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Research Article

EFFECT OF WHEAT FLOUR REPLACEMENT WITH GARDEN NIGHTSHADE (SOLANUM NIGRUM) FRUITS POWDER ON THE NUTRITIONAL, PHYSICAL, COLOR, RHEOLOGICAL AND SENSORY CHARACTERISTICS OF PAN BREAD

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ABSTRACT

The objective of this study was to evaluate the nutritional, physical, color rheological and sensory effects that the replacement of garden nightshade powder (GNFP) would have in different percentages 5, 10, and 15%, in a formulation of pan bread. The results showed that GNFP had higher protein, fibers, Antioxidant activity and carbohydrate contents of 16.50, 12.91, 93.68 and 77.41%, respectively. Pan bread containing GNFP exhibited higher crude protein, fibers, and antioxidant activity. All of the mixes' physical attributes, such as weight and density, rose compared with the control, but their specific volume and volume dropped. Pan bread containing GNFP has a lower L* and b* values and higher a* values for both crust and crumb compared with control samples. Also, the addition of GNFP to wheat flour at different proportions is due to an increase in water absorption (%), dough time, stability, mixing tolerance, dough weakening. On the contrary, degree of elasticity, extensibility, elasticity after 5 min, proportional number and energy decrease compared with dough WF. Results of sensory evaluation indicated that brightness of the pan bread decreased with increasing fruit powder and that 15% fruit powder pan bread had the lowest score for overall acceptability.

1. Introduction

Wheat (*Triticum aestivum*) is the most significant crop for baking over all other cereals due to its superior baking performance (Meeus et al., 2021). Since prehistoric times, bread has been the most significant staple food consumed by human. The essential minerals, vitamins, and antioxidants content in baked bread make it essential to human health (Bojňanská et al., 2022). Bread is a major contributor to micronutrient intakes and supplies 11–12% of calories, 16–20% of carbs, 10–12% of protein, and 17–21% of fiber for all age groups. One of the most popular grain products consumed worldwide is pan bread (Ershidat et al., 2024).

In Egypt, wheat is the most important grain crop. Egypt is the world's largest importer of wheat, with the General Authority for Supply Commodities of the Ministry of Supply and Internal Trade alone being the top buyer internationally (Gebreil, & Mohamed, 2023).

It follows that wheat policy is a top concern for the government and that wheat is a product of utmost importance in Egypt.

Egypt's unique social conditions highlight the significance of wheat policy: guaranteeing the food security of all Egyptian is a major problem for the government, with over 25% of the country's population living below the poverty line FAO (Boliko, 2019). Many developing countries have been encouraged to initiate initiatives. This is accomplished by launching initiatives to assess the viability of locally obtainable substitute flour for wheat flour.

For reducing the expense of imported wheat, some of the wheat flour used in baking is substituted with locally cultivated grains (Eleazu et al., 2014).

However, the lack of some important amino acids, such as lysine, in wheat flour proteins reduces the nutritional value and quality of grain and its derivatives (Dhingra and Jood, 2004).

The Solanaceae family includes the widespread edible medical herb known as garden nightshade (*Solanum nigrum*), which is native to Southeast Asia and is currently found across temperate to tropical parts of Europe, Asia, and America.There are 188 known chemical components of Solanum nigrum. Among these, polysaccharides, phenols, alkaloids, and steroidal saponins are the principal bioactive constituents (Chen et al., 2022). *Solanum nigrum* is used as food and medicinal in several locations. Micronutrients, including beta-carotene, vitamins C and E, minerals (iron, calcium, and zinc), and dietary fiber, are abundant in Solanum nigrum.

Garden nightshade can be valuable added by a variety of processing and preservation methods, including boiling, drying, and fermentation (Sangija et al., 2021).

Since there is little information available about the use of garden nightshade fruit powder in pan bread products, the main objective of this study was to evaluate the impact of wheat flour substitution with different levels of GNFP on the rheological properties of dough, as well as nutritional, physic-chemical, and sensory properties of prepared pan bread.

2. Materials and methods

2.1. Materials

In August 2021, garden nightshade fruit was harvested from the Kafr El Sheikh governorate in Egypt. The fruit were free of physical damage, harm of insects and fungus infestation. All ingredients used in pan bread preparation including El-Doha wheat flour (72%), active dry yeast (*Saccharomyces cerevisiae*), salt (sodium chloride), sugar (sucrose) and corn oil were purchased from Kazyon market, Kafr El-shiekh city, Egypt. All chemicals and reagents (analytical grade) used in this study were obtained from Sigma Aldrich Chemical Co. (St. Louis, M.O, USA).

2.2. Preparation of GNFP

The fruits of the garden nightshade were transported directly to the food technology lab at the college of agriculture at Kafrelshiekh University. There, dirt and other impurities were removed by washing them with tap water. The fruits were placed on a tray and dried for two days at 40ºC in an air oven. The dried fruits were crushed in a lab mill. The powder was then sieved through 100 meshes and stored in sealed containers at 4± 2ºC.

2.3. Prepare composite flour mixtures

Four composite flour blends were created by partially substituting wheat flour with 5, 10, and 15% GNFP, while 100% wheat flour (0% substitutions) served as the control.

2.4. Pan bread preparation

AACC (2012) described a straight dough method for pan bread manufacture. One hundred grams of wheat flour (72% extraction) was combined with 1% salt, 1.5% compressed yeast, 5.5% corn oil, and 1.5% sugar. Water was added in accordance with the farinograph results. To make dough, all components were combined in a dough mixer. After the dough was oiled and placed in a fermentation bowl, it was proofed for 60 minutes at 40±2ºC and then baked at 220ºC in an electric oven for 25 minutes. The loaves were separated from the metal pan and allowed to cool at room temperature before analysis.

2.5. Rheological properties of blended dough

The 86021 Brabender Farinograph and Extensograph apparatus (Berlin, Germany) were used to assess the rheological characteristics of dough in accordance with the methodology outlined in AACC (2012). The arrival time, development time, stability time, weakening, and mixing tolerance index of the pan bread dough were all estimated using the Farinograph.

2.6. Proximate composition.

The AOAC (2016) technique was used to calculate the approximate composition of pan bread, which includes moisture, crude protein, fat, total ash, and crude fiber. By difference, the total amount of carbs was computed. The formula from Elsebaie et al. (2022) was used to calculate caloric values.

Calorie value (kcal/100g) = 4.1× (%carbohydrates + % protein) + (% fat× 9.1)

2.7. Total phenolic content determination

The pan bread samples were coarsely pulverized and treated with petroleum ether (40-60°C) to remove lipids and resins. The residues were carefully separated and extracted with 500 mL of 80% methanol. Whatman No. 1 filter papers were used to filter the extract, and the filtrates were then dried on a rotary evaporator at 40°C with low pressure (Elsebaie and Essa, 2018). Folin-Ciocalteu technique was used as outlined by Essa et al. (2025) to assess total phenols. The results were recorded as Milligram Gallic equivalents (GAE) per gram of pan bread.

2.8. Physical properties of pan bread

After a one-hour chilling period at room temperature, the volume of the bread loaf was measured using the rapeseed displacement technique (AACC, 2012), and the weight was measured with an electronic scale. Loaf volume/loaf weight was used to calculate a certain loaf volume.

2.9. Color parameters

The color analysis which contain lightness (*L*), redness (*a*), and yellowness (*b*) of processed pan bread were estimated by a Hunter Lab Scan Visible colorimeter (USA) as described by Essa and Mohamed (2018) .

2.10. Sensory evaluation of pan bread

Produced pan bread was evaluated for their sensory characteristics (appearance, taste, odor, sponge, crust colour, crumb colour, distribution of crumb and overall acceptability) as mentioned by Essa and Elsebaie (2018) using a nine hedonic scale after baking by twenty panelists from the staff of food technology Dep., Faculty of agriculture, Kafrelshiekh University, Egypt.

2.11. Statistical analysis

Statistical analysis was made using SPSS software (version 26), and Duncan’s multiple range tests were used for mean comparison. Duncan’s multiple range tests at ($P \leq 0.05$) level were used to compare between means.

3.Results and discussions

3.1. Rheological Properties

Rheologic qualities of dough information may be used to anticipate the quality of final goods and the possible applications of wheat flour. Using a farinograph, the effects of using GNFP in place of wheat flour on the dough's water absorption (WA %), time (min), stability (BU), mixing tolerance (BU), and weakening (BU) were assessed. The findings are shown in Table 1.

Water absorption (WA) was shown to rise as GNFP level rose, from 57.5% in the control sample to 60.0% in the sample with 15% GNFP replacement. Part of the reason for this phenomenon is the abundance of hydroxyl groups in the fiber structure, which interact with hydrogen bonds in water(Gómez et al., 2011). The results align with fiber sources added to wheat flour, which improved the dough's absorption of water, per Abd-El-Moniem and Yaseen (1993) investigation.

The dough development time (DDT) was extended from 2 to 5 minutes when GNFP replaced 15% of the wheat flour. (KohaJdoVá et al., 2011) and Mohamed et al. (2012) showed that during this mixing phase, water is hydrated and flour and dough components develop. Similar trends were observed for DDT by Galanakis (2019). An increase in DDT can lead to the interaction of fibers with gluten, which prevents protein hydration (Zhang et al., 2023).

The integrity of the protein matrix, which is quickly harmed by the addition of new components, is known to have an impact on dough stability (DS) (Wang et al., 2021). Substituting wheat flour with GNFP resulted in an increase of DS from 5.0 to 7.5 min. These observations were similar to those obtained by Anil (2012)and Hadidy and Dreny (2020)for rice bran and doum fruit powder supplemented.

From the measurements, it was also concluded that increasing the levels of GNFP resulted a decrease in the mixing tolerance index (MTI). These findings were consistent with those of KohaJdoVá et al. (2011). The interactions between fiber and gluten can lead to a reduction in MTI (Bouaziz et al., 2010). The results in the same table indicate that the degree of softening increases when using GNFP. The extensograph reveals the viscoelastic behavior of the dough. This device tests the extensibility and resistance to expansion of the dough. Strong flexibility and high resistance outcomes are essential for dough characteristics (Ershidat et al., 2024). Data in the same table demonstrated the impact of replacing wheat flour with GNFP ratios of 0, 5, 10, and 15% on the extensograph parameters. These results showed that the addition of GNFP decreased the resistance to elasticity, extensibility, and energy. These data allowed for the observation that the addition of GNFP to wheat flour decreased elasticity (resistance to extension) to 595 and 590 BU for substituted wheat flour at the levels of 5% and 10% GNFP, respectively. While 15% had the highest decrease of 410 BU in compared with control dough (100% wheat flour) 635 BU. The results in the same table demonstrated that the extensibility parameters of wheat flour dough were lowered as a result of the inclusion of GNFP to wheat flour recorded 120, 110 and 120 mm for 5, 10 and 15% GNFP at comparison with wheat flour dough which recorded 130 mm. However, results indicated that adding GNFP to wheat flour at the level of 5% and 10% increased proportional number to reach 4.96, and 5.36, respectively. Meanwhile, the dough that contained 15% GNFP recorded lower proportional number (3.42) compared with the wheat flour dough recorded 4.88. In terms of energy value, the findings showed that the control sample had the highest energy value (92.50 cm2) while the formula of 5%, 10% and 15% GNFP recorded 88 cm2, 77 cm2 and 63.5cm^2. Ultimately, the findings showed that the formulae's dough elasticity, extensibility, and energy were lower than those of the control sample. These alterations were mostly ascribed to the inclusion of GNFP, which diluted the gluten in wheat flour (Yousif et al., 2020).

Table 1. Effect of different levels of garden nightshade fruit powder as a partial substitute with wheat flour on rheological properties

Parameters	Treatments			
	Control	***5% GNFP**	**10% GNFP**	**15% GNFP**
Farinograph				
Water absorption (%)	57.5	58.5	59.0	60.0
Dough development time (min)	2.0	4.0	4.0	5.0
Dough stability (min)	5.0	6.0	6.5	7.5
Mixing tolerance index (BU)	40.0	32.0	28.0	19.0
Degree of softening (BU)	87.0	100.0	114.0	126.0
Extensograph				
Elasticity (BU)	635	595	590	410
Extensibility (mm)	130	120	110	120
Elasticity after 5 min (BU)	605	580	480	380
Proportional Number	4.88	4.96	5.36	3.42
Energy cm^2	92.50	88.00	77.00	63.50

*GNFP means garden nightshade fruit powder

3.2. Chemical composition of pan bread before and after the baking

Table 2 shows the chemical composition of the pan bread formulated with GNFP. The chemical analysis of pan bread showed that the percentage of moisture, protein, ash, crude fiber, available carbohydrates, and total polyphenols content were increased by increasing the amounts of GNFP replacement in the pan bread before and after baking.

The moisture content increased before and after baking from 39.80% and 30.90% for control bread to 41.21% and 32.80% for bread made with 15% GNFP. The increase in moisture content might be due to the high water absorption by GNFP (Ajmal et al., 2006).

Crude protein increased significantly ($p \leq 0.05$) from 13.20 and 13.90% for control bread to 13.91 and 14.43% for bread made with 15% GNFP before and after baking, respectively. Meanwhile, fat content decreased significantly ($p \leq 0.05$) from 3.17 and 3.41% for control bread to 2.70 and 3.09% for bread made with 15% GNFP before and after baking, respectively. In addition, total ash content increased from 1.90 and 2.18% for control to 2.30 and 2.63% for bread made with 15% GNFP before and after baking, respectively. Also, crude fiber increased significantly ($p \leq 0.05$) from 0.82 and 1.20% for control bread to 2.83 and 2.88% for bread made with 15% GNFP before and after baking, respectively. It is important to note that the amount of moisture in pan bread made with GNFP was shown to rise in direct proportion to the amount of fiber present. This is because fiber has the ability to absorb water, raising the moisture content levels necessary to generate dough with the ideal consistency.

The increases in proximate composition parameters of pan bread containing GNFP may be due to variations in composition and ratios of wheat flour (72%), and GNFP. On the other hand, according to the data in the same table, caloric values in pan bread were decreased significantly before and after baking with GNFP addition in comparison with the control sample. Maximum ether extract and caloric value percentage were noticed in the control sample while, treatment contained GNFP with a percentage of 15% showed minimum percentages. The obtained results are in harmony with those reported by Hegazy and El-khamissi (2017)and Sangle et al. (2017).

Table 2. Proximate chemical composition of pan bread prepared by partial replacement of wheat flour with different levels of nightshade fruit powder before and after the baking (on dry weight basis)

Component%	Pan bread samples							
	Control		*** 5% GNFP**		**10% GNFP**		**15% GNFP**	
	Before	**after**	**Before**	**after**	**Before**	**after**	**Before**	**after**
Moisture	39.80^{b}	30.90^{e}	40.03^{b}	31.00^{d}	41.09^{a}	32.60^{c}	41.21^{a}	32.80^{c}
Crude protein	13.20^{e}	13.90^{b}	13.40^{d}	14.10^{b}	13.70^{c}	14.21^{b}	13.91^{b}	14.43^{a}
Fat	3.17^{b}	3.41^{a}	3.01^{c}	3.22^{b}	2.89^{d}	3.18^{b}	2.70^{e}	3.09^{c}
Ash	1.90^{e}	2.18^{c}	2.12^{d}	2.30^{b}	2.21^{c}	2.51^{a}	2.30^{b}	2.63^{a}
Crude fiber	0.82^{h}	1.20^{g}	1.52^{f}	1.85^{e}	2.14^{d}	2.29^{c}	2.83^{b}	2.88^{a}
Total carbohydrates	81.73^{a}	80.51^{d}	81.47^{b}	80.38^{d}	81.20^{c}	80.10^{d}	81.09^{c}	79.85^{e}
available carbohydrates	80.91^{a}	79.31^{b}	79.95^{a}	78.53^{c}	79.06^{b}	77.81^{d}	78.26^{c}	76.97^{e}
Caloric value (kcal/100g)	414.70^{a}	413.19^{a}	410.13^{b}	409.09^{b}	392.31^{e}	406.22^{c}	403.70^{d}	402.86^{d}
Total phenolic (mg GAE/g)	0.486^{g}	0.291^{h}	1.37^{d}	1.09^{f}	2.15^{b}	1.20^{e}	2.91^{a}	1.65^{c}

*GNFP garden nightshade fruit powder
Values followed by the same letter in the same row are not significantly different at $P \leq 0.05$.

Also, data in the same table stated that there was an increase in total phenolic content from 0.486 and 2.91 mg GAE/g for control bread to 2.91 and 1.65 mg GAE/g for bread made with 15% GNFP before and after baking, respectively.

3.3. Physical properties of pan bread:

Physical properties of pan bread prepared with GNFP are presented in Table 3. Results showed that the loaf volume, and specific volume decreased ($p \leq 0.05$) gradually by increasing the level of GNFP. However, the loaf weight and density values of bread containing GNFP increased ($p \leq 0.005$) by increasing the substitution level. The increase in loaf weight may be due to the high content of crude fiber in GNFP which might bind and absorb high amount of water.

The loaf volume and specific volume of prepared pan breads decreased ($p \leq 0.005$) from 1016±2.85 cm3 and 2.57±0.07cm3/gm for control bread to 710.40±0.42cm3 and 1.73±0.04cm3/gm for bread made with 15% GNFP respectively. The decrease in loaf volume could be explained by the fact that substitution of wheat flour with GNFP may cause gluten dilution and consequently, affect the optimal gluten matrix formation during mixing, formulation and baking step.

According to Sallam et al. (2019), the addition of whole wheat flour to bread formulations had a negative effect on carbon dioxide gas production and retention during dough testing, resulting in a decrease in loaf volume. This is because whole wheat flour is high in dietary fiber and gluten-free networks. Purhagen et al. (2012) observed concurrent changes in weight and volume of GNFP pan bread, resulting in an increasing trend in density changes and a decreasing trend in specific volume changes.

3.4. Crust and crumb color properties

Table 4 shows the GNFP percentage effect on the colors of the prepared pan bread's crust and crumb. The findings showed that the GNFP-containing pan bread's crust and crumb colors were considerably ($p \leq 0.05$) darker (lower L* values) than those of the control group (higher L* values). The lower L* values of pan bread containing GNFP can be attributed to the darker hue of GNFP compared to wheat flour.

Also, the dark color may have resulted from the Millard reaction between reducing sugars and proteins during baking, according to Dhingra and Jood (2004) .Increasing the level of GNFP in pan bread resulted in significant (p≤0.05) decrease in crust and crumb colors lightness. According to the same table, pan bread containing GNFP had a lower b* values compared with control.

Table 3. Physical properties of pan bread prepared by partial replacement of wheat flour with different levels of nightshade fruit powder

Pan bread samples	Physical properties			
	Weight (g)	Volume (cm^3)	Specific volume (cm^3/ g)	Density (g /cm^3)
Control	395.00±1.01^c	1016±2.85^a	2.57±0.07^a	0.39±0.02^e
GNFP (5%)	400.00±1.12^b	814.30±1.62^b	2.03±0.05^b	0.49±0.04^d
GNFP (10%)	406.20±1.08^a	757.00±0.92^c	1.86±0.01^c	0.54±0.08^c
GNFP (15%)	410.10±1.20^a	710.40±0.42^{cd}	1.73±0.04^c	0.58±0.03^b

*GNFP garden nightshade fruit powder
- Each value was an average of three determinations ± standard deviation.
Values followed by the same letter in the same column are not significantly different at P ≤ 0.05.

Table 4. Color characteristics of pan bread prepared by partial replacement of wheat flour with different levels of nightshade fruit powder

samples	**Crust color**			**Crumb color**		
	L*	***a****	***b****	***L****	***a****	***b****
Control	55.08^a	0.62^d	12.74^a	63.24^a	-2.98^d	16.19^a
5% GNFP	47.33^b	0.81^c	7.84^b	56.13^b	-2.04^c	8.78^d
10% GNFP	44.25^c	1.21^b	7.56^{bc}	49.80^c	-1.75^b	10.09^c
15% GNFP	40.86^d	2.65^a	7.02^c	47.69^d	-1.31^a	12.36^b

*GNFP garden nightshade fruit powder
-Means with different letter in the same column are significantly different at LSD at (p ≤ 0.05).

Also, data presented in the same table indicated that there was a decrease in *b** values of the crumb along with increasing the GNFP substitution percentage in pan bread in the crust color, but the opposite results were found in the crust color where there was an increase in b* values. There was a slight increase in a* values of crust and crumb as a function of increasing GNFP replacement percentage. Negative −*a** values for slight greenness were observed in results of crumb color. The addition of (GNFP) to the white plain wheat flour has made some significant changes in the color parameters which can be related to the increased protein and phytochemicals contents of dough (El-Kherbawy and Dewidar, 2019).

3.5. Sensory evaluation of pan bread

The sensory evaluation score of pan bread produced from blends of wheat flour (72%) and different replacement levels of GNFP are presented in Table 5. Replacement of wheat flour (72%) with GNFP affected significantly (p ≤ 0.05) on the sensory characteristics of the obtained pan bread.

Pan bread that contained GNFP had a lower appearance value ranged from 7.70 to 8.15 in comparison to the control (8.69). Also addition of GNFP decreased the taste value to be ranged between 6.00 and 6.75 compared to control (6.65). Also, Blending (GNFP) with WF significantly (P ≤ 0.05) decreased the scores of odor, the sponge, crust colour, and the crumb colour.

Generally, there was a decrease in all sensory attributes scores (appearance, taste, sponge, crust color, crumb colour and overall acceptability) except crumb distribution of pan bread containing GNFP compared with the control sample. Also, this decrease rate increased as a function for increasing wheat flour substitution percentage with GNFP. All prepared pan bread samples were accepted

Table 5. sensory evaluation for pan bread prepared by partial replacement of wheat flour with different levels of garden nightshade fruit powder.

Samples	Appearance (9)	Taste (9)	Odor (9)	Sponge (9)	Crust color (9)	Crumb color (9)	Distribution of crumb (9)	Overall acceptability (9)
Control	8.69±0.09[a]	7.65±0.08[a]	8.10±0.08[a]	8.55±0.07[a]	8.64±0.08[a]	8.28±0.07[a]	8.87±0.09[a]	8.42±0.08[a]
5% GNFP	8.15±0.08[a]	6.75±0.07[b]	7.56±0.06[b]	7.74±0.07[b]	7.65±0.08[b]	7.83±0.07[b]	8.17±0.08[a]	7.73±0.09[b]
10% GNFP	7.83±0.06[b]	6.21±0.05[c]	6.72±0.08[c]	6.66±0.09[c]	6.75±0.04[c]	6.57±0.07[c]	7.65±0.07[b]	7.03±0.06[c]
15% GNFP	7.70±0.04[b]	6.00±0.03[c]	6.21±0.07[c]	6.21±0.08[c]	6.48±0.05[c]	6.39±0.07[c]	7.43±0.08[b]	6.76±0.09[d]

*GNFP garden nightshade fruit powder

-Means with different letter in the same column are significantly different at LSD at ($p \leq 0.05$).

4. Conclusions

Compared to control pan bread, the pan bread produced with GNFP will have greater health advantages and be of higher nutritional quality. According to our findings, GNFP might replace wheat flour up to a 10% substitution rate in order to create functional pan bread that is both palatable and nourishing.

5.References

AACC, 2012. Approved method of American association of cereal chemists. 10th Ed. Methods 10-10.03, 44-15.02, 54-21.01 and 56-10.02Am

Abd-El-Moniem, G., Yaseen, A., 1993. High dietary fibre cookies from several sources of bran or husk. *Egyptian Journal of Food Science,* 21, 157-170.

Ajmal, M., Butt, M., Sharif, K., Nasir, M., Nadeem, M., 2006. Preparation of fiber and mineral enriched pan bread by using defatted rice bran. *International Journal of Food Properties,* 9, 623-636. https://doi.org/10.1080/10942910600580625

Anil, M., 2012. Effects of wheat bran, corn bran, rice bran and oat bran supplementation on the properties of pide. *Journal of food processing and preservation*, 36, 276-283. https://doi.org/10.1111/j.1745 549.2011.00592.x

AOAC, 2016. Association of Official of Analytical Chemists. Official Methods of Analysis, 18th ed.; *Association of Official of Analytical Chemists*: Arlington, VA, USA.

Bojňanská, T., Vollmannová, A., Lidiková, J., Musilová, J., 2022. Use of common buckwheat in the production of baked and pasta products. IntechOpen London, UK.

Boliko, M.C., 2019. FAO and the situation of food security and nutrition in the world. *Journal of nutritional science and vitaminology*, 65, S4-S8.

Bouaziz, M.A., AMARA, W.B., Attia, H., Blecker, C., Besbes, S., 2010. Effect of the addition of defatted date seeds on wheat dough performance and bread quality. *Journal of texture studies*, 41, 511-531. https://doi.org/10.1111/j.1745-4603.2010.00239.x

Chen, X., Dai, X., Liu, Y., Yang, Y., Yuan, L., He, X., Gong, G., 2022. Solanum nigrum Linn.: an insight into current research on traditional uses, phytochemistry, and pharmacology. *Frontiers in Pharmacology*, 13, 918071. https://doi.org/10.3389/fphar.2022.918071

Dhingra, S., Jood, S., 2004. Effect of flour blending on functional, baking and organoleptic characteristics of bread. *International journal of food science & technology*, 39, 213-222. https://doi.org/10.1046/j.0950-423.2003.00766.x

El-Kherbawy, G.M., Dewidar, O.M., 2019. Nutritional evaluation of brioche bread made from Egyptian wheat and enriched with garden cress seeds (GCS) powder as a functional food. Suez Canal University *Journal of Food Sciences*, 6, 27-41. https://doi.org/10.21608/scuj.2019.60153

Eleazu, C., Eleazu, K., Aniedu, C., Amajor, J., Ikpeama, A., Ebenzer, I., 2014. Effect of partial replacement of wheat flour with high quality cassava flour on the chemical composition, antioxidant activity, sensory quality, and microbial quality of bread. *Preventive nutrition and food science*, 19, 115. https://doi.org/10.3746/pnf.2014.19.2.115

Elsebaie, E.M., Essa, R.Y., 2018. Microencapsulation of red onion peel polyphenols fractions by freeze drying technicality and its application in cake. *Journal of Food Processing and Preservation*, 42, e13654. https://doi.org/10.1111/jfpp.13654

Elsebaie, E.M., Mousa, M.M., Abulmeaty, S.A., Shaat, H.A.Y., Elmeslamy, S.A.-E., Elgendy, M.S.A., Saleh, F.M., Essa, R.Y., 2022. Application of Gurma melon (Citrullus lantus var. colocynthoides) pulp-based gel fat replacer in mayonnaise. *Foods*, 11, 2731. https://doi.org/10.3390/foods11182731

Ershidat, O.T.M., Elsebaie, E.M., Badr, M.R., 2024. Impact of using plasma activated water in pan bread preparation on dough rheological characteristics and quality properties. *Journal of Cereal Science*, 118, 103983. https://doi.org/10.1016/j.jcs.2024.103983

Essa, R. Y., Elsebaie, E., 2018. Ice plant as antioxidant/anticancer and functional food. *World Journal of Dairy & Food Sciences,* 13, 57-62. 10.5829/idosi.wjdfs.2018.57.62

Essa, R. Y., Elsebaie, E. M., Abdelrhman, W. M., Badr, M. R., 2025. Barnûf leaves: antioxidant, antimicrobial, antidiabetic, anti-obesity, antithyroid, and anticancer properties. *Foods and Raw Materials.* 13(2):394 - 408. https://doi.org/10.21603/2308-4057-2025-2-647

Essa, R.Y., Mohamed, E.E., 2018. Improvement of functional and technological characteristics of spaghetti by the integration of pomegranate peels powder. *American Journal of Food Technology,* 13, 1-7. https://doi.org/10.3923/ajft.2018.1.7

Galanakis, C.M., 2019. Valorization of fruit processing by-products. Academic Press.

Gebreil, S., & Mohamed, M. (2023). Evaluation of Productivity, Physico-Chemical and Technological Characteristics of Some New Egyptian Wheat Varieties. *Food Technology Research Journal*, *2*(3), 158-177. https://doi.org/10.21608/ftrj.2023.334566

Gómez, M., Jiménez, S., Ruiz, E., Oliete, B., 2011. Effect of extruded wheat bran on dough rheology and bread quality. *LWT-Food Science and Technology*, 44, 2231-2237. https://doi.org/10.1016/j.lwt.2011.06.006

Hadidy, G.E., Dreny, E.E., 2020. Effect of addition of doum fruits powder on chemical, rheological and nutritional properties of toast bread. A*sian Food Science Journal,* 16, 22-31. https://doi.org/10.9734/afsj/2020/v16i230169

Hegazy, A., El-khamissi, H.A., 2017. Nutritional protein quality evaluation of wheat bread supplemented by rice bran flour. *Journal of Biological Chemistry*, 12, 321-333.

KohaJdoVá, Z., KaroVičoVá, J., Schmidt, Š., 2011. Lupin composition and possible use in bakery: A review. *Czech Journal of Food Sciences,* 29(3), 203–211. https://doi.org/10.17221/252/2009-cjfs

Meeus, Y., Janssen, F., Wouters, A.G., Delcour, J.A., Moldenaers, P., 2021. The role of arabinoxylan in determining the non-linear and linear rheology of bread doughs made from blends of wheat (Triticum aestivum L.) and rye (Secale cereale L.) flour. *Food Hydrocolloids*, 120, 106990. https://doi.org/10.1016/j.foodhyd.2021.106990

Purhagen, J.K., Sjöö, M.E., Eliasson, A.C., 2012. Fibre-rich additives—the effect on staling and their function in free-standing and pan-baked bread. *Journal of the Science of Food and Agriculture*, 92, 1201-1213. https://doi.org/10.1002/jsfa.4684

Sallam, A., Khalil, A., Mostafa, M., El Bedawy, A., Atef, A.A., 2019. Quality aspects of pan bread prepared by partial substitution of wheat flour with defatted rice bran. *Menoufia Journal of Food and Dairy Sciences*, 4, 89-99. https://doi.org/10.21608/mjfds.2019.174871

Sangija, F., Martin, H., Matemu, A., 2021. African nightshades (Solanum nigrum complex): The potential contribution to human nutrition and livelihoods in sub-Saharan Africa. *Comprehensive Reviews in Food Science and Food Safety*, 20, 3284-3318. https://doi.org/10.1111/1541-4337.12756

Sangle, J., Sawate, A., Patil, B., Kshirsagar, R., 2017. Nutritional and sensory quality of wheat bread supplemented with stabilized rice bran. *Food science research journal,* 8(1), 112–118. https://doi.org/10.15740/has/fsrj/8.1/112-118

Wang, Z., Ma, S., Sun, B., Wang, F., Huang, J., Wang, X., Bao, Q., 2021. Effects of thermal properties and behavior of wheat starch and gluten on their interaction: A review. *International journal of biological macromolecules*, 177, 474-484.https://doi.org/10.1016/j.ijbiomac.2021.02.175

Yousif, E.-S.I., Yaseen, A.A., Abdel-Fatah, A.-F.A., Shouk, A.-H.A., Gadlla, M.G., Mohammad, A.A., 2020. Pan bread quality as affected by some nano and fermented-nano food industries by-products. *Bulletin of the National Research Centre*, 44, 1-12. https://doi.org/10.1186/s42269-020-00315-x

Zhang, H., Liu, S., Feng, X., Ren, F., Wang, J., 2023. Effect of hydrocolloids on gluten proteins, dough, and flour products: A review. *Food Research International*, 164, 112292. https://doi.org/10.1016/j.foodres.2022.112292