to hulled barley, as no processing is needed to remove the inedible outer hull. (Madakemohekar, et al., 2018). The use of hull-less barley varieties with high levels of β-glucans is interesting to obtain functional barley flours that can be easily incorporated into foods to meet the authorized health claims of β-glucan. Barley flours usually have a higher water absorption ability than
wheat flours for its greater content of soluble fiber, which can positively affect their baking properties (Holtekjølen, et al., 2008). Barley (Hordeum vulgare L.) is the fourth most important cereal crop worldwide, after wheat, corn and rice, belonging to family Poaceae (Marwat, et al., 2012). Barley is a cereal grain derived from the annual grass Hordeum vulgare. It has many uses; serves as a major animal fodder, as base malt for beer and certain distilled, and as a component of various health foods. It is used in soups and stews, and in barley bread of various cultures. Barley like wheat and rye contains gluten. In a 2017 ranking of cereal crops in the world, barley was fourth in terms of quantity produced around 148.03 million tons (FAOSTAT, 2017).

Germination, a complex process causing physical, chemical and structural changes in grains, has been identified as an inexpensive and effective technology for improving cereal quality. The germination process is characterized by the growth of the embryo of the grain, manifested by the rootlets growth and increase modification of the contents of the endosperm (Guine & Correia, 2013).

Germinated cereal grains also show higher total phenolic content and antioxidant activity than those of un-germinated rice, wheat and oat. The germination process improves the nutritional quality of cereal. During the process of germination, significant changes in the biochemical, nutritional, and sensory characteristics of cereals occur due to degradation of reserve materials as used for respiration and synthesis of new cell constituents for developing embryo in the seed (Sharma, Saxena, &Riar, 2016).

Talbina is an Arabic word made of the word laban which means milk, this may also designate in the case of barley grains when they reach the milky stage, so the inside of these grains is white and liquid resembling milk (Abd El-Hassib, 2007).

Among Arabs, Talbina food has been used to relieve depression. It is prepared by cooking ground roasted barley with milk for a few minutes and then sweetened with honey. (Aly, Hathout, Sahab, 2011). Aisha, the Prophet Mohammed’s wife, used to recommend Talbina based on a recommendation by the Prophet Mohammed, peace be upon him. (Al-Bukhari, 2002). “Aisha”, used to recommend At-Talbinah for the sick and for those who grieved over a dead person. She used to say “I heard Allah’s Apostle saying ‘At-Talbinah gives rest to the heart of the patient and makes it active and relieves some of his sorrow and grief.’” (Al-Bukhari, 2002). Other than the Hadith and the cultural use, there is little scientific evidence regarding the use of Talbina in reducing symptoms of depression.

The present study was carried out to determine the chemical composition content as well as minerals, vitamins, nutritional and antinutritional factors of two Egyptian barley grains varieties (Giza 128 & Giza 134) and their germinated forms. Moreover, Talbina which made from both varieties was assessed for their sensory evaluation.

MATERIALS AND METHODS

Materials:
Ten kilograms of each variety of Egyptian barley grains (Hordeum vulgare L.) Giza128 (hull-less barley), and Giza134 (hulled barley) were obtained from Agricultural Research Center, Giza (ARE), Egypt in year 2019.

Chemicals:
Folin-Ciocalteu, phenol reagent, tannic acid, 1-diphenyl-2-picrylhidrazyl radical (DPPH) and rutin from Sigma-Aldrich Company (St. Louis, Missouri, USA), all GC chemicals from Fisher Scientific Inc. caffeine standard from ADH company was used. All solvents and chemicals used for analysis were of analytical grade.

Methods:
Technological methods:
Preparation of raw barley:
For the preparation of raw barley flour, barley grains were thoroughly cleaned from broken seeds, dust and other foreign materials, and then milled. The obtained flour was placed in an air-tight plastic container until use, and stored in refrigerator.

Preparation of germinated barley:
Soaking: Grains which were freed from broken grains, dust and other foreign materials, and then it soaked in water (1:5 w/v) for 12 h at room temperature.

Germination: The presoaked (12 hr.) grains were spread on wet cotton in aluminum baskets at ambient conditions and watered two to three times a day, grains were germinated for 24, 48, 72 hr at room temperature 23± 2 °C. The germinated grains were rinsed with distilled water then dried at 55-60 °C for 24 hr., milled to obtain grain sprout flour. The flour was packed in an air-tight plastic container until use, and stored in refrigerator. (Juana, et al., 2005).

Preparation of Talbina:
Talbina was prepared from raw barley flour (Giza 128, Giza 134) and germinated barley flour for 72hr. (Giza 128, Giza 134). Talbina was prepared by adding whole barley flour to water (1:10 w/v) according to (Youssef, 2008) and (1:5 w/v), then the mix was heated at 80 ± 5°C for 5 minutes with continuous stirring until reaching a porridge like texture. Talbina is made by adding one tablespoon of barley flour to one cup of cold milk, and stir, then cook on a low heat for 10-15 minutes with continuous stirring. (Scully and Dumville, 1997).
Physical methods

One thousand grain weight, 1000 grain volume was determined according to Williams et al., 1983. Grain weight was calculated as the mean weight of 1000 undamaged barley grains. For the determination of grain volume, grains were transferred to a 250 ml measuring cylinder, and 100 ml distilled water were added. Grain volume was determined as total volume minus 100. Density (g/mL) was then determined by dividing the weight of the barley by its volume, using the following formula:

\[ \text{Density} = \frac{\text{grain weight}}{\text{grain volume}} \] (g/ml)

Chemical methods:

Moisture, crude protein, crude fat, crude fiber and carbohydrate (by difference) of both raw and germinated barley flour were determined according to the standard A.O.A.C. methods. Total phenolic (TP) content of barley flour was assayed by Folin-Ciocalteu reagent and tannic acid as a standard (Singleton et al., 1965). The reaction mixture was kept in dark at ambient temperature (22 °C) for (2 hr.), before measuring the absorbance at a wavelength of 765 nm using UV-Vis Spectrophotometer (Laxco-Alpha-1102, Suite). (Ozgen, et al., 2008).

Total flavonoids content of barley flour were determined spectrophotometrically at a wavelength of 430 nm using UV-Vis Spectrophotometer (Laxco-Alpha-1102, Suite) as mentioned by (Hmid et al., 2013). The method is based on the formation of a complex of flavonoid- aluminium. Rutin was used as a standard and the flavonoid level was expressed as mg of rutin equivalent per one kg of sample.

The DPPH (2, 2-diphenyl-1-picrylhydrazyl) radical scavenging activity of methanolic extracts was determined following the method reported by (Jayanthi and Lalitha, 2011) and compared by standard ascorbic acid.

Total tannins content of barley was colorimetrically estimated as tannic acid by subtraction from total polyphenol content as described in AOAC (2000) The total tannins in the extracted polyphenols samples were precipitated by adding polyvenyl pyrroliedone (PVPP), storing at 4°C for 15 min and centrifugation for 10 min at 3000 rpm. Absorbance of the collected supernatant, representing simple phenolic compounds rather than tannins; was measured at a wave length of 760 nm using UV-Vis Spectrophotometer (Laxco-Alpha-1102, Suite). Phytic acid was determined according to (Plaami, 1991) and oxalic acid was estimated followed the guidelines of the AOAC (2000).

Minerals determination:

Calcium, magnesium, iron, manganese and zinc were determined in flour samples using atomic absorption. The grains were ground, ashed at 450°C, and digested in 10 mL 1mol/L HCl. Minerals (Ca, Mg, Fe, Mn and Zn) were measured by atomic absorption spectrometry (AA680, Shimadzu, Japan). Standardized procedures for measuring the mineral element concentrations followed the guidelines of the (AOAC, 2000).

Vitamins determination:

HPLC technique as described by (Aslam, et al., 2008) and (kozlove, et al., 2003) was used for determination of vitamins (A, D, Niacin, C).

Sensory evaluation:

Colour, texture, taste, odour and over all acceptability of Talbina were evaluated by randomly chosen ten panelists of the members of the Food Science and Technology Department, Faculty of Agriculture, Alexandria University, Egypt. A ten point scale was used, whereas; 9 mean the best and 1 means the least, as described by (Piggott, 1988).

Statistical analysis

All determinations were performed in triplicate (n = 3) and the data were expressed as mean ± standard deviation (SD). Data were statistically analyzed using statistical analysis system ver. 8.1 (2000). A difference was considered statistically significant, when P < 0.05, SAS (2004).

RESULTS AND DISCUSSION

Physical properties of barley grains:

Some physical properties of barley grains were determined, and the results obtained are presented in Table (1).

The environmental factors, such as rainfall, temperature, soil conditions, fertilization and genetic factors, can contribute to variations in the chemical composition and physical characteristic of cereal grains (Rodehutscord, et al., 2016). The mean weight and volume of the 1000 grains were 50.73± 0.19 (g) and 85 ± 5 (ml), respectively.

<table>
<thead>
<tr>
<th>Table 1: Physical properties of barley grains varieties</th>
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<tr>
<td><strong>Physical parameters</strong></td>
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<td>--------------------------------------------------------</td>
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<tr>
<td><strong>Giza 134</strong></td>
</tr>
<tr>
<td>Wt. of 1000 seeds (g)</td>
</tr>
<tr>
<td>V. of 1000 seeds (ml)</td>
</tr>
<tr>
<td>Density (g/ml)</td>
</tr>
</tbody>
</table>

Each value represents the average of three determinations.*
Also, the density was 0.60± 0.02 (g/ml) for Giza 128, while the mean weight and volume and density for Giza 134 were 52.72±1.78 (g), 85 ± 5 (ml), 0.62 ± 0.02 (g/ml), respectively. Moreover, Farooqui, et al., 2018, showed that the 1000 kernel weight of barley was 42.08 (g), density 0.62 (g/ml).

**Chemical composition of barley grains:**

Barley differs greatly in chemical characteristics, due to genotype and environment and the interaction between the two. Wide ranges in chemical composition of barley have been reported (Oscarsson, et al., 1996). The data represented in Table (2) show the chemical composition for the two barley varieties.

**Moisture:**

It could be seen that the moisture content Table (2) was increased during soaking and germination. The highest moisture content for both Giza 128 and Giza 134 was in the germinated grains for 72hr. (11.6% and 12.4%, respectively). Moreover, there were no significant differences in the moisture content for Giza 128, whereas there were considerable significant differences for germinated Giza 134. Farooqui et al., 2018, found that the moisture content of non-germinated and germinated barley flour varied between 11.2 to 12.51% it means that moisture content was increased after germination. Similar to the results were reported by (Khatoon, and Prakash, 2006), in germinated legumes. As germination proceeds, legumes took up water from the surroundings in order for the metabolic process to commence. Dry legumes absorb water rapidly, influenced by the structure of the legume. The increase in water uptake with time is due to the increasing number of cells within the seed becoming hydrated (Nonogaki, et al., 2010).

**Fats:**

It could be seen from Table (2) that there was a decrease in the fat content for soaked and germinated grains for 24, 48 and 72hr. for both varieties (Giza 128 and Giza 134) compared with raw grains. Furthermore, there were considerable significant differences between the five treatments under study for Giza 128, whereas, there was no significant differences between the raw and soaked sample (12 hr.). Although, there were significant differences in the three germinated treatments for Giza 134 variety. Erkan et al., 2006, reported that fat ranged between 1.62-1.92% in hulled barley and 1.9% in hull-less barley. Similar results of decrease in the fat content after soaking, germination are differences in the three germinated treatments for Giza 134 variety, a significant differences was observed between the soaked and raw sample for Giza128 variety. Also, crude protein content of the soaked sample (12 hr.) was decreased for Giza134 variety, to reach 9.22% and then it increased during the germination process to reach 14.15% in the germinated grains for 72hr. Farooqui, et al., 2018, showed that the crude protein increases after germination from 12.69% to 14.87%, same result also reported by Khader, 1983. Also, Warle, et al., 2015, found the protein content affected by soaking, germination of barley had an increasing effect on protein content (11.25 % to 13.85 %). Khader, 1983, showed an increase in protein content after germination. The increase in protein content with germination treatment might be due to the reduction in the carbohydrate fractions which utilized during the early stages of germination (Abrahamsen and Sudia, 1966) Likewise, Dagnia, et al., 1992 reported that, the increase in protein could be attributed to the utilization of fats and carbohydrates as energy sources for the developing sprouts. Moreover, Sastryand Tummuru, 1985, reported that the whole kernels protein content was significantly higher in hull-less barley (12.9%-16.7%)

**Ash:**

It could be noticed from Table (2) that the ash content in soaked barley (12hr.) was decreased for the three germinated samples compared to the raw sample for both varieties (Giza 128 and Giza 134). Also, there were significant differences between the five treatments. Ash recorded 2.4-2.8% in barley from Jordan, morocco and the FAO; (Ereifej and Haddad, 2001). While, Youssef, et al., 2013 showed that it ranged between 2.29-2.86%. Also, Erkan, et al., 2006, reported that the ash content was higher in hull- less barley (1.3%) than hulled barley (0.86-1.03 %). Moreover, Youssef, et al., 2013 found, that ash content of ungerminated barley flour decreased from 1.59 % to 1.39 % (w.b) during germination. Ash content was significantly decreased in germinated barley, parallel to observations of (Ohtsubo, et al., 2005, Khatoonand Prakash, 2006; and Hahm, et al., 2008). The decrease in ash content represents loss in minerals due to rootlet and washing of the barley in water to reduce the sour smell during the period of germination (Tatsadjieu, et al., 2004).

**Crude fibre:**

The data in Table (2) indicated that the crude fiber content for soaked barley as well as for the three germinated samples was increased for both varieties. Also, there was significant difference between the soaked and raw sample for Giza 128 variety, a significant differences was observed between the three and germinated samples compared to the raw sample.
Table 2: Chemical composition of barley germ varieties (on wet weight basis)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Moisture (%w/w)</th>
<th>Crude Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Dried Crude Matter (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>10.2 ± 0.1</td>
<td>11.0 ± 0.1</td>
<td>3.5 ± 0.1</td>
<td>5.4 ± 0.2</td>
<td>72.8 ± 0.3</td>
</tr>
<tr>
<td>Variety A</td>
<td>10.5 ± 0.2</td>
<td>11.2 ± 0.2</td>
<td>3.6 ± 0.2</td>
<td>5.5 ± 0.3</td>
<td>73.1 ± 0.4</td>
</tr>
<tr>
<td>Variety B</td>
<td>10.7 ± 0.3</td>
<td>11.4 ± 0.3</td>
<td>3.7 ± 0.3</td>
<td>5.6 ± 0.4</td>
<td>73.3 ± 0.5</td>
</tr>
</tbody>
</table>

Note: Values are mean ± standard deviation. **Denotes significant differences at p < 0.05.
On the other hand, there was no significant difference between the samples which germinated for 48 and 72 hr. Crude fiber recorded 3.4-4.2% in barley from Jordan, Morocco and the FAO (Ereifej and Haddad, 2001). While, Youssef, et al., 2013, found that it ranged between 3.83-4.37%. The crude fiber content was higher in the hulled barley (3.7%), while it was 1.9% in the dehulled barley; as well as hull-less barleys had more digestible energy than the hulled cultivars (Wang and Fields 1978). Similar results were shown by Warle, et al., 2015, where they reported that crude fibre was increased in germinated barley from 3.58% to 5.61%. In germinated rice, the amount of crude fibre was contributed by the presence of bran layer, an outer layer of rice that contained fibre. A study by Azizah, et al., demonstrated that crude fibre was decreased in soaked peanut and mung bean, but conversely increased in soaked rice and soybean. This indicates that germination process affects the level of crude fibre during the period of soaking before the actual phase of germination.

**Digested Carbohydrates:**

It could be seen from the results given in Table (2) that there was a significant increase in the digested carbohydrates content during soaking for the two varieties under study. At the same time, the carbohydrates content was decreased after germination compared to the raw sample. Also, there were no differences after germinating for (24 and 48 hr.) for Giza 128 variety as well as for Giza 134 variety for (48 and 72 hr.), carbohydrates recorded 75.7-87.2%; in barley from Jordan, Morocco and the FAO; (Ereifej and Haddad, 2001). Also, Farooqui, et al., 2018, found that carbohydrates content, in barley before and after germination ranged from 68.9 to 63.79. Moreover, Chauhan, et al., 2015, showed that there was significant difference in carbohydrate content among amaranth before and after germinated flours. The decrease in carbohydrates in germinated grains may be attributed to increase in alpha-amylase activity which breakdown complex carbohydrates into simpler and more absorbable sugars (Hung, et al., 2011). The soaking, germination treatments given to barley grains decreased the total carbohydrate contents 72.02 % to 61.06 % in germinated flour of barley, due to the active respiration process during soaking and germination (Warle, et al., 2015).

**Mineral composition of barley grains:**

As shown in Table (3) there was a decrease in the content of the calcium, magnesium, iron, zinc and manganese in the germinated grains for 72 hr. compared with raw grains for both varieties under study. Also, Giza 128 variety exhibited higher content of the minerals in the raw and the germinated grains (72hr.) compared with Giza 134 variety. Svetlana, and Ozcan, 2016, reported that mineral content in raw barley as calcium, magnesium, iron, manganese, zinc, 487, 1724, 57.7, 18.8, 21.7 (mg/kg) respectively. On the other hand, Farooqui et al., 2018, showed that the mineral composition of barley were analyzed and results revealed that macro-elements such as calcium, magnesium increased with germination from 110 to 130, 160 to 180 (mg/100g), respectively. While the micro elements as iron, manganese were reduced with germination from 8.70 to 7.1, 1.54 to 1.49 respectively. Also, zinc is increases from 2.92 to 3.48 (mg/100g). The results reported are in close agreement with these findings of (Hubner, et al., 2010). As compared to un-germinatedseed, germinated seeds contain low mineral content (Narsih, 2012; Sharma, Saxena, & Riar, 2016).

**Vitamin content of barley grains:**

As shown in Table (4), there was an increase in vitamins A, D, C and Niacin for both Giza 128, 134 varieties in germinated grains for 72 hr. compared with the raw grains. Also, Giza 128 variety exhibited higher content of the vitamins under study in both the raw and the germinated grains (72hr.) compared with Giza 134 variety.

Vitamins are important micronutrients required by the human body for normal growth and self-maintenance. Vitamins are grouped into categories such as fat and water-soluble vitamins and a lack of vitamins may lead to vitamin deficiencies which can cause health problems (Ottaway, 2008; Dionex Corporation, 2010). Warle, et al., 2015 have been reported that germination improves the bioavailability of the various minerals, vitamins and crude fibers along with the nutritional profile of the seed grains.

The vitamin A in hulled barley was 22 (IU/100g), (National Standard Reference, 2018). Moreover, Lehiedzinska and Szefer, 2006, have reported that a niacin content in barley was 4.07 mg/100g. Also, niacin in hulled barley was 4.604 mg/100g (National Standard Reference, 2018). Niacin increased during germination in both soybean and mung bean, but the highest values for this vitamin were observed in sprouted peas (Burkholder and Veigh, 1994).

Also, Kim, et al., 1993, reported that the nutritional value of soybean sprouts changes during the germination; the vitamin C content increases approx. to its 200-fold value compared to the non-germinated seed, at the same time, in the course of two, three, four, five, six and nine days of sprouting the nutritional value of the lupine sprouts increased significantly owing to the increase of the vitamin C content.
<table>
<thead>
<tr>
<th>Sample of Rye</th>
<th>Vehem Contents</th>
<th>CPEA 124</th>
<th>CPEA 128</th>
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Table 2: Vehem Contents of Rye, Grams per 100 g (on dry weight basis)

<table>
<thead>
<tr>
<th>2.78</th>
<th>3.33</th>
<th>1.81</th>
<th>1.74</th>
<th>1.87</th>
<th>1.32</th>
<th>1.08</th>
<th>1.04</th>
<th>1.19</th>
<th>1.04</th>
<th>0.86</th>
<th>0.66</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.36</td>
<td>9.75</td>
<td>3.72</td>
<td>2.44</td>
<td>3.84</td>
<td>4.14</td>
<td>1.83</td>
<td>1.53</td>
<td>1.19</td>
<td>1.04</td>
<td>0.86</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Table 3: Vehem Contents of Rye, Grams per 100 g (on dry weight basis)
Nutritional and antinutritional content of barley grains:
Total phenol, flavonoids and antioxidant activity (DPPH):

It could be seen that the results given in Table (5) that the total phenols were decreased in both Giza 128 and 134 varieties (germinated grains for 72 hr.) compared with the raw grains. Meanwhile, the decrease in the total phenols content for Giza 128 variety was more pronounced (20.3%) than the decrease in Giza 134 variety (7.5%). On the other hand, the flavonoids content decreased for both varieties Giza 128 and Giza 134 in the germinated sample for 72hr. compared with the raw sample. Although, the decrease in the flavonoids content was more pronounced in Giza 128 variety (44.4%) compared with the decrease in Giza 134 variety (11.1%). The data presented in Table (5) reveals that there was a significant decrease in the DPPH content (12.8%) in germinated grains for 72 hr. for Giza 128 variety, and 9.8% only for Giza 134 variety (germinated for 72 hr.) compared with the raw grains. Pokorn, 2007, reported that the antioxidants have become one of the most important concerns in human nutrition because of high concentration of free radicals, both in food and after food ingestion. Moreover, Farooqui, et al., 2018, showed that the nutritional composition such as total phenolic content, antioxidant activity and total flavonoids content of barley flour before and after germination were ranged from 2.12 to 1.85 (mg ferulic acid equivalents/g), 11.37 to 14.36% and 0.29 to 0.37 (mg catechin equivalents/g). These results are in close agreement with these findings of (Lu et al. 2007). Warle, et al., 2015, reported that the germination not only improves the bioavailability of the various minerals, vitamins and dietary fibers along with the nutritional profile of the seed grains, but also reduces some antinutritional factors. Polyphenols are the biggest group of phytochemicals that have been found in plant-based foods and have been linked to several health benefits. Therefore, dietary polyphenols have received tremendous attention among nutritionists, food scientists, and consumers due to their roles in human health (Tsao, 2010). On the other hand, Yang, et al., 2013 analyzed the profiles of common flavonoids in unhulled purple barley, normal barley, and hulled purple barley. The bran-rich fraction of barley grain contained the most flavonoid content, whereas the hull fraction did not contain any significant flavonoid content. The total average content of flavonoids in hulled purple barley (124.8 mg/g) was significantly higher than that in unhulled purple barley (69.40 mg/g) and normal barley (48.50 mg/g). Durazzo, et al., 2014, found that total flavonoid content varies within the range 114 -227 mg/100g for Italian barley. However, for twenty Japanese barley landraces, total flavonoid content varied from 154 to 324 mg/100g. Several factors affect the phenolic content and availability, including environmental conditions, agronomic practice (Gelinias, and Kinnon, 2006) and industrial or domestic processing (Özer, et al.,2006). Moreover, Kim, et al., 2007, studied the flavonoid content of 127 lines of hulled and unhulled colored barley wherein the total flavonoid content was found to range between 62.0 and 300.8 mg/g. Arif, et al., 2011, reported that germination of grains including wheat and barley results in increased concentration of some phytochemicals such as phenolic compounds, flavonoids, and tannins. After germination, the percent relative nutritive value of wheat and barley increases. Clinical studies indicate that flavonoids may be the bioactive substances present in cereal grains responsible for the moderation of many diseases including cancer and coronary heart diseases (Gani, et al., 2012). Generally, the content of flavonoids in barley grains are proportional to the degree of color depth, and blue and purple barley grains have been discovered to possess the most flavonoid content among barley varieties (Liu, 2013).

Table 5: Nutritional and antinutritional content of the barley grains varieties (on wet weight basis)

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<tbody>
<tr>
<td>Total phenol (mg/kg)</td>
<td>76.59±0.29</td>
<td>61.13±0.62</td>
<td>59.64±0.43</td>
<td>55.17±0.24</td>
</tr>
<tr>
<td>Flavonoids (mg/kg)</td>
<td>75.20±0.01</td>
<td>41.83±0.88</td>
<td>37.44±0.17</td>
<td>33.29±0.25</td>
</tr>
<tr>
<td>DPPH radical scavenging activity (%)</td>
<td>38.22±0.09</td>
<td>33.33±0.07</td>
<td>35.54±0.04</td>
<td>32.06±0.13</td>
</tr>
<tr>
<td>Phytic acid (mg/g)</td>
<td>0.90±0.02</td>
<td>0.63±0.02</td>
<td>0.88±0.04</td>
<td>0.56±0.01</td>
</tr>
<tr>
<td>Oxalic acid (mg/g)</td>
<td>6.04±0.09</td>
<td>3.27±0.17</td>
<td>5.55±0.20</td>
<td>2.93±0.48</td>
</tr>
<tr>
<td>Tannic acid (mg/g)</td>
<td>21.10±0.54</td>
<td>17.70±0.41</td>
<td>18.40±0.17</td>
<td>11.26±0.28</td>
</tr>
</tbody>
</table>

$^{a,b,c}$ Means with different superscripts within rows are different (P ≤ 0.05)
Phytic acid, oxalic acid and tannic acid:

The data represented Table (5) indicated, anti-nutritional factor in raw and germinated barley. There was a significant decrease in the phytic acid content for both varieties Giza 128 and Giza 134 (30% and 36%, respectively) during the germination for 72hr. compared with the raw sample. Moreover, there was a significant decrease in the oxalic acid content in germinated grains for 72 hr. in both varieties Giza 128 (45.9%) and Giza 134 (47.2%). Furthermore, there was a significant decrease in the tannic acid content in the germinated grains for 72 hr. in both varieties Giza 128 (16.1%) and Giza 134 (18.8%). Gupta and Sehgal, 1991, observed a decrease in phytic acid contents of cereal grains used for preparing weaning foods as a result of soaking and germination. The decrease in the level of phytic acid during soaking may be attributed to leaching the acid out into soaking water under the concentration gradient (Abd El Rahaman et al., 2007; Vadivel, et al., 2011). Other researchers have reported a decrease in the level of phytic acid during germination due to phytase activity in the germinating grains. Phytase activity was observed during germination of wheat, barley, rye and oats, which hydrolyze phytate to phosphate and myoinositol phosphates (Larsson and Sandberg, 1992). Germination of pearl millet grains at 30°C for 24 hr. reduced the phytic acid by more than 50% (Khetarpaul and Chauhan, 1990). Sokrab, et al., 2012, reported that phytic acid content of both genotypes decreased significantly within the first 2 days of germination. There after, it decreased at a lower rate from day 4 to 6 day of germination and the reduction exceeded 80% at the end of germination process for both genotypes. The results showed that germination had significantly reduced phytic acid content of the genotypes grains with time. Warle, et al., 2015 reported that the germination not only improves the bioavailability of the various minerals, vitamins and dietary fibers along with the nutritional profile of the seed grains, but also reduces some anti-nutritional factors. Barley (Hordeum vulgare) is classified as a low-oxalate plant and, like many other crops, produce sand accumulates oxalic acid, but its biosynthesis, accumulation, and catabolism are not yet sufficiently known (Wagner, 1981). Caliskan, 2000, reported that oxalic acid and its salts are produced and stored in different amounts in all part of plant, but that their levels may vary depending on the age of the plants, the growing season and cultivation conditions. Formation of oxalic acid may occur by several pathways. Brudzynski, and Salamon, 2011, reported that most of investigated barley samples showed an oxalic acid content between 39.5 and 65.3 mg/kg (d.m.) compared to data cited by (Wagner, 1981). Important grains which are used for human and animal consumption are known to contain a significant amount of tannin contents like sorghum (Sorghum bicolor), millet (Panicum milisecum), barley (Hordeum vulgare) and anumber of other legume seeds (Kumar, 2007). Tannins are phenolic plant secondary compounds, with ranging molecular weights and complexity (Waghorn, 2000). Also, Makkar, 2003 reported that widely distributed in nature and are the fourth most abundant plant constituent following cellulose, hemicellulose and lignine. Tannins have several specific properties: antibacterial, antitumor, antivirus and antimutagenic functions. Plant tannins have also beneficial properties to human health (Kumari, 2012). The condensed tannin content of the complementary food ranged from 1.12 to 2.71 mg catechine equivalent/100 g. The observed reduction in tannin content after germination was a result of formation of hydrophobic association of tannins with seed proteins and enzymes. In addition, loss of tannins during germination may also be due to the leaching of tannins into the water (Shimelis and Rakshit, 2007) as well as washing during germination and binding of polyphenols with other organic substance such as carbohydrate or protein. (Khetarpaul, and Bishnoi, 2002).

Sensory evaluation of Talbina of barley grains varieties:

Table (6) showed the sensory evaluation results for Talbina prepared from raw and germinated (72hr.) barley flour for Giza 128 and 134 varieties which conclude the color, texture, taste, odor as well as the overall acceptability.

1- There was a significant decrease in the five characteristics (color, texture, taste, odor and overall acceptability) for the germinated barley (72hr.) compared to the raw barley for Giza 128 variety.

2- There were no significant differences for the color, texture, odor and overall acceptability between the raw and germinated barley (72hr.) sample for Giza 134 variety, although there was significant differences between the two samples in case of taste.

3- There were significant differences in all the organoleptic characteristics under study between the Talbina prepared from the raw barley flour for Giza 128 and Giza 134. The results of Giza 128 variety were higher compared to Giza 134 variety.

4- Also, there were significant differences in case of the color, taste and the overall acceptability between the Talbina prepared from germinated for (72hr.), barley flour for Giza 128 and Giza 134 variety, although there were no significant differences in case of the texture and odor for both varieties.
Table 6: Sensory Evaluation of Tallow Prepared from Raw and Retained bile by Four

<table>
<thead>
<tr>
<th>Sample</th>
<th>Color</th>
<th>Texture</th>
<th>Taste</th>
<th>Overall</th>
<th>Aroma</th>
<th>Overall</th>
<th>Aroma</th>
</tr>
</thead>
<tbody>
<tr>
<td>China 128</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Differences with different superscripts within rows are different (p < 0.05).*
Talbina is a popular traditional food product in the Arab world prepared by mixing barley flour and milk and cooking for 10 to 15 minutes. In Islam, Talbina was prescribed for seven diseases (Hadith), these include grief, high cholesterol levels, heart disease, treatment of cancer, effects of aging, diabetes and hypertension.

Talbina is a food product with high potential applications as a functional food. (Youssef, et al., 2013)

Nowadays, the main changes in demand for agricultural and food products are being fueled by population growth and lifestyle modifications. Many food manufacturers today are looking to replace wheat flour by alternative flours to be included in new formulations with high nutritive value and bioactive properties. (Vicentini, et al., 2016).

**CONCLUSION**

In the present study germination of barley was carried out under controlled conditions of soaking, germination. From the result, it can conclude that chemical, mineral and nutritional properties were significantly influenced by the germination process. A significant decrease in crude fat, ash and carbohydrate of the two varieties of barley, (Giza 128 and Giza 134). Moreover, the minerals content, as Ca, Mg, e, Zn and Mn, decreased by the germination process for (72 hr.). Furthermore, vitamins content (A, D, Niacin and C indicated shown to increase in germinated flour (72 hr.) for both Giza 128, and Giza 134 varieties. Also, nutritional properties as total polyphenols, flavonoids and antioxidant activity were decreased in the germinated flour. On the other hand, it was found that germination process improved the sensory evaluation of Talbina product compared with that prepared from raw one.

**REFERENCES**


National Nutrient Database for Standard Reference
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المتخصى العربي

دراسات كيماوية وتغذوية على الشعر الخام والمستبنت

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أظهرت هذه الدراسة تأثير الإنبات على التركيب الكيماوي والفيزيائي والكيفي والمعادن ومحتوى الفيتامينات والصفات التغذوية ومصادر التغذية لصنفين من الشعر: صنف عاري (جزرة 124) وصنف مغطى (جزرة 128) وصنف مغطى. تم الحصول عليها من مركز البحوث الزراعية - جزيرة، مصر. كما شملت الدراسة تقييم القيمة الغذائية للتينين التي المحضرة من دقيق الشعر الخام والمستبنت (27 ساعة) لكل من الصنفين.

أظهرت النتائج أن متوسط وزن وحجم/الف حبة كان 73,50 ± 19,00 (جم)، 65 ± 5 (مل) والكثافة 168,50 ± 14 (جم/مل). وفيما متوسط وزن وحجم/الف حبة لصنف جرية 128 بلغ 52,72 ± 5 (جم/مل) والكثافة 12,62 ± 3 (جم/مل) على التوالي. وعلاوة على ذلك فقد اوضحت الدراسة أن الإنبات لمدة 27 ساعة أعطى محتوى رطبو أعلى في كن من الكنينين حيث بلغت نسبته
(11,16%) في صنف جذوة 128 (124%) في صنف جذوة 128. كما أدى النقص إلى انخفاض نسبة البروتينات الخام وكان ذلك انخفاضًا معنويًا، ولم تتفتح أي فروق معنوية بين النسب البروتينية في فئات مستويات النقص الثلاثة عند مقارنتها بالعينة الخام في الصنف 128، ومن ناحية أخرى كانت الفروق واضحة ومعنوية لمعاملات النبات عند مقارنتها بالعينة الخام والمنقحة. كما اجريت انخفاض محتوى بروتينات الربما في حالة الشعير المنقح والمستبنت (23,48٪) عند مقارننها بالعينة الخام وذلك في كلا الصنفين في الدراسة.

كما أظهرت النتائج انخفاضًات محتوى المعادن (كالسيوم، مغنيسيوم، حديد، زئبق، مغنيز) في العينة المستبنت (127ساعة) مقارنة بالعينة الخام وذلك للصنفين جذوة 128، جذوة 124، وكذلك لوحت زيادة محتوى الفيتامينات (أ، د، نiacine، ج) في صنفي الشعير أثناء الانتهاء. وأيضاً أظهر الصنف جبة 128 بين النسب من المعادن والفيتامينات في كل من العينة الخام والمستبنت. كما لوحت زيادة محتوى الفيتامينات (أ، د، niacine، ج) في صنفي الشعير أثناء الانتهاء. ومن ناحية أخرى تبين أن هناك انخفاض معنوي في كل من المركبات الغذائية (لفيتولات الكلاية، الفلافونويدات، مضادات الأكسدة) ومضادات التذبج (حمض الفيتريك، حمض الناتريك وحمض الأوكساليك) للعينات المستبنتة (127ساعة) مقارنة بالعينات الخام في كلاً من الصنفين، إلا أنه كانت نسبة الانخفاض في الصنف الأول (جذوة 128) هي (20,3٪، 4,4٪، 8٪) و لفروقات (الفلافونيات، الفلافونويدات، مضادات الأكسدة) على التوالي. كما أنها تشكلت الدراسة أيضاً أن التقييم الحسي للتلبية المحذرة من دقيق الشعير الخام والمستبنت (127ساعة) في صنفي الشعير (جذوة 128، جذوة 124) والتي شملت (اللون، القوام، الطعم، الرائحة، القبول العام) حيث أوضح أن النتائج للفوان يذبج الحسي ووجود فروق معنوية بين كل من اللون والطعم والقبول العام، في حين لأي وفوق معنوية لصفات القوام والرائحة للتلبية المحذرة من دقيق الشعير المستبنت (127ساعة) من صنفي جذوة 128 وجذوة 124.