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Production of ginger-flavored bread from wheat-soy composite flour

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Abstract
The present investigation involved the development of ginger-flavored bread utilizing a composite flour consisting of wheat and soy. Different amounts of ginger powder (0%, 3%, 5%, and 7%) were employed in the formulation. The evaluation included the determination of antioxidant activity, proximate composition, and sensory attributes through the use of hedonic testing. The bread with 7% ginger demonstrated the greatest degree of antioxidant activity (24.42±4.03). However, it was observed that the sensory quality of the bread was reduced, particularly when larger doses of ginger were used. The gingerbread containing 3% ginger exhibited notable sensory characteristics and had noteworthy antioxidant properties when compared to the control group. However, it is important to note that these differences were not found to be statistically significant (p>0.05) in the majority of sensory aspects. The gingerbread with a ginger concentration of 3% exhibited a higher protein content as a result of the use of soy flour. However, as the ginger concentration increased, the protein content decreased. Furthermore, the inclusion of ginger concentration resulted in a rise in moisture content, crude fiber, and ash content, with the exception of ash, crude fiber, and moisture content, which exhibited a decrease at the maximum level of ginger utilized.

Keywords: Bread, ginger powder, proximate analysis, antioxidant activity, sensory quality

Introduction
Bread, a fundamental dietary staple, is traditionally crafted from wheat flour, salt, and yeast and enjoys widespread consumption globally (You *et al.*, 2021) [35]. However, it's important to note that while bread can be derived from various grains, including corn, barley, millet, rice, and soy flour, wheat remains indispensable for achieving the desired leavening, courtesy of its gluten content. Bread holds a special significance within the baking industry, both in terms of production and consumption. Presently, consumers exhibit a preference for healthier food choices to mitigate the risk of non-communicable diseases, driving industry and research efforts to optimize bread-making technologies, thereby enhancing the diversity, quality, taste, and accessibility of bread products (Hathorn *et al.*, 2008) [16].

Among the potential ingredients incorporated into bread formulations are herbs, spices, or composite flour, all integral parts of the human diet. For thousands of years, they have served to augment the flavor, color, and aroma of food while offering preservative, antioxidative, antimicrobial, and medicinal attributes. Ginger, scientifically known as *Zingiber officinale* Roscoe, represents a monocotyledonous herbaceous plant widely recognized for its therapeutic properties (Ali *et al.*, 2008) [3]. Consequently, ginger has garnered substantial attention as a botanical dietary supplement, particularly in the United States and Europe, for its efficacy in managing chronic inflammatory conditions (Yang *et al.*, 2009) [34]. The rhizomes, the spice of commerce, exhibit aromatic, thick-lobed, corrugated, and scaly structures characterized by a zesty, lemon-like fragrance. Notably, ginger comprises biologically active constituents, notably the pungent gingerols and shogaols (Prakash *et al.*, 2012) [25].

In the context of bread production, wherein diverse functional ingredients are introduced to enhance nutritional value and fulfill specific functional roles, the inclusion of such ingredients has surged in popularity due to their potential to mitigate chronic disease risks beyond basic nutritional functions (Eswaran *et al.*, 2013) [15].

Ginger, being a medicinal plant with a rich history of usage spanning a wide array of unrelated ailments, including arthritis, cramps, rheumatism, sprains, sore throats, muscular aches, constipation, vomiting, hypertension, indigestion, dementia, fever, and infectious diseases, holds immense promise (Ali *et al*., 2008) [3].

Composite flour is a blend of starch-rich tuber flours such as cassava, yam, and potato with protein-rich flours and cereals, often incorporating or excluding wheat flour, serves to meet specific functional characteristics and enhance nutrient composition. For instance, wheat blended with sweet potatoes yields a composite flour that exhibits superior nutritional value in terms of mineral content, vitamins, fiber, and proteins when compared to single-cereal flours (Awuni *et al*., 2018) [6]. Soy flour, gluten-free by nature, presents itself as a viable substitute for wheat flour, catering to individuals with gluten intolerance. Wheat bread, while renowned as a source of calories and complex carbohydrates, unfortunately possesses low micronutrient content, particularly in essential amino acids, vitamins, and minerals (De la Hera *et al*., 2012; Turfani *et al*., 2017) [14, 32]. Furthermore, gluten intolerance in some individuals leads to celiac disease, resulting in severe inflammation and mucosal damage within the small intestine (Scherf, 2019) [29]. Importantly, non-wheat-producing countries grapple with the high cost of wheat flour imports, siphoning away valuable resources from domestic food production and, in certain cases, elevating public debt burdens (Abass *et al*., 2018) [1]. Hence, numerous endeavors underscore the utilization of composite flour derived from indigenous crops such as roots, tubers, cereals, and legumes, aiming to partially replace wheat flour and fashion nutritionally enriched functional foods (Benayad *et al*., 2021) [9].

The introduction of soy flour not only diminishes reliance on wheat flour but also elevates the nutritional profile of bread, courtesy of its unique protein content, notably lysine and threonine. Simultaneously, the incorporation of ginger powder into bakery products significantly enhances their functional attributes (Zuraida, 2013) [36]. Ginger-enriched products exhibit favorable health characteristics, poised to compete effectively in the marketplace (Prakash *et al*., 2012) [25]. Consequently, the objective of this study was to develop ginger-flavored bread using a composite flour blend of wheat and soy, while evaluating the nutritional, antioxidant, and sensory properties of the resulting bread.

Materials and Methodology's

Study Area

The study was carried out at Food Science Bakery located at the department of Food Technology and Agro-processing in Sokoine University of Agriculture, Morogoro, Tanzania.

Preparations of ginger powder

A Total of 4 kg Wheat flour and soybeans were purchased from Chief Kingalu market in Morogoro municipality together with other ingredients namely ginger roots, salt, yeast and blue band. The purchased gingers were peeled, grated and spread on a large plate and sun dried for 4 days. Dried ginger was then blended and sieved to obtain 200 g of fine powder ready to be used in the preparation of ginger flavored bread.

Preparation of soy flour

Soybean were picked and winnowed to remove waste and then roasted on medium flame for 5 minutes then cooled. The roasted soybeans were then grinded to produce fine powder that was then sieved to obtain a protein-rich, gluten-free, homemade soybeans flour ready to be used in bread making.

Preparation of Ginger Flavored Bread

Warm water (43 °C), wheat flour, brown sugar, baking soda, salt, ginger powder and soy flour were mixed and kneaded for 10 minutes. The dough was proofed and covered for 60 minutes at 25 °C. The dough was then divided, shaped and baked for 10 min at 180 °C (Arnold *et al*., 2022) [4]. Figure 1 shows a flowchart of bread production.

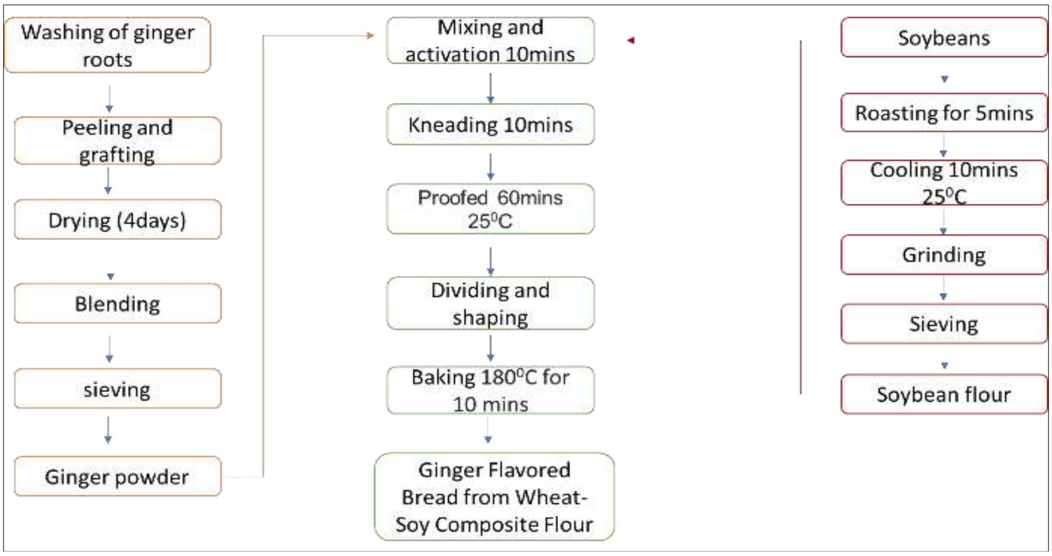

Fig 1: Flowchart for the preparation of Ginger Flavored Bread from Wheat-Soy Composite Flour.

Formulation of Composite Flour and ginger powder for Bread making: Several samples were meticulously constructed, each exhibiting unique amounts of ingredients. Within this set, the control group was represented by sample no. 516, which included no ginger powder (0% ginger). On the other hand, samples nos. 615, 756, and 654 were exposed to different amounts of ginger powder, precisely 3%, 5%, and 7%, respectively.

Table 1: Formulation of Composite Flour and ginger powder for Bread Production

Sample				
Sample code no.	516	615	756	564
Ingredients				
Wheat flour (g)	1000	700	700	700
Soy flour (g)	0	300	300	300
Ginger powder (0%)	0	3	5	7
Salt (tsp)	2	2	2	2
Yeast (tsp)	1.5	1.5	1.5	1.5
Sugar(g)	100	100	100	100
Margarine (g)	100	100	100	100
Water (ml)	500	500	500	500

Sensory evaluation

A group consisting of 30 judges, ranging in age from 20 to 50 years, was chosen to evaluate the sensory qualities of the bread that was baked. These characteristics included color, odor, taste, flavor, aroma, and overall level of acceptance. The sensory evaluation was conducted in sensory booths located in the sensory laboratory at the Department of Food Science and Agro-Processing, Sokoine University of Agriculture. Judges utilized a 9-point hedonic rating scale, where a rating of 9 signified "like extremely," while a rating of 1 indicated "dislike extremely" for each of the sensory characteristics under consideration.

Proximate composition

Standard Association of Official Analytical Chemistry Methods, AOAC were adopted for estimating moisture content, ash content, crude fiber content and protein content of the produced breads.

Crude protein determination

The crude protein content analysis of the samples followed an absorbance-based method. In each case, 1g of the respective sample was placed into individual test tubes, and subsequently, 10 ml of water and 1 ml of NaOH solution with a concentration of 1N were added. To ensure thorough mixing, a malt shaker was employed, followed by filtration using filter paper. Concurrently, a blank sample was prepared for reference. A solution was then created by combining 10 ml of the Folin-Ciocalteu Phenol reagent with 10 ml of water, resulting in a 20 ml solution. This solution was subsequently added to each test tube, including the blank, and 0.4 ml of this mixture was pipetted into the samples. The prepared samples were placed in a dark environment and allowed to incubate for 30 minutes. Following incubation, the absorbance of each sample was measured at a wavelength of 517 nm using a spectrophotometer. This procedure, known as the Lowry assay, capitalizes on the reaction between proteins and the Folin-Ciocalteu reagent in the presence of sodium hydroxide (NaOH) to generate a measurable color change. The magnitude of this color change is directly proportional to the protein concentration within the samples, enabling precise determination of crude protein content.

Moisture Content Analysis.

The percentage of water content is determined by the oven method. This method is carried out by means of a porcelain dish dried in an oven at 105 °C for 1 hour then put in a desiccator for 15 minutes until it is cool then weighed (a). The bread samples were macerated and then weighed as much as 2 grams (b) in a porcelain dish. The sample is then dried in an oven at 105 °C for 4 hours. Next, the sample was removed from the oven and put in a desiccator for 15 minutes until it cooled the sample was then weighed. The drying process is repeated for 1 hour to constant weight (c). Calculation of moisture content by the formula:

$$\% \text{ moisture content} = \frac{b - (c - a)}{b} \text{ x}100\%$$

Were

a - Weight of dish (g)

b - Weight original of sample (g)

c- Weight dried sample and dish (g)

Ash content determination

Ash content was determined according to AOAC (2010), method 923.03. A total of 5 g of samples were kept in a tarred crucible. Place crucibles in a cool muffle furnace. Use tongs, gloves, and protective eyewear since the muffle furnace is warm. Samples were ignited for 24 hours at 550 °C. The muffle furnace was turned off and opened after the temperature dropped. Crucibles were transferred into a desiccator with a porcelain plate and desiccant. The crucible was covered, and a desiccator was closed to allow the crucibles to cool prior to weighing. The percentage of ash was calculated using the following formula:

$$\text{Ash } (\%) = \frac{(\text{Weight of ash (g)})}{\text{weight of dried sample(g)})} \text{x}100$$

Crude fiber Determination

Crude fiber was determined by using the AOAC (2010) official method 920.86. Ankom fiber analyzer (Model ANKOM 220, USA) was used, and the percentage of crude fiber was calculated according to the formula:

$$\% \text{ Crude Fiber} = \frac{(D-G)}{A} \text{x}100$$

Where; D = Residue (g), G = Ash weight (g), A = Sample weight (g)

Antioxidant Activity Analysis

The assessment of antioxidant activity was conducted using the 2, 2-dipheny l-1-picrylhydrazyl (DPPH) free radical capture method. First, approximately 2 g of macerated cookies were selected for analysis. These samples were paired with 1 ml of an ethanol solution. Subsequently, the mixture underwent centrifugation to separate deposits from solutions. Next, a 200-µl portion of the sample solution was mixed with 1 ml of DPPH solution. The resulting mixture was then kept in darkness at room temperature for a duration of 30 minutes. Following the incubation period, the solution was transferred to a cuvette for absorbance measurements using a UV-visible spectrophotometer at a wavelength of 517 nm. A control solution was also prepared following the same procedure, but it contained only ethanol and DPPH solutions. The process generally entails the comparison of the absorbance of the sample with that of the control in order to measure the extent of free radical capture and, subsequently, determine the antioxidant activity of the tested materials as per the formula:

$$\% \text{ antioxidant activity} = \frac{(\text{Absorbance of blank} - \text{ Absorbance of sample})}{\text{Absorbance of blank}} \times 100$$

In this study data was collected using sensory questionnaire sheets and Laboratory experiments.

Data analysis

The obtained data collected using sensory questionnaire sheets and laboratory experiments were statistically analyzed using the SPSS statistical package (Version 9.05). An analysis of variance (ANOVA) and multiple range test were used to determine the significance difference among various treatments at $p<0.05$.

Results and Discussion

Sensory Analysis

The organoleptic properties of wheat bread produced by using 100% strong wheat flour as a control sample and ginger-flavored bread samples prepared by partial replacement of wheat flour with 300 g of soy flour and 3, 5, and 7% ginger powder were evaluated to select the best substitution level that produces high-quality bread. The bread samples were evaluated by 30 panelists for sensory properties, and the results are as shown in Table 2.

Table 2: Sensory characteristics of the ginger flavored bread samples

Sample Attributes	Color	Taste	Aroma	Flavor	Texture	Overall acceptability
Control	8.13±0.94^{a}	7.43±1.17^{a}	7.23±1.52^{a}	7.43±1.10^{a}	7.17±0.79^{a}	8.07±0.91^{a}
3%ginger	7.77±0.68^{a}	7.13±0.63^{a}	7.20±0.96^{a}	7.20±1.22^{a}	7.23±0.94^{a}	7.33±0.80^{b}
5%ginger	7.30±1.02^{b}	5.63±1.09^{b}	5.63±1.25^{b}	5.47±1.22^{b}	6.13±1.46^{b}	5.13±0.86^{c}
7%ginger	6.37±1.19^{c}	4.27±1.08^{c}	4.40±1.07^{c}	3.67±0.96^{c}	5.03±1.54^{c}	3.70±0.79^{d}

Values represent mean± standard deviation score of sensory parameters (color, taste, aroma, flavor, text and overall acceptability). Values within the same column having different superscript letters are significantly different at $p<0.05$.

The results from Table 2 reveals significance differences ($p<0.05$) in most sensory attributes tested, including color, aroma, texture, flavor, taste, and overall acceptability. Interestingly, no significant difference ($p>0.05$) was found between the control sample and bread containing 3% ginger in all parameters. However, there were significant differences ($p<0.05$) across all sensory properties when comparing the control bread sample (without ginger) to bread with 5% and 7% ginger flour. These results indicate that the control bread, made solely with 100% wheat flour, scored higher in overall acceptability than other samples, with scores decreasing as ginger powder levels increased. Various chemical reactions occurring between protein and carbohydrates are effective on the color values of the bread, and formulation causes differences in the color of the final product (Turkut *et al*., 2016) [33]. The color of the bread crust in bread containing 3% ginger did not exhibit a significant difference compared to the control sample ($p>0.05$). However, when the concentration of ginger in the bread increased, the color considerably decreased ($p<0.05$) as shown in Table 2. The color of the crust was influenced by both the varying quantities of ginger powder used and, more significantly, the Maillard reaction that occurred throughout the cooking process (Michalska *et al*., 2008) [20]. Rather than focusing on the color outcomes of bread crumbs, the collected data for each parameter in the present study exhibited substantial and proportional variations in relation to the quantity of ginger powder incorporated. The color of the bread is influenced by chemical reactions between protein and carbohydrates during baking, leading to variations in the final product's color. Additionally, the Millard reaction during baking plays a crucial role in color changes. Notably, most parameters correlated significantly and proportionally with ginger powder content. Overall acceptability peaked at 3% ginger inclusion (7.33±0.80), declining with higher ginger percentages, indicating that ginger has the potential to mimic the qualities of whole wheat bread. This aligns with previous research suggesting that ginger powder's pungency, attributed to gingerols compounds, may negatively impact bread acceptability. In previous study, Balestra *et al*. (2011) [8] suggested that the addition of ginger powder in the bread formula would not interfere positively on bread acceptability, in fact the sample with the lowest amount of ginger powder (3%) showed the highest value of overall acceptability. In contrast to this finding, Shalini and Devi (2005) [31] discovered that bread with 10% ginger was highly received. The observed discrepancy can likely be attributed to variations in food habits among the examined populations. Furthermore, the inclusion of soy flour, while increasing protein content and dough water absorption, also affects sensory properties, leading to decreased bread volume and darker appearance. In conclusion, the best bread for consumption emerged as the one produced with 3% ginger powder and 300 g of soy flour, offering an acceptable alternative despite the sensory challenges posed by ginger and soy flour incorporation. A separate investigation indicated that the inclusion of soy flour had an impact on the sensory qualities of bread, resulting in reduced loaf volume and a darker appearance (Ayele *et al*., 2017) [7]. Hence, it can be observed that both the addition of ginger powder and the incorporation of soy flour have a detrimental effect on the sensory attributes of the bread. The study concludes that bread generated by partially replacing wheat flour with 3% ginger powder and 300 g of soy flour was deemed acceptable, in comparison to bread produced by adding 5% and 7% ginger powder. Therefore, it can be considered the most favorable bread option for eating.

Proximate composition analysis

The evaluation results of nutritional properties are known as follows, the highest rate of proteins (12.16 g/100 g) in 3% of ginger bread sample, ash (11.27%) in 5% ginger moisture content (33.42%) in sample with 5% ginger. Proximate composition data of bread samples were analyzed and the results are as shown in Table 3.

Table 3: Proximate composition of ginger flavored bread samples

Sample	Moisture %	Protein mg/g	%Ash	%CF
0% ginger	29.42±4.23	1.46±1.53	0.86±0.16	1.91±0.24
3% ginger	32.02±1.68	12.3±0.33	2.36±0.45	3.68±0.07
5% ginger	33.42±0.48	4.05±0.02	11.27±1.01	3.62±0.76
7% ginger	30.01±0.42	3.02±0.01	1.53±0.19	2.01±0.04

Protein content

In the analysis, the bread sample without ginger powder exhibited a lower protein content (1.46±1.53) compared to samples containing ginger powder and soy flour. This difference arises from soy flour's inherently higher protein content when compared to wheat flour. Notably, the inclusion of 3% ginger powder and 300 g of soy flour in the formulation led to a significant increase in protein content (12.1±0.33 mg/g) due to the additional protein contribution from soy flour (table and Fig.1). However, at higher ginger powder percentages (5% and 7%), there was a noticeable decline in protein content (Fig. 1). This decline can be attributed to the adverse impact of higher ginger percentages on gluten development in the bread, resulting in a reduction in protein content. This aligns with previous findings that reported a decrease in protein and carbohydrates at elevated ginger concentrations (Martinez *et al*., 2014) [19]. The decrease in protein content at higher ginger concentrations may be attributed to a dilution effect, where an increase in ginger powder proportion leads to a reduction in the overall ratio of wheat and soy flour. This effect corresponds with research indicating that both wheat and soy flour are rich in protein content, and as ginger is added in greater quantities, it may dilute the protein-rich components of wheat and soy flour, ultimately decreasing protein content in the bread (Atudorei *et al*., 2023) [5]. Additionally, ginger contains various compounds that could potentially interact with the proteins present in wheat and soy, further contributing to the observed reduction in protein content (Ibrahim *et al*., 2015) [17]. It's important to note that specific recipes and baking conditions can also influence the protein content of the bread.

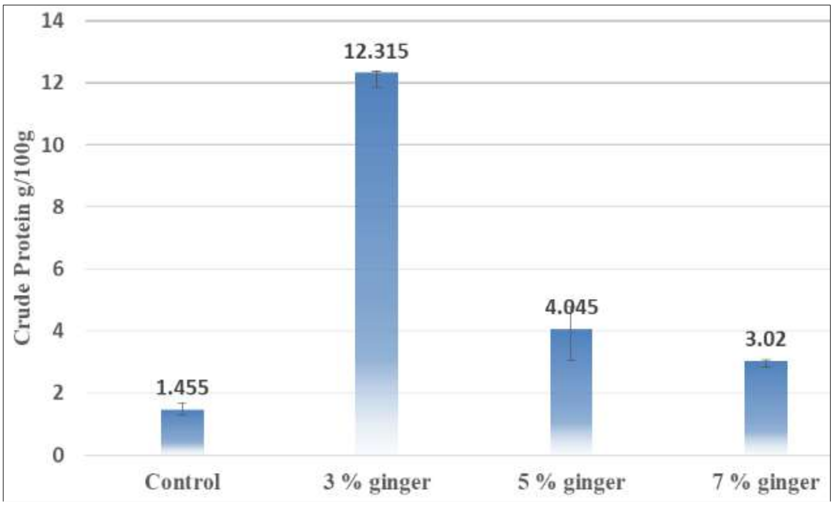

Fig 2: Protein content of ginger bread

Moisture content

As the levels of ginger powder increased, there was a noticeable rise in the moisture content of the bread, shifting from 29.42±4.23 to 33.42±0.48 (Table 2). This increase in moisture content can be attributed to the augmenting ginger percentage, which introduces more moisture into the overall dough mixture. The higher moisture content in ginger bread is primarily due to the water-holding capacity of ginger powder. This observation aligns with previous research findings that ginger powder exhibits a high water-holding capacity (Park *et al*., 2015) [24]. Moreover, ginger's hygroscopic nature, meaning its propensity to absorb moisture from the environment, further contributes to the elevated moisture content when incorporated into the bread dough. This phenomenon is consistent with reports indicating that ginger has the ability to absorb moisture not only from the dough itself but also from its surroundings, thus increasing the overall moisture content (Adeola & Ohizua, 2018) [2]. Additionally, ginger contains enzymes capable of breaking down starch molecules in the dough, resulting in a softer and more liquid-like texture that retains more moisture within the dough, consequently raising the overall moisture content (Cichero, 2015) [11]. However, at higher ginger percentages, there was a decline in moisture content. This decrease can be attributed to the binding properties of soy flour, which, at higher ginger levels, may not be sufficient to counteract the moisture content, thus leading to reduced moisture levels (Cho & Rhee, 2002) [10]. Furthermore, ginger's capacity to form a slight solid content, owing to its starch-rich composition, acts as a thickening and gelling agent, particularly pronounced at certain concentration levels. This phenomenon justifies the slight reduction in moisture content in bread containing 7% ginger, and these results corroborate findings from previous studies (Dauda & Adegoke, 2014) [13].

Ash content

It is evident that bread made solely from wheat flour contained a relatively low ash content of 0.86% as shown in figure 3. However, as the ratio of substituted ginger powder increased, there was a corresponding increase in ash content. These findings resonate with research by Kausar and Nadeem (2017) [18], who observed increased ash and fiber content in cookies containing ginger powder. Additionally, these results align with the work of Prakash (2010) [26], which indicated that ginger boasts higher fiber and ash contents. Therefore, the incorporation of ginger in increasing concentrations led to a rise in ash content within the bread. Ash content serves as an indicator of a food's mineral content and plays a role in the metabolism of macronutrients such as protein, fat, and carbohydrates, as noted by Okaka and Ene (2005) [23]. However, it's worth noting that at the highest ginger percentage (7%), there was a decrease in ash content (1.53%). This reduction may be attributed to a dilution effect, as reported by Ojinnaka *et al*. (2013) [22], where both wheat and soy flour have their inherent ash content. The addition of higher amounts of ginger powder may dilute the ash content contributed by wheat and soy flour, resulting in an overall decrease in ash content in the bread.

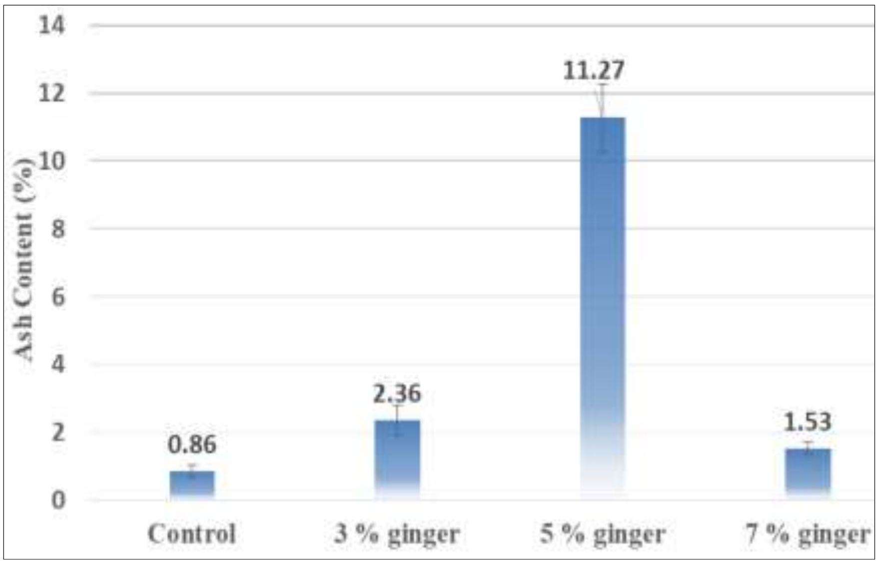

Fig 3: Ash content of ginger flavored bread

Crude fiber content

The results underscore the influence of ginger percentage on the crude fiber content (Fig 4). In samples devoid of ginger (0% ginger), the crude fiber content in ginger bread increased (3.68%) in comparison to bread made solely from wheat flour (1.91%). This increase can be attributed to the presence of other components in the bread produced from the flour mixture, contributing to the overall fiber content. However, in the sample containing 7% ginger, there was a reduction in crude fiber content. This decrease is primarily a consequence of the dilution effect stemming from the addition of a higher ginger percentage to the wheat-soy flour mixture, which impacts fiber content, as noted in previous research (Prakash, 2010) [26]. Notably, the fiber content in ginger is not as concentrated as that in wheat-soy flour, resulting in an overall lower crude fiber content. It's important to acknowledge that additional factors, such as variations in processing methods or differences in the ginger used, could also contribute to the observed changes in crude fiber content, as suggested by Serrem (2011) [30]. Further research would be essential to comprehensively elucidate these effects.

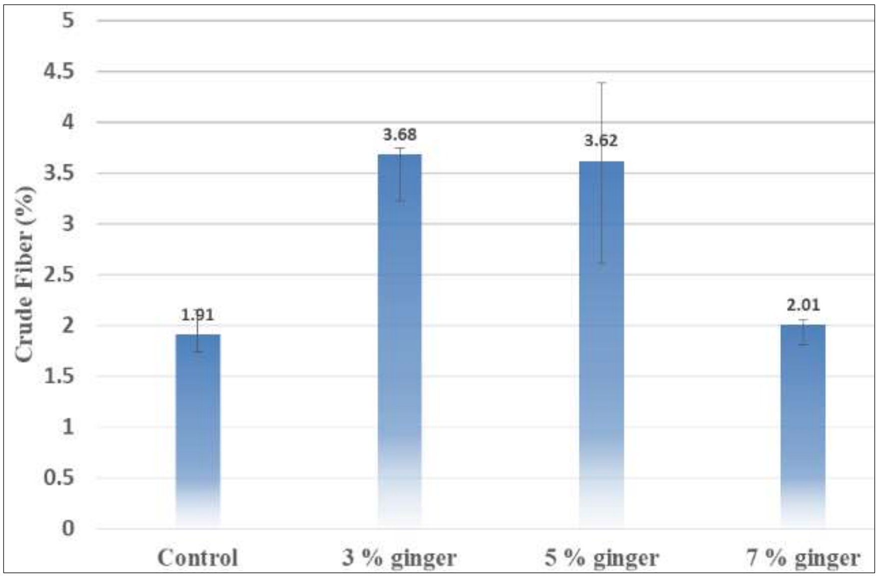

Fig 4: Crude fiber of ginger flavored bread.

Antioxidant activities

The means of antioxidant activities of the samples are shown in Figure 5. The results clearly demonstrate a consistent increase as ginger percentages rise from one sample to the next. The results demonstrate a consistent increase in antioxidant activity with the progressive addition of ginger powder to the wheat-soy flour mixture in ginger bread production. These findings align with previous research by Balestra *et al*. (2011) [8], who observed the highest antioxidant activity in bread samples containing the highest ginger concentrations. The antioxidant activities of plant phytochemicals primarily involve preventing the production of free radicals, neutralizing or scavenging these radicals in the body, and reducing or chelating the transition metal composition of foods, as noted by Oboh *et al*. (2012) [21].

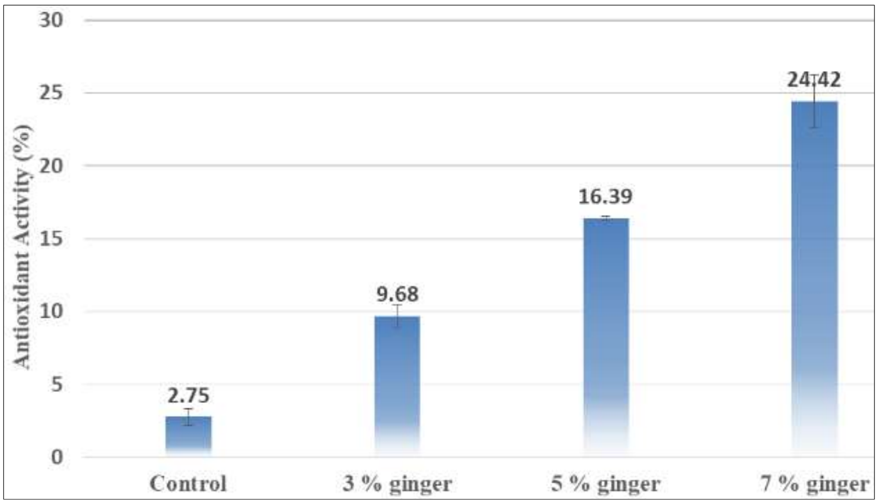

Fig 5: Antioxidant activity of ginger flavored bread

Specifically, ginger, rich in bioactive compounds like gingerols and phenolic compounds, possesses a high percentage of antioxidants. When ginger powder is incorporated into the bread, it concentrates these gingerols, leading to enhanced antioxidant activity. Gingerols, known for their potent antioxidant properties, effectively scavenge free radicals, reduce oxidative stress, and inhibit inflammation, making them valuable in protecting against various chronic diseases. In light of the results presented in Figure 5 and Table 2, which depict antioxidant activity and sensory characteristics of the produced bread, the most favorable choice for consumption appears to be bread containing 3% ginger. This particular sample boasts good sensory quality, moderate antioxidant activity, and the highest protein content among the samples, offering potential health benefits to consumers. Selecting the appropriate quantity of ginger powder and processing parameters is crucial in achieving baked goods that are both healthy, with a high concentration of antioxidants, and do not adversely affect the rheological properties of the dough or alter the desired physical and sensory attributes of the bread.

Conclusion

The addition of ginger powder across different percentages (0% to 7%) brings about notable changes in both sensory characteristics and nutritional quality of the bread samples. Among these samples, the bread containing 3% ginger powder stands out with favorable sensory attributes in comparison to 5% and 7%. Furthermore, it exhibits doubled antioxidant activity and improved nutritional content, particularly protein content, when compared to the control bread. The inclusion of soy flour plays a role in enhancing the protein content of ginger bread, while the addition of ginger powder significantly boosts the overall antioxidant activity of the bread. This positions ginger powder as a potential functional ingredient with health-promoting properties. However, it's crucial to carefully select the appropriate amount of ginger powder and fine-tune processing parameters to achieve baked breads that are both healthy, rich in antioxidants and nutrients, and maintain positive sensory characteristics.

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