J. of Food and Dairy Sci., Mansoura Univ., Vol. 12 (10): 259 -271, 2021

Journal of Food and Dairy Sciences

Journal homepage: www.jfds.mans.edu.eg
Available online at: www.jfds.journals.ekb.eg

Utilization of Garden Cress Seeds Gum and Arabic Gum As Natural Gums in Improving Rheological, Physical and Sensory Properties of Pan Bread

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ABSTRACT

This study was carried out to examine the utilization of garden cress seeds gum(GCS gum)and Arabic gum in processing pan bread. Rheological properties of dough, physical properties, sensory properties, color parameters, texture profile analysis and bioactive compounds(total phenolics content(TPC)and total flavonoids content(TFC))were determined. Extracted GCS gum and Arabic gum were used to prepare pan bread at the rate of 0.1% GCS gum and 3% Arabic gum.The pan bread samples were prepared by partially replacing the wheat flour by 5, 10, 15, 20 and 30% of garden cress seed flour(GCS flour).Results of farinograph and extensograph indicated that addition of Arabic gum with the concentration of 3% improved stability,elasticity and degree of softness in compare with those of control and GCS gum samples. Also,results of physical properties namely weight,volume, specific volume, density, height and index to volume showed that pan bread samples with GCS and Arabic gum 5% were nearly in the same values with control sample. Results of bioactive compounds also showed that addition of GCS gum and Arabic gum increased the amount of TPC and no significant difference observed in TFC.When, DPPH% assay in all pan bread samples was increased in compared with the control one. All pan bread samples didn't show observed changes up to 5 days of storage under different storage conditions(room and refrigerator temperatures).Spoilage was pointed out by black, gray, brownish yellow and green coloration on the pan bread samples. It is recommended that addition of 0.1% GCS gum and 3% Arabic gum improved pan bread properties.

Keywords: Garden Cress Seeds Gum, Arabic Gum, Pan Bread, Farinograph, Antioxidant Activity and Antimicrobial Activity.

INTRODUCTION

Several studies have shown that medicinal plants are origin of various nutrient and non-nutrient molecules, many of which show antioxidant and antimicrobial properties which can preserve the body against both pathogens and cellular oxidation reactions (Wojdylo *et al.*, 2007). Garden cress seeds (GCS) (*Lepidium sativum* L. (Brassicaceae (cruciferae) family)) are famous for its medicinal and nutritional value. Its extract contains a lot of phytochemical substances responsible for its antioxidant and antimicrobial properties as α-tocopherol, β-sitosterol, tannins, benzyl isothiocyanate, flavonoids, alkaloids, triterpenes and sterols (Abdel-Bary *et al.*, 2017). Methanol and water extracts of GCS are reported to inhibit growth of six opportunistic pathogens namely *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumonae*, *Proteus vulgaris*, *Pseudomonas aeruginosa* and one fungus *Candida albicans* (Adam *et al.*, 2011). GCS when soaked in water forms a transparent gel (6.5 – 15 % mucilage) around the whole seed (Wadhwa *et al.*, 2012). GCS aqueous extract has anticancer, hypoglycaemic and antihypertensive activity (Mahassni and Al-Reemi, 2013).

Gum Arabic (syn. Gum Acacia (Leguminosae family)) is a natural edible, dried gum harvested from the exterior stems and branches of *Acacia seyal*, *Acacia polyacantha*, and *Acacia senegal* trees. There are several recent studies emphasized on antioxidant and antimicrobial activities of the crude extracts of gum acacia. Such as an efficient capacity for deactivation of excited electronic states and moderated radical scavenging capacity and generation of free radicals. The antioxidant function of gum Arabic associated with its protein fraction, mainly by amino acid residues such as histidine, tyrosine and lysine (Ali and Al Moundhri, 2006).

Phenolic acids are the main antioxidants in cereal grains, which seem to have the greatest potential to be beneficial to our health as a result of their scavenging free radicals, inhibition of lipid peroxidation and thus their anticancer activity (Mateo *et al.*, 2011). Furthermore, bakery products are subjected to microbial spoilage in particular mold growth due to high water activity. (Saranraj and Geetha 2012). Therefore, the current study aimed to examine the utilization of garden cress seeds gum (GCS gum) and Arabic gum in processing pan bread.

MATERIALS AND METHODS

Materials:

1-Raw Materials:

Garden cress seeds (GCS) and Arabic gum were purchased from a certified herbal store in Cairo, Egypt.

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DOI: 10.21608/jfds.2021.204710

While, pan bread ingredients namely commercial wheat flour extraction (72%), sugar, dried yeast and oil were purchased from the local market, El-Mansoura, Egypt.

2-Chemicals:

Dextrose, agar, sodium nitrite (NaNO2), sodium hydroxide (NaOH), sodium bicarbonate (NaHCO3) and aluminum chloride (AlCl3) were obtained from El-Gomhoria Company, Cairo, Egypt. While, HPLC grade methanol was purchased from Al-Shark Al-Awsat Company, Cairo, Egypt. Gallic acid, DPPH (2, 2-diphenyl-1-picrylhydrazyl), rutin and Folin-Ciocalteu reagent were purchased from Sigma–Aldrich Chemical Co. (St. Louis, USA), Cairo, Egypt.

Methods:

1-Extraction and Purification of Garden Cress Seed Gum:

Extraction by Extractor:

Garden cress seed gum (GCS gum) was extracted from whole seeds using distilled water (20:1, 25:1 and 30:1). Soaking and stirring for 15 min according to Razmkhah *et al.* (2016). Whole seeds (20 g) were stirred using Acculplate hot plate magnetic stirrer (LABNET Model PC-420D, Mexico) for 15 min at 25ºC and 500 rpm. Separation of the gum from the whole swollen seeds was achieved by passing the seeds through an extractor (MORE MJ-1000 fruits juicer, Egypt) equipped with a rotating plate that scraped the outer gum layer on the seed surface. The extracted gum was filtered through muslin cloth to remove dirt particles and ensure clarity of the gum. The extracted gum was dried in an oven on 60ºC for 24 h and the dried gum was ground manually and considered as crude GCS gum. The yield weighted and calculated (13.5%). Finally, the dried gum stored at room temperature for further analysis.

Purification Using Ethanol 95%:

According to Divekar *et al.* (2010), the crude GCS gum was purified and precipitated out by adding two volumes of 95% ethanol to one volume of the crude GCS gum and were stirred using Acculplate hot plate magnetic stirrer (LABNET Model PC-420D, Mexico) at 500 rpm and 25ºC until precipitate. The collected precipitate was dried in an oven on 60ºC for 12 h. The yield was weighted and calculated. The purified GCS gum was ground manually and stored at room temperature for further analysis.

2-Chemical Composition for Garden Cress Seed Flour, Wheat Flour and Arabic Gum:

Samples of Garden cress seed flour (GCS flour), wheat flour and Arabic gum were chemically analyzed to itemize the following: crude protein, moisture, crude fat, ash and crude fiber contents according to A.O.A.C. (2000), whereas total carbohydrates content was calculated by the difference.

3-Pan Bread Preparation:

Pan bread was prepared according to Penfild and Campbell (1990). Pan bread recipe was altered by partially replacing the wheat flour (72% extraction) by 5, 10, 15, 20 and 30% of GCS flour, with the addition of 0.1% purified GCS gum compared with 3% Arabic gum. Pan bread recipe was as presented in Table (1):

Table 1. Ingredients of Pan Bread Prepared using Different Percentages of Garden Cress Seed Flour with the addition of 0.1% Garden Cress Seed Gum compared with 3% Arabic Gum

Ingredients / gm	Pan Bread Samples										
	Control	GCS[1] gum					Arabic gum				
		5%	10%	15%	20%	30%	5%	10%	15%	20%	30%
Wheat Flour (72%)	100	95	90	85	80	70	95	90	85	80	70
Garden Cress Seed Flour	-----	5	10	15	20	30	5	10	15	20	30
Arabic Gum	-----	-----	-----	-----	-----	-----	3	3	3	3	3
GCS Gum	-----	0.1	0.1	0.1	0.1	0.1	-----	-----	-----	-----	-----
Oil	10	10	10	10	10	10	10	10	10	10	10
Salt	1	1	1	1	1	1	1	1	1	1	1
Sugar	4	4	4	4	4	4	4	4	4	4	4
Dried Yeast	1	1	1	1	1	1	1	1	1	1	1

[1]GCS: Garden Cress Seed.

4-Dough Rheological Properties:

The control and best chosen blends were subjected to farinograph and extensograph.

Farinograph Properties:

The control and the selected pan bread blends with 5, 10 and 15% GCS flour were chosen to determine the rheological properties. Hydration and mixing attributes of pan bread dough were determined using the farinograph (Brabender Duis Bur G, type 810105001 No. 941026 West Germany) according to (A.A.C.C., 2000) at bread and pastry Research Department, Food Technology Research Institute, Giza, Egypt.

Extensograph Properties:

Extensograph properties for the incorporated blends were determined according to (A.A.C.C., 2000) using an Extensograph (Barabender Duis Bur G type 860001 No. 946003 West Germany) at bread and pastry Research Department, Food Technology Research Institute, Giza, Egypt.

5-Pan Bread Properties:

Physical Properties of Different Prepared Pan Bread Samples:

The pan bread samples were examined to determine appearance by photos, index to volume (cm) and height (cm). Weight (g) was measured by using a sensitive balance (1g) according to Johnson (1990). The method of A.A.C.C. (2000) was used to determine the volume (cm3) by rapeseeds displacement method, while density (g/cm3) and specific volume (cm3/g) calculated according to A.A.C.C. (2000) using the following equations:

$$\textbf{Specific Volume (cm}^3\textbf{/g) = Volume (cm}^3\textbf{) / Weight (g)}$$

$$\textbf{Density (g/cm}^3\textbf{) = Weight (g) / Volume (cm}^3\textbf{)}$$

Sensory Properties of Different Prepared Pan Bread Samples:

Nine sensory attributes (appearance, crumb color, crust color, cell size, cell uniformity, texture, odor, taste and general acceptability) were examined for the different prepared samples of pan bread, using a 5 point scale, where 5 = excellent, 4 = good, 3 = satisfactory, 2 = fair, and 1= poor. The freshly sliced pan bread samples were cut into 1×1 cm pieces and served to 20 trained panelists from Food Industries Department, Faculty of Agriculture, Mansoura University, El-Mansoura, Egypt. Instruction score sheets (descriptive test) for evaluating samples were given to panelists. They were provided with eleven randomly coded samples (control pan bread, pan bread samples with 5, 10, 15, 20 and 30% of GCS flour with 0.1% GCS gum, as well as pan bread samples with 5, 10, 15, 20 and 30% of GCS flour with 3% Arabic gum. Accuracy and precision were evaluated statistically.

Color Determination for Different Prepared Pan Bread Samples:

The pan bread samples color was measured at Faculty of Agriculture, Cairo University, Giza, Egypt, using Chroma Meter CR-400 colorimeter (Konica Minolta Sensing, INC. Japan), with the Space color CIE Lab system equipped with a 2° observer system and calibrated with a white tile and a D-65 illuminant source. The obtained *L*, *a* and *b* color parameters from them the following color parameters were obtained: Chroma index (Equation 1), hue angle (Equation 2) and browning index (Equation 3 and 4) (Bal *et al.,* 2011):

$$\text{Chroma index} = (a^{*2} + b^{*2})^{0.5} \quad (1)$$

$$\text{Hue} = \tan^{-1} (b^{*} / a^{*}) \quad (2)$$

$$BI = 100\ (x - 0.31)/0.17 \quad (3)$$

$$X = a^{*} + 1.75\ L^{*} / 5.645\ L^{*} + a^{*} - 3.012\ b^{*} \quad (4)$$

Texture Profile Analysis (TPA) of Different Prepared Pan Bread Samples:

The pan bread samples texture profile was analyzed using CT V1.6 Texture Analyzer (Brookfield, Engineering Laboratories, Inc. USA) following method 74-09 according to **A.A.C.C. (2000)** at bread and pastry, Research Dep., Food Technology Research Institute, Giza, Egypt. One slice of prepared pan bread sample 7×5 mm approximately was used. A cylindrical probe (TA-AACC36) at 2.50 mm/s speed, target 40.0% and trigged load 5.00 N to punch the pan bread sample. Data and curves were automatically obtained by computer software (TA-CT-PRO Software) to show the power amount needed for penetration in pan bread samples. Samples textural properties were (hardness, adhesiveness, resilience, cohesiveness, springiness, gumminess and chewiness).

6-Bioactive Compounds Determination for Pan Bread Samples:

Determination of Total Phenolics Content:

The total phenolics content (TPC) of pan bread samples methanolic extracts was determined at Pesticides Laboratory, Faculty of Agriculture, Mansoura University, El-Mansoura, Egypt, using the method described by El-Sayed *et al.* (2017) with a slight modification. 0.5 mL of sample extract, 2.5 mL of Folin- Ciocalteus reagent mixed with H_2O (10:90) and 2.5 mL sodium bicarbonate ($NaHCO_3$) (7.5%). The blank sample contains 0.5 mL of methanol, 2.5 mL of 10% Folin-Ciocalteus reagent and 2.5 mL 7.5% $NaHCO_3$ in H_2O. The absorbance was recorded at 765 nm versus a blank sample and gallic acid as the standard. The TPC was expressed as mg GAE/g.

Determination of Total Flavonoids Content:

The total flavonoids content (TFC) of pan bread samples methanolic extracts was determined using a colorimetric assay reported by El-Sayed *et al.* (2017) at Pesticides Laboratory, Faculty of Agriculture, Mansoura University, El-Mansoura, Egypt. 0.5 mL of sample extract was added to 2 mL of distilled water and 150 µL of 5% sodium nitrite ($NaNO_2$), and incubated at room temperature for 6 min, then 150 µL of 10% aluminum chloride ($AlCl_3$) was added then incubated again at room temperature for another 6 min, then added 2mL of 4% sodium hydroxide (NaOH). The mixture was incubated at room temperature for the third time for 15 min. The absorbance was measured at 510nm versus a blank sample, and rutin was used as the standard. The TFC was expressed as mg RE/g.

DPPH Radical Scavenging Activity:

The antioxidant activity of pan bread samples methanolic extracts was determined using DPPH free radical scavenging method used by Akroum *et al.* (2010) at Pesticides Laboratory, Faculty of Agriculture, Mansoura University, El-Mansoura, Egypt. 2 mL of sample extract was mixed with 2 mL of DPPH in methanol (0.1mmol/L). The control contained methanol only and DPPH. The mixtures were shaken and kept in dark for 30 min at room temperature. The absorbance was measured at 517 nm. The DPPH scavenging activity was calculated from the following equation:

$$\%\ \text{DPPH scavenging activity} = [A_C - A_s \div A_C] \times 100$$

where, A_C **is absorbance of control and** A_s **is absorbance of sample.**

7- Storage of Different Prepared Pan Bread:

The pan bread samples were stored at room temperature (25±2ºC) and refrigerator temperature (3 – 5ºC) and were observed for 12 days. The stored samples were visually observed for fungi growth according to Ijah *et al.* (2014).

8- Total Fungi Count:

Potato Dextrose Agar (PDA) media were prepared according to Saeed *et al.* (2018) at Microbiology Laboratory, Faculty of Agriculture, Mansoura University, El-Mansoura, Egypt. 50 g of agar was dissolved in 2.5 litter distilled water. The solution was divided into 8 flasks, and was covered tightly with cotton plugs. Then, the media was sterilized in an autoclave at about 121°C and 15 lbs for 15 min, and then put aside to cool.

According to Aneja (2003) and Jay (2005), pan bread sample (10 g) were soaked in 100 ml water (stock solutions), and shacked for 15 min.. The serial dilution was 10 ml of bread sample solution was transmitted to 90 ml of sterilized distilled water, which gave 10^{-1} dilution. Dilutions were transmitted to the dissolved media in sterilized Petri dishes. Then these inoculated Petri dishes were incubated at 30°C for 7 days. After incubation, numbers of colonies were counted and multiplied by dilution factor to find out the number of spores per gram of a sample.

$$\text{No. of spores/g} = \text{No. of colonies} \times \text{Dilution factor}$$

$$\text{Dilution factor} = \text{Reciprocal of dilution (e.g., } 10^{-1} = 10^{1})$$

9- Statistical Analysis:

Data were analyzed statistically by analysis of variance, for statistical significance ($P \leq 0.05$) using LSD test (one way ANOVA) according to Steel *et al.* (1997), using the statistical program CoStat (Ver. 6.303).

RESULTS AND DISCUSSION

1. Chemical Composition for Garden Cress Seed Flour, Wheat Flour and Arabic Gum:

Chemical composition for garden cress seed flour (GCS flour), wheat flour and Arabic gum is summarized in Table (2). According to the LSD analysis method, data showed that wheat flour contain as mean ± SD 11.58 ± 2.79 g/100g crude protein, 1.61 ± 0.64 g/100g crude fat, 9.78 ± 1.31 g/100g moisture, 1.11 ± 0.56 g/100g ash, 1.18 ± 0.70 g/100g crude fiber and 74.74 ± 2.25 g/100g carbohydrates (by difference). The GCS flour was scored statistically the highest amount of crude protein (19.90 ± 9.82 g/100g) among all samples. When, there were no significant differences observed between wheat flour and GCS flour (11.58 ± 2.79 and 19.90 ± 9.82 g/100 g, respectively). But Arabic gum was scored statistically the lowest amount of crude protein (2.36 ± 0.91 g/100 g) among all samples. These data are in agreement with those represented by Zia-Ul-Haq *et al.* (2012) who reported that GCS flour was scored 24.2 ± 0.5% of crude protein. Whereas, Adeyeye (2016) reported that wheat flour was scored 8.48 ± 0.12% of crude protein. Also, agreed with Amir *et al.* (2015) who stated that wheat flour was scored 13.90% of crude protein. Also, Mansoori *et al.* (2020) exhibited that Arabic gum was scored 2.50 ± 1.07 % of crude protein.

Table 2. Chemical Composition of Garden Cress Seed Flour, Wheat Flour and Arabic Gum

Samples	Crude Protein (g/100g)	Crude Fat (g/100g)	Moistur (g/100g)	Ash (g/100g)	Crude Fiber (g/100g)	Carbohydrates (g/100g)
Wheat Flour	11.58 ±2.79^{ab}	1.61 ±0.64^{b}	9.78 ±1.31^{ab}	1.11 ± 0.56^{c}	1.18 ±0.70^{b}	74.74 ±2.25^{a}
GCS[1] Flour	19.90 ±9.82^{a}	19.77 ± 10.23^{a}	4.64 ±1.81^{c}	8.65 ± 2.65^{a}	9.36 ±2.53^{a}	37.68 ±16.36^{b}
Arabic Gum	2.36 ±0.91^{c}	0.25 ±0.11^{b}	12.23 ± 0.86^{a}	2.68 ± 0.69^{b}	0.73 ±1.93^{b}	82.35 ±0.02^{a}

[1]GCS: Garden Cress Seed.
Each value is the mean of 3 replicates ± SD. **All values on dry weight basis.**
Values in the same column with different superscript letters (a, b…) are significantly different (P ≤ 0.05).

Concerning the crude fat, Table (2) showed that GCS flour was scored statistically the highest amount of crude fat 19.77 ± 10.23 g/100g among all samples. When, there was no significant difference observed between wheat flour and Arabic gum (1.61 ± 0.64 and 0.25 ± 0.11 g/100g, respectively), when recording statistically the lowest content. These data are matched with those represented by Zia-Ul-Haq *et al.* (2012), who reported that GCS flour was scored 23.2 ± 0.2 % of crude fat. Whereas, Adeyeye (2016) reported that wheat flour was scored 2.29 ± 0.06% of crude fat. Also, agreed with the findings of Amir *et al.* (2015) who stated that wheat flour was scored 1.50 % of crude fat. Also, Mansoori *et al.* (2020) reported that Arabic gum was scored 0.14 ± 0.01 % of crude fat.

In terms of moisture, results stated that Arabic gum was observed statistically the highest amount of moisture (12.23 ± 0.86 g/100g) among all samples. But GCS flour was scored statistically the lowest amount of moisture (4.64 ± 1.81 g/100g). In harmony, Mansoori *et al.* (2020) reported that Arabic gum was recorded 9.17 ± 0.19 % of moisture. Also, these findings matched with Amir *et al.* (2015) who stated that wheat flour was scored 9.50% of moisture. Whereas, Adeyeye (2016) mentioned that wheat flour was observed 8.64 ± 0.18% of moisture. When, Zia-Ul-Haq *et al.* (2012) reported that GCS flour was scored 2.9 ± 0.1% of moisture.

With regard to ash content data presented in Table (2) displayed that wheat flour was recorded statistically the lowest amount 1.11 ± 0.56 g/100g of ash content. Where, GCS flour was scored statistically the highest amount 8.65 ± 2.65 g/100g of ash content. These data are in conformity with those described by Zia-Ul-Haq *et al.* (2012), who reported that GCS flour was recorded 7.1 ± 0.1% of ash content. As, Adeyeye (2016) reported that wheat flour was observed 1.57 ± 0.04% of ash content. In parallel, Amir *et al.* (2015) stated that wheat flour was recorded 1.28 % of ash content. Also, Mansoori *et al.* (2020) reported that Arabic gum was scored 3.11 ± 0.17 % of ash content.

Concerning crude fiber, results showed that GCS flour was scored statistically the highest amount of crude fiber (9.36 ± 2.53 g/100g) among all samples. When, there was no significant difference observed between wheat flour and Arabic gum (1.18 ± 0.70 and 0.73 ± 1.93 g/100g, respectively). These results are in agreement with those recorded by Adeyeye (2016) who reported that wheat flour was recorded 1.42 ± 0.05% of crude fiber. In harmony, Amir *et al.* (2015) stated that wheat flour was observed 1.73% of crude fiber. Where, Zia-Ul-Haq *et al.* (2012) reported that GCS flour was scored 11.9 ± 0.4% of crude fiber.

Regarding the carbohydrates content, Table (2) displayed that there was no significant difference observed between Arabic gum and wheat flour (82.35 ± 0.02 and 74.74 ± 2.25 g/100g, respectively), when recording statistically the highest carbohydrates content. While, GCS flour was scored statistically the lowest amount of carbohydrates 37.68 ± 16.36 g/100g between all samples. These results are matched with those recorded by Zia-Ul-Haq *et al.* (2012) who reported that GCS flour was observed 30.7 ±1.2% of carbohydrates. Also, Mansoori *et al.* (2020) reported that Arabic gum was scored ~85.08 % of carbohydrates.

2. Effect of Garden Cress Seed Gum and Arabic Gum addition on Dough Rheological Properties:

Effect on Farinograph and Extensograph Properties of Different Flour Blends:

The results of effect of garden cress seed gum (GCS gum) and Arabic gum addition on dough rheological properties are presented in Table (3). The 0.1% purified GCS gum was incorporated in pan bread dough compared to 3% Arabic gum. The water absorption (%) was increased with the addition of GCS flour and incorporation of Arabic gum and was ranged from 59.7% for 5% Arabic gum to 75.5% for 15% Arabic gum when compared to control (60%). Where, the addition of GCS gum didn't affect the water absorption. Therefore, Razavi and Karazhiyan (2009) explained that GCS gum is able to absorb more water quickly. This effect has been attributed to the hydroxyl groups in the GCS gum structure and chain conformation which allows more water interaction through hydrogen bonding. In accordance, Asghar *et al.* (2007) supplemented wheat flour with Arabic gum and carboxymethyl cellulose (CMC). In addition, they narrated that water absorption raise to 65.6 % for 3% Arabic gum, where control wheat flour was scored 60.4% of water absorption. Increment in the water absorption by the addition of gums to wheat flour has also earlier been quoted by Rosell *et al.* (2001). In harmony, Marpalle *et al.* (2014) evidenced that increase in water absorption was observed with increasing flaxseed level addition.

Table 3. Effect on Farinograph and Extensograph Properties of Different Flour Blends

Samples		Farinograph					Extensograph			
		Water Absorption (%)	Arrival Time (Min.)	Dough Development Time (Min.)	Stability (Min.)	Degree of Softness (B.U.)	Elasticity (B.U.)	Extensibility (E) (Mm)	Proportional Number P.N. (R/E)	Energy (Cm^2)
Control		60.0	1.0	2.0	4.0	70	410	100	4.10	68
GCS[1] Gum	5%	71.5	1.0	2.0	9.0	70	250	60	4.17	26
	10%	75.0	1.0	2.0	9.5	60	620	75	8.27	74
	15%	75.5	1.5	2.9	11.0	50	600	65	10.10	51
Arabic gum	5%	59.7	1.0	1.5	9.5	60	440	80	5.50	52
	10%	61.5	1.5	3.0	11.0	50	590	75	7.87	83
	15%	75.5	1.5	3.0	10.5	50	660	65	10.15	56

[1]GCS: Garden Cress Seed.

Concerning arrival time (Min.), results demonstrated an increase in arrival time with the addition of GCS flour and incorporation of GCS gum or Arabic gum. Arrival time was vary between 1.0 for dough with 5 and 10% GCS gum and dough with 5% Arabic gum to 1.5 Min for dough with 15% GCS gum and dough with 10 and 15% Arabic gum when compared to1.0 Min for control dough.

The dough development time (Min.) or time necessary to reach 500 BU of dough consistency was increased for 3 Min at dough with 10 and 15% Arabic gum and for 2.9 at dough with 15% GCS gum. Opposite to that, dough development time was decreased for 1.5 Min at dough with 5% Arabic gum. When, there was no difference observed between control dough and dough with 5 and 10% GCS gum (2.0 Min).

Stability (Min.) is an indication of flour strength, with higher values suggesting stronger dough whereas gives an indication for the dough tolerance against mixing. This was clearly affected by the addition of all different GCS flour percentages and incorporation of GCS gum or Arabic gum and was alternated between 9 Min for dough sample with 5% GCS gum to 11 Min for dough sample with 15% GCS gum and dough sample with 10% Arabic gum when compared to the control dough (4.0 Min). Dough stability was increased by adding 0.1% GCS gum and 3% Arabic gum. These results are in accordance with those represented by Sahraiyan *et al.* (2013) who reported that the stability value affected by the addition of *Lepidium Sativum* seed gum and guar gum and was ranged from 3.6 to 10.3 min. An increase of dough stability was produced by adding 1% *Lepidium Sativum* seed gum. Also, the results indicated that at levels higher than 0.6 *Lepidium Sativum* seed gum was more effective on stability than guar gum.

In respect to degree of softness (B.U.) was decreased with the addition of GCS flour and incorporation of GCS gum or Arabic gum and was ranged from 50 B.U. for dough sample with 10 and 15% Arabic gum and dough sample with 15% GCS gum to 70 B.U. for dough sample with 5% GCS gum when compared to the control one (70 B.U.). On contrast, Asghar *et al.* (2007) represented an increase in dough softening about 80 B.U. for dough sample with 3% Arabic gum, where the control dough sample was about 40 B.U. for degree of softness.

The Extensograph supplied information about the dough viscoelastic property (Walker and Hazelton, 1996). This equipment measures extensibility of dough for its resistance to extension. The combination of good extensibility and good resistance properties indicate desirable dough (Sahraiyan *et al.*, 2013). The effect of different GCS flour levels and incorporation of GCS gum or Arabic gum on the extensograph characteristics of dough are tabled in Table (3). In relation to elasticity (B.U.) was increased with the addition of GCS flour and incorporation of GCS gum or Arabic gum and was vary between 250 B.U. for dough sample with 5% GCS gum to 660 B.U. for dough sample with 15% Arabic gum, when compared to control dough (410 B.U.). These results are in accordance with those described by Sahraiyan *et al.* (2013) who measured the effect of *Lepidium Sativum* seed gum on the dough extensograph characteristics. Additionally, they reported that the sample with maximum level of *Lepidium Sativum* seed gum (1.0%) recorded the highest elasticity (resistance to extension) at 20 min and 65 min (710 ± 9.0 and 450 ± 4.0 B.U., respectively).

The extensibility (E) (Mm) was decreased with increasing level of GCS flour and was vary between 60 Mm for dough with 5% GCS gum to 80 Mm for dough with 5% Arabic gum when compared to control dough (100 Mm). Moreover, Sahraiyan *et al.* (2013) stated that the extensibility (E) was increased with increasing level of *Lepidium Sativum* seed gum from 0.3% (155 ± 5.0) to 0.6% (165 ± 7.1) and then was decreased at 1.0% (105 ± 4.0l) in rice-wheat bread recipes.

On the other hand, the results indicated that the proportional number (P.N.) (ratio of R/E) was increased in all dough samples when compared to the control dough. The P.N. predicts dough handling properties and dough fermentation tolerance. So an increase promoted by addition suggests good handling properties and a large dough tolerance at the fermentation stage (Rosell *et al.*, 2001). Moreover, P.N. was increased with the addition of GCS flour and incorporation of GCS gum or Arabic gum and was vary between 4.17 for dough with 5% GCS gum to 10.15 for dough sample with 15% Arabic gum when compared to control one (4.10). On the other hand, Sahraiyan *et al.* (2013) indicated that P.N. was increased with the addition of *Lepidium Sativum* seed gum and was recorded 6.76 ± 0.27 when compared to the control (1.28 ± 0.00).

Also, results showed that energy (Cm^2) value was decreased to 26 Cm^2 for dough with 5 % GCS gum thereafter was increased to 74 Cm^2 for dough with 10% GCS gum afterwards was decreased to 51 Cm^2 for dough with 15% GCS gum, when compared to the control (68 Cm^2). Also, dough sample with 10 % Arabic gum was increased to 83 Cm^2 then, 15% Arabic gum was decreased to 56 Cm^2.

In brief, GCS gum and Arabic gum addition resulted in an increase in water absorption, arrival time, dough development time, stability, elasticity and proportional number. On the other hand, GCS gum and Arabic gum addition produced a decrease in degree of softness, extensibility and energy. These outcomes are in accordance with prior studies conducted by Elkhalifa *et al.* (2007) who cited that the addition of guar gum rose water absorption, dough development time and dough stability. On contrast, the addition of gum Arabic with or without guar gum dropped water absorption, dough development time and dough stability. These information are in agreement with the facts quoted by Asghar *et al.* (2007) who cited that arrival time augmented to 3.0 min for sample with 3% Arabic gum, where the control was scored 1.5 min. Whereas, dough stability for sample with 3% Arabic gum was 17 min, where the control was scored 12 min. When, dough development time was also grew 9 min, where the control was scored 4.5 min. In harmony, Abdulmola and Elbah (2012) cited that water absorption, development time and dough stability were grew upon adding 0.50%, 0.75%, and 1% of Arabic gum to wheat flour. Inversely, degree of dough softening was lessened. Likely, Sahraiyan *et al.* (2013) studied the effect of guar, GCS gum and guar-GCS gum in rice-wheat flour at levels of 0%, 0.3%, 0.6% and 1% w/w on flour basis. The GCS gum incorporation increased water absorption, dough development time, dough stability and viscosity. The extensibility value was increased with increasing gum concentrations from level 0.3% to level 0.6% and then dropped at 1% level.

2. Effect of Garden Cress Seed Gum and Arabic Gum addition on Pan Bread Properties:

Results in Tables (4, 5, 6 and 7) showed the effect of garden cress seed gum and Arabic gum addition on physical properties, sensory properties, color parameters and texture profile analysis in pan bread samples.

Effect on Physical Properties in Pan Bread Samples:

Physical properties of prepared pan bread namely weight, volume, specific volume, density, height and index to volume with different levels of garden cress seed flour with the addition of 0.1% GCS gum compared with 3% Arabic gum addition is enrolled in Table (4). The weight after baking was weighted statistically the highest value at pan bread sample with 30% GCS gum (185 ± 4.24 g), and was weighted statistically the lowest value at pan bread sample with 5% Arabic gum (141 ± 5.66 g), when the control one was weighted (152 ± 2.12 g). It is observed that weight was increased significantly with increasing GCS flour level and the GCS gum and Arabic gum addition.

It is clear from the data given in Table (4) that the volume was measured statistically the highest at control pan bread sample (393 ± 4.95cm^3), and was measured statistically the lowest at pan bread sample with 30% GCS gum (230 ± 4.24 cm^3) and pan bread sample with 30% Arabic gum (230 ± 6.36 cm^3). It is obvious that volume was decreased significantly with increasing GCS flour level and the GCS gum and Arabic gum addition. It is obvious from the facts located in Table (4) that the specific volume was measured statistically the highest at control sample (2.59 ± 0.06 cm^3/g), and was measured statistically the lowest at pan bread sample with 30% GCS gum (1.24 ± 0.06 cm^3/g). It is lucid that specific volume was reduced significantly with increasing GCS flour level and the GCS gum and Arabic gum addition.

Table 4. Physical Properties of Prepared Pan Bread with Different Percentages of Garden Cress Seed Flour with addition of 0.1% GCS Gum compared with 3% Arabic Gum

Characteristics	Control*	GCS[1] gum					Arabic gum				
		5%	10%	15%	20%	30%	5%	10%	15%	20%	30%
Weight before Baking (g)	176± 3.54^{bcd}	167± 3.54^{d}	183± 4.95^{bc}	169± 4.95^{cd}	191± 6.36^{a}	205± 7.07^{a}	167± 2.83^{d}	180± 2.83^{bcd}	167± 3.54^{d}	186± 3.54^{b}	195± 4.24^{a}
Weight after Baking (g)	152± 2.12^{def}	144± 3.54^{ef}	157± 2.83^{bcd}	153± 4.24^{cd}	162± 4.95^{b}	185± 4.24^{a}	141± 5.66^{f}	152± 4.95^{cde}	148± 4.95^{f}	153± 3.54^{cde}	167± 4.95^{bc}
% Weight after Baking	86.36	86.23	85.79	90.53	84.82	90.24	84.43	84.44	88.62	82.26	85.64
% Change in Weight (comparison to control)	100	94.74	103.29	100.66	106.58	121.71	92.76	100	97.37	100.66	109.87
Volume (cm^3)	393 ± 4.95^{a}	315 ± 7.07^{c}	320 ± 9.19^{c}	235 ± 4.24^{e}	287 ± 11.31^{d}	230 ± 4.24^{e}	355 ± 4.24^{b}	343 ± 6.36^{b}	355 ± 4.95^{b}	240 ± 3.54^{e}	230 ± 6.36^{e}
% Change in Volume (comparison to control)	100	80.15	81.42	59.80	73.03	58.52	90.33	87.28	90.33	61.07	58.52
Specific Volume (cm^3/g)	2.59± 0.06^{a}	2.19± 0.06^{cd}	2.04± 0.08^{d}	1.54± 0.09^{fg}	1.77± 0.06^{e}	1.24 ± 0.06^{h}	2.52± 0.05^{b}	2.26± 0.06^{c}	2.40± 0.06^{b}	1.57± 0.04^{ef}	1.38± 0.04^{gh}
Density (g/cm^3)	0.39± 0.03^{e}	0.46± 0.04^{de}	0.49± 0.05^{cd}	0.65± 0.04^{bc}	0.56± 0.04^{cd}	0.80± 0.06^{a}	0.40± 0.06^{e}	0.44± 0.06^{e}	0.42± 0.05d^{e}	0.64± 0.03^{b}	0.73± 0.06^{b}
Height (cm)	3.5± 0.06^{a}	3.3± 0.06^{ab}	3.14± 0.07^{b}	2.94± 0.45^{c}	2.84± 0.07^{c}	2.54± 0.06^{cd}	3.06± 0.10^{b}	2.84± 0.09^{c}	3.13± 0.07^{b}	2.32± 0.04^{d}	2.62± 0.03^{cd}
% Change in Height (comparison to control)	100	94.29	89.71	84	81.14	72.57	87.43	81.14	89.43	66.29	74.86
Index to Volume (cm)	5.35± 0.06^{a}	5.07± 0.05^{b}	4.73± 0.08^{de}	4.93± 0.08^{c}	4.86± 0.08^{cd}	4.64± 0.05^{de}	5.09± 0.07^{b}	5.07± 0.09^{b}	4.84± 0.06^{cd}	4.55± 0.05^{e}	4.74± 0.07^{de}

[1]GCS: Garden Cress Seed.
Each value is the mean of 3 replicates ± SD.
Values in the same row with different superscript letters (a, b,.) are significantly different ($P \leq 0.05$).
***Control: 100% wheat extraction 72%.**

Concerning, density was measured statistically the highest at pan bread sample with 30% GCS gum (0.80 ± 0.06 g/cm^3), and was measured the lowest at control pan bread sample (0.39 ± 0.03 g/cm^3). It is clear that density was increased significantly with increasing GCS flour level and the GCS gum and Arabic gum addition. When about, height was measured the highest at control pan bread sample (3.5 ± 0.06 cm), and was measured statistically the lowest at pan bread sample with 30% GCS gum (2.54 ± 0.06 cm). Data clarified that height was reduced with increasing GCS flour level and the GCS gum and Arabic gum addition.

Results in Table (4) indicated that index to volume was measured the highest at control pan bread sample (5.35 ± 0.06 cm), and was measured statistically the lowest at pan bread sample with 30% GCS gum (4.64 ± 0.05 cm) and pan bread sample with 20% Arabic gum (4.55 ± 0.05 cm). Results also, clarified that index to volume was reduced significantly with increasing GCS flour level and the GCS gum and Arabic gum addition.

Likely, Marpalle *et al.* (2014) exhibited that bread volume and specific volume were not much excited at level of 5 g flaxseed /100 g wheat flour. On the other hand, bread volume and specific volume were lessened significantly beyond 5% flaxseed substitution. Where, Wang *et al.* (2002) reasoned the decrease in bread volume and specific volume to arising from the dilution of gluten and interference of lignans and dietary fibers in the gluten network. Since, Bartkiene *et al.* (2014) exhibited that 10% fermented defatted flaxseed incorporation have a positive effect on specific volume of wheat - flaxseed bread. Further, Sahraiyan *et al.* (2013) studied the effect of guar, *L. sativum* seed and guar- *L. sativum* seed gum in rice-wheat flour at levels of 0%, 0.3%, 0.6% and 1% w/w on flour basis. Additionally, Sahraiyan *et al.* (2013) noticed an increase in specific volume where, statistically the highest increase was at bread sample with 1% *L. sativum* seed and 1% guar gum. Where, Barcenas *et al.* (2009) explained that because Arabic gum considered an effective improver in diminishing crumb hardness and rising bread specific volume and it also is an ineffective gluten hydrator. That Arabic gum consists of a branched but compact structure and inhibits reaction between polar groups with gluten peptide chains. Arabic gum targeted starch viscometric properties.

While, Faid (2013) studied the effect of the substitution of wheat flour with 5, 10 and 15% of Arabic gum on the physical properties. It could be noticed that, Arabic gum replacement heightened bread weight, volume and specific volume. Also, Abdulmola and Elbah (2012) studied the effect of addition at levels 0.50%, 0.75%, and 1% of Arabic gum on the volume and height of bread. Additionally, they cited that adding Arabic gum to wheat flour led to increasing dough gas retention capacity by forming gum Arabic-gluten network, hence, prompt bread volume and height.

Effect on Sensory Properties in Pan Bread Samples:

Sensory properties of different prepared pan bread samples are stated in Table (5) and Figure (1). It is observed from the results in Table (5) that there was no significant (P < 0.05) difference observed between control, 5% GCS gum and 5% Arabic gum (4.90 ± 0.30, 4.67 ± 0.48 and 4.71 ± 0.46, respectively) in pan bread appearance. Where, statistically the lowest score was for pan bread sample with 30 % Arabic gum and 30% GCS gum (1.48 ± 0.60 and 1.76 ± 0.70, respectively).

Table 5. Effect on Sensory Properties of Different Prepared Pan Bread Samples

Samples		Appearance	Crust Color	Crumb Color	Cell Size	Cell Uniformity	Texture	Taste	Odor	General Acceptability
Control		4.90 ± 0.30^{a}	4.86± 0.36^{a}	4.95 ± 0.22^{a}	4.95 ± 0.22^{a}	4.95 ± 0.22^{a}	5.00 ± 0.00^{a}	5.00 ± 0.00^{a}	4.81 ± 0.40^{a}	4.86 ± 0.36^{a}
GCS[1] Gum	5%	4.67± 0.48^{ab}	4.52± 0.51^{ab}	4.81± 0.40^{ab}	4.52± 0.51^{b}	4.48± 0.51^{b}	4.76± 0.44^{ab}	4.48± 0.51^{b}	4.43± 0.51^{bc}	4.43± 0.51^{b}
	10%	4.48± 0.51^{b}	4.38± 0.50^{b}	4.62± 0.50^{ab}	4.33± 0.91^{bc}	3.24± 0.44^{de}	4.43± 0.51^{c}	4.00± 0.71^{cd}	4.24± 0.44^{bcd}	4.19± 0.40^{bc}
	15%	3.95± 0.86^{c}	3.90± 0.70^{c}	3.86± 0.85^{c}	4.05± 0.74^{c}	3.05± 0.86^{e}	3.95± 0.59^{d}	3.62± 0.80^{ef}	4.00± 0.71^{de}	3.90± 0.70^{cd}
	20%	2.33± 0.58^{d}	2.62± 1.07^{e}	2.90± 0.77^{d}	2.76± 0.62^{d}	2.10± 0.83^{f}	3.24± 0.44^{e}	3.43± 0.51^{f}	3.52± 0.51^{f}	3.38± 0.50^{e}
	30%	1.76± 0.70^{e}	1.67± 0.80^{f}	1.48± 0.68^{e}	1.33± 0.48^{f}	1.29± 0.46^{g}	1.24± 0.44^{g}	1.29± 0.46^{h}	1.33± 0.48^{h}	1.33± 0.48^{g}
Arabic Gum	5%	4.71± 0.46^{ab}	4.57± 0.51^{ab}	4.57± 0.51^{b}	4.52± 0.51^{b}	4.43± 0.51^{bc}	4.57± 0.51^{bc}	4.33± 0.48^{bc}	4.57± 0.60^{ab}	4.52± 0.51^{ab}
	10%	4.48± 0.51^{b}	4.33± 0.66^{b}	4.19± 0.40^{c}	4.38± 0.50^{bc}	4.10± 0.70^{c}	4.29± 0.78^{c}	4.24± 0.62^{bc}	4.19± 0.81^{cd}	4.43± 0.51^{b}
	15%	3.67± 0.48^{c}	3.38± 0.50^{d}	3.00± 0.71^{d}	3.00± 0.89^{d}	3.48± 0.60^{d}	3.95± 0.67^{d}	3.81± 0.75^{de}	3.76± 0.77^{ef}	3.67± 0.66^{de}
	20%	2.62± 0.50^{d}	2.29± 0.90^{e}	1.43± 0.60^{e}	2.14± 0.79^{e}	2.29± 0.78^{f}	2.62± 0.50^{f}	2.52± 0.75^{g}	2.76± 0.77^{g}	2.14± 0.85^{f}
	30%	1.48± 0.60^{e}	1.29± 0.56^{f}	1.14± 0.36^{e}	1.14± 0.36^{f}	1.19± 0.40^{g}	1.33± 0.48^{g}	1.24± 0.44^{h}	1.33± 0.48^{h}	1.38± 0.67^{g}

[1]GCS: Garden Cress Seed.

Each value is the mean of 20 replicates ± SD.

Values in the same column with different superscript letters (a, b,.) are significantly different (P ≤ 0.05).

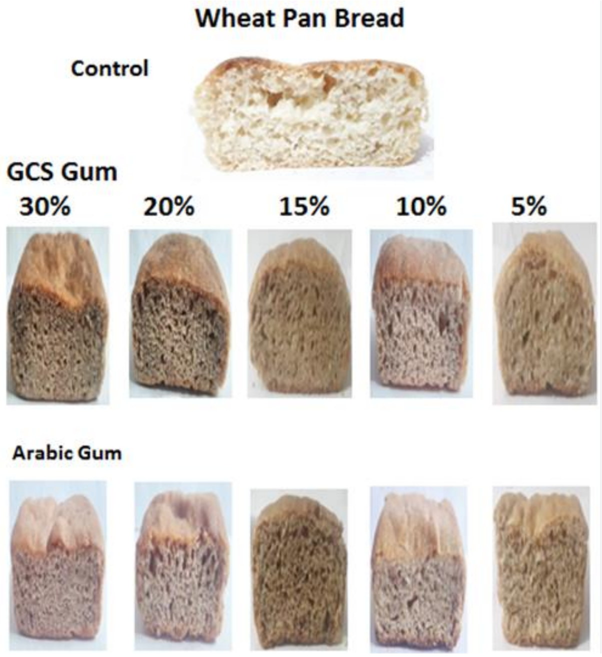

Figure 1. Effect on Photographic Appearance of Different Prepared Pan Bread Samples

Respecting pan bread crust color, the control pan bread sample (4.86± 0.36) was noticed closed to pan bread sample with 5% GCS gum and 5% Arabic gum (4.52± 0.51 and 4.57 ± 0.51, respectively). Where, statistically the lowest score was for pan bread sample with 30% Arabic gum and 30% GCS gum (1.29 ± 0.56 and 1.67 ± 0.80, respectively). As for pan bread crumb color, control pan bread sample (4.95 ± 0.22) was noticed closed to pan bread sample with 5% and 10% GCS gum (4.81 ± 0.40 and 4.62 ± 0.50, respectively). Where, the lowest score was for pan bread sample with 30% Arabic gum and 30% GCS gum (1.14 ± 0.36 and 1.48 ± 0.68, respectively). Results indicated that statistically the highest cell size score was for the control one (4.95 ± 0.22). Whereas, the lowest score was for pan bread sample with 30 % Arabic gum and 30% GCS gum (1.14 ± 0.36 and 1.33 ± 0.48, respectively). In case of cell uniformity, the highest score was for the control one (4.95 ± 0.22). While, the lowest score was for pan bread sample with 30 % Arabic gum and 30% GCS gum (1.19 ± 0.40 and 1.29 ± 0.46, respectively).

Concerning texture, Table (5) indicated that texture of control pan bread sample (5.00 ± 0.00) was noticed closed to pan bread sample with 5% GCS gum (4.76 ± 0.44). While, the lowest score was for pan bread samples with 30% GCS gum and 30 % Arabic gum (1.24 ± 0.44 and 1.33 ± 0.48, respectively). As for odor, there was no significant (P < 0.05) difference observed between the control sample (4.81 ± 0.40) and pan bread sample with 5% Arabic gum (4.57 ± 0.60). When, pan bread samples with 30% GCS gum and 30 % Arabic gum were the same (1.33 ± 0.48), considered statistically the lowest samples. In terms of general acceptability, there was no significant (P < 0.05) difference observed between the control sample (4.86 ± 0.36) and pan bread sample with 5% Arabic gum (4.52 ± 0.51). When, pan bread samples with 30% GCS gum and 30 % Arabic gum were statistically the lowest ones (1.33 ± 0.48 and 1.38 ± 0.67, respectively).

In harmony, Asghar *et al.* (2007) concluded that 3% Arabic gum can improve the overall acceptability of frozen dough pizza. According to Marpalle *et al.* (2014), it was pointed out that darkness of bread crust and crumb were increased significantly with increasing flaxseed level, summarizing that 10% roasted ground flaxseed was acceptable based on sensory evaluation. In accordance, Sahraiyan *et al.* (2013) studied the effect of guar, *L. sativum* seed and guar-*L. sativum* seed gum in rice-wheat flour at levels of 0%, 0.3%, 0.6% and 1% w/w on flour basis. In addition, Sahraiyan *et al.* (2013) showed that all rice-wheat bread samples were acceptable sensorial. Also, Faid (2013) studied the effect of the substitution of wheat flour with 5, 10 and 15% Arabic gum on the organoleptic properties. And resulted that organoleptic properties of pan bread showed their gradually improvement in all properties (crust color, crust quality, bread volume, crumb color, crumb grain, texture, taste and aroma). Identically, Alaunyte *et al.* (2012) reported that the growing interest in the benefits of whole grain products has resulted in the development of baked products incorporating less utilized raw materials. However, addition of whole grains can have detrimental effects on textural and sensory bread product qualities.

Rana and Kaur (2016) reveals out the effect of Germinated Garden Cress Seed Flour (GGCSF) supplementation into biscuits. The sensory characteristics vary according to the garden cress seed levels. GGCS biscuits were desirable in terms of color, texture and taste. The most acceptable ratio was 10% GGCS based on good sensory evaluation. Hence, Rana and Kaur (2016) concluded that GGCSF fortified bakery products should be incorporated in malnutrition intervention program to defeat iron deficiency.

3-Effect on Color Parameters in Pan Bread Samples:

Color parameters of different prepared pan bread samples are illustrated in Table (6). It is apparent from the facts given in Table (6) that *L* value that describes lightness (whiteness and brightness) was decreased significantly with the addition of GCS flour in combination with GCS gum or Arabic gum. So, the control pan bread sample (65.44 ± 0.21) was displayed the highest *L* value. When, pan bread sample with 15% GCS gum (36.55 ± 0.29) was considered statistically the lowest in *L* value. Furthermore, Table (6) clarified that *a* value (-green, + red) that describes the tendency to redness when it is positive (if *a* > 0) was increased significantly with the addition of GCS flour in combination with GCS gum or Arabic gum. So that pan bread sample with 20% GCS gum (11.44 ± 0.17) was considered statistically the highest in *a* value. While, the control pan bread sample (5.24 ± 0.18) was scored statistically the lowest *a* value.

It is evident that *b* value (-blue, +yellow) that describes yellowness was increased significantly with the addition of GCS flour in combination with GCS gum or Arabic gum. So that pan bread sample with 10% GCS gum (25.26 ± 0.38) was scored statistically the highest in *b* value. While, there was no significant difference observed between the control and pan bread sample with 30% GCS gum (21.58 ± 0.34 and 21.35 ± 0.18, respectively). Whereas, *b* value of pan bread sample with 30% Arabic gum (17.96 ± 0.54) was observed the lowest *b* value. When, Chroma index was increased significantly with the addition of GCS flour in combination with GCS gum or Arabic gum. Therefore, pan bread samples with 10 and 20% GCS gum (27.03 ± 0.23 and 27.44 ± 0.38, respectively) were noticed statistically the highest values when compared to the control (22.21 ± 0.54). Where, significantly the lowest was pan bread sample with 30% Arabic gum (19.86 ± 0.38).

Table 6. Effect on Color Parameters of Different Prepared Pan Bread

Samples		Color Parameters					
		L	*a*	*b*	Chroma Index	Hue	BI
Control		65.44 ±0.21^{a}	5.24 ±0.18^{g}	21.58 ±0.34^{d}	22.21 ±0.54^{e}	76.35 ±0.45^{a}	47.06 ±0.26^{i}
GCS[1] gum	5%	50.07 ±0.37^{e}	7.26 ±0.10^{e}	23.20 ±0.28^{c}	24.31 ±0.24^{d}	72.62 ±0.34^{c}	70.59 ±0.23^{f}
	10%	50.34 ±0.33^{e}	9.61 ±0.08^{c}	25.26 ±0.38^{a}	27.03 ±0.23^{ab}	69.17 ±0.36^{d}	82.35 ±0.25^{d}
	15%	36.55 ±0.29^{i}	7.87 ±0.40^{e}	19.53 ±0.30^{e}	21.06 ±0.28^{f}	68.05 ±0.22^{e}	88.24 ±0.35^{c}
	20%	46.15 ±0.39^{f}	11.44 ±0.17^{a}	24.94 ±0.52^{b}	27.44 ±0.38^{a}	65.36 ±0.02^{f}	94.12 ±0.40^{b}
	30%	38.02 ±0.24^{h}	10.26 ±0.11^{b}	21.35 ±0.18^{d}	23.69 ±0.21^{d}	64.33 ±0.08^{g}	100.00 ±0.42^{a}
Arabic gum	5%	59.65 ±0.08^{b}	6.63 ±0.37^{f}	23.11 ±0.35^{c}	24.04 ±0.35^{d}	73.99 ± 0.62^{b}	58.82 ±0.49^{h}
	10%	57.52 ±0.27^{c}	7.80 ±0.28^{e}	24.66 ±0.40^{b}	25.86 ±0.38^{c}	72.45 ±0.30^{c}	64.71 ±0.06^{g}
	15%	52.78 ±0.47^{d}	8.62 ±0.23^{d}	22.49 ±0.29^{c}	24.09 ±0.40^{d}	69.03 ±0.11^{d}	64.71 ±0.36^{g}
	20%	52.84 ±0.36^{d}	9.66 ±0.40^{c}	24.52 ±0.23^{b}	26.35 ±0.45^{b}	68.50 ±0.35^{de}	76.47 ±0.06^{e}
	30%	40.25 ±0.29^{g}	8.47 ±0.33^{d}	17.96 ±0.54^{f}	19.86 ± 0.38^{g}	64.75 ±0.44^{g}	70.59 ±0.42^{f}

[1]GCS: Garden Cress Seed.
Each value is the mean of 2 replicates ± SD.
Values in the same column with different superscript letters (a, b,.) are significantly different (P ≤ 0.05).

Concern hue was lessened significantly with the addition of GCS flour in combination with GCS gum or Arabic gum. Consequently, the control sample (76.35 ± 0.45) was displayed statistically the highest value. Hence, pan bread samples with 30% GCS gum and 30% Arabic gum (64.33 ± 0.08 and 64.75 ± 0.44, respectively) were displayed statistically the lowest value. With regard to browning index (BI) was enlarged significantly with the addition of GCS flour in combination with GCS gum or Arabic gum. Consequently, the control pan bread sample (47.06 ± 0.26) was displayed statistically the lowest value. Hence, pan bread sample with 30% GCS gum (100.00 ± 0.42) was displayed significantly the highest value.

In harmony, Marpalle *et al.* (2014) exposed that the pan bread *L* and *b* values were statistically observed a significant decrease along with increasing flaxseed flour level, resulted from the initial dark flaxseed flour color, arising from the products of maillard reaction between flaxseed phenolic compounds and proteins. While, pan bread *a* value were observed a significant ($p < 0.05$) increase along with increasing flaxseed flour level. Parallel, Ahmed (1999) observed a significant increase in redness and a significant decrease in lightness of flaxseed snacks.

Similarly, Ishida and Steel (2014) resulted that the white pan bread and whole wheat grain pan bread samples *L* and *a* values were 74.73, 64.45, 0.37 and 3.85, respectively. The values were showing that the whole grain pan bread samples were more reddish in color than the white pan bread samples. The white pan bread and whole wheat grain pan bread samples *b* values were 15.51 and 18.98, respectively, exposing that the whole grain pan bread samples were also more yellowish in color than the white pan bread samples. Likely, Esteller and Lannes (2005) exposed that the *L*, *a* and *b* values of white pan bread were scored 62.37, 1.14 and 10.88, respectively.

Effect on Texture Profile Analysis in Pan Bread Samples:

Texture profile analysis (TPA) of different prepared pan bread samples is tabled in Table (7). It is plain from the information established in Table (7) that hardness was heightened significantly with the addition of GCS flour in combination with GCS gum or Arabic gum. Where, pan bread sample with 15% Arabic gum (9.51 ± 0.37) was displayed statistically the lowest while the control one was scored 10.67 ± 0.40. Hence, pan bread sample with 5% GCS gum (20.67 ± 0.78) was displayed statistically the highest score. Table (7) exhibited that adhesiveness was heightened significantly with the addition of GCS flour at pan bread sample with 5% GCS gum (0.60 ± 0.21) then was dropped significantly at pan bread samples with 10 and 15% Arabic gum (0.00 ± 0.03 and 0.00 ± 0.02, respectively). When, the control sample was scored 0.10 ± 0.06.

Results showed in Table (7) indicated that resilience was decreased significantly at pan bread samples with 5, 10, 15 and 20% GCS gum (0.50 ± 0.05, 0.51 ± 0.04, 0.53± 0.02 and 0.56 ± 0.04, respectively), then increased significantly at pan bread sample with 30% GCS gum (0.63 ± 0.05), when compared to the control sample (0.63 ± 0.04). Further, there was no significant difference observed between the control and pan bread sample with 30% GCS gum (0.63 ± 0.04 and 0.63 ± 0.05, respectively) and were considered statistically the highest values. Where, pan bread sample with 20% Arabic gum (0.39 ± 0.03) was recorded statistically the lowest value.

Results exhibited that cohesiveness was dropped significantly with the addition of GCS flour in combination with GCS gum or Arabic gum. Therefore, the control and pan bread sample with 15% Arabic gum (1.16 ± 0.02 and 1.14 ± 0.07, respectively) were recorded statistically the highest value. Pan bread sample with 20% Arabic gum (0.82 ± 0.08) was noticed statistically the lowest value. Data indicated that springiness was grown significantly with the addition of GCS flour in combination with GCS gum or Arabic gum. Pan bread samples with 5, 15% GCS gum and 5% Arabic gum (2.35 ± 0.06, 2.35 ± 0.05 and 2.35 ± 0.03, respectively) was displayed statistically the highest score. Pan bread sample with 15% Arabic gum (1.94 ± 0.07) was observed statistically the lowest value. Table (7) pointed that gumminess was flourished significantly at pan bread sample with 5% GCS gum (19.70 ± 0.04) then was decreased significantly at the rest of samples. Pan bread sample with 15% Arabic gum (11.10 ± 0.06) was displayed statistically the lowest value.

Table 7. Effect on Texture Profile of Different Prepared Pan Bread Samples

Samples		Hardness	Adhesiveness	Resilience	Cohesiveness	Springiness	Gumminess	Chewiness
Control		10.67± 0.40^{fg}	0.10± 0.06^{de}	0.63± 0.04^{a}	1.16± 0.02^{a}	2.16± 0.05^{bc}	12.71± 0.03^{h}	27.50± 0.03^{h}
GCS[1] gum	5%	20.67± 0.78^{a}	0.60± 0.21^{a}	0.50± 0.05^{bc}	0.93± 0.04^{bc}	2.35± 0.06^{a}	19.70± 0.04^{a}	46.30± 0.03^{a}
	10%	13.61± 0.78^{cd}	0.10± 0.05^{de}	0.51± 0.04^{bc}	0.88± 0.04^{e}	2.10± 0.10^{bc}	12.47± 0.04^{i}	26.20± 0.06^{i}
	15%	14.42± 0.60^{c}	0.20± 0.04^{cd}	0.53± 0.02^{bc}	0.99± 0.02^{bc}	2.35± 0.05^{a}	14.67± 0.04^{d}	34.50± 0.03^{c}
	20%	13.06± 0.52^{cd}	0.30± 0.02^{bc}	0.56± 0.04^{b}	0.97± 0.04^{bcd}	2.27± 0.06^{b}	12.96± 0.09^{g}	29.40± 0.05^{f}
	30%	12.20± 0.40^{de}	0.40± 0.03^{b}	0.63± 0.05^{a}	1.05± 0.03^{b}	2.14± 0.06^{c}	13.15± 0.08^{f}	28.20± 0.05^{g}
Arabic gum	5%	13.24± 0.43^{cd}	0.20± 0.04^{cd}	0.44± 0.03^{de}	0.99± 0.06^{bc}	2.35± 0.03^{a}	13.41± 0.06^{e}	31.50± 0.05^{e}
	10%	11.53± 0.70^{ef}	0.00± 0.03^{e}	0.46± 0.04^{de}	1.00± 0.06^{bc}	1.96± 0.10^{d}	11.96± 0.04^{j}	23.40± 0.04^{j}
	15%	9.51± 0.37^{g}	0.00± 0.02^{e}	0.54± 0.03^{bc}	1.14 ± 0.07^{a}	1.94± 0.07^{d}	11.10± 0.06^{k}	21.50± 0.06^{k}
	20%	18.71± 1.24^{b}	0.10± 0.03^{de}	0.39± 0.03^{e}	0.82± 0.08^{de}	2.12± 0.06^{bc}	16.12± 0.06^{c}	34.20± 0.06^{d}
	30%	18.04± 0.86^{b}	0.20± 0.04^{cd}	0.47± 0.02^{cd}	0.90± 0.06^{cde}	2.16± 0.04^{bc}	16.79± 0.04^{b}	36.30± 0.06^{b}

[1]GCS: Garden Cress Seed.
Each value is the mean of 2 replicates ±SD.
Values in the same column with different superscript letters (a, b,.) are significantly different (P≤ 0.05).

Table (7) pointed that chewiness was flourished significantly with the addition of GCS flour in combination with GCS gum or Arabic gum. The lowest value was noticed for pan bread sample with 15% Arabic gum (21.50 ± 0.06) and the highest value was noticed for pan bread sample with 5% GCS gum (46.30 ± 0.03) when the control sample was scored 27.50 ± 0.03. These results are in accordance with Soibe *et al.* (2015) who mentioned that bread hardness was grew with the addition of plantain (10-40%). Interestingly, 3% Arabic gum addition was lowered bread hardness. Further, plantain bread samples with 2% or 3% Arabic gum showed minimal springiness. Furthermore, there was no significant difference observed in cohesiveness and resilience when gumminess was increased significantly. Finally, Soibe *et al.* (2015) summarized that 3% Arabic gum addition was garnished bread texture.

Plausible, Cui *et al.* (1994) explained that gumminess was multiplied with increasing the flaxseed flour level, because of the increased water absorption due to the presence of flaxseed gum, through decreasing water holding capacity of gluten and thus increased gumminess. Likely, Marpalle *et al.* (2014) mentioned that flaxseed gum displayed at higher levels shear thinning behavior due to the presence of Arabinoxylan, so little decrease in gumminess was observed at bread with 15 % flaxseed flour than at the bread with 10 % flaxseed flour.

4. Bioactive Compounds:

Effect on Total Phenolics Content, Total Flavonoids Content and DPPH Radical Scavenging Activity of Different Prepared Pan Bread Samples:

Total phenolic compounds content, total flavonoids content and DPPH % radical scavenging activity of different prepared pan bread samples are illustrated in Table (8). It is observed that total phenolic content (TPC) was increased significantly with the addition of GCSF. The highest amount of TPC was observed in pan bread sample with 5 and 15% Arabic gum (0.47 ± 0.02 and 0.48 ± 0.02 mg GAE/g, respectively). While, the lowest amount of TPC was in pan bread samples with 5 and 15% GCS gum (0.13 ± 0.07 and 0.13 ± 0.08 mg GAE/g, respectively). While, results of TPC control sample was 0.27 ± 0.03 mg GAE/g.

Table 8. Effect on Total Phenolic Content, Total Flavonoid Content and DPPH Radical Scavenging Activity of Different Prepared Pan Bread Samples

Pan Bread Samples		Total Phenolic Content mg GAE/g	Total Flavonoid Content mg RE/g	DPPH Radical Scavenging Activity %
Control		0.27 ± 0.03^{c}	4.28 ± 5.47^{a}	75.32 ± 3.63^{e}
GCS[1] Gum	5%	0.13 ± 0.07^{d}	4.42 ± 5.20^{a}	84.09 ± 2.34^{cd}
	10%	0.21 ± 0.02^{cd}	5.72 ± 3.54^{a}	84.09 ± 2.34^{cd}
	15%	0.13 ± 0.08^{d}	4.98 ± 4.67^{a}	89.39 ± 1.56^{ab}
	20%	0.20 ± 0.10^{cd}	5.26 ± 4.14^{a}	92.39 ± 1.49^{a}
	30%	0.20 ± 0.12^{cd}	5.16 ± 4.94^{a}	93.67 ± 0.78^{a}
Arabic Gum	5%	0.47 ± 0.02^{a}	4.67 ± 5.08^{a}	87.56 ± 1.83^{bc}
	10%	0.42 ± 0.02^{ab}	5.06 ± 5.25^{a}	90.21 ± 1.44^{ab}
	15%	0.48 ± 0.02^{a}	5.11 ± 5.23^{a}	82.46 ± 2.58^{d}
	20%	0.31 ± 0.02^{bc}	5.14 ± 5.20^{a}	90.11 ± 0.32^{ab}
	30%	0.18 ± 0.05^{cd}	4.97 ± 5.17^{a}	90.55 ± 0.79^{ab}

[1]GCS: Garden Cress Seed.
Each value is the mean of 2 replicates ±SD.
Values in the same column with different superscript letters (a, b,.) are significantly different (P≤ 0.05).

Respecting total flavonoids content (TFC), there was no significant difference observed between bread samples. TFC was ranged from 4.28 ± 5.47 mg RE/g for control sample to 5.72 ± 3.54 mg RE/g for pan bread sample with added 10% GCS gum. Table (8) figured out that DPPH % radical scavenging activity was increased significantly with the addition of GCSF. The lowest content was at pan bread control sample 75.32 ± 3.63 %, whereas the highest content was at pan bread sample with 30 and 20% GCS gum (93.67 ± 0.78 and 92.39 ± 1.49 %, respectively).

Likely, Vogrincic *et al.* (2010) displayed that the buckwheat flour supplementation to wheat flour had heightened the total phenols level and improves bread antioxidant content. In detailing, baking temperature affected the bioavailability of total phenols content and raised antioxidant activity in bread samples by Maillard's reaction products formation. Peng *et al.* (2010) explained that the phenolic compound reacted with starch and proteins of bread thus affected starch and protein digestibility, functional properties and antioxidant capacity of fortified bread.

5. Antimicrobial Activity:

Different prepared pan bread samples were stored up to 12 days at room (25±2ºC) and cooled (3 – 5ºC) temperature. Shelf life of different prepared pan bread samples prolonged storage period (12 Days) shown in table (9). All pan bread samples didn't show observed changes up to 5 days of storage under different storage condition (room and refrigerator temperature). Spoilage was pointed out by black, gray, brownish yellow and green coloration on the pan bread samples.

Table 9. Shelf Life of Different Prepared Pan Bread Samples Prolonged Storage Period (12 Days)

Pan Bread Samples		Shelf Life (days)	
		Room Temperature	Refrigerator Temperature
Control		8	NG*
GCS[1] gum	5%	6	7
	10%	6	NG
	15%	5	6
Arabic gum	5%	6	NG
	10%	6	NG
	15%	5	NG

[1]GCS: Garden Cress Seed. *NG: No growth observed.

Nevertheless at refrigerator temperature (3 – 5ºC), pan bread samples exceed prolonged storage period for 12 days, except sample with 5% and 15% GCS gum exceed up to 7 – 6 days of storage, respectively. However, pan bread sample with 15% of Arabic gum and GCS gum showed an observed microbial change after 5 days of storage under room storage temperature conditions.

In accordance, Ijah *et al.* (2014) mentioned that bread lasted for 6–8 days before noticing obvious spoilage, indicated by yellow, black and green coloration. And found that mold growth was consisted of *Penicillium* sp., *Aspergillus flavus, Mucor mucedo* and *Rhizopus stolonifer*. Explanatory Shama *et al.* (2011) demonstrated that GCS seeds contain benzyl isothiocyanate, flavonoids, tannins, triterpens, alkaloids, sterols and glucosinolates, which exhibited an antimicrobial effect. Particularly, Tannins inhibit protein synthesis by building an irreversible compound with proline-rich proteins. Abstractly, Rana and Kaur (2016) stated that preservatives stabled bakery products against fungi attack, helped to minimize food wastage caused by microorganism spoilage. Thus, preservatives usage resulted in longer shelf life for bakery products stored at store and home.

Effect of Storage Conditions on Total Fungi Count for Pan Bread Samples:

Results of pan bread samples for total fungi count during a storage period of 12 days are shown in Table (10). Table (10) demonstrated that there was no growth observed at the first day of storage for all samples at room and cooling temperature. In harmony, Unachukwu and Nwakanma (2015) exhibited on the first two days of storage that there was no growth observed for all samples. Also, Badr (2015) observed that pan bread samples have no detected growth at zero time of storage.

Table 10. Effect of Storage Conditions on Total Fungi Count for Pan Bread Samples

Pan Bread Samples		Room Temperature (cfu/g)			Refrigerator Temperature (cfu/g)		
		Day 1	Day 7	Day 12	Day 1	Day 7	Day 12
Control		NG*	NG	$57×10^2$	NG	NG	NG
GCS[1] gum	5%	NG	$1×10^2$	$64.9×10^2$	NG	NG	$4.2×10^2$
	10%	NG	$0.3×10^2$	$3.7×10^2$	NG	NG	NG
	15%	NG	$20.9×10^2$	$21×10^2$	NG	NG	$60.1×10^2$
Arabic gum	5%	NG	$0.1×10^2$	$30.9×10^2$	NG	NG	NG
	10%	NG	$1.3×10^2$	$46.2×10^2$	NG	NG	NG
	15%	NG	$25×10^2$	$32×10^2$	NG	NG	NG

[1]GCS: Garden Cress Seed. *NG: No growth observed.
Each value is the mean of 2 replicates.

Also, results in Table (10) showed that total fungi count was increased significantly with increasing of GCSF content at room temperature. Results of total fungi count was increased for pan bread samples prepared with 5 and 15% GCS gum ($1×10^2$ and $20.9×10^2$ cfu/g, respectively) at room temperature and other pan bread samples prepared with 5 and 15% Arabic gum ($0.1×10^2$ and $25×10^2$ cfu/g, respectively). Concerning to results of total fungi count at day 7 of refrigerator storage, there was no growth count observed for all pan bread samples.

While in the same Table at day 12 at room temperature, the growth was increased rapidly. Results noticed that at room temperature at pan bread sample with 5 and 15% GCS gum counted $64.9×10^2$ and $21×10^2$ cfu/g, respectively. While, other samples with 5 and 15% Arabic gum counted $30.9×10^2$ and $32×10^2$ cfu/g, respectively when compared to control one ($57×10^2$ cfu/g). Where, the pan bread sample prepared with 10% has observed the highest count $46.2×10^2$ cfu/g. In addition, at 12 days of refrigerator temperature storage there was no growth observed for pan bread samples with 5, 10 and 15% Arabic gum. Where, pan bread samples with 10% GCS gum have no growth observed.

In according, Unachukwu and Nwakanma (2015) demonstrated that bread over a storage period of 7 days had a fungal range of 6-8 x 10^3 cfu. With increasing storage period fungal count grew. Day 7 recorded the highest fungal count. Additionally, Unachukwu and Nwakanma (2015) isolated *Mucor spp, Aspergillus spp, Fusarium spp, Penicillium spp and Rhizopus spp* from stored bread.

In parallel, Badr (2015) determined total mold count during 12 days storage period at room temperatures in pan bread partially substituted of wheat flour with watermelon rind powder (WMRP) levels (3, 6, 9 and 12 %). In addition, they noted that control pan bread sample counted higher mold count (2.1, 3.2 and 5.2 log cfu /g) at 2, 4 and 6 days, respectively. While, pan bread samples with 3, 6, 9 and 12 % WMRP (1.7, 2.3, 2.8 and 5.2 log cfu /g) after 2, 4, 6 and 8 days, respectively.

Therefore, Badr (2015) concluded that the reduction of mold count may be ascribed to replacement with watermelon rind powder containing high level of phenolic compounds which inhibit or kill microbial growth and subsequently has a reduced microorganisms growth and a slow increase in microbial numbers, leading to increasing the antioxidant potential and shelf life with accepted sensory quality.

CONCLUSION

The addition of 0.1% GCS gum and 3% Arabic gum led to improve the rheological properties and antioxidant activity of pan bread and increasing the shelf life of stored pan bread at room temperature and at refrigerator temperature due to its increased phenolic compounds content. Results indicated that color parameters namely, *L* value and hue were decreased. When, *a* value, *b* value, Chroma index and browning index were observed a significant increase. Based on antioxidant activity results, Arabic gum increased the total phenolics content. Where, GCS gum was decreased the total phenolics content. There was no significant difference observed in total flavonoids content among all pan bread samples. While, Arabic gum and GCS gum increased DPPH % radical scavenging activity in all pan bread samples. These results indicated that pan bread samples containing GCS gum and Arabic gum had improved its shelf life. Based on physical, sensory, texture, antioxidant activity and microbiological analysis, pan bread samples with 5 and 10% GCS flour with incorporation of both Arabic gum and GCS gum were showed optimum properties and fitted for functional bread development.

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الإستفادة من صمغ حب الرشاد والصمغ العربي كصموغ طبيعية في تحسين الصفات الريولوجية والفيزيائية والحسية لخبز القوالب

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أجريت هذه الدراسة بغرض الإستفادة من صمغ حب الرشاد والصمغ العربي في تحسين الصفات الريولوجية والفيزيائية والحسية لخبز القوالب. تم تقدير الصفات الريولوجية للعجين, الصفات الفيزيائية, الحسية, اللون, القوام و المركبات الفعالة (المحتوي الكلي للفينولات و الفلافونيدات). تم استخدام 0.1% صمغ حب الرشاد المستخلص و 3% الصمغ العربي لتحضير خبز القوالب. تم تحضير عينات خبز القوالب بالإستبدال الجزئي لدقيق القمح بنسبة 5, 10, 15, 20 و 30% دقيق حب الرشاد. اظهرت نتائج الفارينوجراف والاكستنسوجراف أن اضافة نسبة 3% من الصمغ العربي عملت علي تحسين صفات الثبات, المطاطية و درجة النعومة بالمقارنة بالعينة الضابطة (الكنترول) والعينات المصنعة من صمغ حب الرشاد. أيضا أظهرت نتائج الصفات الفيزيائية (الوزن, الحجم, الحجم النوعي, الكثافة, الإرتفاع و مؤشر الحجم) أن عينات خبز القوالب المضاف لها 5% صمغ حب الرشاد والصمغ العربي كانت قريبة نسبيا إلي العينة الضابطة. وأظهرت أيضا نتائج تقدير المواد الفعالة حيويا أن اضافة حب الرشاد والصمغ العربي أدي إلي ارتفاع المحتوي الكلي من الفينولات ولم تظهر أي فروق معنوية بين العينات في المحتوي الكلي للفلافونيدات. بينما ازدادت قيم DPPH في كل عينات خبز القوالب بالمقارنة بالعينة الضابطة. تحت ظروف التخزين المختلفة (درجة حرارة الغرفة والثلاجة) لم تظهر عينات الخبز أي تغير ملحوظ حتي 5 أيام من ظروف التخزين المختلفة. وكانت مظاهر الفساد كتلون أسود, رصاصي, بني مصفر و أخضر علي عينات خبز القوالب. ويوصي بأن اضافة 0.1 % صمغ حب الرشاد و 3% صمغ عربي تعمل علي تحسين صفات خبز القوالب.

الكلمات المفتاحية: صمغ حب الرشاد, الصمغ العربي, خبز القوالب, الفارينوجراف, النشاط المضاد للأكسدة والنشاط الميكروبي.