

Research paper

Chemical, sensory and microbiological evaluation of novel product manufactured from water soluble constituents of germinated grains

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Abstract

Currently there is an increasing preference among consumers for foods that provide compounds that are beneficial to health and well-being. The objective of this study was to manufacture and evaluation of novel food product from germinated barley (barley like jam) compared to similar wheat product (wheat like jam). Results revealed that total phenolic compounds content increased in final product comparing to the original grains from 41,458 and 74.271 to 98.646 and 145.833 Eq. (mg Gallic acid /100g) respectively, antioxidant activity increased from 63.561 and 38.485 to 66.439 and 55.152 Eq. (mg ascorbic acid /100g). FRAP assay and DPPH scavenging activity increased from 21.78 and 35.58g/100g to 52.45 and 49.08g/100g for wheat and barley respectively. The increase in total viable count, yeast and molds was faster in wheat than in barley product over the storage period. Barley product had insignificant decrease in overall acceptability comparing to wheat product. It was concluded that germination of wheat and barley would be good method for development of functional food products with high content of bioactive compounds comparing to the original grains.

Keywords: Wheat; barley; germination; phenolics; antioxidant activity.

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1. Introduction

Compared to the seeds it was established that the sprout has a higher nutritional value due to its biological value protein, the higher content of polyunsaturated fatty acid, vitamin and the better transmission of the minerals. During the germination the polysaccharides degrade into oligo- and monosaccharides, the fats into free fatty acids, the proteins into oligopeptides and free amino acids. They improve the efficiency of both the protein-decomposing and the carbohydrates and fatty acids decomposing enzymes, therefore, germination can be considered as one kind of predigestion that helps to break down the high-molecular complex materials into their building blocks **Marton et al., (2010)**. During the germination the polysaccharides degrade into oligo- and monosaccharides, the fats into free fatty acids, whereas the proteins into oligopeptides and free amino acids, which processes support the biochemical mechanisms in our organism. They improve the efficiency of both the protein-decomposing and the carbohydrates and fatty acids decomposing enzymes, therefore, germination can be considered as one kind of predigestion that helps to break down the high-molecular complex materials into their building blocks. Germination decreases the amount of the antinutritive materials and compounds with health positive effects such as phytochemical properties (glucosinolates, natural antioxidants) could be found after the germination that can have a considerable role in the prevention of cancer. Therefore, germination can develop such functional foods that help in maintaining the health **(Sangronis & Machado, 2007)**.

Amici et al., (2008) found that wheat sprout contained high amount of organic phosphates and it was a powerful mixture of enzymes, reducing glucosides and polyphenols. Antioxidant compounds of wheat sprout protect the deoxyribonucleic acid from the oxidative damages caused by free radicals. They stated that polyphenols like e.g. epigallocatechin-3-gallate had antioxidant and protease effect in the cancerous cell. They reported that the wheat sprout extract reduced the growth of the cancerous cells and increased the amount of the intracellular oxidative proteins. The antioxidant properties of phenolic compounds in grains have been associated with the health benefits attributed to these crops and the value-added products derived from them. Antioxidants may play an important role in the chronic disease prevention by arresting oxidative damage caused by

reactive oxygen species (ROS) to vital biomolecules such as DNA, lipids, and proteins (Hollman 2001)

Barley development or malting (germination) processes could turn barley into a “chemical biofactory” to over-produce pharmaceuticals or nutraceuticals or even naturally occurring biochemicals such as lysine, vitamins, etc. The barley grain or plant would be fractionated to concentrate target chemicals, natural or transformed. Barley is secure in uses for feed, malting, and food, and the potential to improve barley for all these uses is great. According to the positive traits of barley attributes, the future for barley utilization in food products is improving and very promising (Baik, 2008). The objective of the present study was to manufacture acceptable product (like jam) from both of germinated wheat and barley, then evaluate their chemical, sensory, total phenolic compounds content and antioxidant activity.

2. Materials and methods

Wheat (*Triticum aestivum*(Giza - 160 / 1)) and covered barley (*Hordeum vulgare*"Giza 126") were purchased from local market Cairo, Egypt, and manually cleaned to remove broken seeds, dust and other foreign matter, then kept in an airtight polyethylene bags at room temperature in a dry place.

2.1. Steeping and germination

Wheat and barley seeds were washed with running water for 3 minutes. Weighed lots (2 kg) of wheat and barley were steeped in water at 15°C for 52 h to obtain a moisture content of about 42–44g/100g. The steeping water was changed after every 12 h; each time followed by an air-rest of 1h. During the air-rest, the grain was held in still air at ambient temperature (25–27°C). Gibberellic acid was applied by finally steeping another lot in a 1ppm solution for 4 h. Germination of the steeped grains was carried out for 5 days at 15°C and 95g/100g relative humidity. Carbon dioxide and heat of respiration were dissipated by turning the samples twice a day (Tejinder, 2007).

2.2.Pre-cooking and cooking processes:

Five hundred grams of germinated grains was minced with 1500 ml of water at 30°C. After 1 h extraction the weight was filled up to 2000 g. Then, it liquidated through strainer (halls with diagonal of 0.2cm) for separating the hard fibers. The produced extract (st extract) was kept in refrigerator. The remained high fiber part was soaked in 3 liters of water for 3 hours (for obtaining most water soluble components as results indicated that in water extracts, high molecular phenolics were present and more responsible for the antioxidant activity of barley (Bonoli et al., 2004)) and drained again (second extract). First extract was boiled and kept on quite heat. Then, second extract was added gradually to the previous extract during cooking. Cooking was continued until the acceptable odor, jam consistency, sweet taste and brown (chocolate) color were reached (10 hours).

2.3. Chemical analysis:

Moisture, crude protein and crude fat were determined according to the methods of AOAC (1995). Ash content was carried out according to the method of AOAC (2000). Carbohydrates content was calculated by the following equation:

$$\text{Carbohydrates} = 100 - (\text{g}/100\text{g moisture} + \text{g}/100\text{g protein} + \text{g}/100\text{g fat} + \text{g}/100\text{g ash})$$

2.4. DPPH assay

DPPH⁰ free radical scavenging assay carried out according to Matthus (2002) the reaction mixture containing various volumes of different extracts, 25, 50 and 100 µg/ml were added into 4 ml of DPPH⁰ solution (5 mg/500 ml MeOH) and the tubes vigorously shaken and incubated in the dark at room temperature for 30 min. After incubation, the absorbance of the reaction mixture was measured spectrophotometrically at 517 nm. All experiments were carried out in triplicate. The scavenging effect of DPPH⁰ free radical was calculated by using the following equation.

$$\text{g}/100\text{g Inhibition} = [(A_B - A_A)/A_B] \times 100$$

Where: A_B: absorption of blank sample (t = 0 min).

A_A: absorption of sample solution (t = 30 min).

FRAP assay

The AA of DPF extracts was determined using a modified method of the assay of ferric reducing/antioxidant power (FRAP) of **Benzie & Strain (1999)**. The FRAP reagent contained 2.5 ml of a 10 mM tripydyltriazine (T.P.T.Z) solution in 40 mM HCl plus 2.5 ml of 20 mM FeCl₃ · 6H₂O and 25 ml of 0.3 M acetate buffer at pH 3.6. Freshly prepared FRAP reagent (3.0 ml) were warmed at 37°C and mixed with 25, 50 and 100 µg/ml of extract and the reaction mixtures were later incubated at 37 °C . Absorbance at 593 nm was read with reference to a reagent blank containing distilled water which was also incubated at 37 °C for up to 1 h instead of 4 min, which was the original time applied in FRAP assay. Aqueous solutions of known Fe (II) concentrations in the range of 100–2000 µM (FeSO₄ · 7H₂O) were used for calibration (**Shui & Leong, 2006**).

2.5. Microbiological analysis

Microbiological count data are expressed as colony forming units (CFU) per 1 ml. Eight dilutions were carried out to determine the number of bacteria during storage (60 days). Potato dextrose agar medium (Difco) was used for molds and yeasts count according to **APHA (1992)**. Plat count agar medium was used for enumeration the total microbiological count. A known volume of sterile sample 0.1 ml was added to Petri-plates containing agar medium, then the Petri-plates was incubated at 37°C for 48 hours. The total bacterial count was recorded as colony numbers per 1 ml of samples (**APHA 1971**).

2.6. Sensory evaluation

Sensory evaluation of **beverages** were carried out to determine their sensory characteristics by fifteen volunteers according to **Moor (1970)** who recommended the following score (10) excellent, (9) very good, (8) good, (7) medium, (6) fair, (5) poor, (4) very poor, (3) extremely poor.

2.7. Statistical analysis

All data were subjected to a one way statistical significant differences between treatment means were compared using F-test at the $p < 0.05$ level according to **Armitage (1971)**.

3. Results and discussion

3.1. Chemical composition

Proximate composition of the original grains, germinated grains and like jam manufactured from germinated grains of wheat and barley are represented in Table (1). Barley grains had higher content of moisture, ash, fiber and β glucan content than wheat grains, however the reverse was found in protein, fat and total carbohydrates. The same trend was observed in germinated grains except the slight increase in carbohydrates content in germinated barley grains. Barley like jam had an increase in moisture ($11.92 \pm 0.01 \text{g}/100\text{g}$), ash ($2.15 \pm 0.003 \text{g}/100\text{g}$), fiber ($3.82 \pm 0.05 \text{g}/100\text{g}$), carbohydrates ($77.95 \pm 0.72 \text{g}/100\text{g}$) and B glucan content (5.62 ± 0.13) compared to wheat like jam, however, the opposite was observed in protein and fat. On the other hand, moisture content increased by germination due to absorbing of water in both of wheat and barley and this is continued by cooking as a result of using water in preparing process. Thus, a decrease was found in the content of protein, fat, ash, fiber and β glucan. Conversely, carbohydrates content increased by germination $79.26 \pm 0.9 \text{g}/100\text{g}$ to $85.68 \pm 0.68 \text{g}/100\text{g}$ in wheat and from $77.95 \pm 0.72 \text{g}/100\text{g}$ to $85.93 \pm 0.81 \text{g}/100\text{g}$ in barley, then, increased in final product. The decrease in fiber and the increase in TC in the final product can be interpreted by **Quinde-Axtell et al., (2006)** who stated that peeling reduces the contents of insoluble fiber, protein, ash and free lipids, but increases the contents of starch by the removal of outer layers.

Table (1): Chemical composition of wheat and barley grain (original & germinated) and their corresponding products

Samples	Moisture	DW					
		Protein	Fat	Ash	Fiber	TC	B glucan
WG	$11.36^a \pm 0.02$	$16.61^f \pm 0.11$	$1.5^e \pm 0.01$	$1.32^e \pm 0.002$	$1.31^d \pm 0.03$	$79.26^a \pm 0.9$	$1.75^c \pm 0.03$
BG	$11.92^b \pm 0.01$	$14.86^e \pm 0.13$	$1.22^d \pm 0.03$	$2.15^f \pm 0.003$	$3.82^f \pm 0.05$	$77.95^a \pm 0.72$	$5.62^f \pm 0.13$
GW	$52.47^c \pm 0.26$	$11.33^d \pm 0.02$	$1.22^d \pm 0.05$	$0.78^c \pm 0.003$	$0.99^c \pm 0.01$	$85.68^b \pm 0.68$	$1.35^b \pm 0.06$
GB	$54.21^d \pm 0.35$	$8.83^c \pm 0.03$	$1.05^b \pm 0.03$	$1.06^d \pm 0.001$	$3.13^e \pm 0.02$	$85.93^b \pm 0.81$	$4.5^e \pm 0.11$
WLJ	$58.53^c \pm 0.28$	$8.27^b \pm 0.04$	$1.14^c \pm 0.02$	$0.69^a \pm 0.001$	$0.02^a \pm 0.0$	$89.88^c \pm 0.64$	$0.88^a \pm 0.001$

BLJ	66.15^d±0.31	6.94^a±0.06	1.00^a±0.01	0.77^b±0.0	0.26^b±0.01	91.03^c±0.77	3.33^d±0.09
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Means of triplicate ±SD; abcdefg Means with different superscripts within a column and treatment differ (P<0.05); Wheat (N×5.71) and Barley (N×6.25); Where: WG: Wheat grain; BG: Barley grain; GW: Germinated Wheat; GB: Germinated Barley; WLJ: Wheat like jam; BLJ: Barley like jam and TC : Total carbohydrate; DW: Dry weight.

3.2.Mineral content

Minerals content of grains, germinated grains and like jam manufactured from germinated grains of wheat and barley are shown in Table (2). It can be observed that minerals content decreased by germination which may be due to the loss in steeping water. Wheat had higher phosphorus content in all its forms (original (154.53±0.19 mg /100g), germinated (97.64±0.12 mg /100g) and cooked (136.19±0.23 mg /100g) compared to barley in each form (152.23±0.53, 84.73±0.13 and 94.16±0.16 mg /100g, respectively). On the other hand, a decrease was found in phosphorus content of wheat after germination, and then increased after cooking. Also barley took the same trend. Germinated wheat had higher calcium content after germination compared to the germinated barley, and also after cooking compared to wheat like jam. It was observed that calcium content decreased after cooking from 27.39±0.09 mg /100g in germinated wheat to 24.54±0.06 mg /100g in cooked wheat. Also potassium content decreased after cooking. Potassium content of barley increased after cooking to be 98.19±0.11 mg /100g. Germinated barley and barley like jam had lower content than germinated wheat and wheat like jam, respectively. Raw and germinated wheat had higher copper content than raw and germinated barley, respectively; however, barley like jam had the higher content (0.97±0.02 mg /100g) than wheat like jam (0.49±0.0 mg /100g). Barley had higher zinc content than wheat in both of original and germination form; however, wheat product had higher zinc content (0.53±0.001 mg /100g) than barley product (0.49±0.0 mg /100g). Our results are in line with Urbano et al., (2006) who recorded that soaking prior to the germination is responsible for the loss of Mg and Zn that continuously emptying from the seed during the sprouting.

Table (2): Minerals content of wheat and barley grain (original & germinated) and their corresponding products

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Minerals(mg/100g)	Phosphor	Calcium	Potassium	Iron	Copper	Zinc
WG	154.53 ^d ±0.1	32.00 ^e ±0.01	399.18 ^f ±0.75	2.46 ^b ±0.13	0.72 ^c ±0.04	1.21 ^c ±0.09
BG	152.23 ^d	55.85 ^f ±0.12	354.21 ^e ±0.18	3.21 ^b ±0.23	0.71 ^c ±0.03	1.35 ^d ±0.02
GW	97.64 ^b ±0.12	27.39 ^d ±0.09	273.23 ^d ±0.45	1.81 ^b ±0.01	0.56 ^b ±0.0	0.94 ^b ±0.03
GB	84.73 ^a ±0.13	23.44 ^b ±0.02	1.81 ^a ±0.01	0.86 ^a ±0.001	0.52 ^a ±0.01	0.92 ^b ±0.001
WLJ	136.19 ^c ±0.2	24.54 ^c ±0.06	0.56 ^c ±0.0	1.41 ^a ±0.001	0.49 ^a ±0.0	0.53 ^a ±0.001
BLJ	94.16 ^{ab} ±0.1	20.69 ^a ±0.03	0.94 ^b ±0.03	0.82 ^a ±0.01	0.97 ^d ±0.02	0.49 ^a ±0.0

188 Data are average of triplicate analysis ±SD; abcdefg Means with different superscripts within a column and
 189 treatment differ (P<0.05); Where: WG: Wheat grains; BG: Barley grains; GW: erminated Wheat; GB:
 190 Germinated Barley; WLJ: Wheat like jam; BLJ: Barley like jam.

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192 3.3. Color and sensory evaluation

193 Values of the L (Hunter luminosity), **a** (red intensity), **b** (yellow intensity) and ΔE in
 194 original grains, germinated grains and like jam product of both of wheat and barley are
 195 showed in Table (3). Higher **L** values were found in wheat than barley in all forms (raw,
 196 germinated or cooked) with significant differences (p<0.05), Meanwhile, it had a
 197 continuous significant decrease (p<0.05) in wheat from 60.22±0.02 in raw grains to
 198 45.67±0.39 in germinated grains then 32.06±0.01 in wheat like jam. Also barley take the
 199 same behavior as **L** value decreased from 52.08b±0.06 in original grains to 43.78d±0.0 in
 200 germinated grains, then 29.45±0.03 in barley like jam. Wheat had significant differences in
 201 **a** value as it was high comparing to barley in raw and germination form, however, cooked
 202 wheat and barley had the same **a** value. No significant difference was found in **a** value
 203 between germinated and cooked wheat. Also no significant difference was observed in a
 204 value between raw and germinated barley which increased significantly in cooked product.
 205 Wheat had higher **b** value in raw and cooked form than barley in the same form with
 206 significant difference; however they take the same value by germination. Both of wheat and
 207 barley had a continuous decrease in **b** value from raw to germinated, then, cooked form.
 208 ΔE value was higher in original, germinated and wheat like jam than original, germinated
 209 and barley like jam, respectively. On the other hand, a continuous significant decrease was
 210 found in both of wheat and barley from raw to germinated, then, cooked form. The grain
 211 colour of barley can vary from light yellow to purple, violet, blue and black, which is

mainly caused by the level of anthocyanins in the hull, pericarp and/or aleurone layer. Highly colored types are also receiving attention for applications in functional foods due to their antioxidant properties (Nam et al., 2006). Wettstein et al., (1985) evaluated the relationships between chemical constituents of grain and dark color development in cooked pearled barley grain, paste and dough. Differences in the brightness of cooked grain, flour gel and dough were evident among all types of barley. They found negative relationships between the total polyphenol content of grain and the brightness of cooked grain, paste and dough, whereas there was no relationship between PPO (polyphenoloxidase) activity and brightness of cooked grain, gel or dough.

Table (3): Mean Hunter color values of wheat and barley grain (original & germinated) and their corresponding products

Samples	L	a	b	ΔE
WG	60.22 ^a ±0.02	6.02 ^b ±0.09	19.23 ^a ±0.07	63.50 ^a ±0.16
BG	52.08 ^b ±0.06	5.11 ^c ±0.02	18.12 ^b ±0.17	55.38 ^b ±0.32
GW	45.67 ^c ±0.39	6.54 ^a ±0.02	15.31 ^c ±0.13	48.61 ^c ±0.22
GB	43.78 ^d ±0.0	5.12 ^c ±0.01	15.08 ^d ±0.12	46.59 ^c ±0.12
WLJ	32.06 ^e ±0.01	6.57 ^a ±0.12	12.18 ^e ±0.01	34.92 ^d ±0.24
BLJ	29.45 ^f ±0.03	6.60 ^a ±0.2	10.21 ^f ±0.02	31.86 ^d ±0.15

Data are average of triplicate ±SD; abcdefg Means with different superscripts within a column and treatment differ (P<0.05); where: WG: Wheat grains; BG: Barley grains; GW: Germinated Wheat; GB: Germinated Barley; WLJ: Wheat like jam; BLJ: Barley like jam

Organoleptic properties of wheat and barley like jams are shown in Table (4). No significant differences were found between the two products in all sensory parameters. Wheat like jam had higher scores of taste (15.8±1.87), color (16.9±1.73), appearance (16.3a±1.64) and over all acceptability (80.8±8.07) than barley like jam; meanwhile, barley like jam had higher scores in aroma (16.3±2.00) and texture (16.6±1.71). Some functional properties such as increasing of viscosity and water binding achieved from including beta-glucan in products (Morin et al., 2002). Jam consistency of the barley product can be

explained by **Auger (2006)** who recorded that the increased thickness and stickiness of the cookie batter may be due to the beta-glucan present in the barley protein isolate.

Table (4): Organoleptic properties of wheat and barley like jam.

Samples	Taste (20)	Aroma (20)	Color (20)	Texture (20)	Appearance (20)	Overall Acceptability(100)
WLJ	15.8±1.87	16.2±1.93	16.9±1.73	15.6±2.37	16.3 ^a ±1.64	80.8±8.07
BLJ	15.7±3.02	16.3±2.00	16.5±2.27	16.6±1.71	13.8 ^b ±2.39	78.9±9.97

Data are average of 15 ±SD; Where: WG: Wheat grains; BG: Barley grains; GW: Germinated Wheat; GB: Germinated Barley; WLJ: Wheat like jam; BLJ: Barley like jam.

3.4.Total phenol compounds, antioxidant activity and DPPH scavenging activity

Total phenol compounds, antioxidant activity and DPPH scavenging activity of original grain, germinated grain and like jam of wheat and barley are represented in Table (5). Results show that barley grains and barley like jam had higher content of total phenol compound than wheat grains and wheat like jam, respectively. However, germinated wheat had higher content of total phenolic compounds than germinated barley. On the other hand, it is observed that germination increased total phenolic compounds of wheat from 41,458 mg Gallic acid /100g to 197,083 mg Gallic acid /100g which decreased in the cooked product to 98,646 mg Gallic acid /100g. However, continued increase was noticed in barley from 74,271 mg Gallic acid /100g to 88,438 mg Gallic acid /100g then 145,833 mg Gallic acid /100g for original grains, germinated grains, then barley like jam, respectively. Wheat had higher antioxidant activity comparing to barley in raw and cooked form, however, germinated barley had higher antioxidant activity than germinated wheat. Data show that antioxidant activity increased by germination, however it decreased after cooking in both of wheat and barley. This may be due to high moisture content in cooked product. DPPH scavenging activity was higher in raw and germinated barley grains than raw and germinated wheat grains, respectively; however, it was higher in wheat product than barley product. On the other hand, a continuous increase was observed from 21.78 to 49.08, then

to 52.45 in raw, germinated and cooked wheat, respectively. It also increased from 35.58 in raw to 49.08 in germinated barley; however, it decreased to 49.08 in cooked barley. Phenolic acid content in barley was 450-1346 ug/g (Holtekjolen et al., 2006) and in wheat was 1342 ug/g (Matilla, 2005). Amici et al., (2008) during their experiments with wheat sprout found that it was a powerful mixture of molecules such as polyphenols. Polyphenols and phenolic acids present in malt are natural antioxidants. (Karabín, et al., 2006). About 80g/100g of beer polyphenols originate from malt and the remaining 20g/100g come from hop (Friedrich et al., 2000). Antioxidant activity and the content of phenolic acids of barley increased during kilning (Dvořáková et al., 2008).

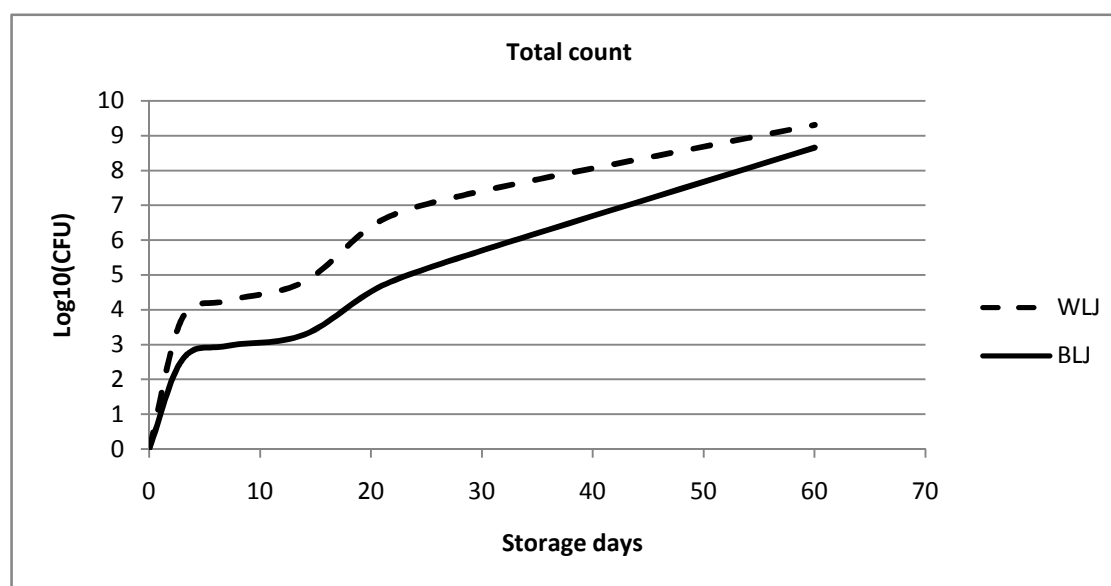
Table (5): Total phenolic compounds, antioxidant activity and total antioxidants of wheat and barley grain (original & germinated) and their corresponding like jams.

Sample no	Total phenolics Eq. (mg Gallic acid /100g)	Antioxidant activity Eq. (mg ascorbic acid /100g) by FRAP assay	g/100g inhibition by DPPH assay*
WG	41,458	63,561	21,78
BG	74,271	38,485	35,58
GW	197,083	68,561	49,08
GB	88,438	98,030	79,75
WLJ	98,646	66,439	52,45
BLJ	145,833	55,152	49,08

g/100g inhibition for TBHQ at concentration of (100ppm) was 98.9g/100g; Where: WG: Wheat grains; BG: Barley grains; GW: Germinated Wheat; GB: Germinated Barley; ; WLJ: Wheat like jam; BLJ: Barley like jam

3.5. Microbiological evaluation

274 Total microbial count of wheat and barley like jam throughout 60 days of storage at
 275 $5^{\circ}\text{C}\pm 1$ is depicted in figure (1). No count was observed after manufacture either in wheat or
 276 in barley like jam due to the long heat treatment. The increase in total viable count was
 277 faster in wheat than in barley like jam over the storage period. The count ranged between
 278 3.766 ± 0.161 on d3 and $9.313 \pm 0.024 \log_{10}$ CFU/ml on d 60 in wheat like jam, however, it
 279 ranged between 2.57 ± 0.046 on d 3 and $8.664 \pm 0.01 \log_{10}$ CFU on d 60 in barley like jam.
 280 The same behavior was observed in yeast and molds count as illustrated in figure (2), as the
 281 count of wheat like jam was 4.189 ± 0.077 on d 3, then increased continuously until
 282 recording $9.634 \pm 0.046 \log_{10}$ CFU/ml on d 60. However, it was 2.534 ± 0.113 on d 3, and
 283 then increased to be $8.844 \pm 0.071 \log_{10}$ CFU at the end of storage period for barley like jam.
 284 Our results are in line with **Olaoye et al., (2006)** who reported that the aerobic plate counts
 285 ($\log$ CFU/g) of the whole wheat bread ranged from 3.20 to 4.50. These counts are minimal
 286 and within safe levels and cannot constitute health hazards (**Jay, 1987; Fawole**). Fresh
 287 bread from wheat flour had mesophyll aerobes 2.80×10^3 (CFU/g), Yeast 2.10×10^1 (CFU/g)
 288 and Molds 3.10×10^2 (CFU/g), (**Moreno-Álvarez et al., 2009**). The slowing of microbial
 289 increase in barley like jam comparing to wheat like jam can be interpreted by **Gorjanović**
 290 (**2007**) who found that TLP-R and TLP-S isolated from malting barley grain inhibited the
 291 growth of *M. lysodeikticus*, *C. albicans*, *S. cerevisiae* and the plant pathogen *F.*
 292 *sporoetrichioides*, known to provoke the cereal disease Fusarium head blight.



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Figure (1): Total viable count of wheat and barley like jam during storage of 60 days.

Where WLJ: Wheat like jam; BLJ: Barley like jam.

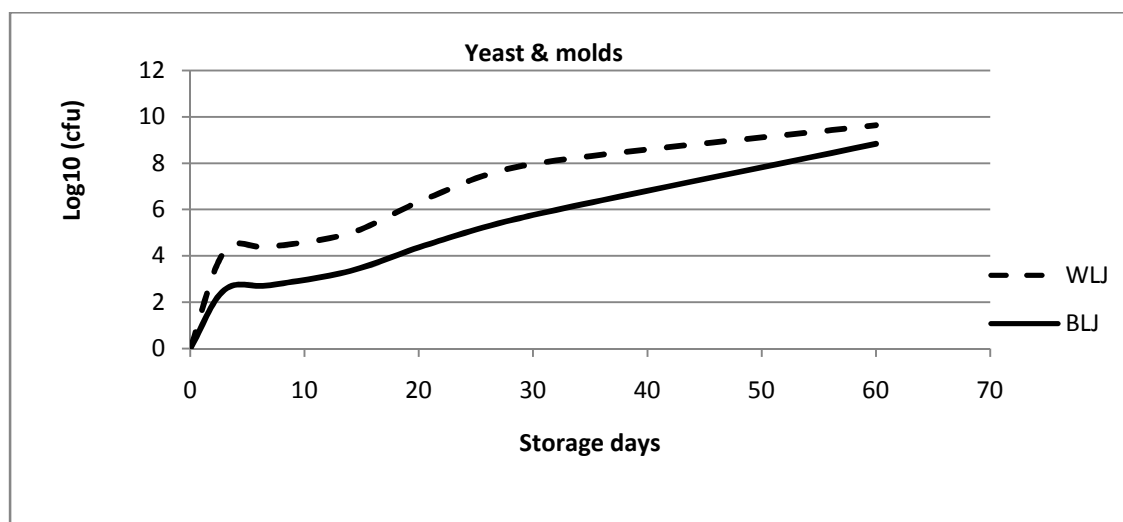


Figure (2): Yeast and mold count of wheat and barley like jam during storage of 60 days.

Where WLJ: Wheat like jam; BLJ: Barley like jam.

4. Conclusion

Most of studies focused on high fiber diet depending on whole grains; however it may not be suitable in some cases such as patients with colon and stomach problems. The present study tried to produce novel product from water soluble constituents of germinated wheat and barley which have not been investigated. Germination caused significant changes in several chemical compositions. In final product of both of wheat and barley, total carbohydrates, total phenolics content, antioxidant activity and DPPH assay scavenging were higher than those in original grain. In wheat like jam, antioxidant activity decreased comparing to the germinated grains, as well as the content of total phenolics,

whereas the DPPH scavenging activity increased. In barley like jam, antioxidant activity and DPPH scavenging activity decreased however total phenolic compound increased. The product can be served directly or as filling for bakery products. The perspective to be considered for future investigations is to examine the effect of these products on oxidative stress, high cholesterol and diabetes. In terms of germination operation, the germination of wheat and barley would be good method for development and application of functional foods.

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