Shelf life and Nutritional Properties of Bread Fortified with Dried Carrot Powder

Nareman S. Eshak
Home Economics Department, Faculty of Specific Education, Assiut University, Egypt
Correspondence: e-mail: nsaed2009@yahoo.com, Fax: 002 0882311535

Abstract:

Bread can be fortified with dietary fiber (DF) from different sources, for example carrot. In Egypt, Carrots still reach a low-cost crop. The aim of this study was to evaluate the shelf life and nutritional properties of bread fortified with dried carrot powder (CP) during the storage period at room temperature (30°C) and refrigeration temperature (3°C). Bread was fortified with (CP) at (5%, 10% and 15%). The physicochemical evaluation (height, weight, volume and specific volume) of control and carrot fortified bread was determined. The results showed that moisture and protein contents decreased in carrot fortified bread by increasing ratio of (CP). There was increasing significantly (P<0.01) with increasing level of (CP) in these parameters; fat, ash and fiber contents of the bread. The weight and volume of the bread increased significantly (P<0.05) when fortified with (CP). The carrot fortified bread was significantly different (P<0.05) compared with control bread in height, and specific volume. The moisture content in the carrot fortified bread had high significantly (P<0.01) decreased at the room temperature, while significantly (P<0.05) decreased at refrigeration temperature. The shelf life of bread at refrigeration temperature is longer (20 days) than at the room temperature (5 days). Carrot fortified bread has significantly (P< 0.05) differences in all sensory evaluation comparing with control at refrigeration temperature. Also, significantly (P<0.05) differences only in (taste and texture) comparing with control at room temperature. There was significant (P<0.05) difference in overall acceptability among the carrot bread through storage time. The sensory evaluation of the carrot fortified bread remained the same nearly at ~15 days at the refrigerator temperature. However, the rejection level was reached only after 20 days.

Key words: Shelf life, bread, carrot powder, fortification, physicochemical, sensory evaluation.

Introduction:

Carrot (*Daucus carota L.*) is one of the popular root vegetables belongs to the Apiaceae family which is grown all over the world. The most common part eaten from carrot is root, although the greens can also be eaten **(Surbhi et al., 2018)**. Original carrots were yellow and purple. The annual production in 2006 for carrots exceeded 1.3 million tonnes that represent about 74 % of the vegetable production in Egypt **(EAD, 2009).** Carrot does not provide many calories in the human diet, but provide nutrition in the form of phytochemicals, such as carotenoids, anthocyanins, and other phenolic compounds **(Shalini et al., 2016; Kumar and Kumar, 2011; and Shyamala and Jamuna, 2010; and Abdel-Moemin, 2016)**. Carrot contains many nutrients which varied according to the species, environment conditions and maturity **(Hasler and Brown, 2009)**.

Carrot is rich of carotene and other phytochemicals and vitamins. The carrot is eaten fresh, cooked or drink. This low-cost crop could be converted to value-added products if processed properly **(Kumar and Kumar, 2011).** Carrot being seasonal and semi-perishable, it cannot be easily made available throughout the year. Drying of carrot during the main season is an important alternative to preserve carrots to the rest of the year **(Krishan et al., 2012)**. Moreover, these vegetables are inexpensive and available in large quantities **(Shyamala and Jamuna, 2010)**.

Bread is a staple food around the world and found in many sizes, shapes, types, and textures. Bread is a dynamic system food because of physical, chemical and microbiological changes which limit its shelf life. The loss of freshness which can be seen in the progressive firming-up of the crumb and unexpected taste and texture of the bread. These changes can be determined by physical and chemical changes (**Valentina and Francesca, 2018)**. Several attempts have been made use the carrot in food products, i.e., breads, cakes, dressing salads, and producing functional drinks. Bread is the most popularly consumed bakery items in the world (**Shyamala and Jamuna, 2015)**. Bread can be fortified with dietary fiber (DF) from different sources, i.e., carrot powder **(Zlatica et al., 2012)**. Adding CP to bakery products increases the intake of DF, and reduces the caloric intake. This also makes bakery products fresh due to their ability to retain water **(Kohajdova et al., 2011)**. There has been much attention from consumers to eat functional foods **(Ndife and Abbo,**

2009). Functional foods are foods have additional functions by adding new ingredients. Functional foods may be designed to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions, and may be similar in appearance to conventional food and consumed as part of a regular diet (USDA, 2010).

Shelf life or storage stability of baked products can be defined as preserving the sensory and physical properties associated with its freshness, such as crumb tenderness, pressure and moisture, by preventing changes in the product related to the fortress during storage **(Baixauli et al., 2008)**. The sensory tests are a powerful tool to demonstrate the shelf life of most perishable and semi perishable foods. The efficiency of sensory tests lies in the fact that changes take place in the product during storage are captured by sensory parameters where taste, smell and appearance are the most obvious criteria. These changes can lead to product degradation and consequent decline in acceptability among consumers **(Witting et al., 2005)**. According to **Hough et al., (2003)**, some food products do not have a specific period of validity; instead, they will depend on the interaction of the food product with the consumer. The aim of this study was to evaluate the shelf life and nutritional properties of bread fortified with (CP) during the storage period at room temperature (30°C) and refrigeration temperature (3°C) using acceptance tests.

2. Materials and Methods

1. Materials

Bread ingredients

All purpose wheat flour with a 72% fractionation ratio (Alsalam company, Cairo, Egypt), fresh yeast, salt (Alsalam company, Cairo, Egypt), corn oil (Alkawsar company, Cairo, Egypt), caster sugar (Alsalam company, Cairo, Egypt), bread improver (Tag Al-Melouk, Cairo, Egypt) and fresh yellow carrot (about 10cm long and 3cm wide).

Chemicals

Petroleum ether 40-60, boric acid, and sulfuric acid 95-97% were purchased from(Applichem-GmbH,D-64291-Darmstadt-Germany).Potassium metabisulphite (KMS) was purchased from Sigma–Aldrich(Darmstadt, Germany).

2. Methods

The municipal yellow medium carrot was washed in running tap water. The cleaned carrot was dried at the room temperature for one hour then peeled by sharp knife, and then cut into slices thickness of approximately ~1 cm by visual estimate. The slices were pretreated by blanching in hot water containing at 90°C with 0.1% potassium metabisulphite (KMS) for 3 minutes (**Eissa et al., 2009)**. The slices were then dried at 65°C for about 16 hours in a hot air oven (Vebmlw Medizinische, Gerete, Berlin, Germany). The dried carrot was ground into a fine powder in laboratory mill (LM 120 Perten Instruments , USA). The ground powder carrot that passed through an 80 mesh sieve was packed into food polyethylene pags at room temperature for further analysis.

Bread was prepared according to **Chauhan et al. (1992)** with replacement of the wheat flour (72% fractionation ratio) by carrot powder in bread doughs (B1, B2, and B3). The percentage of carrot powder was 5%, 10%, and 15%. The bread dough was prepared by mixing the ingredients in a mechanical dough mixer (Moulinex brand, Paris, France). Tap water and corn oil were added to the dry ingredients. All ingredients were mixed again for 10 minutes. All ingredients are given in Table (1). The dough was fermented for 90 minutes and baked in rectangular tefal tray (28cm x 12cm x 6cm) (L x W x H) at 260°C for 30 minutes in an electric oven (Universal, Cairo, Egypt). After baking, bread was left to cool on a cooling rack and cut with a sharp knife into ~1.5 cm slices. Carrot fortified bread was packed in polyethylene bags and stored for 12 hours (overnight) in a dry place before sensory testing began. All determinations and sensory testing were begun in the next day. The carrot fortified bread pictures with different blends are shown in Fig. (1).

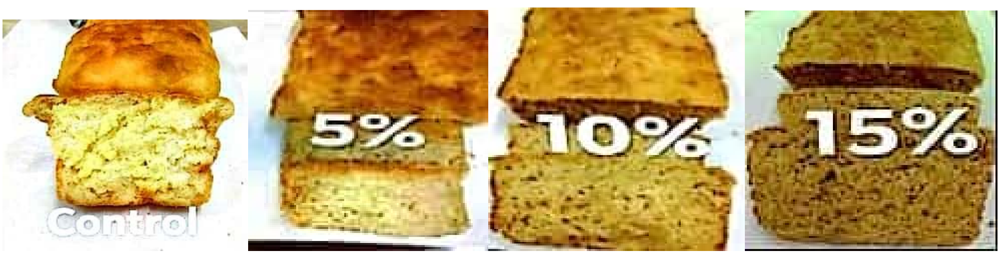

Figure (1): Bread with different concentrations of carrot powder (g/100 g)

Table (1): Doughs of carrot fortified bread with different concentrations of carrot powder (g/100 g)

Ingredients	Samples			
	Basic dough	Composite of dried carrot incorporated dough		
	Dough 1(B0) (control)	Dough 2(B1)	Dough 3(B2)	Dough4(B3)
Wheat flour (g)	100	95	90	85
Carrot powder (g)	--	5	10	15
Salt (g)	2.5	2.5	2.5	2.5
Fresh yeast (g)	2.5	2.5	2.5	2.5
Corn oil (ml)	2	2	2	2
Caster sugar (g)	2	2	2	2
Bread improver (g)	1.2	1.2	1.2	1.2
Water (ml)	65	66	68	70

Dough 1: Wheat flour 100% (B0) control, dough 2: Carrot powder 5% (B1), dough 3: Carrot powder 10% (B2), dough 4: Carrot powder 15% (B3).

Chemical analysis of carrot fortified bread:

Moisture was determined according to the methods of **AOAC (2000)** by taking (3g) of sample in a pre-weighed porcelain crucible, was dried to constant weight at 105°C for 14 hours. Loss in weight was taken as the moisture content of the sample, protein was determined by Micro-Kjeldahl according to the methods of **(AOAC, 2000)**, 1g of sample was placed in a digestion tube; 0.2g $CuSO_4$, 1g K_2SO_4, and 20ml concentrated H_2SO_4 were added to the tube with sweet potato flour. The sample was let digested on digestion block until white fumes can be seen and continue heated for about 60 – 90 minutes until cleared with no charred material remaining. Tube was placed in the distillation apparatus and 50ml NaOH 32% was added. The ammonia in the sample was steam- distilled for 5 minutes into a receiving flash containing 4% boric acid. The sample was titrated with H_2SO_4 0.1N solution. The protein was calculated by the equation: %Nitrogen x 6.25. Crude fiber was determined with an enzymatic–gravimetric procedure according to AOAC Method 991.43 **(AOAC, 2000)**, Crude fiber was determined following the approved AOAC method 962.09. Crude fiber is loss on ignition of dried residue remaining after digestion of sample with 1.25% H_2SO_4 and 1.25% NaOH solutions under specific conditions. 2g of each sample was extracted with ether or petroleum ether and transferred to beakers of ceramic fiber mixture. Two beakers of ceramic fiber mixture for each sample were prepared as follows: 1.5 g dry weight of sample was added to each 100 ml beaker, then 60-75 ml 0.255N H_2SO_4 was added to each beaker and allowed to soak. Beakers were placed on digestion apparatus with pre-adjusted hot plate and boiled exactly 30 minutes. Contents of beaker were filtered through Buchner funnel (pre-coated with ceramic fiber if extremely fine materials are being analyzed). Beaker was rinsed with 50-75 ml boiling H2O and washed through Buchner funnel. Residue was removed before 200 ml 1.25% NaOH was added and boiled exactly 30 minutes. Contents was filtered and then washed with 25 ml boiling 1.25% H2SO4, 50 ml H2O and 25 ml alcohol. Residue was transfer to ashing dish, dried for 2 hours at 130 ± 2o C. Then, it was cooled in desiccator and weighed. Residue was ignited 30 minutes at 600 ± 15oC and cooled in desiccator before being reweighed. % Crude fiber in ground sample = C = (Loss in weight on ignition loss in weight of ceramic fiber blank) x 100- weight sample. Fat was determined by Soxhlet extractor according to **AOAC (2000)**, 3g of sample with hexane using Soxhlet apparatus for 6 hours. The residual hexane was removed from the extracted sample by evaporation. The extracted fat was then dried and weighed and ash was determined according to the method of **AOAC (2000)**, the crucibles containing 5g of sample was charred on a heater before kept in the muffle furnace at 550^{o}C for 4 hours until only white matters can be seen. Then, the crucible with ash content was then cooled in a desiccator and weighed accurately to a constant weight. These analyses were determined in the Central Laboratory for Chemical Analysis, Faculty of Agriculture, Assiut University.

The proximate analysis was carried out in triplicate to obtain a mean value for each nutrient. Carbohydrate was calculated by difference.

Total carbohydrates % = 100 - (moisture% + ash % +fat + % protein + % fiber content)

Total calories were calculated using the equation: **E** = (2.62 × % protein) + (8.37 × % fat) + (4.2 × % carbohydrate) **(Crisan and Sands, 1978).** Where: **E** = Energy as calories per 100 grams sample**.**

Physical analysis of carrot fortified bread:

The volume index of baked carrot fortified bread was measured one day after baking according to AACC methods 10-91 **(AACC, 2000)**. Bread was cut vertically through their center and the heights of the samples were measured at three points (B, C, D; B and D are 3/5 away from the center (C) along the cross-sectioned bread using the index template. These heights were used to calculate the volume index as described in the official method:

The volume index= B+ C+ D

Bread weight was determined by simple weighing using an electronic balance while specific volume was calculated according to the method of **A.A.C.C. (1983)** using the following equation:

$$\text{Specific volume} = \frac{\text{Volume (cm}^3\text{)}}{\text{weight (g)}}$$

Shelf life of carrot fortified bread

Shelf life in terms of moisture acquisition was conducted by storing the carrot fortified bread at room temperature (30°C) and refrigeration temperature (3° C). The moisture content of different composite bread was determined (from initial known moisture content) every day. Results are shown in Table 5.

Sensory evaluation of carrot fortified bread:

Carrot fortified bread and control were stored at room temperature and refrigerator temperature with storage times at (0, 5, 10, 15 and 20) days. During storage, products were kept in aluminum packages. Carrot fortified bread were coded by serving them in 4-digit coded white plastic plates at ambient temperature and subjected to sensory evaluation by semi-trained panel members (n = 40) graduates, staff and non-staff members of the Department of Home Economics, Faculty of Specific Education, Assiut University. The samples were rated on a 1–9-point hedonic scale (1 =dislike extremely, 2= dislike very much, 3= dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely) according to **Watts et al. (1989)**. It was suggested that 10- 49 point scoring scale for overall acceptability (10 = dislike extremely, 49 = like extremely). Scores were collated and analyzed statistically.

Consumer's intent to purchase the carrot fortified bread:

After the sensory evaluation, consumers were asked to evaluate their intention to purchase the tested products, using a 5-point structured scale (1 = certainly will not buy, 5 = certainly will buy) **(Nilda and Marco, 2010).**

Statistical Analysis:

Data were analyzed using analysis of variance (ANOVA) procedure **(Steel and Torrie, 1980)**. Means where significant were separated by the least significant difference (LSD) test. Significance was accepted of $P < 0.05$. Analysis was carried out in three replicates.

Results and Discussion

The gross chemical composition of wheat flour (72 % fractionation ratio) and dry carrot powder is tabulated in **Table (2)**. The results indicate that there are highly significant ($P < 0.01$) moisture, crude protein, crude fiber, fat, ash, total carbohydrates, and energy between wheat flour and dried carrot. These results are in agreement with **Rezaul, (2012)** for wheat and carrot powder, and **Surbhi (2018)** and **Bellur & Prakash, (2015)** for carrot powder only. There is highly significant ($P < 0.01$) difference in moisture**,** fiber and ash between wheat and carrot powder. The moisture content is low in carrot powder compared to wheat flour. Food products with high moisture content are susceptible to microbial attack and therefore have limited shelf life **(Muyanja et al., 2012)**.

Table (2): Gross chemical composition of wheat flour (72 % ext.) and dry carrot powder (% On DWT)*

Raw materials	Moisture %	Crude Protein %	Crude Fiber %	Fat %	Ash %	Total carbohydrate %	Energy (kcal/ 100g)
Wheat flour 72%(g)	13.4± 0.21	10.7± 0.34	1.95± 0.09	1.9± 0.0	0. 9± 0.0	70.94± 0.59	341.8± 1.51
Carrot powder (g)	5.9± 0.05	7.22± 0.56	2.01± 0.02	2.01± 0.02	5.7± 0.40	76.3± 1.07	356.1± 2.86

* dwt basis= dry weight basis.

Hence the low moisture content of the dried samples indicates their stability against microbial attack and potential longer shelf life than control bread **(Nishant and Neeraj, 2018)**. Dietary fiber plays several roles including increasing the shelf life of food products **(Kurek and Wyrwisz, 2015)**. Ash content of a food product is an index to the nutritive value (mineral content, safety, and quality) **(Agoreyo et al., 2011)**.

The data in **Table (3)** showed that the moisture content varied from 7.43 to 2.38%. It was noticed that the moisture content in bread 4 (B3) decreased with the increase carrot powder, which may be result to long storage life of carrot bread. These results are confirmed by those obtained by **(Igbabul et al., 2014)**. The protein contents of the bread loaves decreased significantly ($p<0.01$) with increasing levels of carrot powder. The decrease in protein content could be due to low protein content in carrot powder. This means that carrot bread with the low protein content should be consumed with protein rich diet. These results are confirmed by those obtained by **(Aider et al., 2012)**.

The fat, ash and fiber contents of the bread increased significantly ($p<0.01$) with increasing level of carrot powder. This may be due to the relative high contents in carrot powder compared with wheat flour as shown in Table (2). Similar results were reported by **(Surbhi et al., 2018)**. Dietary fiber improves the shelf life of bread **(Kurek and Wyrwisz, 2015)**. According to **(Schneeman, 2002)** crude fiber contributes to the health of the gastrointestinal system and metabolic system in man.

Table (3): Gross chemical composition of carrot fortified bread (% on DWT)

Samples	Moisture %	Crude Protein %	Crude Fiber %	Fat %	Ash %	Total carbohydrate%	Energy (kcal/100g)
Bread 1 (control)	7.4± 0.05[a]	11.7±0.05[a]	1.8± 0.03[a]	4.8± 0.02[a]	0.97± 0.03[a]	73.3±0.06[a]	378.6± 0.21[a]
Bread 2 (B1)	2.99± 0.04[b]	10.2±0.02[b]	2.5± 0.02[b]	5.2± 0.04[b]	3.5± 0.02[b]	75.6±0.05[b]	387.96± 0.37[b]
Bread 3 (B2)	2.8±0.0[c]	9.7± 0.06[c]	3.3± 0.14[c]	5.7± 0.03[c]	3.8± 0.05[c]	74.7±0.13[c]	386.8± 0.64[c]
Bread 4 (B3)	2.4± 0.01[d]	9.5± 0.06[d]	4.3± 0.04[d]	5.9± 0.04[d]	4.0± 0.02[d]	73.8±0.06[d]	384.5± 0.35[d]

* dwt basis= dry weight basis
Bread 1: Wheat flour 100% (B0) control, Bread 2: Carrot powder 5% (B1), Bread 3: Carrot powder 10% (B2), Bread 4: Carrot powder 15% (B3).
Notes: Values with different letters in the same column differ significantly from each other ($P<0.01$)

Table (3) also, showed that the energy increased significantly ($p<0.01$) in bread (2, 3, 4) compared to the control. Also, we noticed that the energy decreased with increasing levels of carrot powder. This implies that the bread with carrot powder would be a source of low energy for consumers **(Schneeman, 2002)**.

Table (4): Physical properties of carrot fortified bread

Samples	Height (Cm)	Weight (g)	Volume (Cm3)	Specific volume (Cm3 /g)
Bread1(B0) (control)	6.8±0.10[a]	364± 1.00[a]	873±1.53[a]	2.1±0.49[a]
Bread 2(B1)	6.3±0.10[b]	579± 1.00[b]	883±1.53[b]	1.5±0.01[b]
Bread 3(B2)	5.8±0.10[c]	598± 1.00[c]	898±1.53[c]	1.5±0.00[c]
Bread 4(B3)	5.4±0.10[d]	615± 1.00[d]	924±1.00[d]	1.5±0.01[d]

Bread 1: Wheat flour 100% (B0) control, Bread 2: Carrot powder 5% (B1), Bread 3: Carrot powder 10% (B2), Bread 4: Carrot powder 15% (B3). Notes: Values with different letters in the same column differ significantly from each other ($P<0.05$)

The physical properties of the bread from wheat and carrot powder blends are presented in Table (4). The volume of the loaf is one of the most important characteristics of baked goods because it provides a qualitative measure of bread performance **(Kohajdova and Karovicova, 2008)**. The bread weight and volume of the bread increased significantly ($P<0.05$) with increased substitution with carrot powder. Bread4 (B3) recorded the highest values of 615g and 924cm^3 for bread weight and volume while the control had the lowest values of 364g and 873.3cm^3, for loaf weight and volume respectively. The weights of all bread blends of carrot fortified bread were significantly ($P<0.05$) higher than wheat bread. The same trend was observed by **Onuegbu et al. (2013)** in bread production from different composite flours. While, these results are disagreement with those obtained by **(Rubel et al., 2015**) who were found that bread products with dietary fiber considerably decreased loaf volume beyond what would be expected from gluten dilution.

The bread containing carrot powder were significantly different ($P>0.05$) from the wheat bread in height, and specific volume. Generally, the wheat bread had higher height, and specific volume than the bread containing carrot powder.

The effect of shelf life on the moisture content of carrot bread at room temperature (30°C) and refrigeration temperature (3°C) is tabulated in **Table (5 a,b)**. The results showed that the moisture content in the carrot fortified bread had high significantly decreased ($P<0.01$) at room temperature (30°C) while significantly decreased ($P<0.05$) at refrigeration temperature which may be due to the fact that as the time period increases there is a loss of moisture. Also, it was noticed that the shelf life of bread at refrigeration temperature is longer than at the room temperature. These results are in agreement with those obtained by **Sandra et al. (2009) and Elizabeth and Judy, 2009)**. **Adriana et al., (2012)** reported that if bread has been kept at refrigeration temperature, the storage period will exceed the immediate consumption than at room temperature for 3 days.

Table (5)a: Effect of shelf life on moisture content of carrot fortified bread at the room temperature (30° C)

Samples	Storage time (Days)		
	Day 0	Day 5	Day 10
Bread 1(B0) (control)	7.4±0.05^{aA}	3.7±0.05^{aB}	not edible
Bread 2(B1)	2.99±0.04^{bA}	1.4±0.02^{bB}	not edible
Bread 3(B2)	2.8±0.01^{cA}	1.3±0.01^{cB}	not edible
Bread 4(B3)	2.4±0.01^{dA}	1.3±0.01^{Db}	not edible

Notes: Values with different letters in the same column and raw differ significantly from each other (P<0.01)

Table (5)b: Effect of shelf life on moisture content of carrot fortified bread at the refrigeration temperature (3°C)

Samples	Storage time (Days)				
	Day 0	Day 5	Day 10	Day 15	Day 20
Bread 1 (B0) (control)	7.4± 0.05^{aA}	5.7± 0.05^{aB}	5.6± 0.05^{aC}	5.5± 0.04^{aD}	5.4± 0.04^{aE}
Bread 2 (B1)	2.99± 0.04^{bA}	2.3± 0.03^{bB}	2.3± 0.03^{bC}	2.3± 0.11^{bD}	2.3± 0.11^{bE}
Bread 3 (B2)	2.8± 0.01^{cA}	1.9± 0.01^{cB}	1.9± 0.01^{cC}	1.9± 0.01^{cD}	1.9± 0.01^{cE}
Bread 4 (B3)	2.4± 0.01^{dA}	2.0± 0.01^{dB}	2.0± 0.01^{dC}	1.99± 0.01^{dD}	1.99± 0.01^{dE}

Bread 1: Wheat flour 100% (B0) control, Bread 2: Carrot powder 5% (B1), Bread 3: Carrot powder 10% (B2), Bread 4: Carrot powder 15% (B3). Notes: Values with different small letters in the same column differ significantly from each other (P<0.01), while values with different capital letters in the same raw differ significantly from each other (P<0.05)

The effect of shelf life on sensory evaluation of carrot fortified bread at the room temperature (30° C) and refrigeration temperature (3° C) is presented in **Table (6a,b)**. Results showed that incorporation of CP significantly (P< 0.05) differences in (taste and texture) comparing with control at room temperature, while significantly (P< 0.05) differences at refrigeration temperature in all sensory evaluation comparing with control. This may be due to the length of storage period at the refrigerator temperature.

Table (6) $_a$: Effect of shelf life on sensory evaluation of carrot fortified bread at the room temperature (30° C)

Samples	Storage time (days)	Color (10)	Appearance (10)	Taste (10)	Texture (10)	Aroma (10)	Overall acceptability (50)
Bread 1 (B0) (control)	Day 0	9.4± 0.10^a	9.5±0.10^a	9.5± 0.10^a	9.3±0.15^a	9.4± 0.10^a	47.1±0.21^a
	Day 5	9.3± 0.10^a	9.4±0.10^a	9.4± 0.10^a	9.2±0.15^a	9.3± 0.10^a	46.4±0.38^a
Bread 2 (B1)	Day 0	9.3± 0.15^A	9.5±0.15^A	9.5± 0.15^A	9.0±0.10^A	8.5± 0.10^A	45.6±0.31^A
	Day 5	9.3± 0.10 ^{A}	9.4±0.15^A	8.5± 0.10^B	8.1±0.15^B	8.4± 0.15^A	44.6±0.45^A
Bread 3 (B2)	Day 0	9.0± 0.10^c	9.2±0.10^c	9.2± 0.10^c	8.1±0.32^c	7.6± 0.35^c	42.97±0.47^c
	Day 5	8.9± 0.10^c	9.1±0.10^c	8.4± 0.15^d	7.3±0.15^d	7.6± 0.40^c	41.1±0.62^c
Bread 4 (B3)	Day 0	8.9± 0.15^C	8.97±0.10^C	8.7± 0.21^C	7.7±0.21^C	6.97± 0.21^C	41.2±0.21^C
	Day 5	8.7± 0.15^C	7.0±0.10^D	8.3± 0.15 ^{D}	6.8±0.26 ^{D}	6.9± 0.21^C	38.0±0.11 ^{D}

N= 40; 1–9 point scoring scale (1=dislike extremely, 9= like extremely). 10- 49 point scoring scale for overall acceptability (10=dislike extremely, 49= like extremely)
Bread 1: Wheat flour 100% (B0) control, Bread 2: Carrot powder 5% (B1), Bread 3: Carrot powder 10% (B2), Bread 4: Carrot powder 15% (B3).

There were slightly differences in color, appearance and aroma acceptability among the carrot fortified bread at room temperature, but significant (P<0.05) differences in all sensory evaluation except aroma at refrigerator temperature comparing between the first and the end day for shelf life. The taste and texture for carrot fortified bread affected by adding carrot powder. This may be due to extremely high content of fiber in carrot powder, which would tend to make the bread rough. These results are in agreement with those obtained by **Bellur and Prakash, (2015)** they indicated that a higher level of incorporation of carrot powder influenced the taste and texture adversely. Also, **Gomez et al., (2010)** showed that addition of CP to bread dough benefits to extend the shelf life of the product. From the results, it was noticed that there was significant (P<0.05) difference in overall acceptability among the carrot fortified bread at the refrigerator temperature. There was significant (P<0.05) difference in overall acceptability among the carrot fortified bread through storage time. The sensory evaluation of the carrot fortified bread remained the same nearly at 15 days at the refrigerator temperature. However, the rejection level was reached only in 20 days.

Table (6) b: Effect of shelf life on sensory evaluation of carrot fortified bread at the refrigeration temperature (3° c)

Samples	Storage time (days)	Color (10)	Appearance (10)	Taste (10)	Texture (10)	Aroma (10)	Overall acceptability (50)
Bread 1 (B0) (control)	Day 0	9.4± 0.10a	9.5±0.10a	9.5± 0.10a	9.3± 0.15a	9.5±0.10a	47.1±0.21a
	Day 5	9.3± 0.10b	9.5±0.10b	8.97± 0.21b	9.1± 0.10b	9.4±0.10b	46.3±0.21b
	Day 10	9.2± 0.15c	9.3±0.10c	8.8± 0.15c	9.0± 0.10c	9.4±0.15c	45.7±0.25c
	Day 15	9.0± 0.10d	9.1±0.15d	8.6± 0.15d	8.8± 0.10d	9.2±0.15d	44.8±0.21d
	Day 20	8.8± 0.10e	8.8±0.21e	8.0± 0.10e	8.6± 0.15e	8.0±0.15e	43.3±0.38e
Bread 2 (B1)	Day 0	9.3± 0.15A	9.3±0.15A	9.5± 0.15A	9.0± 0.10A	8.5±0.10A	45.6±0.30 A
	Day 5	9.2± 0.15B	9.2±0.10B	9.2± 0.10B	8.9± 0.10B	8.5±0.10A	45.0±0.06B
	Day 10	9.1± 0.10C	8.9±0.10 C	8.9± 0.21C	8.7± 0.10C	8.4±0.15A	44.0±0.46C
	Day 15	9.0± 0.10D	8.8±0.15D	8.6± 0.10D	8.6± 0.15D	8.3±0.20A	43.3±0.26 D
	Day 20	8.8± 0.10E	8.6±0.10E	8.2± 0.10E	8.2± 0.30E	8.2±0.21A	42.0±0.36E
Bread 3 (B2)	Day 0	9.0± 0.10f	9.0±0.10f	9.2± 0.10f	8.1± 0.32f	7.6±0.35f	42.97±0.47 f
	Day 5	9.1± 0.10g	8.97±0.15g	8.8± 0.15g	8.1± 0.21g	7.6±0.35f	42.6±0.53g
	Day 10	8.97± 0.21h	9.0±0.10h	8.6± 0.15h	8.0± 0.10h	7.6±0.40f	42.1±0.53h
	Day 15	8.8± 0.10k	8.8±0.10k	8.5±0. 10 k	7.6± 0.25k	7.5±0.43f	41.2±0.55k
	Day 20	8.7± 0.10m	8.4±0.21m	8.0±0. 10m	7.5± 0.25m	7.4±0.43f	40.1±1.06 m
Bread 4 (B3)	Day 0	8.9± 0.15F	8.8±0.1 F	8.7± 0.21F	7.7± 0.21F	6.97±0.21F	41.2±0.21F
	Day 5	8.8± 0.1G	8.8±0.1G	8.5± 0.15G	7. 7± 0.15G	6.9±0.26F	40.7±0.1G
	Day 10	8.6± 0.06H	8.7±0.1H	8.4± 0.10H	7.5± 0.1H	6.8±0.15F	40.1±0.29 H
	Day 15	8.5± 0.1K	8.4±0.1K	8.1± 0.21K	7.2± 0.15K	6.7±0.15F	38.97±0.4 K
	Day 20	8.5± 0.1M	8.1±0.15M	7.6± 0.15M	6.1± 0.1M	6.6±0.1F	37.9±0.15 M

Bread 1: Wheat flour 100% (B0) control, Bread 2: Carrot powder 5% (B1), Bread 3: Carrot powder 10% (B2), Bread 4: Carrot powder 15% (B3). Notes: Values with different letters in Carrot powder 10% (B2), Formula 4: Carrot powder 15% (B3). Notes: Values with different letters in the same column differ significantly from each other (P<0.05)

Table (7) $_b$: Consumer's intent to purchase (in %) of carrot fortified bread for shelf life at refrigeration temperature (3°c)

Samples	Storage time (days)	Purchase intent				
		Certainly will not buy	Probably will not buy	May or may not buy	Probably will buy	Certainly will buy
Bread 1 (B0) (control)	Day 0	1.1 ± 0.1^{a}	2.2 ± 0.1^{a}	1.7 ± 0.45^{a}	6.4 ± 0.1^{a}	88.6 ± 0.15^{a}
	Day 5	67.5 ± 0.1^{b}	14.1 ± 0.1^{b}	10.97 ± 0.45^{b}	2.2 ± 0.15^{b}	5.3 ± 0.15^{b}
Bread 2 (B1)	Day 0	2.1 ± 0.1^{A}	2.2 ± 0.1^{A}	1.7 ± 0.36^{A}	6.4 ± 0.1^{A}	87.6 ± 0.1^{A}
	Day 5	37.5 ± 0.15^{B}	24.1 ± 0.1^{B}	7.1 ± 0.51^{B}	6.1 ± 0.15^{B}	25.2 ± 0.15^{B}
Bread 3 (B2)	Day 0	3.1 ± 0.1^{c}	3.3 ± 0.15^{c}	1.7 ± 0.5^{c}	8.3 ± 0.15^{c}	83.6 ± 0.1^{c}
	Day 5	31.5 ± 0.1^{d}	27.1 ± 0.1^{d}	1.8 ± 0.42^{d}	9.2 ± 0.1^{d}	30.3 ± 0.15^{d}
Bread 4 (B3)	Day 0	2.99 ± 0.01^{C}	4.3 ± 0.01^{C}	9.7 ± 0.31^{C}	9.4 ± 0.1^{C}	73.6 ± 0.1^{C}
	Day 5	30.1 ± 0.1^{D}	27.1 ± 0.1^{D}	2.4 ± 0.46^{D}	8.2 ± 0.15^{D}	32.2 ± 0.15^{D}

Bread 1: Wheat flour 100% (B0) control, Bread 2: Carrot powder 5% (B1), Bread 3: Carrot powder 10% (B2), Bread 4: Carrot powder 15% (B3).
Notes: Values with different letters in the same column differ significantly from each other

Table (7a,b) shows the results of consumer's intent to purchase of carrot fortified bread for each shelf life at room temperature (30°c) and refrigeration temperature (5°c). It was noticed that the intent to purchase for the carrot fortified bread decreased over time clearly.

When the carrot fortified bread was evaluated fresh formula1 controls (0 days), 88.57% of the consumers certainly buy the bread.

The ratio decreased to 5.27% in 5 days at room temperature and 19.7% in 20 days at refrigeration temperature. The ratios reached levels lower than in bread 4 (B3) at room and refrigeration temperatures. There were significant ($P<0.01$) differences in each bread through shelf life at room and refrigeration temperatures. These results are agreement with those obtained by **(Nilda and Marco, 2010)** who reported that after periods of storage, the purchase intent by consumers has significantly decreased.

Table (7) $_b$: Consumer's intent to purchase (in %) of carrot fortified bread for shelf life at refrigeration temperature (3°c)

Samples	Storage time (days)	Purchase intent				
		Certainly will not buy	Probably will not buy	May or may not buy	Probably will buy	Certainly will buy
Bread 1 (B0) (control)	Day 0	2.1±0.1^{a}	2.2±0.1^{a}	1.7±0.36^{a}	6.4±0.1^{a}	87.6±0.1^{a}
	Day 5	2 ± 0.1^{b}	7.2±0.1^{b}	1.8±0.36^{b}	6.4±0.1^{b}	82.6±0.1^{b}
	Day 10	2.6±0.1^{c}	6.1±0.1^{c}	3.4±0.4^{c}	9.3±0.1^{c}	78.6±0.15^{c}
	Day 15	3.3±0.1^{d}	9.3±0.1^{d}	2.5±0.36^{d}	14.6±0.1^{d}	70.3±0.1^{d}
	Day 20	45.5±0.1^{e}	7.1±0.1^{e}	1.5±0.46^{e}	39.3±0.15^{e}	6.6±0.15^{e}
Bread 2 (B1)	Day 0	3.1±0.1^{A}	3.3±0.15^{A}	1.7±0.5^{A}	8.3±0.15^{A}	83.6±0.1^{A}
	Day 5	3.1±0.1^{B}	3.2±0.1^{B}	3.7±0.4^{B}	7.4±0.1^{B}	82.6±0.1^{B}
	Day 10	4.4±0.1^{C}	4.3±0.1^{C}	1.6±0.4^{C}	6.3±0.1^{C}	83.4±0.1^{C}
	Day 15	6.3±0.1^{D}	7.1±0.15^{D}	2.2±0.46^{D}	9.1±0.1^{D}	75.3±0.15^{D}
	Day 20	35.4±0.15^{E}	11.1±0.1^{E}	3.5±0.45^{E}	43.3±0.1^{E}	6.7±0.1^{E}
Bread 3 (B2)	Day 0	3.1±0.1^{f}	3.3±0.15^{f}	1.7±0.5^{f}	8.3±0.15^{f}	83.6±0.1^{f}
	Day 5	3.1±0.10^{g}	3.2±0.1^{g}	3.7±0.4^{g}	7.4±0.1^{g}	82.6±0.1^{g}
	Day 10	4.4±0.1^{h}	4.3±0.1^{h}	1.6±0.4^{h}	6.3±0.1^{h}	83.4±0.1^{h}
	Day 15	6.3±0.1^{k}	7.1±0.15^{k}	2.2±0.46^{k}	9.1±0.1^{k}	75.3±0.15^{k}
	Day 20	35.4±0.15^{m}	11.1±0.1^{m}	3.5±0.45^{m}	43.3±0.10^{m}	6.7±0.1^{m}
Bread 4 (B3)	Day 0	2.99±0.0^{F}	4.3±0.1 ^{F}	9.7±0.31^{F}	9.40±0.10^{F}	73.6±0.1 ^{F}
	Day 5	3± 0.1^{G}	3±0.1^{G}	2.03±0.45^{G}	8.40±0.10^{G}	83.6±0.15^{G}
	Day 10	4± 0.1^{H}	4.9±0.1^{H}	3±0.4^{H}	7.30±0.10^{H}	80.8±0.1^{H}
	Day 15	5.9± 0.1^{K}	6.3±0.1^{K}	9.6±0.4^{K}	9.60±0.10^{K}	71.3±0.1^{K}
	Day 20	36.3±0.1^{M}	11.1±0.1^{M}	2.6±0.36^{M}	42.30±0.10^{M}	7.7±0.1^{M}

Bread 1: Wheat flour 100% (B0) control, Bread 2: Carrot powder5% (B1), Bread 3: Carrot powder10% (B2), Bread 4: Carrot powder 15% (B3).

Conclusion:

The present study shows that the moisture content is low in the dried carrot powder compared to wheat flour which causes food products with high moisture content are susceptible to microbial attack and therefore have limited shelf life **(Muyanja et al., 2012)**. This gives us an idea about dried carrot powder which has good shelf life enhancing property which can serve as good source for maintaining keeping quality of the baked products. Also, this study shows that storage time for carrot fortified bread significantly influenced on the taste and texture comparing with control at room temperature, while significantly ($P< 0.05$) differences at refrigeration temperature in all sensory evaluation comparing with control. The end of shelf life was determined at about 5 days at room temperature and 20 days for carrot fortified bread. The sensory evaluation of the carrot fortified bread remained the same nearly at 15 days at the refrigerator temperature. However, the rejection level was reached only after 20 days.

Based on this finding it is recommended that the future work needs to focus on the role of fiber on the quality attributes of bread such as texture and taste.

References:

A.A.C.C (1983): Approved Methods of the AACC. Method 22-10, the Association: St. Paul, MN.

AACC (2000): Methods 10-91. Approved methods of the AACC, American Association of Cereal Chemists, St. Pauls, MN, USA.

Abdel-Moemin A.R. (2016): Analysis Of Phenolic Acids And Anthocyanins Of Pasta-Like Product Enriched With Date Kernels (*Phoenix dactylifera* L.) and Purple Carrots (*Daucus carota L. sp. Sativus var. atrorubens*.). Food Measurement and Characterization.10:507–519.

Adriana P., Alexandru N., Giorgiana M., Oana M., and Daiana O. (2012): The Influence of Storage Temperature on the Bread Quality. Bulletin UASVM Agriculture, 69(2). 248-254.

Agoreyo B., Akpiroroh O., Orukpe O., Osaweren and Owabor C. (2011): The effects of various drying methods on the nutritional composition of Musa paradisiaca, Dioscorea rotundata and Colocasia esculenta. Asian Journal of Biochemistry. 6(6):458-464.

Aider M., Sirois-Gosselin M., and Boye J. (2012): Pea, Lentil and Chickpea Protein Application in Bread making Journal of Food Research; (1), 4.

AOAC, (2000): Official Methods of Analysis. 17^{th} ed. Association of Official Analytical Chemists, AOAC International, Arlington, VA.

Baixauli R., Salvador A., and Fiszman S. (2008): Textural and color changes during storage and sensory shelf life of muffins containing resistant starch. Eur. Food Res. Technol. 523–530.

Bellur N. and Prakash (2015): Nutritional composition, acceptability, and shelf stability of carrot pomace-incorporated cookies with special reference to total and β-carotene retention. Cogent Food & Agriculture, 1: 1039886**.**

Chauhan G., Zillman R. and Eskin N. (1992): Dough mixing and bread making properties of quinoa- wheat flour blends. Int. J Food Sci Techno, 27:701 705.

Crisan E. and Sands A. (1978): Nutrition value In: Biology and cultivation of Edibles Mushrooms, edited by Chang ST and Hayes WA, New York, Academic Press. Pp: 137-168.

EAD, Economic Affairs Department (2009): *Agricultural Statistics Bulletin*, Ministry of Agriculture (Cairo, Egypt, 2009).

Eissa H., Fouad G., and Shouk A. (2009): Effect of some thermal and chemical pre-treatments on smoked oyster mushroom quality. International Journal of Food Science and Technology, 44(2), 251-261.

Elizabeth L. and Judy A. (2009): Ph.D., Extension Food Safety Specialist and Extension Foods Specialist. Food Storage For Safety and Quality.

Gomez M., Moraleja A., Oliete B., Ruiz E., and Caballero P. (2010): Effect of fiber size
on the quality of fiber-enriched layer cake. LWT-Food Science and Technology 43: 33-38.

Gonzalez C., Rossello C., Simal S., Garau M., Lopez F., and Femenia A. (2010): Physico-chemical properties of cell wall materials obtained from ten grape varieties and their by-products: grape pomaces and stems. LWT – Food Sci. Technol. 43 (10), 1580-1586.

Hasler C. and Brown A. (2009): Position of the American Dietetic Association: Functional foods. Journal of the American Dietetic Association 109(4) 735–746.

Hough G., Langohr K., Gome G. and Curia A. (2003): Survival analysis applied to sensory shelf life of foods. J. Food Sci. 68, 359–362.

Igbabul B., Num G., and Amove J. (2014): Quality Evaluation of Composite Bread Produced from Wheat, Maize and Orange Fleshed Sweet Potato Flours. American Journal of Food Science and Technology; 2 (4), 109-115.

Kohajdova Z., and Karovicova J. (2008): Influence of hydrocolloids on quality of baked goods. Acta Sci. Pol., Technol. Aliment. 7 (2); 43-49.

Kohajdova Z., Karovicova J., Jurasova M., and Kukurova K. (2011): Application of citrus dietary fiber preparations in biscuit preparation. J. Food Sci. Nutr. Res. 50 (3), 182-190.

Kurek M. and Wyrwisz J. (2015): The Application of Dietary Fiber in Bread Products. J Food Process Techno. 6 (5).

Krishan D., Swati K., Narayan S., and Surekha A. (2012): Chemical composition, functional properties and processing of carrot J. Food Sci. Technol. 49(1):22–32.

Kumar N., and Kumar K. (2011): Development of Carrot Pomace and Wheat Flour Based Cookies. J. Pure & Appl. Sci. & Technol., 1 (1): 5-11.

Muyanja C., Kyambadde D. and Namugumya B. (2012): Effect of Pretreatments and Drying Methods on Chemical Composition and Sensory Evaluation of Oyster Mushroom (PluerotusOestreatus) Powder and Soup. Journal of Food Processing and Preservation. 38;(1): 457- 465.

Ndife J. and Abbo E., (2009): Functional Foods: Prospects and Challenges in Nigereia. J. Sci. Technol., 1(5) 1-6.

Nilda D. and Marco A. (2010): Estimating sensory shelf life of chocolate and carrot cupcake using acceptance tests. Journal of Sensory Studies 25; 260–279.

Nishant K. and Neeraj (2018): Study on physico-chemical and antioxidant properties of pomegranate peel. Journal of Pharmacognosy and Phytochemistry. 7(3): 2141-2147.

Onuegbu N., Ihediohanma N., Odunze O. and Ojukwu M. (2013): Efficiency of wheat: maize composite flour as affected by baking method in bread and cake production Sky Journal of Food Science; 2 (8), 005-013.

Rezaul K. (2012): A Study on the Processing of Wheat-Potato-Carrot Composite Flour Cake. Master of Science (MS) in Food Engineering; Department of Food Technology and Rural Industries Bangladesh Agricultural University, Mymensingh.

Rubel I., Perez E., Manrique G., and Genovese D. (2015): Fiber enrichment of wheat bread with Jerusalem artichoke inulin: Effect on dough rheology and bread quality. Food Structure 3: 21-29.

Sandra M., Joey P., and Grace W. (2009): Storing food for safety and quality. A Pasific Northwest Extension Publication University of Idaho. Oregon State University. Washington State University. P1-22.

Schneeman B. (2002): Gastrointestinal physiology and functions. British Journal of Nutrition.; 88 (2): 159-163.

Shalini S., Neha C., and Sachin K. (2016): Addition of carrot pomace to increase the nutritional and rheological properties of traditional cake. International Journal of Science and Research (IJSR); 5 (5), 1412-1416.

Shyamala B. and Jamuna P. (2015): Nutritional composition, acceptability, and shelf stability of carrot pomace-incorporated cookies with special reference to total and β-carotene retention. Cogent Food & Agriculture, 1: 1039886.

Shyamala B. and Jamuna P. (2010): Nutritional content and antioxidant properties of pulpwastefrom Daucus carota and Beta vulgaris. Mal. J. Nutr. 16 (3), 397-408.

Steel R. and Torrie J. (1980): Principles and Procedures of Statistics. 2nd Ed. New York: McGraw-Hill.

Surbhi S., Verma R., Deepak R., Jain H. and Yadav K. (2018): Introduction: A review: Food, chemical composition and utilization of carrot (Daucus carota L.) pomace. International Journal of Chemical Studies; 6(3): 2921-2926.

USDA (2010): Basics about functional food. Functional Foods Research in ARS US Department of Agriculture, Agricultural Research Service.

Valentina M. and Francesca M. (2018): Strategies to Extend Bread and GF Bread Shelf-Life: From Sourdough to Antimicrobial Active Packaging and Nanotechnology. Fermentation, 4, 9.

Watts B., Ylimaki G., Jeffery L., and Elias, L. (1989): IDRC-277e. Basic sensory methods for food evaluation. Ottawa, Ont., UOC: 664.001.5:339.4 ISBN: 0-88936-563-6.

Witting D., Penna, E., and Estudios (2005): Un enfoque sensorial. In: VII Congreso Nacional de Ciencia y Tecnología de Alimentos. Annals of Congress, Lambayeque, Peru, 7 CD-ROM.

Zlatica K., Jolana K., and Michaela J. (2012): Influence of carrot pomace powder on the rheological characteristics of wheat flour dough and on wheat rolls quality. Acta Sci. Pol., Technol. Aliment. 11(4), 381-387.

الملخص العربي

فترة التخزين والخصائص التغذوية للخبز المدعم بمسحوق الجزر المجفف

يمكن تقوية الخبز بالألياف الغذائية من مصادر مختلفة مثل مسحوق الجزر، الجزر من المحاصيل منخفضة التكلفة الأقتصادية. لذلك الهدف من هذه الدراسة هو تقييم العمر التخزيني والخصائص الغذائية للخبز المدعم بمسحوق الجزر خلال فترة التخزين في درجة حرارة الغرفة (٣٠ درجة مئوية) ودرجة حرارة التبريد (٣ درجة مئوية). تم تدعيم الخبز بمسحوق الجزر بنسبة (٥٪ ، ١٠٪ ، ١٥٪). تم تحديد التقييم الفيزيوكيميائي (الطول والعرض والحجم والحجم النوعي) لخبز العينة الضابطة والعينات الأخري. أظهرت النتائج انخفاض محتوى الرطوبة والبروتين في الخبز المدعم بمسحوق الجزر كلما زادت نسبة مسحوق الجزر، أيضاً هناك زيادة ملحوظة عند القيمة الإحتمالية أقل من ٠,٠١ في محتوي (الدهون، الرماد ، الألياف) بزيادة نسب مسحوق الجزر. أما الوزن والحجم فإزداد زيادة ملحوظة بزيادة مسحوق الجزر ، وكان هناك أيضاً تغيير ملحوظ للخبز المدعم بمسحوق الجزر مقارنة بالعينة الضابطة في (الطول والحجم النوعي). المحتوي الرطوبي في الخبز المدعم بمسحوق الجزر عند القيمة الإحتمالية أقل من ٠,٠٥ . إنخفض بوضوح في درجة حرارة الغرفة عن درجة حرارة الثلاجة.

أيضاً العمر الإفتراضي للخبز عند درجة حرارة الثلاجة كان أطول (٢٠ يوم) من مثيله عند درجة حرارة الغرفة (٥ أيام) كذلك وجود تغيير ملحوظ في الخبز المدعم بمسحوق الجزر في (الطعم والملمس) مقارنة بالعينة الضابطة عند درجة حرارة الغرفة. بينما التغير بالنسبة لدرجة حرارة الثلاجة كان في كل مقاييس التقييم الحسي. أيضاً كان هناك تغيير ملحوظ في القبول العام بين أنواع الخبز المدعم بمسحوق الجزر خلال فترة التخزين.التقييم الحسي للخبز المدعم بمسحوق الجزر كان جيداً حتي اليوم الخامس عشر بينما كان مرفوضاً عندما وصل فقط لليوم العشرين.

الكلمات المفتاحية: العمر الأفتراضي ، الخبز ، مسحوق الجزر ، التدعيم ، الفيزيوكيميائية ، التقييم الحسي.