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Production and Evaluation of Some Bakery Products Containing Ginger Powder

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Abstract The aim of the current study is to investigate the effect of adding ginger powder (0, 3, 6 and 9%) in formulation of antioxidant-enriched bakery products (e.g. bread and rusk) possessed good physico-chemical and sensorial properties. The rheological properties of doughs were evaluated using dynamic rheological measurements. Physical properties, total phenolic and total flavonoid content, antioxidant activity and sensory analysis (hedonic test) of the supplemented bread were determined. The highest phenolic content (194±4.03 mg gallic acid equivalent /100g) were achieved in the bread having the highest percentage of ginger powder (9%). The total flavonoids content in ginger bread was about 6-20 folds higher than in the control bread. The addition of ginger flour to wheat bread, particularly in higher dose, was more effective in enhancing antioxidant activity, which increased from 194 µmol Trolox equivalent antioxidant coefficient (TEAC) /100g in wheat bread to 8205 µmol TEAC /100 g for bread containing 9% ginger powder. Phenolic and tannin were, also, slightly increased with increasing adding ginger powder to wheat flour. The sample containing 9% ginger powder showed the worst results regarding the rheological properties indicating that the dough and the bread had a tough structure. Moreover, by sensory evaluation this bread sample was not acceptable. Among the studied samples, 3% ginger sample showed good rheological characteristics and much higher anti-oxidant content compared to the control. 3% ginger bread and rusk, also, showed the highest sensorial acceptability compared with other ginger powder simples (6 and 9%) and not significantly different in most sensory characteristics compared with control samples (bread and rusk).

Keywords: *ginger powder, antioxidant, total phenolic, total flavonoid, the rheological properties*

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1. Introduction

Common wheat (*Triticum aestivum* L.) is an important component of the human diet, and is used in the production of many food products, including bread, noodles, steamed bread, and cakes, providing energy based on the high contents of protein and carbohydrate. Wheat products contain high levels of antioxidants, mostly coming from phenolics, which confer protection against cancer and heart diseases [1,2].

Synthetic antioxidants, such as butylated hydroxyanisole (BHA) and butylated hydroxyltoluene (BHT), are suspected of being carcinogenic and causing liver damage [3]. It is believed that an increased intake of food, which is rich in natural antioxidants, is associated with a lower risk of degenerative diseases, particularly cardiovascular diseases and cancer [4].

In wheat grain, most of the phenolic compounds are located in the bran, which constitutes the outermost parts of the grain. Traditionally, the milling of the wheat grain aimed to remove the bran or outer layers of the grain to obtain the refined white flour [5] and as a result removing most of the phenolic compounds.

Ginger (*Zingiber officinale* Roscoe) is a root or an underground stem (rhizome) known to contain gingerols (oleoresin) with several health benefits. It is reported to reduce the risk of colon cancer, obesity, diabetes, cardiovascular diseases, cold related-diseases and arthritis [6,7]. The extracts of ginger have multiple pharmacological effects, cardiotonic effects, gastro-intestinal actions thermogenic, and antibiotic activities they are also important as digestive stimulants [8].

Ginger is one of the oldest spices with a distinct flavour and pungency. Ginger is used as a main seasoning material in the diet. It plays a significant role as a taste enhancer because it contains essential oils, it is used in whole, ground paste or liquid form mainly for flavouring and seasoning food. Ginger is a fair source of vitamins i.e., β- carotene, vitamin C and minerals. It is, also, used as a flavouring substance in soft drinks, alcoholic and nonalcoholic beverages and confectionery. Varieties of pickles are, also, prepared from ginger. As it is known to possess medicinal properties, it is also used in pharmaceutical preparations [9].

Ginger is a good source of antioxidant and most of the antioxidant components exhibit higher activities in alcoholic media as determined by different assays. Hence, apart from its medicinal properties, ginger can also be used as an antioxidant supplement [10]. Due to their properties, medicinal plants are used as primary health care aid among 80% of the world's population in the form of plant extracts or their active components [11]. Ginger powder, also, increased the protein, ash and fiber content while decreased the NFE content. These results can be used to improve the nutritional value of food by adding ginger powder [12].

Considering the health benefits of wheat and ginger powder, their incorporation as composite blends in the preparation of bread and cookies may enhance nutritional and health status of consumers. Several studies have reported the use of wheat based composite flour [13-19].

The aim of the study is to develop a novel bread by different concentrations of ginger powder. All these developed products along with the control sample were analyzed for their physico-chemical and organoleptic characteristics.

2. Materials and Methods

2.1. Materials

Strong and weak wheat flour (72% ext.) samples were obtained from Grain Soils and Flour Mills Organization at KSA. The fresh ginger and other ingredients for pan bread and rusk preparation were purchased from the local market at Jeddah, Kingdom of Saudi Arabia.

2.2. Preparation of Ginger Powder

Based on Shirshir et al., [20] method, the fresh ginger was collected from local market and washed with clean water to remove dirty and other field-damaged portion. After cleaning, the clean and fresh ginger was sliced up to 2 to 3 mm with knife. The slices were dried in an oven dryer at 75°C for 20 hr up to 9 - 11% moisture content. After cooling at room temperature, the dried ginger slices were grounded into powder in a blender. Then they were sieved and packaged in high density polythene bags and plastic containers. All polythene bags and plastic containers containing ginger powder were identified and stored at room temperature.

2.3. Flour Blends

Wheat flour was well blended with ginger powder to produce individual mixtures containing 0, 3, 6 and 9% replacement levels. All samples were stored in airtight containers and kept in a refrigerator until required.

2.4. Chemical Composition

Standard Association of Official Analytical Chemistry Methods, AOAC [21] were adopted for estimating moisture, ash, crude fiber, fat and protein contents. Total carbohydrates were calculated as: 100 - (protein + fat+ crude fiber+ moisture + ash).

2.5. Farinograph Test

Farinograph test was carried out to determine the water absorption (%), arrival time (min), dough development time (min), dough stability (min) and degree of softening (dough weakening, BU) of dough prepared from the various treatments under investigation. It was carried out by using Farinograph apparatus (Brabender Duis Bur G, type 810105001 No 941026 made in West Germany) available at Rheology Laboratory of Food Technology Research Institute by using 300g samples based on 14% moisture content. The previous parameters were obtained from the farinograms except the percentage of water absorption which was recorded directly from the farinograph instrument as described in the AACC, [22].

2.6. Extensograph Test

Wheat flour dough was tested using Brabender extensograph apparatus (available at Rheology Laboratory of Food Technology Research Institute) according to the method described in the AACC [22]. The extensogram was used to record the following measurements: elasticity (BU), extensibility (mm), proportional number (elasticity/extensibility) and energy of dough (cm^2).

2.7. Antioxidant Components and Antioxidant Activity

Antioxidant components content (total phenolic, tanins and total flavonoids compounds) and antioxidant activity were estimated in the tested pan bread samples. The total phenolic (as mg gallic acid equivalent /100 g dry weight) and flavonoids (as milligrams of catechin equivalents per 100 g dry weight) compounds as well as antioxidant activity (μM of Trolox equivalent (TE) /100 g dry weight) were determined according to the method described by Gorinstein et al., [23]. The tannins contents were determined (mg /100 g dry weight) based on the method of Aslam Shad et al., [24].

2.8. Pan bread Processing

Pan bread making was carried out at automatic commercial baking line according to AACC [22]. The pan bread ingredients were100 g strong wheat flour, 1g instant active dry yeast, 1g salt (sodium chloride), 5g sugar (sucrose), 5g shortening and an adequate water amount (according to farinograph test). Pan bread was manufactured as follows: the dry ingredients were manually mixed in a wide bowel and then added to mixing bowel. Shortening and water were added to all ingredients. The components were thoroughly mixed with electric mixer for 2 min at low speed. The mixing speed was then changed to medium for 2 min and then at high speed for 8 min. The dough was divided into pieces, rounded by hand and allowed to relax for 10 min. The doughs were molded then panned and proofed (fermented) for 60 min at (30°C) and 86% relative humidity in a fermentation cabinet. The proofed pieces were baked at 210°C/21 min in an electric oven. Subsequently, the baked bread samples were then cooled for 1 hr at room temperature (30°± 2°C), packed in polyethylene bags and used for further analyses.

2.9. Baked Rusk (Formula and Preparation):

Rusks were formulated and prepared according to Yaseen [25]. The rusk formula for each loaf included 100 g weak wheat flour (14% moisture), 1.5 g dry yeast, 1.5 g salt, 5 g sugar, 3.0 g vegetable oil, 2.0 g fennel (*Foeniculum vulgare*) and an adequate amount of water to obtain dough of optimum consistency. Flour samples and all ingredients were mixed in Hobart mixer (Model N50, Hobart, Edmonton, Alberta, Canada). Dough was kneaded until reaching to maximum consistency (10–12 min), and then it was left for 20 min for resting. Dough was divided into pieces of 150 g (as pan capacity), then it was mechanically molded and put in pans. Pans were left in the fermentation chamber (National Manufacturing Company, Lincoln, NE) for 90 min at 32°± 1°C and 85% relative humidity and then was baked in a revolving reel oven (National Manufacturing Company, Lincoln) at 220 °± 1°C for 25 min. The Rusks were allowed to cool on racks for about 30 min, then were put in a refrigerator at 5°C for about 2 hr and then were mechanically sliced to about 1 cm thickness. The sliced pieces were roasted at 200° C for 15 min. Due to inferior handling properties of formulas containing high level of fiber, slicing the baked dough after 2 hr or more period of refrigeration at 5°C was recommended during preparation.

2.10. Physical Properties of Pan Bread and Rusk

The weights of bread loaves were determined after cooling for one hour. Bread loaf volume was measured by rape seed displacement method as described by Gupta et al., [26]. Specific volumes of bread were calculated by dividing the volume (cm^3) by their weight.

Rusks from control and supplemented flours were baked in triplicate samples. After removing from the oven, rusks were immediately weighed and then placed on a wire grid for about 2 hr before the volumes were determined. Volumes of rusk were measured by the rapeseed displacement method as previously mentioned. Specific volumes were calculated by dividing the volume by the weigh.

2.11. Sensory Evaluation of the Loaf Bread

Pan bread were organoleptically evaluated for their external and internal properties according to Lawless and Heymann [27]. The sensory attributes were carried out by ten semi trained panelists whom were asked to score the external and internal characteristics using the following report sheet.

Properties	Score value	Properties	Score value
Crust color	15	Taste	15
Summitry of form	15	Aroma	15
Texture	15	Slicing quality	10
Crumb color	15		

2.12. Sensory Evaluation of Rusk

A panel of 10 judges (in the age group of 20 to 50 years, comprising of professional, student and consumers) were asked to evaluate the following organoleptic characteristics of the prepared rusks. The tested attributes were general appearance, color, odor, taste and structure It was carried out using a 10-point hedonic rating scale ranging from like extremely (10) to dislike extremely (1) for each characteristic, as suggested by Austin and Ram [28].

2.13. Statistical Analysis

The obtained results were statistically analyzed using SPSS statistical package (Version 9.05) according to Rattanathanalerk et al., [29], via analysis of variance (ANOVA). Duncan's multiple range test and least significant difference (LSD) were chosen to determine any significant difference among various treatments at $p<0.05$.

3. Results and Discussion

Rheological properties of wheat flour dough are essential for the successful manufacturing of bakery products because they determine its behavior during mechanical handling, thereby affecting the quality of the finished products [30]. Therefore, the faringraph and extensograph parameter measurements were highly concerned in the current study and recorded in Table 1 and Table 2, respectively.

The results presented in Table 1 and illustrated in Figure 1 showed the effect of substitution of 3, 6 and 9% strong wheat flour (72% ext.) with the same amount of ginger powder on farinograph parameters. The obtained data showed that the same faringraph parameters (arrival time, and dough stability) recorded higher values in the individual wheat flour, whereas, others (water absorption and dough weakening) recorded a lower value in the individual wheat flour. The obvious mentioned results are indicated in Table 1. Addition of ginger powder mainly increased the water absorption by increasing the ginger powder level from 0% to 9%. The highest increase in water absorption (59.1%) was found with the addition of 9% ginger powder compared to that found in the control sample (57.7%). Similar effects on water absorption were observed by Abou-Zaid et al., [31] when fiber rich matter was added Abou-Zaid et al., [31] reported that the differences in water absorption are mainly caused by addition fiber rich matter, which retain more water. Abd El-Moniem and Yassen, [32], also, reported that, addition of fiber sources to wheat flour caused an increase in water absorption of the produced dough. This may be due to higher water hydration capacity of the fibers.

Table 1. Influence of ginger addition to pan bread wheat flour on the Farinograph measurements of the resulted dough

Sample	Water absorption(%)	Arrival time (min)	Dough development time (min)	Dough stability (min)	Dough weakening (BU)
100%WF	57.7	1.0	2	6	70
3%GF	58.1	1.0	2	5.5	80
6%GF	58.8	0.5	2	5	90
9%GF	59.1	0.5	2.5	4.5	90

WF = wheat flour, GF = ginger powder, BU=Brabander Unit.

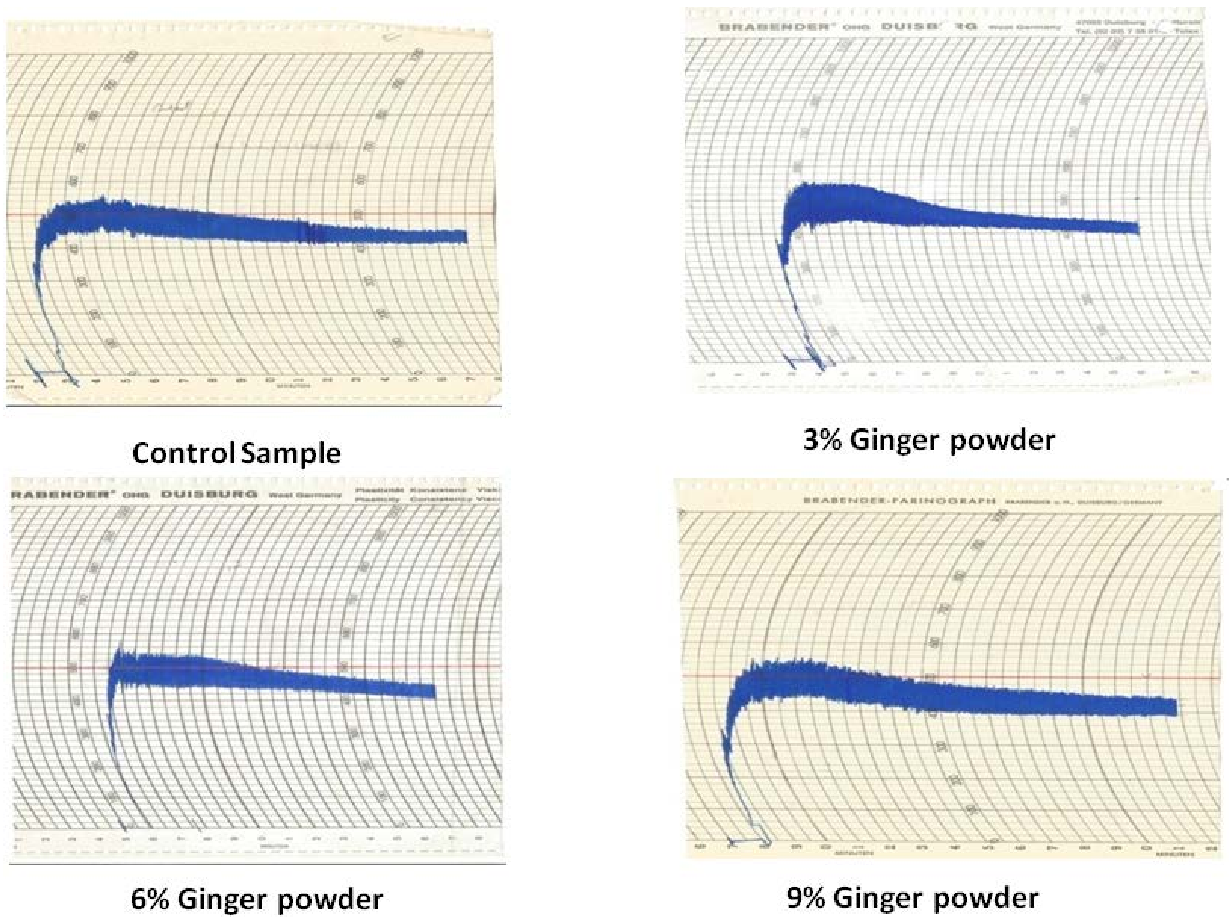

Figure 1. Farinograms of the dough prepared from strong wheat flour (72% ext.) and its blends with ginger powder

In the same way**,** the dough development time increased to 2.5 in 9% ginger powder sample compared with control and other blends. Similar observation was noticed for the degree of softening (Dough weakening). The data presented in (Table 1) observed that the degree of weakening values (BU) increased by the increasing level of ginger powder from 3 to 9% in wheat flour blends. Degree of softening (BU) increased to 70, 80, 90 and 90 BU for wheat flour substitution with 0, 3, 6 and 9% ginger powder, respectively. On the contrary arrival time was decreased by ginger powder increasing in the blend.

Dough stability is the most important index for dough strength and attributed to protein poor in sulfhydril groups, which normally caused a softening or degradation action of the dough [33]. The results show that, in the increasing proportion of ginger powder in wheat flour led to a progressive decrease in the dough stability (min) which was gradually decreased to 5.5, 5.0 and 4.5 min. as the increasing levels of the ginger powder blends with 3, 6 and 9%, respectively. These results are lower than that obtained for the control sample which represented about 6.0 min. These results are in agreement with those found by Abdel-Samieet al., [34]. They reported that, addition of ginger powder (1–5%) decreased the dough stability significantly compared to the control sample (wheat flour dough). That may be because the variation in the addition levels of some components such as fiber or phenolic compounds.

Data presented in Table 2 and Figure 2 showed the effect of substitution of 3, 6 and 9% wheat flour (72% ext.) with the same amount of ginger powder on extensograph measurments, i.e. extensibility (mm), elasticity (BU), proportional number (BU/mm) and energy of dough (cm^2). As given in the obtained data, it could be noticed that the resistance to extension (elasticity) of the dough showed a decrease, which was represented about 480, 480 and 470 B.U., as the amount of ginger powder increased by 3, 6 and 9% ginger powder, respectively, as compared to the control sample (495 BU). From Table 2. It could be, also, observed that the dough extensibility and energy of 6% ginger powder dough recorded highest scores in comparison with control and other blends. Concerning the proportional number, the results in the same Table showed that the values were gradually decreased in the samples which were substituted with 3, 6 and 9% of ginger powder when compared to the control sample.

Table 2. Influence of ginger addition to pan bread wheat flour on the Extensograph measurements of the dough

Sample	Elasticity (BU)	Extensibility (mm)	Proportional number (BU/mm)	Energy of dough (cm^2)
100%WF	495	130	3.8	70
3%GF	480	140	3.4	70
6%GF	480	160	3.0	79
9%GF	470	130	3.6	62

WF = wheat flour, GF = ginger powder, BU=Brabander Unit.

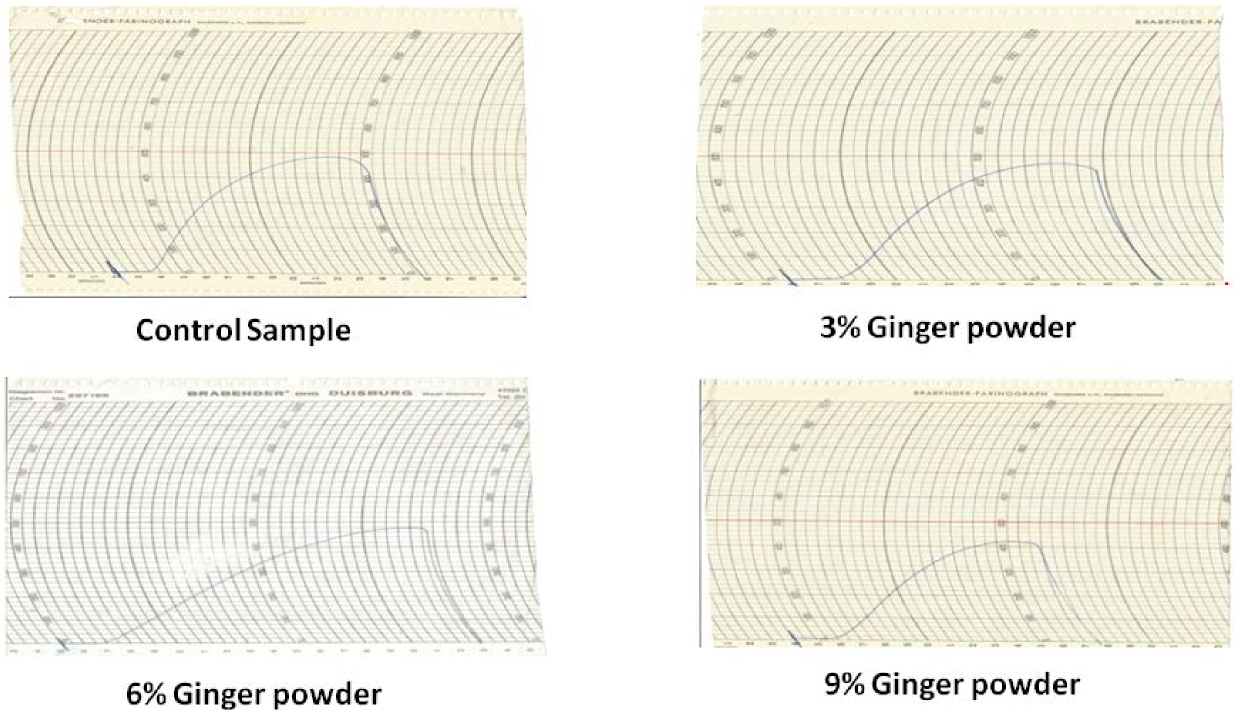

Figure 2. Extansograms for the dough prepared from strong wheat flour (72% ext.) and its blends with ginger powder

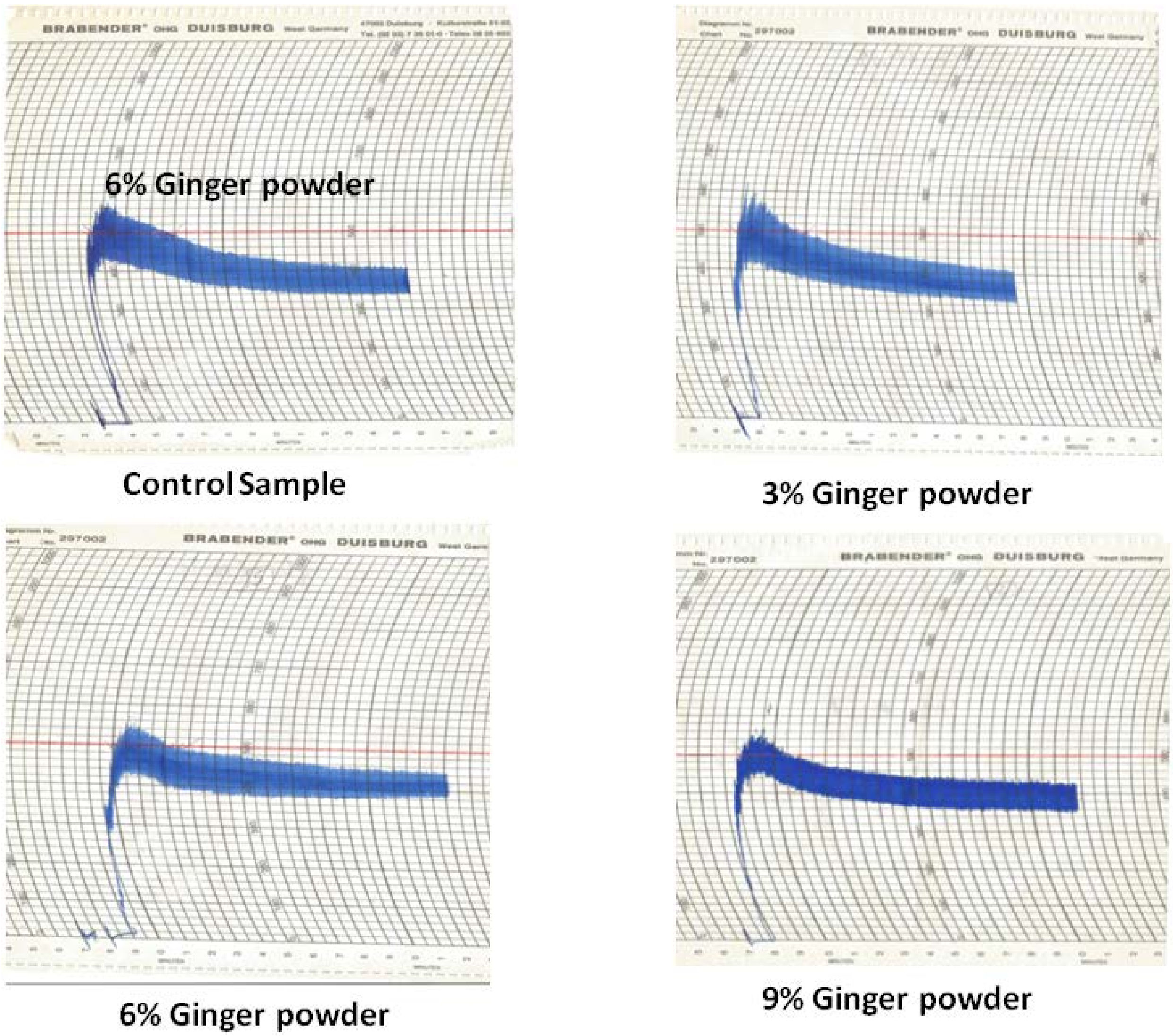

Figure 3. Farinograms for the dough prepared from weak wheat flour (72% ext.) and its blends with ginger powder

Table 3. Influence of ginger addition to weak wheat flour (in rusk formula) on the Farinograph measurements of the dough

Sample	Water absorption (%)	Arrival time (min)	Dough development time (min)	Dough stability (min)	Dough weakening (BU)
100%WF	56.8	0.50	1.00	3	130
3%GF	57.4	0.50	1.50	2.50	130
6%GF	58	0.50	1.00	2.50	90
9%GF	58.4	1.00	1.50	2.00	110

WF = wheat flour, GF = ginger powder, BU=Brabander Unit.

These results are in accordance with the data obtained by Ismail [33] who reported that the resistance to extension of the dough decreased as a result of increasing their fiber content that destroyed the gluten matrix in the dough, regardless of their higher content of protein as compared to the control sample.

Some studies reported that incorporation of different percentages of spice (ginger) up to 6% did not cause any significant change on dough characteristics and on bread rheological properties. By the way, Vadhera et al., [34] showed that up to 5% level of ginger might be used in formulation in order to obtain a dough and bread with optimal rheological and physical characteristics.

From the obtained results in Table 3, it could be observed that by increasing the substitution levels in the blends, the water absorption was found to be increased as compared with control sample (100% weak wheat flour).

As given in Table 3 and Figure 3, it could be concluded that the arrival time of 3 and 6% blends was found to be as the same time (0.5 min.) compared with control (0.5 min). On the other hand, the arrival time was increased from 0.5 to 1.0 min. by increasing the amount to 9% ginger powder.

Moreover, the results indicated that substitution with ginger powder resulted in lower dough stability time, i.e., increasing proportion of ginger powder in wheat flour blends led to a progressive decrease in the dough stability, which was decreased to 2 min in 9% ginger sample. These results are lower than that obtained for the control sample that represented about 3.0 min. This result in agreement with Abdel-Samie et al., [35] who found that the addition of 5% ginger decreased dough stability (from 8.4 in the control sample to 6.7 min with 5% ginger addition).

From the same results (Table 3 and Figure 3) it could be also observed that the replacement of wheat flour with ginger powder reduced the dough weakening, except the level of 3% ginger powder blend which showed the same weakening of the dough as compared with the control sample.

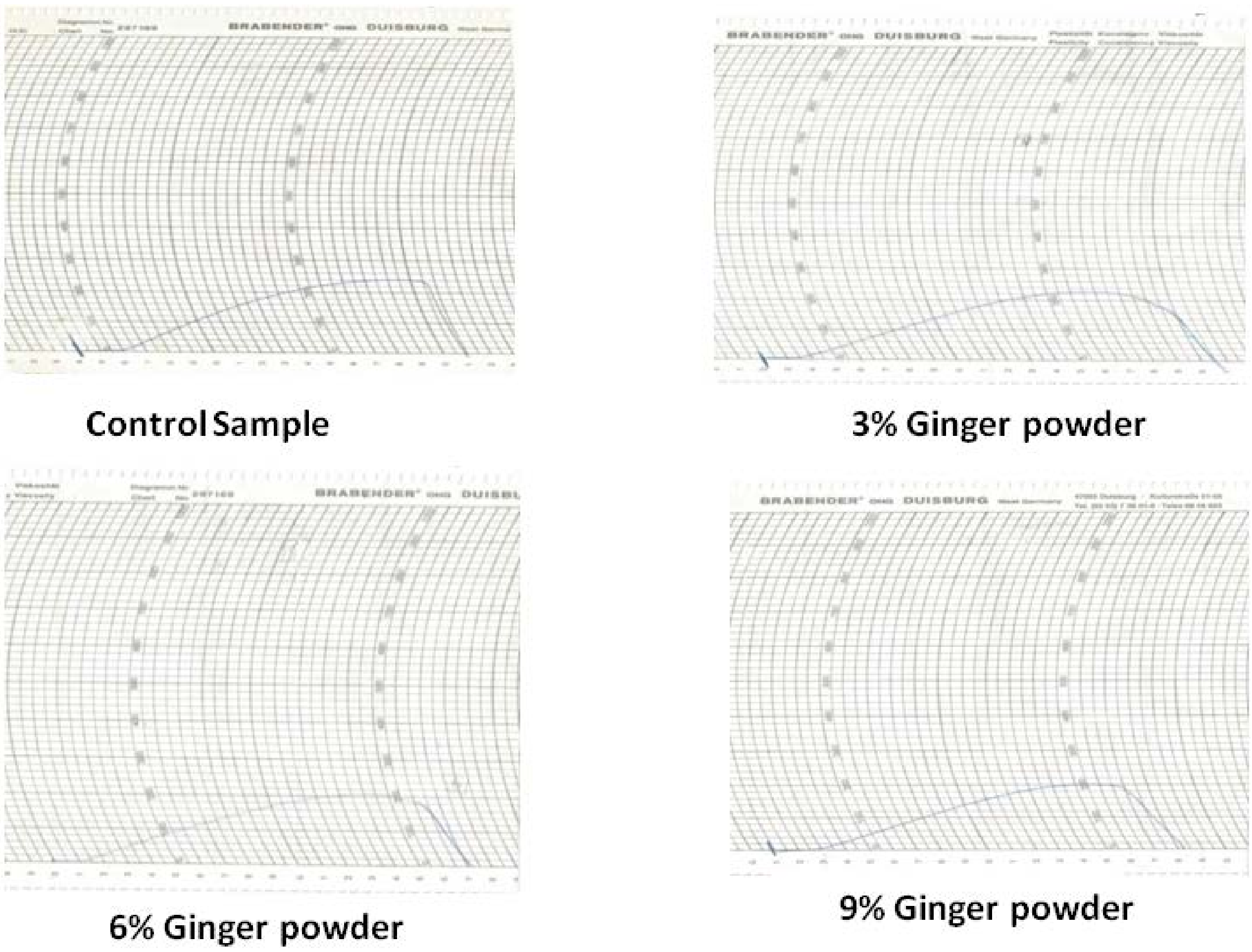

Figure 4. Extansograms of the dough prepared from weak wheat flour (72% ext.) and its blends with ginger powder

Table 4. Influence of ginger addition to weak wheat flour (rusk flour) on the Extensograph measurements of the dough.

Sample	Elasticity (BU)	Extensibility (mm)	Proportional number (BU/mm)	Energy of dough (cm^2)
100%WF	240	150	1.6	40
3%GF	230	160	1.4	42
6%GF	205	150	1.3	35
9%GF	200	150	1.3	34

WF = wheat flour, GF = ginger powder, BU=Brabander Unit.

Data presented in Table 4 and Figure 4 showed the effect of substitution of weak wheat flour (72% ext.) with 3, 6 and 9 ginger powder on extensogram properties. As given in the obtained data, it could be noticed that the resistance to extension (elasticity) of the dough showed a pronounced decrease as the amount of ginger powder increased, which was represented about 230, 205 and 200 BU as the increasing of ginger powder in wheat flour blends ratio increased to 3, 6 and 9%, respectively as compared to the control sample (240 BU). These results are in accordance with the data obtained by Hegazy and Faheid, [36] who reported that the resistance to extension of the dough decreased as the result of increasing their fiber content that destroyed the gluten matrix in the dough,

From Table 4, it could be also observed that the dough extensibility was increased in the blends at ratio of 6% ginger powder, which was represented about 160 mm, as compared to the control sample and other blends (150 mm).

Concerning the proportional number, the results in the same Table showed that the values of proportional number were gradually decreased for the ginger blend samples when compared to the control sample. With regard to the dough energy, the data showed that the addition of ginger powder to weak wheat flour at the ratio of 3% caused a little bit increase; where the dough energy value reached (42 cm^2), and then decreased to (35 and 34 cm^2) for 6 and 9% ginger powder, respectively.

Carson and Sun [37] reported that addition of fiber resource to wheat flour produces marked negative effects on rheological properties of dough. Hamaker [38] noted that, the decrease in energy and elasticity of dough affected by increasing the percentage of fiber, may be due to the reduction of gluten as the percentage.

The physical properties of the produced pan bread as affected by addition of ginger powder are presented in Table 5. Results showed that, there were a significant increase in weight (P>0.05) with increasing addition of ginger powder in relative to control pan bread sample, except 3% ginger sample which recorded the same value (136.5 g).

Vadhera et al., [34] explained the reduction in loaves volume to be due to the dilution of wheat gluten as a result to addition of ginger powder and the increased in fiber content. This data confirm the results of rheological dough properties presented in Table 2 and Table 3. As expected, the values of specific volume followed a similar trend as that of volume. The highest value of specific volume was recorded for control pan bread.This finding is in agreement with that reported by Aluko and Olugbemi [39], who found lower volumes associated with composite flour as opposed to 100% wheat. This can be attributed to lower levels of gluten network in the dough and consequently less ability of the dough to rise, due to the weaker cell-wall structure.

Physical characteristics of rusk, such as volume, weight and specific volume (cm^3/g), were affected by the increase in the level of ginger powder as presented in Table 6. The replacement of wheat with ginger powder caused a gradual decrease in rusk volume. Sharma and Chauhan [40] explained that it could be due to that a dilution effect on gluten with the addition of non-wheat flour to wheat flour and less retention of CO^2 gas caused the depression in volume. As expected, the values of specific volume recorded the similar trend as that of volume. On the contrary, weight of rusk increased with increasing ginger powder to wheat flour ratios, except for 3% ginger rusk which recorded lower values. The increase in weight may be due to the increase in fiber content which have a higher water holding capacity [41]. The changes in volume and weight values are reflected in specific volume which consistently increased from 0.40 in control sample to 0.47 in 9% rusk ginger samples.

The organoleptic properties of pan bread produced by using 100% strong wheat flour (72% ext.) as control sample and pan bread sample prepared by partial replacement of wheat flour with 3, 6 and 9% ginger powder were evaluated to select the best substitution level for produce a high quality pan bread. The bread samples were evaluated by ten panelists for sensory properties and the results are as shown in Table 7. The results in this Table show that there were varied significant differences (p>0.05) in the most tested sensory properties (Crust color, summitry of form, texture, crumb color and taste) of produced pan bread among the control bread sample and 3 % level of substitution with ginger powder.

Table 5. Physical measurements of pan bread prepared by partial replacement of wheat flour (72% ext.) ginger powder

Blends	Loaf Weight (g)	Loaf Volume (cm^3)	Specific volume (cm^3/g)
100%WF	136.5^c±0.55	492^a±2.20	3.60^a±0.01
3%GF	136.5^c±0.59	472.0^b±1.42	3.46^b±0.02
6%GF	138.4^b±1.12	467.0^c±0.83	3.37^b±0.06
9%GF	140.56^a±0.76	461.0^d±0.92	3.28^{bc}±0.02

* Each Mean value, within the same column, followed by the same letter is not significantly different at p<0.05.
*Each value is followed by its ± standard deviation.

Table 6. Physical measurements of rusk prepared by partial replacement of weak wheat flour (72% ext.) ginger powder

Blends	Weight (g)	Volume (cm^{3})	Specific volume (cm^{3}/g)
100%WF	56.1^{b}±0.40	140.0^{a}±1.23	0.40^{a}±0.01
3%GF	53.3^{c}±0.76	130.0^{b}±2.98	0.41^{a}±0.02
6%GF	58.0^{b}±0.34	135.0^{c}±2.3	0.43^{a}±0.01
9%GF	61.1^{a}±0.80	130.0^{b}±1.45	0.47^{a}±0.03

* Each Mean value, within the same column, followed by the same letter is not significantly different at p<0.05.
*Each value is followed by its ± standard deviation.

Table 7. Sensory characteristics of fresh pan bread prepared by partial replacement of strong wheat flour (72% ext.) with ginger powder

Samples	Crust color	Summi-try of form	Texture	Crumb color	Aroma	Taste	Slicing quality
100%WF	14.89^{a} ±0.00	14.85^{a} ±0.33	14.60^{a} ±0.06	15.00^{a} ±0.04	14.90^{a} ±0.42	14.95^{a} ±0.47	10.00^{a} ±0.21
3%GF	14.50^{a} ±0.15	14.55^{ab} ±0.49	14.40^{a} ±0.51	14.77^{ab} ±0.42	14.30^{b} ± 0.48	14.90^{a}± 0.66	9.50^{b}±0.36
6%GF	14.00^{b} ±0.66	14.20^{b} ±0.63	13.60^{b} ±0.84	14.40^{b} ± 0.48	13.60^{c} ± 0.56	13.00^{b} ± 1.00	9.45^{b} ±0.68
9%GF	13.50^{c}±0.77	13.87^{b}±0.42	13.20^{c}±0.96	13.45^{c} ±0.53	12.80^{d} ±0.63	12.50^{c} ± 0.51	9.15^{bc} ±0.33

* Each Mean value, within the same column, followed by the same letter is not significantly different at p<0.05.
*Each value is followed by its ± standard deviation.

On the other hand, significant difference (P<0.05) in all sensory properties between the control pan bread sample and pan bread made from what flour with 6 and 9% ginger flour.

The total scores values were a reflection of all the tested quality attributes and acceptability of the pan bread. These values were calculated from 100 as a sum of the received sensory scores. The results demonstrated that, the mean total score values of control bread sample which was produced by using 100% wheat flour (72%ext.) was higher than those of other samples and gradually decreased with increasing replacement levels of ginger powder.

Generally, it could be concluded that, the pan bread produced by particular replacement of wheat flour with 3% ginger powder gave bread loaves more acceptable rather than the pan bread produced by added 6 and 9% ginger powder. The obtained results are in agreement with Balestra et al., [42] who suggested that the addition of ginger powder in the bread formula would not interfere positively with bread acceptability; in fact the sample with the lowest amount of ginger powder (3%) showed the highest value of “overall acceptability”.

The effects of ginger on sensory characteristics of rusks are presented in Table 8. With the increase in the level of ginger powder in the formulation, the sensory scores for structure, taste, odor and general appearance of rusk decreased. Replacement of wheat flour with 6 and 9% of ginger flour impaired the color which decreased from 9.95 in control to 9.3 in 9% ginger powder. But odor of rusks which increased from 9.90 in control sample to 9.94 in 3% ginger powder. Control samples had maximum color, taste, structure and General appearance. The color, taste, structure and general appearance attributes score for control sample was 9.95, 9.94, 10 and 9.5, respectively on a 10-point hedonic scale.

Table 8. Sensory characteristics of fresh rusks prepared by partial replacement of weak wheat flour (72% ext.) with ginger powder

Samples	General appearance	Color	Odor	Taste	Structure
100%WF	9.50^{a} ±0.00	9.95^{a} ±0.00	9.90^{a} ±0.42	9.94^{a} ±0.47	10.00^{a} ±0.21
3%GF	9.30^{a} ±0.15	9.70^{b} ±0.42	9.94^{a} ± 0.48	9.90^{a}± 0.66	9.50^{b} ±0.36
6%GF	9.48^{a} ±0.66	9.40^{c} ± 0.48	9.60^{b} ± 0.56	9.00^{b} ± 1.00	9.45^{b} ±0.68
9%GF	9.25^{ab}±0.77	9.30^{c} ±0.53	8.98^{c} ±0.63	8.67^{c} ± 0.51	9.45^{b} ±0.33

* Each Mean value, within the same column, followed by the same letter is not significantly different at p<0.05.
*Each value is followed by its ± standard deviation.

Table 9. Proximate chemical composition of pan bread prepared by partial replacement of strong wheat flour with ginger powder

Samples	Moisture*	Crude Protein*	Lipids*	Crude fiber*	Ash*	Carbohydrate*
100%WF	28.76^{b}±1.23	13.04^{a}±035	2.52^{a}±0.12	0.78^{c}±0.16	0.60^{b}±0.01	83.06^{a}±1.89
3%GF	28.83^{a}±3.11	12.91^{a}±0.40	2.60^{a}±0.15	1.50^{bc}±0.60	0.72^{a}±0.03	82.27^{ab}±2.03
6%GF	28.95^{a}±0.90	12.64^{ab}±0.90	2.67^{a}±0.08	1.98^{b}±0.20	0.79^{a}±0.04	81.92^{ab}±1.11
9%GF	29.20^{a}±1.37	12.30^{c}±1.12	2.75^{a}±0.05	2.65^{a}±0.10	0.90^{a}±0.01	81.40^{b}±0.90

* Represented as % on dry weight basis.
- Each Mean value, within the same column, followed by the same letter is not significantly different at p<0.05.
- Each value is followed by its ± standard deviation

Table 10. Proximate chemical composition of rusk prepared by partial replacement of weak wheat flour with ginger powder

Samples	Moisture*	Crude Protein*	Lipids*	Crude fiber*	Ash*	Carbohydrate*
100%WF	3.80^{b}±0.29	11.30^{a}±089	3.52^{b}±0.04	0.82^{b}±0.01	0.55^{b}±0.01	83.81^{a}±0.98
3%GF	3.84^{ab}±0.34	11.23^{a}±0.26	3.75^{ab}±0.05	1.00^{a}±0.00	0.64^{ab}±0.09	83.38^{b}±1.90
6%GF	3.90^{a}±0.12	11.00^{ab}±0.19	3.94^{a}±0.00	1.12^{a}±0.00	0.72^{a}±0.08	83.22^{b}±2.34
9%GF	4.20^{a}±0.17	10.72^{b}±0.28	4.25^{a}±0.10	1.19^{a}±0.04	0.81^{a}±0.03	83.03^{ab}±3.09

* Represented as % on dry weight basis.
- Each Mean value, within the same column, followed by the same letter is not significantly different at p<0.05.
- Each value is followed by its ± standard deviation

Such as pan bread results, the rusks made from blends containing 3% level of ginger powder was not significantly (p<0.05) different in the most tested sensory characteristics (general appearance, odor and taste) than the control. There were, also, no significant differences among all samples in general appearance. Referring to the similar results, Abdel-Samie et al., [35] found that the highest level of ginger additions (5%) had scores of 6.8 and 7.5, not significantly different from the control cookies sample with an appearance score of 8. The same authors indicate that cookies with ginger powders had similar sensory attributes (texture, flavor, appearance and overall acceptability) compared to the control sample. Therefore, prepared cookies, even with ginger additions at the highest level of 5% are expected to have a good acceptability.

There was an increase in the moisture content as levels of ginger powder increased up to 9% (Table 9 and Table 10). The moisture content is an indication of quality and stability of products. Higher moisture in ginger powder incorporated bread and rusk could be due to water holding capacity of powders. Table 9 and Table 10 showed that both products (pan bread and rusks) manufactured from wheat flour only contained high amounts of protein and carbohydrates, but when the ginger powder ratio increased, the protein and carbohydrate contents decreased.

On contrary, both products (pan bread and rusks) manufactured by wheat flour only contained low lipid, fiber and ash amounts, but as the ginger powder substituted ratio increased, the lipid, fiber and ash contents increased. These observations agree with Tusneem et al., [12], who reported an increase in ash and fiber in cookies containing ginger powder. The results are meanable due to the ginger powder contained higher significant lipid, fiber and ash amounts than wheat flour.

These results are consistent with the findings of Adel and Prakash [10] who showed that, protein and fat content was found to be 5.98 and 4.37g /100 g DW. The reported values for composition of ginger by various authors are in the following range; protein, 5.2 to 8.7, fat, 5.5 to 7.3 and ash, 2.5 to 5.7 g/100 g DW [43,44,45]. Shirshir et al., [20], also, found that the fat content of fresh ginger and dried ginger were 2.50% and 1.98 % respectively.

Concerning to wheat flour, Martinez et al., [46] reported that the protein, lipid, crude fiber, ash and total starch of commercial wheat flour were 12.2, 0.9, 0.3, 0.76 and 76.0%, respectively. So there was an increase in ash, fiber and fat but protein and carbohydrates decreased in pan bread and rusks with increasing of ginger powder levels.

Antioxidant components content (total phenolic as mg gallic acid equivalent /100 g dry weight, tanins as mg /100 g dry weight and total flavonoids as milligrams of catechin equivalents per 100 g dry weight) compounds and antioxidant activity (as µM of Trolox equivalent (TE) /100 g dry weight) were estimated in the tested pan bread samples. The resulted pattern could be considered as a good representation for the other tested products (Rusk). Finally, the producers could put in mind such conclusion to apply the procedure in the implementation of the resemble products.

The results of the total antioxidant activity, Flavonoids, Tannin and Total polyphenols showed significantly increments with increasing the addition of ginger powder to wheat flour in the production of pan bread (Table 11). Our results agree with Balestra et al., [42] who reported that the highest antioxidant activity was observed for the bread samples containing the highest ginger concentrations. This is because ginger contains a high percentage of antioxidants. Adel and Prakash [10] found that, ginger is a good source of antioxidant and most of the antioxidant components exhibit higher activities in alcoholic media as determined by different assays. Kahkonen et al., [47] reported that ginger was higher in phenols than most cereals and vegetables. Gorinstein et al., [23], also, found that ginger was higher in phenols than some alternative cereals such as amaranth, buckwheat and quinoa confirming that ginger is a good source of phenols.

Table 11. Antioxidant components and total antioxidant activity of pan bread prepared by partial replacement of wheat flour with ginger powder

Samples	Total antioxidant activity µmol/100 g	Flavonoids mg/100 g	Tannin mg/100 g	Total polyphenols mg/100 g
100%WF	194.00^{d}±4.33	2.20^{d}±0.39	ND	130.0^{d}±1.22
3%GF	2735.28^{c}±12.90	8.41^{c}±0.90	50.00^{c}±1.30	151.3^{c}±3.56
6%GF	5470.56^{b}±14.22	16.00^{b}±1.67	90.00^{b}±2.32	172.6^{b}±5.33
9%GF	8205.84^{a}±22.23	25.09^{a}±1.56	140.00^{a}±1.87	194.0^{a}±4.03

* ND= Not determined
* Each Mean value, within the same column, followed by the same letter is not significantly different at p<0.05.
*Each value is followed by its ± standard deviation.

Balestra et al., [42] used ginger powder in concentrations of 3, 4, 5, and 6% for bread preparation. Although the highest antioxidant activity was observed for the sample containing the highest dose, this bread had unpleasant sensorial and rheological properties. Same author, Balestra et al., [42] found that the breads prepared with 3% ginger powder was better than the control bread not only for the antioxidant effect, but also for sensorial properties.

4. Conclusion

Addition of ginger powder at different percentage (from 0% to 9%) changes dough machinability and bread making performances. The dough with the highest amount of ginger powder (9%) showed the lowest value of elasticity. The sensory analysis of the baked samples of both pan beard and rusk showed the highest values of hardness and the lowest value of overall acceptability. The results showed that 3% of ginger powder for bread and 3, 6% ginger powder for rusks could be included without altering dough handling and rheological properties. Incorporation of ginger powder in formulation markedly increased the total phenolics content and antioxidant activity. Therefore, ginger powder could be regarded as a potential health-promoting functional ingredient. Thus, it is of importance to choose appropriate amount of ginger powder and processing parameters to obtain healthy baked goods (high level of antioxidants) without promoting negative effects on the rheological properties of dough and, also, without changing the desirable physical and sensorial characteristics of the bread and rusks. Generally, among the studied samples, bread with 3% of ginger powder showed good rheological and sensorial characteristics and doubled anti-oxidant content compared to the control bread. The rusk gives good results in all those qualities with a level up to 6% powder ginger with doubled the content of antioxidants as compared with other acceptable samples (3% ginger pan bread and rusks) and control rusk sample.

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