Physicochemical Properties and Quality Characteristics of Pan Bread Fortified with Different Levels of Ginger; Technological Study

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Abstract:

Healthier foods are preferable for consumers to prevent non-communicable diseases. Therefore, researchers are involved to enhancing bread production technology to improve quality of bakery. The aim of research is to evaluate the effect of adding 2, 4 and 6% of ginger to wheat pan bread on physicochemical properties, rheological and quality characteristics. The results of tannins and saponins showed that the level of tannin in ginger was 0.024 mg/100g and non-detected in wheat. While the saponins in ginger were 4.59 mg /100g, they were not detected in wheat. Sensory evaluation showed that the overall acceptability of pan bread containing 2, 4, and 6% ginger powder was more acceptable to the committee members (40) than the levels of ginger at 10 and 12%. The chemical composition of pan bread with ginger 6% showed highest content of protein, fat, fiber and ash compared with raw wheat and pan bread of wheat. The values of antioxidant activity and total phenol were 35.23% and 160.23 mg/100g pan bread supplemented with 6% ginger compared to the values of pan wheat 20.74% and 118.26 mg/100g, respectively. The results showed that incorporation of low level of ginger up to 6% did not cause any pronounced change on dough characteristics and on bread rheological properties. The results of this study suggest that adding ginger powder at a level of 6% to pan bread can enhance the antioxidant, rheological, sensory qualities, and functional food characteristics in our daily diet.

Keyword: Ginger, Pan Bread, antioxidants, rheological and sensory properties

1. Introduction

Herbs play a significant role in the human diet and can be utilized as a constituent in the preparation of bread. Certain plant species such as ginger, grapefruit, and chamomile. play significant roles in promoting

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human health and well-being **(Hussain et al., 2015)**. It's worth noting that certain plants. Therefore, ginger is recognized for its numerous health advantages as a herb that can lower cholesterol levels. Ginger have been found to have hepatoprotective properties and are commonly consumed by humans **(Shakya, 2016)**.

Ginger (*Zingiber officinale)* is classified within the Zingiberaceae family and is commonly employed as a culinary additive in diverse global cuisines. According to **Zhukovets and Özcan (2020),** ginger is a rich source of antioxidants and contains numerous antioxidant components, making it a viable supplement with high antioxidant content.

Ginger rhizomes are composed of various constituents, including proteins (9%), carbohydrates (60-70%), crude fiber (3-8%), ash (8%), water (9-12%), and volatile oil (2-3%) **Paredes et al. (2023).** In addition, ginger comprises several significant constituents within the category of essential oils. Furthermore, ginger is comprised of a multitude of additional bioactive constituents, such as mucilage, proteins, vitamin B6, vitamin C, calcium, magnesium, phosphorus, potassium, sulfur, and linoleic acid. According to **Rehman and Fatima (2018)** .

Wheat *(Triticum aestivum* L.), is a crucial constituent of the human diet. It manufactures food items such as bread, noodles, steamed bread, and cakes. Common wheat contains high protein and carbohydrate contents provide energy to the human body. According to **Akbari et al. (2022)** and **Brouns et al. (2012)**, wheat products are rich in antioxidants, primarily derived from phenolics, that provides a safeguard against cancer and heart ailments. Hence, there is a concerted effort by both industry and researchers to enhance the technology involved in bread making, to enhance the diversity, caliber, flavor, and accessibility of bakery items, including bread **(Zhou et al., 2014)**.

Bread is a popular cereal product and contains many nutrients, such as vitamins and minerals, especially phosphorus and copper **(Ibrahim et al., 2015).** From a nutritional perspective, it can be observed that the bread possesses a low concentration of crucial amino acids such as lysine, tryptophan, and threonine, as indicated by **Meybodi et al. (2019)**.

The enrich of wheat with ginger powder in making bread and cookies can potentially improve individuals' health and nutritional well-being, given the health advantages associated with these ingredients **(Jukić et al., 2022)**. **Almasodi (2018)** found that the inclusion of ginger powder in bread and biscuits made from wheat has improved the nutritional and health condition of customers.

Khazdair et al. (2019), observed that bread containing 3% ginger powder exhibited favorable rheological and sensory properties and a two-fold increase in antioxidant content compared to the control bread.

The aim of research is to study the effect of adding different levels of ginger on physicochemical properties, rheological and quality characteristics of pan bread to produce functional bread

2. Materials and Methods

2.1. Materials

Ginger (*Zingiber officinale*). Wheat flour extracted 72%, salt and yeast were obtained from local markets in Alexandria, Egypt.

Chemicals All chemicals and reagents used were analytical grade obtained from EL-Gomhouria Company for Trading Medicines, Chemicals and Medical Supplies

2.2. Methods

2.2.1. Preparation of Ginger Powder

Fresh ginger washed with clean water to remove the dirty part. After cleaning, fresh ginger is cut into slices. The slices were dried in oven at 40^{o}C for 6h milled by using the electric grinder (Moulinex, France) to obtain powder, then ginger powder was sieved on (siever 0.2 mm) and kept in polythene bag until used **(Almasodi, 2018).**

2.2.2. Preparation of pan bread supplemented with ginger

The ingredients of pan bread supplemented with ginger are shown in the following **table (1).**

Table (1): Ingredients used for preparation of pan bread supplemented with ginger Powder

Ingredients / Treatment	Wheat Flour (g)	Ginger (g)	Sugar (g)	Yeast (g)	Salt (g)	Water (ml)
Control Pan Bread (100%) wheat flour	100	-	2	2.5	0.7	50
Pan Bread (2% Ginger + 98% wheat flour)	98	2	2	2.5	0.7	50
Pan Bread (4% Ginger + 96% wheat flour)	96	4	2	2.5	0.7	50
Pan Bread (6% Ginger + 94% wheat flour)	94	6	2	2.5	0.7	50
Pan Bread (10% Ginger + 90% wheat flour)	90	10	2	2.5	0.7	50
Pan Bread (12% Ginger + 88% wheat flour)	88	12	2	2.5	0.7	50

Procedures

To prepare pan bread supplemented with ginger at different levels (2,4,6,10 and 12) proportions, the dough was first prepared by mixing the dry ingredients, wheat flour, salt, dry yeast and sugar. Then ginger and warm water were added slowly until the dough is formed; Dough incubated in a warm place for 30 minutes until fermentation. After that, the dough was cut into spherical pieces and rolled out in a round shape (loaf) and then left for another 20 minutes for fermentation. Then the loaves baked on medium heat on a Tefal frying pan until the loaves baked **(Saba, 2012)**.

2.2.3. Determination of tannins and saponins

Tannin and saponins were determined in 0.5 gm samples of wheat and ginger using the methods described by **Ayo et al. (2016)**.

2.2.4. Sensory evaluation

Sensory evaluation of pan bread and pan bread supplemented with different concentration of ginger 2, 4, 6, 10 and 12% were conducted using 40 consumer panelists on a 9 points hedonic scale quality analysis **(Almasodi, 2018).**

2.2.5. Chemical composition

Samples of ginger powder, wheat flour, pan bread and pan bread supplemented with ginger were analyzed to determine, protein, moisture, ash, fat and fiber using the methods mentioned in **(AOAC, 2005).** Carbohydrate content was estimated as a difference by calculation as described in **(AOAC, 2002)** as follows:

Carbohydrates%=100- (protein%+ ash%+ fat%+fiber%+Moisture%).

2.2.6. Determination of antioxidant activities and total phenolic compounds

The free radical scavenging capacity of pan bread and pan bread supplemented with ginger were measured using a stable 2, 2 diphenyl-1-picrylhydrazyl (DPPH) radical described by **Wronkowska et al. (2010).** Antioxidant capacity was calculated as percentage of discolouration defined as in the following equation.

DPPH· s□avenging a□tivity (%) = [(A0- A1)/A0] × 100

Where, A0 is the absorbance of the control reaction, and A1 is the absorbance in the extract. Samples were analyzed in triplicate. Total phenolic of the methanolic extracts of pan bread and pan bread supplemented with ginger were determined by using Folin-Ciocalteu reagent as described by **Singlaton and Rossi (1965).**

2.2.6. Rheological and Extensograph of Dough

Farinograph test of pan bread and pan bread supplemented with ginger was carried out to determine the water absorption, development time, stability and softening of dough of the resultant after 12.0 min. While Extensograph test was carried out to determine Extensibility, Resistance to extension and Energy according under curve with planimeter to the method described in **(AOAC, 2002).**

2.3. Statistical analysis

Data were analyzed using IBM SPSS software package version 23.0. Quantitative data was described using mean, standard deviation. Significance of the obtained results was judged at the 5% level. F-test (ANOVA) used to compare between more than two groups, and Post Hoc test (LSD) for pairwise comparison **(Kirkpatrick, 2015).**

3. Results and Discussion

3.1. tannin and saponins of wheat and raw ginger

The data in the **table (2)** showed the contents of contents of tannin and saponins in wheat and raw ginger. The tannin content in ginger was measured to be 0.024 mg /100g, while no tannin was discovered in wheat. The ginger contained 4.59 mg/100g of saponins, but no saponins were found in the wheat. The current results in consistent with **Ogbuewu et al. (2014)** they reported a high level of saponin (4.01 mg/100g) and low level in tannin (0.02 mg/100g). Also, **Adanlawo and Dairo (2007)**, reported saponins content of 3.85 mg/100g in ginger. Remarkably, the observed higher concentration of saponins in ginger supported the earlier reports of **Johnson et al. (1986)**. Moreover, **Nwinuka et al. (2005)**, screened the phytochemical in ginger spices and showed the presence of tannins and saponins. Saponin level was 3.99 mg/100g in ginger and very low concentrations of tannin (0.01mg/100g). These levels unlikely to pose toxicity problems to human, since they are much below the toxic levels, of (2-5g) stated by **Ogunka-Nnoka and Mepba (2008)**. In contrast, **Akubor et al. (2017)**, reported that wheat flour contains (0.5 mg/100g) and (1.0 mg/100g) of saponins and tannins. They reported that saponins and tannins are influenced by type or variety of the plant, environmental conditions, the type of soil, post-harvest conditions, and applied fertilizers..

Table (2): Phytochemical estimation of wheat and raw ginger

Variables / Treatment groups	Phytochemical	
	Total tannins	Total saponins
	mg/100g	
Ginger	0.024 ± 0.01	4.59 ± 0.48
Wheat	ND	ND

***ND= not detected**

3.2. Sensory evaluation

The data in the **table (3),** and **photo (1**) showed the sensory evaluation of pan wheat pan bread and pan bread samples supplemented with different concentrations of ginger 2, 4, 6, 10 and 12%. The results showed that the mean values for color at concentration 6% of ginger bread had the highest color overall acceptability score of 8.18, followed by bread supplemented with 4% of ginger bread 7.47, while the score was 6.24. For bread contains 12% of ginger, which had the lowest color values and in overall acceptability as well. In the case of tasting, the mean values of overall acceptability showed that 6% of ginger pan bread had the highest value of taste overall acceptability 8.47 compared with other treatments. While the treatment of pan bread with 12% ginger had the lowest overall acceptability value (6.47). The overall values of overall acceptability showed that 6% of ginger pan bread had the highest value of general overall acceptability 8.24, followed by the treatment of pan bread with 4% ginger pan bread (7.47), while the treatment of pan bread with 10 and 12% added ginger had the lowest general overall acceptability values 6.88 and 6.53, thus these concentrations were rejected and 2, 4 and 6% concentrations of ginger (the highest acceptability values) were used for biochemical studies.

In general, the overall acceptability gradually decreased with increasing the levels of ginger and that might due to the increasing of pungent substance (Gingerol) in higher concentrations of ginger. The current results in compatible with **Almasodi (2018)** they concluded that, bread produced by replacement of wheat flour with 3% ginger gave bread loaves more acceptable rather than those of bread produced by added 9% ginger. Furthermore, the findings of this study align with the research conducted by **Balestra et al. (2011)**, which proposed that incorporating ginger powder into the bread recipe would not have a positive impact on bread acceptability. Interestingly, the sample containing the least amount of ginger powder demonstrated the highest level of "overall acceptability."

Table (3): Sensory evaluation of pan wheat bread and pan bread supplemented with different levels of ginger powder

Variables / Treatment groups	Color	Taste	Odor	Textures	Overall acceptability
Pan wheat bread	6.91 [bc*] ±0.36	7.12 [bcd] ±1.41	7.0 [b] ±1.37	7.18 [bc] ±0.88	7.24 [bcd] ±1.39
Pan Bread (Ginger 2% + wheat flour 98%)	7.12 [b] ±1.22	7.29 [bc] ±0.59	7.29 [bc] ±0.85	7.53 [ab] ±0.87	7.35 [bc] ±0.93
Pan Bread (Ginger 4%+ wheat flour 96%)	7.47 [b] ±1.07	7.76 [b] ±0.90	7.65 [b] ±0.86	7.88 [a] ±0.78	7.47 [bc] ±1.23
Pan Bread (Ginger 6%+ wheat flour 94%)	8.18[a]±0.53	8.47 [a] ±0.51	8.35 [a] ±0.61	8.24 [a] ±0.75	8.24 [a] ±0.56
Pan Bread (Ginger 10% + wheat flour 90%)	6.41 [c] ±1.42	6.74 [c] ±0.79	6.71 [c] ±0.77	6.76 [c] ±0.75	6.88 [c] ±0.49
Pan Bread (Ginger 12% + wheat flour 88%)	6.24 [c] ±0.97	6.47 [cd] ±1.33	6.29 [cd] ±1.31	6.35 [cd] ±1.32	6.53 [cd] ±1.33
F	**8.659***	**9.228***	**8.947***	**9.986***	**5.154***
P	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***
LSD 5%	**0.680**	**0.670**	**0.682**	**0.623**	**0.716**

****Data was expressed using Mean ± SD.** Means in the **same column** with **same letters** are not significant

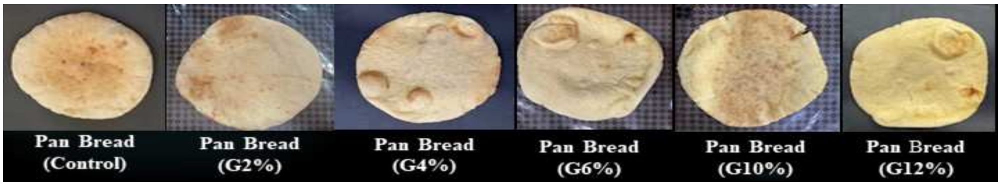


Photo (1): Pan bread of supplemented with different levels of ginger Powder compared to control pan bread

3.3. Chemical composition

The data in **table (4)** showed the chemical composition of raw ginger, raw wheat, pan wheat bread and pan bread supplemented with three concentrations of ginger powder, 2, 4 and 6%. The highest protein content in raw ginger 11.35 g/100g, while the lowest protein in raw wheat and wheat pan bread 9.45 g/100g and 9.93 g/100g. For pan bread supplemented with ginger the data showed no significant differences of protein between the pan bread supplemented with 4% and 6% of ginger, where the percentage of protein were 11.11g/100g and 11.17g/100g. In the case of fat, the data showed highest fat content presented in raw ginger 7.40 g/100g, while the lowest fat in raw wheat and wheat pan bread 1.20 g/100g and 1.28 g/100g. For the pan bread supplemented with ginger the data showed significant differences of fat between the pan bread supplemented with the three concentrations of ginger in one side and raw ginger in other side. The same trend was in the percentage of fiber and ash. In the case of carbohydrates, the data showed the lowest carbohydrates were presented in raw ginger 47.02 g/100g, while the highest carbohydrates in raw wheat and wheat pan bread 72.69 g/100g and 72.85 g/100g. Moreover, the percentage of carbohydrates in the pan bread supplemented with ginger reduced with increasing the percentage of ginger.

The current results showed that the chemical composition of ginger powder contain 11.35, 7.40, 12.59, 8.12, 47.02 and 13.36% of protein, fat, fiber, ash, carbohydrate and moisture, respectively. The results varied with that reported with **Zagórska et al. (2022)** in which 8.05, 1.75, 5.90, 5.06, 40.4 and 6.90 of protein, fat, fiber ash, carbohydrate and moisture, respectively. The variation of moisture content might due to the degree of drying and the type of ginger. These results were close with that reported by **Shawir et al. (2023)** in which raw wheat (72%) extraction contained 11.54% protein, 1.0% fat, 0.58% ash and varied in the percentage of carbohydrates (83.3%). The present findings align with the research conducted by **Almasodi (2018)**. The bread exhibited a reduction in carbohydrate content as the concentration of ginger powder increased. The individual who documented the findings stated that ginger powder exhibited much higher levels of lipids, fiber, and ash when compared to wheat flour. The findings of our study revealed a significant rise in the levels of ash, fiber, and fat in pan bread that was enriched with ginger. Conversely, the concentration of carbs in the pan bread exhibited a notable decrease as the amount of ginger supplementation increased.

Table (4): Chemical composition of raw ginger, wheat flour, wheat pan bread and pan bread supplemented with different levels of ginger Powder

Variables / Treatment groups	Protein	Fats	Raw Fiber	Ash	Carbohydrates	Moisture
	g/100g					
Raw ginger	11.35[a*] ±0.43	7.40 [a] ±0.91	12.59 [a] ±0.21	8.12 [a] ±1.52	47.02 [c] ±2.81	13.36 [a] ±2.17
Wheat flour	9.45 [b] ±1.05	1.20 [c] ±0.09	0.73 [c] ±0.04	0.79 [c] ±0.02	72.69 [a] ±2.14	15. 14[a] ±1.17
Wheat pan bread	9.93 [b] ±0.06	1.28 [c] ±0.05	0.54 [c] ±0.24	0.96 [c] ±0.03	72.85 [a] ±1.12	14.44 [a] ±1.13
Pan Bread (Ginger 2% + wheat flour 98%)	10.74 [b] ±0.10	3.71 [b] ±0.55	1.12 [b] ±0.20	1.61 [b] ±0.26	70.62 [a] ±0.31	12.20 [b] ±1.34
Pan Bread (Ginger 4%+ wheat flour96%)	11.11 [a] ±0.16	3.93 [b] ±0.62	1.14 [b] ±0.02	1.73 [b] ±0.09	69.18 [b] ±1.30	12.92 [b] ±1.24
Pan Bread (Ginger 6% + wheat flour94%)	11.17 [a] ±0.13	4.41 [b] ±0.22	1.16 [b] ±0.04	1.87 [b] ±0.07	67.57 [b] ±2.28	13.82 [b] ±1.12
F	68.93*	65.688*	45.47*	28.98*	361.46*	98.83*
P	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
LSD 5%	0.287	0.684	0.218	1.110	0.709	0.373

***Data was expressed using Mean ± SD.**
Means in the **same column** with **same letters** are not significant

3.4. Antioxidant activity and total phenolic content

The data in the **table (5)** showed that the antioxidant activity in the pan wheat bread, was 20.74%, and the antioxidant activities of pan bread supplemented with three concentrations of ginger (2, 4, 6%) were 22.79, 29.73, and 35.23%, respectively. The antioxidant activity of the pan bread supplemented with the three levels of ginger was greater compared to the pan wheat bread. The activity of antioxidant in pan bread supplemented with ginger increased significantly with increasing the percentage of ginger, that might due to the presence of high percentage of gingerol compound **(Tinello et al., 2020)**. The same trend was observed in the total phenolic content, where the pan wheat bread had the lowest level of 118.26 mg/100g, while the highest total phenolic content was recorded in pan bread supplemented with 6% of ginger (160.23 mg/100g). The total phenolic content of the pan bread supplemented with the three concentrations of ginger were greater compared to pan wheat bread. The total phenolic contents in pan bread supplemented with ginger increased significantly with increasing the percentage of ginger. The data matched with that reported by **Prakash (2010)** in which ginger is a good source of antioxidant and phenolic contents. Also, **Balestra et al. (2011)**, reported that bread containing 3% of ginger enhanced the antioxidant activities and increased the total phenolics. Similar trend was reported by **Özcan (2022)**, the addition of ginger at 3, 6, and 9%, to wheat, increased the total activity of antioxidants. According to **Almasodi (2018)**, ginger has a higher phenol content compared to other cereals like wheat and quinoa, hence establishing ginger as a reliable phenol source. The current results are in the line with **Amjad et al. (2021),** who reported that the total phenolic content for pan bread samples supplemented with ginger were increased with increasing the levels of ginger.

Table (5): Antioxidant activity and total phenolic content of pan wheat bread and pan bread supplemented with different levels of ginger powder

Variables / Treatment groups	DPPH (%)	Total phenolics mg/100g
Wheat pan bread	20.74* c ±3.91	118.26[d]±2.13
Pan Bread (Ginger 2% + wheat flour 98%)	22.79[c]±1.86	130.37[c] ±0.77
Pan Bread (Ginger 4%+ wheat flour96%)	29.73[b] ±1.62	143.71[b] ±1.54
Pan Bread (Ginger 6% + wheat flour94%)	35.23[a] ±2.36	160.23[a] ±0.96
F	**19.63***	**832.36***
P	**<0.001***	**<0.001***
LSD 5%	**4.88**	**1.96**

***Data was expressed using Mean ± SD.**
Means in the **same column** with **common letters** are not significant (i.e. Means with **Different letters** are significant)

3.5. Rheological characteristics of the dough

3.5.1. Farinograph test

Farinograph test includes water absorption, development time, stability and softening of dough for pan wheat and pan bread supplemented with different concentrations of ginger is shown in **Table (6)** and **photo (2)**. The data revealed that adding different concentrations of ginger to wheat flour at 2, 4, and 6%, resulted in a non-significant increase in the percentage of water absorption. The percentage of water absorption were 58.5, 60.0, 60.0 and 60% for dough of pan wheat and pan bread supplemented with different concentrations of ginger (2, 4, and 6%), respectively.

On the other hand, the development of time of dough by adding different concentrations of ginger to wheat flour at 2, 4, and 6% were 2.0,3.0 and 3.0 min, respectively. While the development time wheat flour dough was 2.0 min. Statistical analyses showed significant differences in the developmental time between wheat flour dough and dough of wheat flour supplemented with 4, and 6% of ginger. The dough stability value increased in dough of wheat flour supplemented with 6% of ginger (4 min.) compared with (3.0 min.) for wheat flour dough. The data showed a significant increase in the degree of softening between treatments. The dough softening degree were, 82, 67, 97 and 96 B.U. in wheat flour and wheat flour supplemented with 2, 4, and 6% of ginger, respectively.

3.5.2. Extensograph test

Extensograph test includes Extensibility, Resistance to extension, and Energy of dough for pan wheat and pan bread supplemented with different concentrations of ginger is shown in **Table (6)**. The Extensibility of dough by adding different concentrations of ginger to wheat flour at 2, 4, and 6% were 169.0, 129.0 and 125.0 mm, respectively. While the Extensibility of wheat flour dough was 158 mm. Statistical analyses showed significant differences in the Extensibility of dough between wheat flour and wheat flour supplemented with 2, 4, and 6% of ginger. The data also revealed that adding different concentrations of ginger to wheat flour resulted in significant increase in the Resistance to extension. The Resistance to extension were 200.0, 228.0, 358.0 and 387.0 B.U for dough of pan wheat and pan bread supplemented with different concentrations of ginger (2, 4, and 6%), respectively. The data revealed that adding different concentrations of ginger to wheat flour resulted in significant increase in the Energy. The Energy were 52.0, 62.0, 65.0 and 65.0 cm^2 for dough of pan wheat and pan bread supplemented with different concentrations of ginger (2, 4, and 6%), respectively.

The rheological qualities of dough made from wheat flour play a crucial role in the production of bakery goods as they dictate its response to mechanical manipulation, thus impacting the overall quality of the final products **(Amjid et al., 2013)**. Hence, the measurements of the faringraph and extensograph parameters were of significant importance in the present investigation. According to **Almasodi's (2018)** findings, the incorporation of ginger powder resulted in a notable enhancement in water absorption. This effect was seen to be directly proportional to the concentration of ginger powder utilized. The inclusion of 9% ginger powder resulted in the most significant enhancement in water absorption, exhibiting a 59.1% increase compared to the control sample's water absorption of 57.7%. In a study conducted by **Arı Akın et al. (2021)**, it was observed that the incorporation of fiber sources into wheat flour resulted in a notable augmentation in the water absorption capacity of the resultant dough. The observed phenomenon could potentially be attributed to the greater water hydration capacity exhibited by the fibers, as suggested by the findings of **Balestra et al. (2011)**. The study revealed that the duration of dough development increased as the proportion of ginger powder incorporation increased, up to a maximum of 8 percent, when compared to the control sample. The increasing inclusion of ginger powder resulted in an improvement in dough stability, with the control sample exhibiting the maximum level of dough stability. The control sample exhibited a higher degree of softening in comparison to the ginger treatments. Similarly, the incorporation of wheat flour into chickpea flour resulted in an increase in water absorption **(Amjad et al., 2021)**. According to **Almasodi (2018)**, the study observed a decrease in the resistance to extension (elasticity) of the dough as the percentage of ginger powder grew. Specifically, the values representing this decrease were about 480, 480, and 470 B.U. for 3%, 6%, and 9% ginger powder, respectively, in comparison to the control sample which had a resistance to extension of 495 B.U. Furthermore, it is worth noting that the dough extensibility and energy of the dough containing 6%

ginger powder exhibited the greatest ratings when compared to the control group and other mixtures. Several investigations have indicated that the inclusion of varying proportions of ginger spice, up to 6%, does not result in any notable alterations to the features of dough or the rheological qualities of bread. In a study conducted by **Balestra et al. (2011)**, it was demonstrated that using ginger at a concentration of up to 5% in the formulation can yield dough and bread with ideal rheological and physical properties.

The present study aligns with the findings of **Arufe et al. (2017)**, which indicated that the augmentation of dietary fiber content resulted in a reduction in dough extensibility and an increase in dough elasticity across all tested samples. Our results showed non-significant difference of most farinograph characteristics between dough of wheat pan bread and the dough of pan bread supplemented with low levels of ginger 2 and 4%. While a significant variation estimated of extensograph parameters was noticed between dough of wheat pan bread and the dough of pan bread supplemented with different levels of ginger. Whereas extensibility reduced with increasing the level ginger. While an increase of elasticity and energy were observed in dough of pan bread supplemented with different levels of ginger compare with dough of wheat pan bread.

In general incorporation of low level of ginger up to 4% did not cause any pronounced change on dough characteristics and on bread rheological properties.

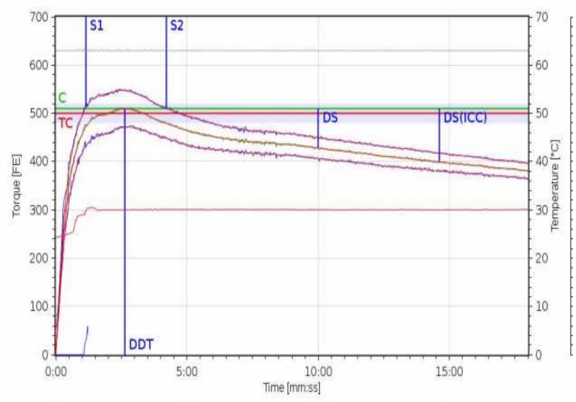
Table (6): Effect of pan wheat bread and pan bread supplemented with different concentrations of ginger on Farinograph and Extensograph characteristics of wheat dough

Variables / Samples of Dough	Farinograph characteristics				Extensograph characteristics		
	Water absorption (%)	Development time (min)	Dough Stability (min)	Softening of dough (B.U)**	Extensibility (mm)	Resistance to extension (B.U)	Energy (cm^2)
Wheat pan bread	58.5 ^{a}*±1.68	2 ^{b} ±0.07	3 ^{b} ±0.06	82 ^{b} ±2.19	158 ^{b} ±2.98	200 ^{d} ±2.02	52 ^{c} ±1.06
Pan Bread (Ginger 2% + wheat flour 98%)	60 ^{a} ±2.07	2 ^{b} ±0.05	3 ^{b} ±0.08	67 ^{c} ±1.69	169 ^{a} ±3.07	228 ^{c} ±2.06	62 ^{b} ±1.10
Pan Bread (Ginger 4%+ wheat flour96%)	60 ^{a} ±1.70	3 ^{a} ±0.08	3 ^{b} ±0.05	97 ^{a} ±2.66	129 ^{c} ±1.12	358 ^{b} ±3.57	65 ^{a} ±1.66
Pan Bread (Ginger 6% + wheat flour94%)	60 ^{a} ±1.08	3 ^{a} ±0.04	4 ^{a} ±0.07	96 ^{a} ±3.18	125 ^{c} ±1.92	387 ^{a} ±3.96	65 ^{a} ±1.05
f	0.608	241.999*	163.296*	96.088*	240.806*	2807.270*	73.561*
p	0.629	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
LSD 5%	**3.143**	**0.121**	**0.128**	**4.701**	**4.549**	**5.733**	**2.348**

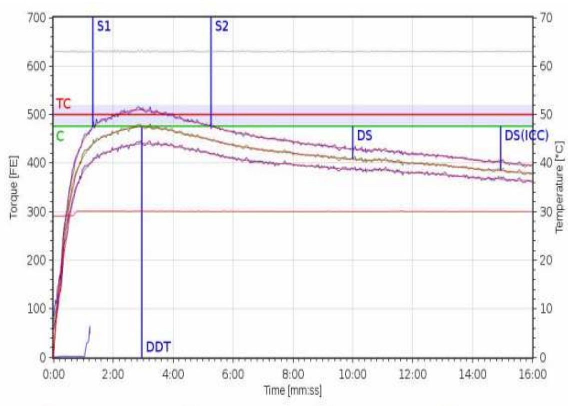
***Data was expressed using Mean ± SD.**

Means in the **same column** with **common letters** are not significant (i.e. Means with **Different letters** are significant).

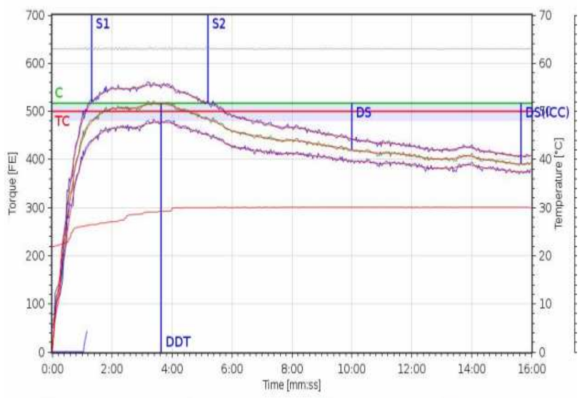
**B.U (Brabender unite) softening (10min after beginning)



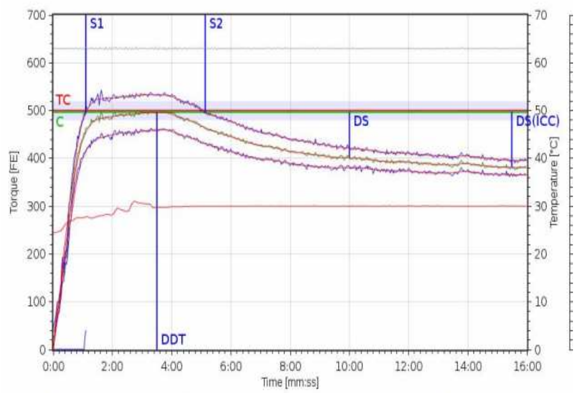
Control Wheat Dough



Pan Bread Dough + (Ginger 2%)



Pan Bread Dough + (Ginger 4%)



Pan Bread Dough + (Ginger 6%)

photo (2): Farinograms for the dough prepared of pan wheat bread and pan bread supplemented with different concentrations of ginger

Conclusion

The addition of ginger powder to the formulation of pan bread had significant effects on nutritional quality, antioxidant activity, sensory, and rheological properties. As the supplementation of ginger powder at levels 2, 4, and 6 increased pan bread ash, fiber, protein, and antioxidant activity content. As a result of the sensory and chemical evaluation, the overall acceptability of pan bread was found to be best in pan bread supplemented with 6% ginger powder. It can be concluded that the addition of ginger powder improved the nutritional quality and functionality of pan bread.

Ethical Approval

All study experiments were ethically approved by the Scientific Research Ethics Committee, Faculty of Specific Education, Alexandria University (Approval no ٠٨-١٠-٢٠٢٣SREC 010827).

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الخواص الفيزيائية والكيميائية وسمات الجودة للخبز المدعم بمستويات مختلفة من الزنجبيل دراسات تكنولوجية

الملخص العربي:

يفضل المستهلك دائما تناول الأطعمة الصحية للوقاية من الأمراض غير المعدية. لذلك، يشارك الباحثون والمعنيون بصناعه الاغذية بجهد كبير من خلال تكنولوجيا إنتاج الخبز لتحسين جودة المنتجات. هدفت هذه الدراسة إلى تحضير خبز صينية القمح بإضافة مسحوق الزنجبيل بخمسة مستويات (٢، ٤، ٦،١٠، ١٢٪) لإنتاج خبز صينية القمح الذي يتميز بخصائصه الفيزيائية والكيميائية والريولوجية والنوعية الجيدة. وقيمة غذائية ومضادات أكسدة أعلى، والتي يمكن استخدامها كغذاء وظيفي للوقاية من الأمراض. أظهرت نتائج تحليل مضادات التغذية (التانيين والصابونيين) أن مستوى التانين في الزنجبيل بلغ ٠,٠٢٤ مجم/١٠٠جم و بلغت نسبة الصابونين في الزنجبيل ٤.٥٩ مجم/١٠٠جم بينما لم يظهر التحليل تواجدهما في القمح. أظهر التقييم الحسي أن التقبل العام لخبز الطاسة الذي يحتوي على ٢ ، ٤ و ٦٪ مسحوق زنجبيل كانت أكثر قبولاً لدى أعضاء اللجنة (٤٠) من مستويات الزنجبيل ١٠ و ١٢٪ لذلك تم اختيار خبز الطاسة الذي يحتوي على ٢ و ٤ و ٦٪ من مسحوق الزنجبيل وأجريت التجارب عليه. أظهر التحليل الكيميائي لخبز الطاسة المدعم بالزنجبيل ٦٪ أعلى محتوى من البروتين والدهون والألياف والرماد مقارنة بالقمح الخام وخبز القمح. بلغت قيمة النشاط المضاد للأكسدة والفينول الكلي ٣٥,٢٣٪ و١٦٠,٢٣ ملجم/١٠٠ جرام للخبز المضاف إليه ٦٪ من الزنجبيل مقارنة بخبز القمح ٢٠,٧٤٪ و١١٨,٢٦ ملجم/١٠٠ جرام على التوالي.أظهرت النتائج أن إضافة مستوى منخفض من الزنجبيل يصل إلى ٦٪ لم يسبب أي تغيير ملموس في خصائص العجين والخصائص الريولوجية لخبزالطاسة. ومن النتائج المتحصل عليها من هذه الدراسة يوصى بضرورة تسليط الضوء على إضافة مسحوق الزنجبيل بمستوى ٦٪ إلى الخبز الطاسة لزيادة خصائص مضادات الاكسدة ،الخصائص الريولوجية والحسية والغذائية الوظيفية في نظامنا الغذائي اليومي.

الكلمات الافتتاحية: نبات الزنجبيل، منتجات المخابز ، مضادات الأكسدة ،الخصائص الريولوجية والحسية