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Chemical, Sensory and Microbiological Evaluation of Novel two Products Manufactured from Germinated Barley and Wheat Grains

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Author's contribution

This whole work was carried out by the author FME.

Original Research Article

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ABSTRACT

Aims: This study was to manufacture and evaluation of novel food product from germinated barley (barley like jam) comparing to the same product manufactured from wheat (wheat like jam).
Study Design: Germinated grains of both of wheat and barley was minced with water, liquidated and cooked then chemically sensory and microbiologically evaluated.
Place and Duration of Study: Products manufacture and analysis were carried out through 60 days of storage period at faculty of specific education laboratory, Mansoura Univ. and national research center, Giza, Egypt.
Methodology: Five hundred grams of germinated grains was minced with 1500 ml of water at 30ºC. After 1 h extraction the weight was filled up to 2000 ml. Then it liquidated for separating the hard fibers. The produced extract (first 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 component. Moisture, crude protein and crude fat, Phosphorus, calcium, potassium, iron, copper and zinc, total phenolics Eq. (mg Gallic acid) were determined. Products antioxidant activity was measured by $DPPH^0$ (1,1-diphenyl-2-picryl hydrazyl radical) and ferric reducing FRAP (free radical antoxidant power) assay.
Results: 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

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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.
Conclusion: Novel forms of products can be produced from germinated wheat and barley grains with high content of bioactive compounds comparing to the original grains. In the context of development of acceptable functional foods for consumers.

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

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, 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 [1]. 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 [2].

Wheat sprout contained high amount of organic phosphates and it was a powerful mixture of enzymes, reducing glucosides and polyphenols. It is stated that polyphenols like e.g. epigallokatechin-3-gallate had antioxidant and protease effect in the cancerous cell. The wheat sprout extract reduced the growth of the cancerous cells and increased the amount of the intracellular oxidative proteins [3]. 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 [4].

Barley development or malting (germination) processes could turn barley into a ‘‘chemical biofactory’’ to over-produce pharmaceuticals or nutriceuticals 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 [5]**.** The objective of the present study was to manufacture acceptable product (like jam) from both of germinated wheat and barley without adding sugar, then compare 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 authenticated in Crop Department, Agriculture Research Center, Giza, Egypt. Grains were 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 tap water for 3 minutes. Weighed lots (2 kg) of wheat and barley were steeped in water at 15ºC for 52 h to get a moisture content of about 42–44g/100g. The steeping water (18ºC) was changed after every 12 h; each time followed by an air-rest of 1h. The grain was exposed to still air at ambient temperature (25–27ºC) during the air-rest. Gibberellic acid (GA) was applied by finally steeping another lot in a 1ppm solution for 4 h (GA was used for its ability to induce starch breakdown in the endosperm of the seed [13]). Germination process was carried out for 5 days at 15ºC and 95% relative humidity. The samples were turned twice a day for dissipation of carbon dioxide and heat of respiration [6].

2.2 Pre-Cooking and Cooking Processes

Five hundred grams of germinated grains was minced by blender at 2000 rpm for 3 minutes with 1500 ml of water at 30°C. After 1 h extraction the weight was filled up to 2000 ml. Then it liquidated through strainer (halls with diagonal of 0.2cm) for separating the hard fibers. The produced extract (first extract) was kept in refrigerator (7ºC±2). 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 [7] and drained again (second extract), First extract was boiled in an uncovered stainless steel pan and kept on quite heat (100ºC). Then second extract was added gradually to the previous extract during cooking (100ºC). Cooking was continued until the acceptable odor, jam consistency, sweet taste and brown (chocolate) color were reached (10 hours). The hot products were packaged under sterilization conditions in sterilized glass jars (size 100ml). Microbiological evaluation was carried out on 0, 3, 7, 14, 21, 30, 60 day from the same container which stored at refrigerator (7±2).

2.3 Chemical Analysis

2.3.1 Moisture, crude protein and crude fat

Were determined according to the methods of AOAC (1995) [8]. Ash content was carried out according to the method of AOAC (2000) [9]. Carbohydrates content was calculated by the following equation:

Carbohydrates = 100 – (g/100g moisture + g/100g protein + g/100g fat + g/100g ash)

2.3.2 Mineral analysis

Individual elements (Ca, P, K, Na, Fe, Mn and Cu) in all samples were determined according to the method described by Chapman & Pratt [1978] [10]. Results are expressed on dry basis.

2.4 DPPH Assay

The reaction mixture containing various volumes of MRPs, 25,50 and 100 µg/ml were added into 4 ml of $DPPH^0$ solution (5 mg/500 ml MeOH) and the tubes vigorously shaken and incubated in the dark at room temperature for 30 min. After incubation at 25°C±1, the absorbance of the reaction mixture was measured spectrophotometrically at 517 nm. All experiments were carried out in triplicate [11]. The scavenging effect of $DPPH^0$ free radical was calculated by using the following equation.

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

Where:

A_B: absorption of blank sample (t= 0 min).
A_A: absorption of sample solution (t= 30 min).

2.5 FRAP Assay

The ability of the extracts (WLJ and BLJ) to reduce ferric ions was measured using the ferric reducing antioxidant power (FRAP) method described by [12]**.** 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 37ºC and mixed with 25,50 and 100 µg/ml of extract and the reaction mixtures were later incubated at 37ºC. Absorbance at 593 nm was read with reference to a reagent blank containing distilled water which was also incubated at 37ºC 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 lM (Fe_{SO4} -$7H_2O$) were used for calibration [13].

2.5.1 Total phenolic content

A modified spectrophotometrical method with Folin-Ciocalteau reagent was used for determination of total phenolic. Dry extract of phenolics was dissolved in 5 ml of methanol.A 0.5 ml of the sample solution was diluted with distilled water after pipetted into a 10 ml volumetric flask. the solution was stirred and 0.5 ml Folin-Ciocalteau reagent was added. 1.2 ml 20% sodium carbonate solution was added, the reaction mixture was left standing for 20 min. After refilling with distilled water to the mark and thorough agitation, the reaction mixture was left standing for 20 min and then was measured on the spectrophotometer at λ = 765 nm against the blank. TP was expressed as mg gallic acid equivalents in 100 g of WLJ and BLJ (mg GAE 100/g) as the average of three determinations. The calibration curve was linear in the range of 0.02–0.45 mg GAE [14].

2.6 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 (Difico) was used for molds and yeasts count [15]**.** Plat count agar medium was used for enumeration the total microbiological count. A known volume of sample 0.1 ml was added to sterile Petri-plates containing agar medium, then the Petri-plates was incubated at 37**º**C for 48 hours. The total bacterial count was recorded as colony numbers per 1 ml of samples [16].

2.7 Sensory Evaluation

Sensory evaluation of like-jam were carried out to determine their sensory characteristics by fifteen volunteers. The following score were recommended: (10) excellent, (9) very good, (8) good, (7) medium, (6) fair, (5) poor, (4) very poor, (3) extremely poor [17].

2.7.1 Color evaluation

Color assessment was performed using a Hunter™ Colorlab Colorimeter, with direct reading as L*=lightness (where 0 = black, 100 = white), a* (-a* = greeness, +a = redness), and b* (-b* = blueness, +b* = yellowness). These values were compared to a standard white plate [18]. Color difference calculated as sample minus standard is stated with a ∆ symbol.
The ∆E value is defined by the following equation:

$$\Delta E = v(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2.$$

2.8 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 [19].

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, ash, fiber, carbohydrates and B glucan content 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±0.9g/100g to 85.68±0.68g/100g in wheat and from 77.95±0.72g/100g to 85.93±0.81g/100g in barley, then, increased in final product. The decrease in β glucan can be attributed to its loss in steeping water. The decrease in fiber and the increase in TC in the final product can be attributed to the peeling that reduces the contents of insoluble fiber, protein, ash and free lipids, but increases the contents of starch by the removal of outer layers [20].

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±013 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 those which revealed that soaking prior to the germination is responsible for the loss of Mg and Zn that continuously emptying from the seed during the sprouting [21].

3.3 Color and Sensory Evaluation

Color values of the L (Hunter luminosity), a (red intensity), b (yellow intensity) and ΔE in original grains, germinated grains and like jam product of both of wheat and barley are showed in Table 3. Higher color L values (lightness) were found in wheat than barley in all forms (raw, germinated or cooked) with significant differences ($p<0.05$), Meanwhile, it had a continuous significant decrease ($p<0.05$) in wheat from 60.22±0.02 in raw grains to 45.67±0.39 in germinated grains then 32.06±0.01 in wheat like jam. Also barley take the same behavior as darkness increased expressed by the of decrease color L value from 52.08b±0.06 in original grains to 43.78d±0.0 in germinated grains, then 29.45±0.03 in barley like jam. Wheat had significant differences in a value indicating high redness comparing to barley in raw and germination form, however, cooked wheat and barley had the same color a value. No significant difference was found in color a value between germinated and cooked wheat. Also no significant difference was observed in a value between raw and germinated barley which increased significantly in cooked product. Wheat had higher yellowness expressed as color b value in raw and cooked form than barley in the same form with significant difference; however they take the same value by germination. Both of wheat and barley had a continuous decrease in color b value (blueness increase) from raw to germinated, then, cooked form. ΔE value was higher in original, germinated and wheat like jam than original, germinated and barley like jam, respectively. On the other hand, a continuous significant decrease was found in both of wheat and barley from raw to germinated, then, cooked form. The grain 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 [22]**.** The relationships between chemical constituents of grain and dark color development in cooked pearled barley grain, paste and dough was evaluated. 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 [23]. The color of wheat, usually white or red, is related to pigments in the seed coat. The barley water may have a slight color due to natural pigments in the grain. All raw noodles containing barley flour had significantly reduced brightness (L*) and yellowness (b*), elevated redness (a*). Although there is a preference for white color in noodles, health-conscious consumers may eventually accept a darker color

[24]. Blue is localized in the aleurone layer of barley kernel [25]. All the barleys contain higher phenolic activity than that of the wheat flour. Barley polyphenols may be the factor cause discoloration in baked products [26]. The purple and blue colors in barley kernels are usually the results of a phenolic compound on the surface of the grains, particularly the anthocyanins. Many shades of the basic colors are possible, due to combinations of anthocyanins and their interactions with other phenolic compounds [27]**.** Malt is dried at higher temperatures for a longer time to develop unique flavors and color. Specialty malts are usually intended for uses in food products (Briess Industries, Inc, Chilton, Wiscousin) [28].

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 [29]**.** Jam consistency of the barley product may be due to the beta-glucan present in the barley protein isolate [30].

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 µg/g [31] and in wheat was 1342 µg/g [32]. During the experiments with wheat sprout it is found found that it was a powerful mixture of molecules such as polyphenols [33]. Polyphenols and phenolic acids present in malt are natural antioxidants [34]. About 80g/100g of beer polyphenols originate from malt and the remaining 20g/100g come from hop [17]. Antioxidant activity and the content of phenolic acids of barley increased during kilning [35].

Table 1. Chemical composition of wheat and barley grain (original & germinted) and their corresponding products (on dry weight basis)

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

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

Table 2. Minerals content of wheat and barley grain (original & germinted) and their corresponding products (on dry weight basis)

Minerals (mg/100g)	Phosphorus	Calcium	Potassium	Iron	Copper	Zinc
WG	154.53^{d}±0.19	32.00^{e}±0.01	399.18^{f}±.75	2.46^{b}±0.13	0.72^{c}±0.04	1.21^{c}±0.09
BG	152.23^{d} ±0.53	55.85^{f}±0.12	354.21^{e}±.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}±.45	1.81^{b}±0.01	0.56^{b}±0.0	0.94^{b}±0.03
GB	84.73^{a}±013	23.44^{b}±0.02	91.89^{a}±.17	0.86^{a}±0.001	0.52^{a}±0.01	0.92^{b}±0.001
WLJ	136.19^{c}±0.23	24.54^{c}±0.06	155.17^{c}±.32	1.41^{a}±0.001	0.49^{a}±0.0	0.53^{a}±0.001
BLJ	94.16^{ab}±0.16	20.69^{a}±0.03	98.19^{b}±.11	0.82^{a}±0.01	0.97^{d}±0.02	0.49^{a}±0.0

Data are average of triplicate analysis ± 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

Table 3. Mean hunter color values of wheat and barley grain (original & germinted) 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	45.67c±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[†]±0.03	6.60[a]±0.2	10.21[†]±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

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

3.5 Microbiological Evaluation

Total microbial count of wheat and barley like jam throughout 60 days of storage at 5ºC±1 is depicted in Fig. 1. No count was observed after manufacture either in wheat or in barley like jam due to the long heat treatment. The increase in total viable count was faster in wheat than in barley like jam over the storage period. The count ranged between 3.766 ± 0.161on d3 and 9.313±0.024lg CFU/ml on d 60 in wheat like jam, however, it ranged between 2.57± 0.046 on d 3 and 8.664±0.01lgCFU on d 60 in barley like jam. The same behavior was observed in yeast and molds count as illustrated in Fig 2 as the count of wheat like jam was 4.189±0.077 on d 3, then increased continuously until recording 9.634±0.046 lgCFU/ml on d 60. However, it was 2.534±0.113 on d 3, and then increased to be 8.844±0.071 lgCFU at the end of storage period for barley like jam. The aerobic plate counts (lg CFU/g) of the whole wheat bread ranged from 3.20 to 4.50 [36]. These counts are minimal and within safe levels and cannot constitute health hazards [37]. The germination step is the main source of contamination in sprouts as bacteria present in the seeds may become internalized during the sprouting (US FDA) [38]. In various studies, the microbial loads in seeds were found to be between 3.0 and 6.0 log CFU/g; with sprouts having counts that were 2 or 3 logs greater [39]. Consumers are recommended to cook the sprouts thoroughly to inhibit or eliminate the bacteria present (US FDA) [40,41]. Fresh bread from wheat flour had mesophyll aerobes $2.80x10^3$ (CFU/g), Yeast $2.10x10^1$ (CFU/g) and Molds $3.10x10^2$ (CFU/g) [42]. TLP-R and TLP-S isolated from malting barley grain inhibited the growth of *M. lysodeikticus*, *C. albicans, S. cerevisiae* and the plant pathogen *F. sporotrichioides,* known to provoke the cereal disease *Fusarium* head blight [43] which may interpret the slowing of microbial increase in barley like jam comparing to wheat like jam can.

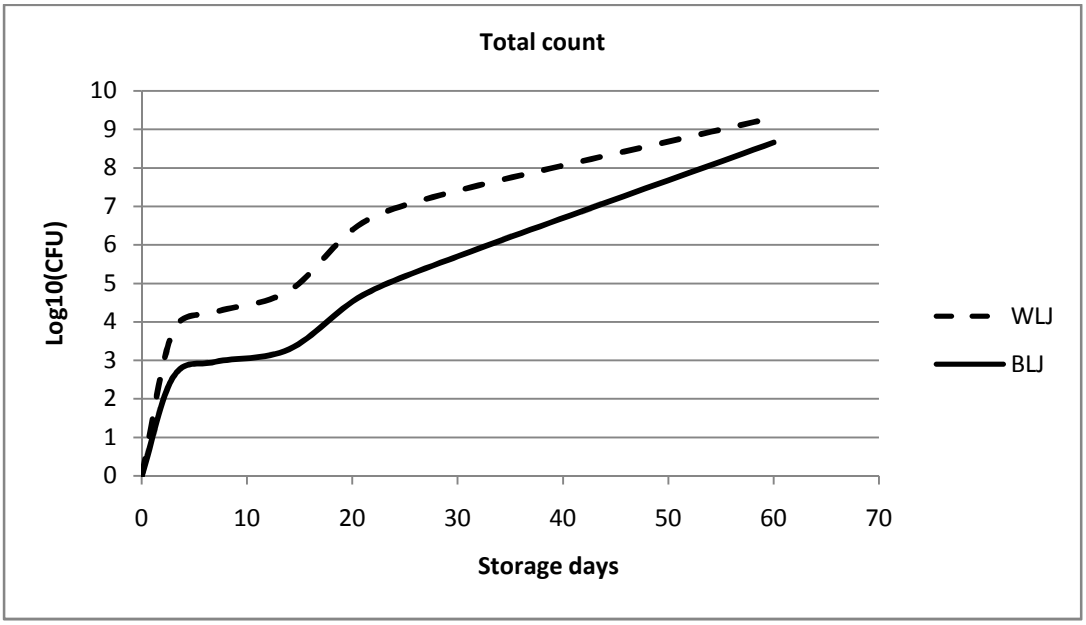

Fig. 1. Total viable count of wheat and barley like jam during storage of 60 days Where WLJ: Wheat like jam; BLJ: Barley like jam

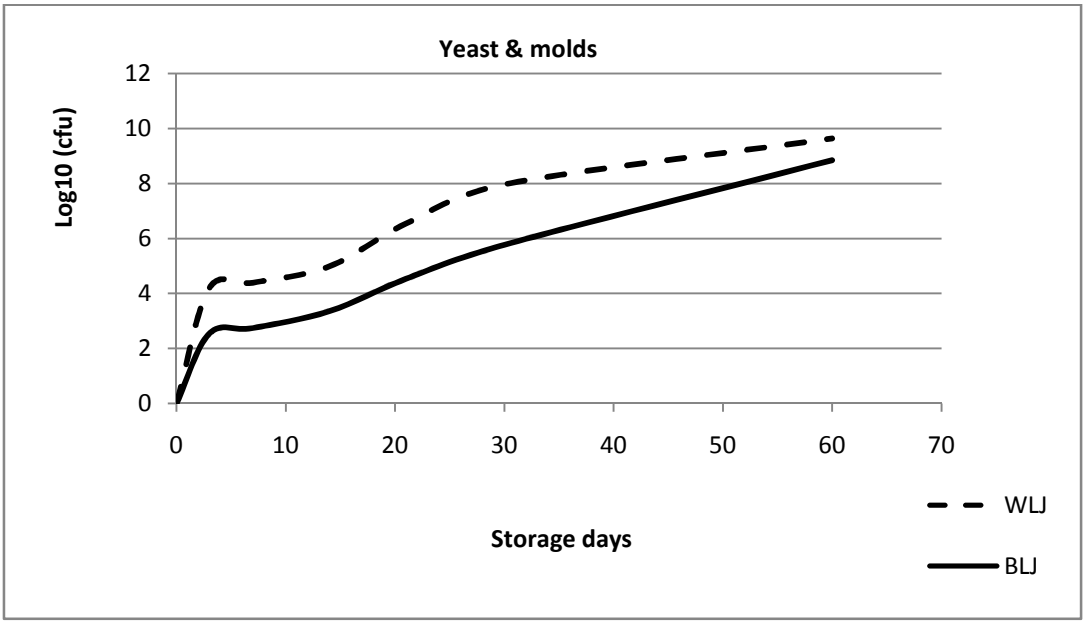

Fig. 2. Yeast and mold count of wheat and barley like jam during storage of 60 days. Where WLJ: Wheat like jam; BLJ: Barley like jam

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	% 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

4. CONCLUSION

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 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.

COMPETING INTERESTS

Author has declared that there are no competing interests exist.

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