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Some Technological Treatments to Enlarge the Shelf Life of Puff Pastry

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Authors' contributions

This work was carried out in collaboration among all authors. Author AMAM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MAAK and HHS designed the study, wrote the protocol, managed the analyses of the study managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Wheat bran is generally considered a byproduct of wheat milling industry, but it is a great source of fibers, minerals, and antioxidants that are important for human health. This study examined values of functional component for product from two bioprocessing (germination and fermentation) for wheat Giza171 variety. Also, it was examined for puff pastry (the pate) product, evaluated functional component (phenolic compound and antioxidant activity), sensory attribute, texture parameter, and mineral content. The results showed that total phenolic compound (TPC) and antioxidant activity (%RSA) values were highest in fermentation bran cell (with 2.5% yeast) (3465, 51.18), respectively. The volume increased with increasing percentage germination, while specific volume recorded the highest value for control (4.24). Sensory attributes of pate had the highest value from germination whole meal flour. Hardness decreased in all puff pastry from treatment compared with the control pate. Phenolic compounds and antioxidant activity for the product during storage period had the highest values for pate made from fermentation bran with 2.5% yeast during storage periods (TPC= 1960 and 1432.5; %RSA= 49.61 and 43.31, respectively). Also, mineral content increased for all treatments compared with the control. Functional whole wheat

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products with enhanced health-promoting value and safety without renouncing the good-tasting standards whereas required for consumers. In this concept, functional whole wheat was demonstrated for two bioprocessing: improve eating quality, nutrition and shelf life for pate product.

Keywords: Whole wheat flour; bioactive compounds; germination; fermentation; puff pastry; functional foods.

1. INTRODUCTION

Wheat bran is generally considered a byproduct of the flour milling industry, but it is a great source of fibers, minerals, and antioxidants that are important for human health. Phenolic acids are a specific class of wheat bran components that may act as antioxidants to prevent heart disease and decrease the incidence of colon cancer. Moreover, they have anti-inflammatory properties that are potentially significant for the promotion of gastrointestinal health. Evidence on the beneficial effects of phenolic acids as well as of other wheat bran components is encouraging the use of wheat bran as an ingredient of functional foods (Laddomada et al. [1]). Due to its strong antioxidant activity, they possess anti-carcinogenic activity and diabetes alleviation properties and could be associated with cardiovascular disease prevention, obesity and aging control (Žilić [2]).The bran/germ fractions contribute 83% of TPC of the whole meal flour. Actually, they are 15- to 18- folds greater than that of respective endosperm fractions and the starchy endosperm contributes only 17% of TPC (Adom et al. [3]). Most of the cereal phenolic compounds (PCs) are bound to cell wall polysaccharides. The amount of bound PCs in wheat, maize, rice and oats are 90, 87, 71 and 58%, respectively (Adom and Liu [4]). Microbial fermentation leads to a decrease in the level of carbohydrates, poly-and oligosaccharides, synthesis of some amino acids and improvement in availability of B group vitamins (Nout and Ngoddy [5]), increasing the content of the essential amino acids lysine, methionine and tryptophan (Adams [6]). Fermentation increases the amount of PCs (Katina et al. [7]). Free PCs may be easily extracted through conventional techniques, while to enhance the release of bound phenolic, hydrolysis processes have been used and fermentation is considered as one of the best processes to obtain bioactive compounds with a high quality and a high activity (Martins et al. [8]). Generally, fermentation by yeast is commonly used for the preparation of alcoholic beverages, but now the potential of yeast to enhance the bioactive property of cereals and whole grains has also been evaluated (Prabhu et al.[9]).

Germination has a strong influence on the nutritional quality of cereal grains and can be used as a tool to improve its nutritional value. However, some compounds deemed beneficial, such as beta-glucans, might be degraded during germination material and adapt the germination process for the respective purpose (Hubner and Arendt [10]). Sprouts are outstanding sources of protein, vitamins and minerals and they contain such in the respect of health-maintaining important nutrients like glucosinolates, phenolic and selenium. As the sprouts are consumed at the beginning of the growing phase their nutrient concentration remains very high. In the sprouts besides the nutrients phytochemicals, vitamins, minerals, enzymes and amino acids are of the most important in the respect of human health (Finley [11]). However, germination has been repeatedly reported as way to improve folate content in wheat (Koehler et al. [12]). In the short run, germination of cereals and other seeds might be an easy way to increase the uptake of folates. Also, Hubner and Arendt [10] and Koehler et al. [12] proved the effects of germination whole grain on the chemical composition, mineral content, and folate content. Sprout is a source of soluble sugars, protein and amylases in the dough and promotes the activity of yeast resulting in good bread texture and bigger loaf volume, good flavor and color to the finished baked products. Also, sprout products are for non-fermented bakery products such as crackers, cookies and muffins (Arif et al. [13]).

Puff pastry is a non-yeasted, laminated bakery product made from many thin layers of dough which is separated by alternate fat layers. The unique combination of fat and dough of puff pastry gives them their light, delicate and flaky texture, which adds a characteristic and highly desirable sensory enhancement. Puff pastry making is a complicated process that involves widely varying production practices and the making of puff pastry still remains an art. The production process depends on the quantity of

two main ingredients: flour and fat. Flour and fat must be of a tailored quality with specific characteristics (Wickramarachchi et al. [14]). It has delicate and flaky texture which comes from a unique combination of fat and dough. These bakery products are made from many thin layers of dough which are separated by alternate fat layers, because of which they are considered to be high fat food. Properties of puff pastry depend mostly on the quality of flour, which must be specifically tailored for this purpose. The most commonly used flour in the production of puff pastry is refined wheat flour. Lately, the requirements of consumers for healthy bakery products have a great response in the baking industry. In the market, there are new products made with ingredients that have high nutritional value (Olivera-Šimurina et al. [15]).

Oxidative damage to biomolecules in the body has been associated with certain disease conditions. Grains contain a wide array of phytochemicals that exert health benefits in humans through various mechanisms including antioxidant properties and mediation of hormones. Several studies involving whole grain intakes have shown a consistent protective role of whole grain consumption in reduced risk of colorectal cancer, breast cancer, coronary heart disease, diabetes, and reduced total mortality (Kwami and Hai [16]).To improve the eating quality and nutrition, many researchers have focused on modifying the properties of wheat bran, and several microorganisms have been adopted for fermentation (Roopesh et al. [17] and Messia et al. [18]). Fermented bran increases the content and bioavailability of several functional compounds, such as water-extractable arabinoxylans, total free phenols, and soluble fiber, but only has a slight impact on physical properties. As a result, when forming the dough, the pH and total acidity values increase, and the maximum height, gas retention, and stabilization time of the dough decrease after adding wheat bran fermented by Lactobacillus (Basa et al. [19]).

The aim of study to demonstrate the effect of fermentation and germination on the stability of active components of puff pastry and their effect on chemical, sensory, and texture of puff pastry.

2. MATERIALS AND METHODS

2.1 Materials

Wheat grains (variety, Giza 171) were obtained from Field Crops, Institute, Agricultural Research Centre, Ministry of Agriculture, Giza, Egypt. Wheat flour (whole wheat flour as control) was prepared by milling the grains, commercial wheat flour 72% ex. rate.

Baking ingredients: sugar, corn oil, margarine and salt were obtained from local market, Cairo, Egypt.

2.2 Methods

2.2.1 Germination of wheat grain

The grains were germinated according to Juana et al. [20], where grains were washed with 0.7% sodium hypochlorite, soaked in distilled water at room temperature for 12 hr (1: 4 w/v), and shaken every 30 min.The water was then drained off, grains were then transferred and spread on trays which were covered by muslin cloths. The muslin cloths allowed oxygen to enter for grains, while minimizing contamination. The grains were germinated at 25±3℃, for72 hr and sprayed daily with distilled water in order to maintain an adequate moisture level. The grains were weighed prior to soak, and after soaking before the germination operation. The germinated seeds were dried at 55-60℃, milled to obtain whole grain sprouted flour and stored in the refrigerator after in polyethylene bags until used.

2.2.2 Bran fermentation

The solid culture medium contained 2g sugar, 2g $CaSO_4 \cdot 2H_2O$, and196g wheat bran (Lung [21]). The moisture content of the medium was adjusted to55ml/100g, and the medium was loaded into an autoclavable gusseted breathable plastic bulk mushroom grow bag. The loaded bags were prepared in triplicates and autoclaved at 121°C and15psi for 120 min. After cooling, the bags returned to room temperature, they were inoculated with different concentrations: 1.5, 2.0 and 2.5% of *Saccharomyces cerevisiae* suspension and then incubated under standard conditions (37±2°C and 60% relative humidity) for 2 days. The raw and fermented wheat bran was dried in a vacuum drier at 60°C until the moisture content was 3-4%, then milling, filtered through a 100-mesh sieve and blend with flour at the same percentage of wholemeal grain.

2.2.3 Preparation the blends from different flour

The flour blends prepared from two separate formulations:

Formulation 1, germination flour was added at different percentages 30, 40 and 50% to flour extraction rate (72%) from grains of Giza 171 variety.

Formulation 2, fermentation bran by different concentrations of yeast 1.5, 2.0 and 2.5% added at the same percentages its presence in whole grain.

2.2.4 Pilot production of puff pastry

The dough was mixed in a laboratory scale Diosna mixer (Dierks&Söhne GmbH, Osnabrück, Germany) at low speed (85 rev/min) for 1 min and at high speed (120 rev/min) for 4 min. The dough formulation of the two separate formulation germination flour at different percentages: 30, 40 and 50%, and fermentation bran at percentage in whole grain (at different yeast quantity) puff pastry is shown in Table 1.

The final dough temperature was in the range of about 21±1°C. The dough was sheeted on a Pastry Sheeter Model MK 500-600 (Mac. Pan, Italy) to a thickness of 10 mm. The puff pastry margarine (amount according experimental design) is sheeted to the same thickness and placed into the dough sheet according to English method (Mc Gill [22]). The dough was laminated to the same thickness, folded by one three-fold (1x3) and re–rolled to 10 mm. The dough is then folded into fourths (1x4) and then was refrigerated at 5°C for 20 min. These steps were repeated twice to generate 144 theoretical fat layers. The pastry sheet of final thickness 10 mm was cut into forma constant, and weight 35±1 g. The dough pieces were allowed to rest for 10 min at room temperature, and then baked for 15 min at 220°C. And pate was storage at room temperature (25± 5°C) for 30 days for analysis.

2.2.5 Physical properties of puff pastry (pate)

After cooling, puff pastry (pate) revere subjected to physical measurements according to method described by AACC, [23] as follows: Height (cm), Weight (g), Volume (cm^3), and Specific volume (cm^3/g).

2.3 Chemical Analysis

Moisture, protein, ash, crude fiber and ether extract were determined according to the methods described in AOAC, [24]. Total carbohydrates were calculated by difference.

2.4 Determination Total Phenolic Compounds (TPC)

Total phenol content was determined using the method of Makkar et al. [25]. An aliquot (50 µl) of methanol extract was put in test tube and the volume was made up to 500 µl with distilled water. Then, 250 µl of Folin Ciocalteu reagent was added into the test tube, followed by 1.25 ml of sodium carbonate solution. The tubes were vortexed before incubated in dark place for 40 min. The absorbance was read at 725 nm using spectrophotometer (Shimadzu). Total phenolic content was expressed as mg gallic acid equivalents (GAE) g_1FW through the calibration curve with gallic acid.

2.5 Determination Antioxidant Activity

Antioxidant activity was measured by DPPH determination (Kim et al. [26]). To 2.9 ml of DPPH (0.004% (W/V) in methanol/H_2O (8:2 v/v), 100 µl of the sample methanollic extract was added. The mixture was shaken and allowed to

Table 1. Formulas of two separate blends puff pastry (pate)

Ingredients	Control 72% ext. rate	Whole meal flour 100%	Germination whole meal flour (g/100g)			Fermentation bran at different quantity of yeast (g/100g)		
	1	2	3/1	3/2	3/3	4/1	4/2	4/3
Germination whole meal flour/fermentation bran	100	100	30	40	50	28	28	28
Wheat (g)	100	-	70	60	50	72	72	72
Sugar (g)	2	2	2	2	2	2	2	2
Margarine (g)	70	70	70	70	70	70	70	70
Salt (g)	2	2	2	2	2	2	2	2
Water	48	55	58	60	62	60	60	60

stand at 20 °C in a dark place for 30 min. After decrease in absorbance, the resulting solution was monitored at 517 nm. The DPPH radical scavenging activity of phenolic compounds was expressed as mg /100 g of dry matter and as mg /100 ml of VCEAC in 30 min. The control solution was consisted of 100 µl of methanol and 2.90 ml of DPPH solution. The radical solution was freshly prepared.

The percentage inhibition of the DPPH radical (IP50) by the samples was calculated using the formula:

$$IP50 = [(Ac - Ax)/Ac] \times 100\%$$

Scavenging ability (%) = [(A_{517} of control - A_{517} of sample) / A_{517} of control] ×100

2.6 Sensory Evaluation

Ten panelists specialized in bread and pastries from Bread and Pasta department, Food Technology Research Institute (FTRI), Agriculture Research Center, Egypt were selected to conduct sensory assessment tests. Before the test, panelists were given some information on the importance of the experience. Panelists were re-briefed on use of hedonic scale questionnaire to evaluate the pate. Testing session lasted approximately 15 min. Puff pastry were evaluated as the method described by Soronja-Simović et al. [27] for Crust appearance (10), crust color (10), Lamination (20), Eating quality (20),Volume (20),Taste (10), Odor (10) and Overall Acceptability (100).

2.7 Texture Analysis

A texture analyzer (BROOKFIELD CT3 TEXTURE ANALYZER Operating Instructions Manual No. M08-372-C0113, Stable Micro Systems, USA) was used to measure the texture profile of puff pastry (pate) in terms of hardness (N), cohesiveness, Gumminess (N), Chewiness (mj), Adhesiveness (mj), springiness (mm) and Resilience of the samples according to the method described by Gomez et al. [28].

2.8 Statistical Analysis

The Data were analyzed using Costat, version 3.03 for personal computers according to Ott [29]. The tests used ANOVA test and descriptive statistics test. A treatment effect was assumed to be statistically significant at $P< 0.05$.

3. RESULTS AND DISCUSSION

3.1 Values of Functional Components Present in Raw Materials (Whole Flour of Sprouts Wheat and Fermentation Bran)

Values of functional components present in raw materials are listed in Table 2. The data indicated that total phenolic compounds (mg GAE/samples) recorded the highest values (3465.0 and 3115.0) in fermentation bran cells (fermentation with 2.5%, followed by 2.0% yeast) compared with flour of whole meal and extraction rate (72%) to same wheat variety (1467.5 and 1310.0). Also, antioxidants activity (RSA%) (DPPH radical scavenging activity (%)) exhibited the highest values in the same samples (51.18, 45.69, 11.57 and 9.61, respectively. Also, it can be evident that fermentation induced structural break-down of cereal cell walls leading to the liberation and /or synthesis of various bioactive compounds, hence increasing the amount of polyphenols liberated (Heinio et al. [30]). In the present findings, total phenolic compounds and antioxidants activity for germination whole meal flour were higher than whole meal for the same variety. These results implied that, phenolic compounds play an important role in health benefits, attributing to their highly antioxidant capacity. Thus, the consumption of whole grains is considered to have significant health benefits in prevention from chronic diseases such as cardiovascular disease, diabetes, and cancer because of the contribution of phenolic compounds existed. In addition, the extracts from cereal bran are considered to be used as a source of natural antioxidants (Hung [31]). These results are in agreement with Hung et al. [32], where phenolic acid profiles of flours from two Canadian wheat classes, Canadian Western Red Spring (CWRS) and Canadian Western Amber Durum (CWAD) exhibited a significantly higher content than the sound sample. Dordevic et al. [33] showed that, fermentation led to increase in phenol content, measured by TPC method, and more or less of antioxidant activities, measured by all three methods. Higher anti-oxidative activity was observed in samples fermented with *L. rhamnosus*, compared with samples fermented with *S. cerevisiae*. Bound phenolic, whose importance in TPC may be released by alkali, acid or enzymatic treatment of samples

prior to extraction, which can be used to explain fermentation-induced increase in TPC leading to higher anti- oxidative potential of fermented cereal extracts.

3.2 Physical Properties of Puff Pastry Made from Bioactive Component Material

The physical properties of puff pastry are showed in Table 3. The data showed that, the height of pate decreased as the percentage of germination flour, and yeast quantity for fermentation bran increased when compared with the pate made from flour 72% ex. rate. This trend was in opposite within the weight as pate with higher level of germinated flour and yeast quantity for fermented bran, where it was found to be height. The volume deceased in pate made from flour whole male, and flour 72% ex. rate, but increased yeast quantity for fermentation bran, resulted in increase in percentage germination flour. In contrast, the specific volume recorded increase of control pate, followed by pate made with whole meal and pate made with fermentation bran with 1.5% yeast quantity. This results are implied to natural processes (germination and fermentation), where it may be due to increase natural component as vitamins and produce dextrin to improve volume and specific volume. However, increase weight may due to increase in fiber. These results are in accordance with that obtained by Olivera-Šimurina et al. [15], where margarine exerted the largest and the most important effect on the increase in volume of the product. The combination of ascorbic acid and margarine had also positive effect on the volume of product, but in a lesser amount, thus it is less important. The ascorbic acid and transglutaminase individually did not have an important influence on the volume, but combination of them considerably contribute to decrease in the volume, which was expected, considering the oxidation effect of both additives. Also, Abdallah and Abo El-Naga [34] found that increase in weight with sprouted whole meal flour may be due to the high levels of fibers in the substituted cakes samples which increased the water absorption and consequently affected on weight. In contrast, many researchers found that the rheological quality of the gluten protein is of greater importance than the protein content of the flour (Wickramarachchi et al [14]). It is generally accepted that, strong flours give an increased lift **(**Taylor [35]) and weak flours have low lift which could be due to destruction of the layers early in lamination, resulting in poor gas retention and low pastry lift and results decreased volume and physical properties of product (Wickramarachchi et al [14]).

3.3 Sensory Evaluation of Puff Pastry Made from Bioactive Component Material

Data in Table 4 and Fig. 1 showed that, puff pastry from germination whole meal flour at three different substitutes had the highest acceptable values for sensory attributes compared with the control. While, puff pastry from fermentation bran at different levels of yeast recorded the lowest scores for sensory attributes. Laminations a vital quality attributes of puff pastry and plays on important role in sensory and consumer acceptance of products which recorded highest value in puff pastry form.

Color scores of germinated whole meal product were significant increased. This may be due to germination process activated enzymes, increase reducing sugar, and amino acid to increase Millard reaction as reported by Ghavidel and Prakash [36].

Table 2. Values of functional components present in raw materials

Sample	Total phenols(mg GAE/100g sample)(as mg Gallic acid equivalents)	Antioxidants DPPH radicals scavenging activity
1	1310.0	9.61
2	1467.5	11.57
3	1750.0	12.55
4	3027.5	43.53
5	3115.0	45.69
6	3465.0	51.18

-sample 1= wheat flour ex. rate 72%, 2= whole meal flour;3= Germinated whole meal flour, 4, 5, 6= Bran cell fermentation with 1.5, 2.0, and 2.5%, respectively

Table 3. Physical properties of puff pastry

Sample	Height (cm)	Weight (g)	Volume (cm^3)	Specific volume (cm^3/gm)
1	2.50 ±0.05[a]	16.97 ±0.01[a]	72.0 ±0.5[a]	4.24 ±0.03[a]
2	2.33 ±0.03[a]	17.08 ±0.07[a]	70.0 ± 0.5[ab]	4.09 ±0.01[a]
3/1	2.36 ±0.07[a]	18.38 ±0.06[a]	70.0 ±0.5[ab]	3.81 ±0.01[a]
3/2	2.43 ±0.02[a]	18.38 ±0.04[a]	73.3 ±0.5[a]	3.99 ±0.01[a]
3/3	2.43 ±0.03[a]	18.50 ±0.34[a]	75.0 ±0.8[a]	4.05 ±0.02[a]
4/1	2.17 ±0.01[ab]	18.70 ±0.17[a]	73.3 ±1.1[a]	3.92 ±0.02[a]
4/2	2.10 ±0.05[ab]	20.76 ±0.57[ab]	70.0 ±0.5[ab]	3.37 ±0.06[ab]
4/3	2.07 ±0.01[ab]	23.92 ±0.59[b]	66.6 ±0.6[b]	2.78 ±0.04[b]

-sample 1=wheat flour ex. rate 72%, 2= whole meal flour, 3/1, 3/2, 3/3=germinated whole meal flour as substituted 30, 40, and 50%, respectively, with wheat flour ex. rate 72%,and 4/1, 4/2, 4/3=bran fermentation with yeast as percentage 1.5, 2.0 and 2.5%, respectively; Means in the same column with different letters are significantly different (p≤ 0.05). Each mean value is followed by ± SE

The present data indicated that, germination process may be to due increased enzymes and vitamins which play oxidation role to produce high quality of non-yeasted puff pastry. As documented by Olivera-Šimurina et al. [15] the addition optimal ratio: from 3.60 to 10 mg/kg for ascorbic acid, from 0.03 to 3 mg/kg for trans glutamines and from 29.84 to 30% for margarine on dough basis, these ingredients have been based on the consideration of their major and interaction effects. During the optimization of spelt puff pastry quality, the following goals were set maximum volume, minimum firmness and maximum overall acceptability.

3.4 Texture Analysis of Puff Pastry during the Storage Periods

Data presented in Table 5 showed texture analysis of puff pastry made from wheat flour 72% ex. Rate, whole meal wheat flour and functional components (germination wheat flour and fermentation bran).The hardness recorded decreased value in all puff pastry from functional components treatments compared with control in storage period. Whereas the lowest value for hardness recorded in puff pastry made from 50% germination whole wheat flour within storage period. Also the puff pastry made from 50%

germination whole wheat flour recorded the lowest value for other parameter for texture test (Cohesiveness, Gumminess, Chewiness, and Springiness) within storage period compared with the other samples. This results probably due to production dextrin and fiber break down for

germination process that had high water absorption in dextrin.

These results are in agreement with Bechtel et al. [37], Natalia et al. [38] and also, Chalamacharla et al. [39] who reported that, bran comprises water-insoluble fiber involved in the protection of grain and endosperm. This fiber is made of arabinoxylan (AX) (19-25%), starch (17-29%), protein (14-18%), Lignin (~3%), β-glucans (1-3%), and other components which it has gained the attention of many researchers as functional ingredient in many cereals based foods. Katina et al. [40] reported that solubilization of AX during the 20 hr fermentation and decreased endogenous xylanase activities are proposed as the main reasons for the improved technological functionality of fermented bran. Olivera-Šimurina et al. [15] reported that the addition optimal ratio: from 3.60 to 10 mg/kg for ascorbic acid, from 0.03 to 3 mg/kg for trans glutaminase and from 29.84 to 30% for margarine on dough basis these ingredients have been based on the consideration of their major and interaction effects of spelt puff pastry quality and due to minimum firmness.

3.4.1 Total phenols (as mg/g Gallic acid) and antioxidants of puff pastry product during storage periods (30 days)

Total phenols and antioxidants of puff pastry product during storage are showed in Table 6. The results observed that, total phenolic (mg GAE/g sample) recorded the highest value in puff pastry made from whole meal flour and followed by fermentation bran with 2.5% yeast in zero time compared with other samples, whereas after end of storage period, it recorded the highest puff pastry made from fermentation bran with 2.5% yeast and follow made from 50% germination wheat flour compared with the control made from wheat flour 72% ex. rate and whole meal flour. While, antioxidants content (DPPH radicals

Table 4. Sensory evaluation of puff pastry

Sample	Crust appearance (10)	Crust color (10)	Lamination (20)	Eating quality (20)	Volume (20)	Taste (10)	Odor (10)	Overall acceptability (100)
1	8.45± 0.24^{a}	8.8± 0.2^{a}	19.6± 0.22^{a}	18.9± 0.31^{a}	17.8± 0.41^{ab}	9.5± 0.22^{a}	9.8± 0.13^{a}	92.85± 1.2^{a}
2	8.8± 0.2^{a}	8.8± 0.2^{a}	18.7± 0.21^{a}	18.2± 0.3^{a}	18.1± 0.40^{ab}	9.3± 0.21^{a}	9.25± 0.25^{a}	91.15± 1.2^{a}
3/1	9.25± 0.13^{a}	9.2± 0.13^{a}	19.2± 0.32^{a}	18.8± 0.29^{a}	19.05± 0.33^{a}	9.7± 0.15^{a}	9.45± 0.26^{a}	94.65± 1.0^{a}
3/2	9.15± 0.18^{a}	9.3± 0.15^{a}	19.1± 0.31^{a}	18.5± 0.34^{a}	19.35± 0.21^{a}	9.7± 0.15^{a}	9.45± 0.15^{a}	94.95± 1.1^{a}
3/3	8.7± 0.21^{a}	8.8± 0.24^{a}	19.7± 0.15^{a}	18± 0.33^{ab}	18.75± 0.37^{a}	9.7± 0.15^{a}	9.4± 0.26^{a}	92.75± 1.3^{a}
4/1	7.8± 0.13^{ab}	8.05± 0.24^{ab}	17.6± 0.4^{b}	17.5± 0.37^{b}	17.3± 0.26^{b}	8.7± 0.26^{ab}	9.0± 0.33^{ab}	85.65± 1.4^{b}
4/2	7± 0.39^{b}	7.3± 0.42^{b}	17.7± 0.49^{ab}	17.6± 0.33^{b}	16.8± 0.38^{bc}	8.3± 0.26^{b}	8.6± 0.30^{ab}	83.4± 2.2^{b}
4/3	6.8± 0.32^{b}	7.3± 0.33^{b}	17.2± 0.29^{b}	17.6± 0.30^{b}	17.1± 0.48^{b}	8.7± 0.33^{ab}	8.6± 0.4^{ab}	83.5±1.3^{b}

sample 1=Wheat flour ex. rate 72%, 2= whole meal flour, 3/1, 3/2, 3/3=germinated whole meal flour as substituted 30, 40, and 50%, respectively, with wheat flour ex. rate 72%, and 4/1, 4/2, 4/3=bran fermentation with yeast as percentage 1.5, 2.0 and 2.5%, respectively

Means in the same column with different letters are significantly different (p≤ 0.05). Each mean value is followed by ± SE.

Table 5. Texture parameters of puff pastry (pate) during the storage periods

Parameters \ Pate	Storage periods	1	2	3/1	3/2	3/3	4/1	4/2	4/3
Hardness(N)	Zero	12.21	14.15	5.44	3.62	3.46	4.51	11.14	13.61
	30 day	21.82	22.75	8.07	7.23	4.71	5.75	14.47	16.25
Cohesiveness	Zero	0.55	0.58	0.43	0.52	0.52	0.66	0.60	0.58
	30 day	0.42	0.53	0.33	0.46	0. 50	0.55	0.50	0.42
Springiness(mm)	Zero	3.14	3.37	2.16	2.26	2.77	3.43	3.22	2.68
	30 day	2.39	2.9	1.26	1.84	1.91	3.43	2.45	1.74
Gumminess (N)	Zero	7.18	12.18	3.07	2.83	1.82	2.63	7.04	9.44
	30 day	20.40	21.71	4.28	3.01	2.71	3.99	9.95	14.51
Chewiness(mJ)	Zero	22.60	25.30	5.90	4.30	3.40	4.60	24.20	30.40
	30 day	31.50	33.6	9.20	9.10	8.90	10.70	30.70	38.00

-sample 1=control72% ex. rate, 2= whole meal flour, 3/1, 3/2, 3/3=germinated whole meal flour as substituted 30, 40, and 50%, respectively, with wheat flour ex. rate 72%, and 4/1, 4/2, 4/3=bran fermentation with yeast as percentage, 1.5, 2.0 and 2%, respectively

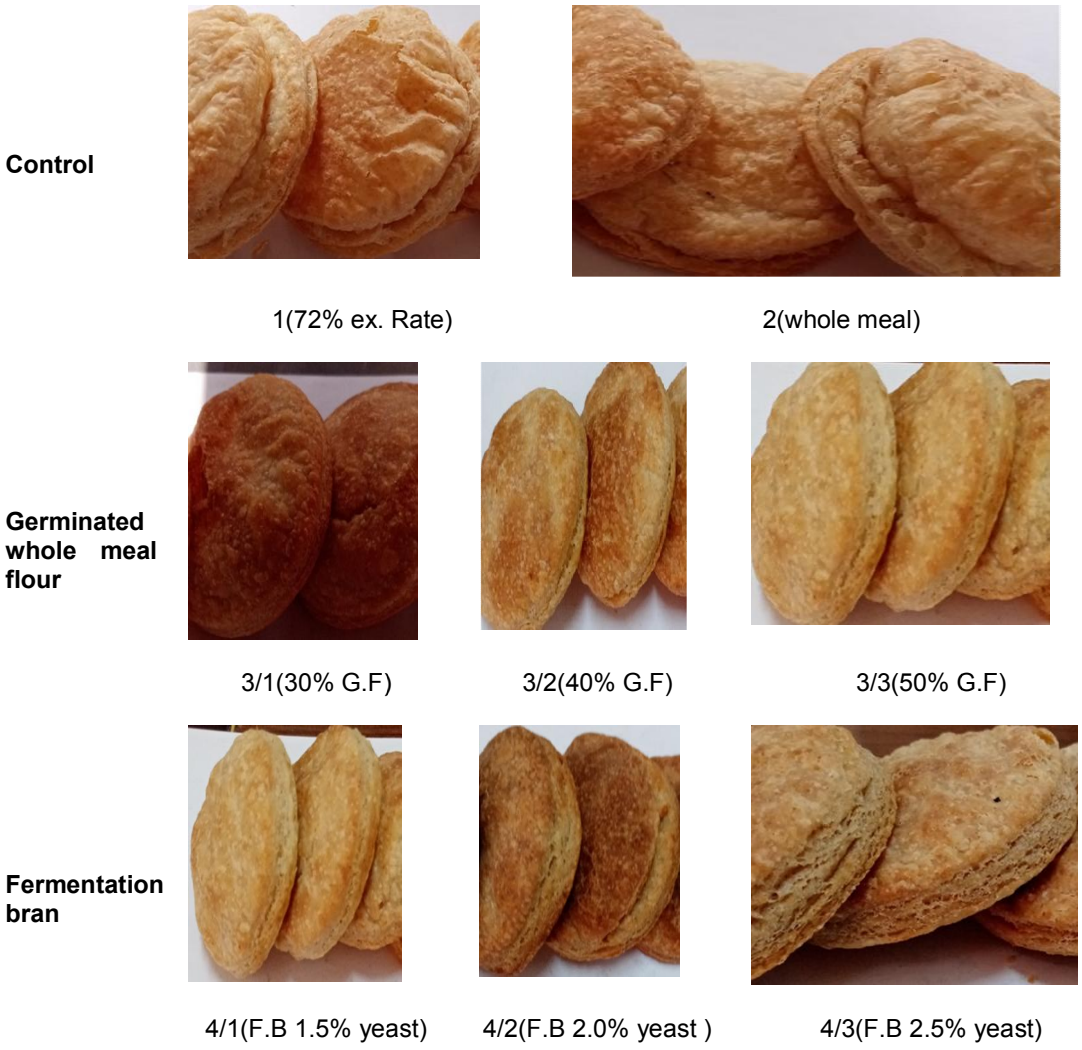

Fig. 1. Pate made from control 72% ex. rate, whole meal flour, germinated whole meal (G.F), and fermentation bran (F.B)

Table 6. Total phenols (as mg/g Gallic acid) and antioxidants of puff pastry product during storage periods (30 days)

Sample	Total phenols(as mg/g Gallic acid)		Antioxidants DPPH radicals scavenging activity	
	Zero time	End of storage	Zero time	End of storage
1	1347.5	742.5	20.98	12.94
2	4240.0	750.0	26.08	25.29
3/1	1365.0	790.0	21.57	17.65
3/2	1367.5	962.5	31.57	27.84
3/3	1490.0	1195.0	34.51	28.82
4/1	1567.5	1035.0	40.59	30.41
4/2	1620.0	1057.5	45.49	33.92
4/3	1960.0	1432.5	49.61	43.31
L.A.A			92.94	-

-sample 1=control 72% ex. Rate, 2= whole meal flour, 3/1, 3/2 and 3/3= germinated whole meal flour as substituted 30, 40, and 50% respectively, with wheat flour 72% ex. rate and 4/1, 4/2 and 4/3=bran fermented with yeast as percentage 1.5, 2.0 and 2.5%, respectively L.L.A:L=ascorbic acid

Table 7. Minerals compositions in pate (ppm)

Sample	Na	K	Ca	Fe	P	Mg	Mn	Cu	Zn
1	2300	1613	1845	94.40	1342	660.5	134.1	57.4	92.5
2	1626	1845	1278	49.76	1467	737.5	150.0	44.3	96.4
3/1	2005	1526	1328	41.42	1230	543.7	114.0	107.8	94.5
3/2	1694	1618	1517	58.17	1373	648.1	145.9	52.5	91.6
3/3	1651	1702	1569	89.60	1494	692.0	200.5	22.9	47.9
4/1	1713	2055	1384	71.95	1588	739.6	160.7	48.7	86.8
4/2	2036	2170	1637	100.2	1694	784.2	179.8	65.6	103.2
4/3	2086	2303	1787	108.6	1755	858.3	183.7	105.7	108.9

-sample 1=control 72% ex. rate, 2= whole meal flour, 3/1, 3/2 and 3/3 = germinated whole meal flour as substituted 30, 40, and 50%, respectively, with wheat flour72% ex. rate, and 4/1, 4/2 and 4/3=bran fermentation with yeast as percentage 1.5, 2.0 and 2.5% respectively

scavenging activity) in puff pastry recorded samples made from fermentation bran the highest contents during zero time and end storage period (30 days) and followed by samples which made from different percentage of germinated flour. These results indicated that, fermentation process due to activated enzymes and increased polyphenol compounds in the product, which play antioxidant role in products to protective them from damage during the storage period.

These results are in agreement with Ktenioudaki et al. [41] who reported that, the highest TPC was observed for the sourdough brewer's spent grain bread (BSG bread) with dough conditioner (61.30 mg GAE/100g sample). The TPC of bound extracts was higher than that of the free extract, but there were no significant differences among the bread sample. TPC is similar with the antioxidant capacity as measured by both DPPH and FRAP assays to be high for the bound extracts. In the case of free phenolic extracts, anti-oxidant activity was higher for all the sour dough BSG breads than the control.

3.5 Mineral Content in Puff Pastry Made from Bioactive Components

Data in Table 7 showed that, mineral content of puff pastry (the pate) made from bioactive components. It noticed from the results, increased content of calcium (Ca), potassium (K), ferric (Fe), phosphorus (P), magnesium (Mg), manganese (Mn), copper (Cu), and zinc (Zn) in puff pastry made from fermentation bran with different quantity yeast as follow made from germination wheat flour compared with the control from whole meal and wheat flour 72% ex.

rate. While, sodium (Na) content increased in puff pastry made wheat from 72% ex. rate flour compared with other samples. These results indicated that, phytic acid is the major storage form of P in cereals and legumes which chelates minerals and prevents their intestinal absorption, where several pre-processing treatments such as soaking, fermentation, germination, and treatment of grains with phytase enzyme reduce the phytic acid content in grains [42]; Rasane et al. [43] and Rasane et al. [44]). Polyphenols are potent to bind positively charged proteins, amino acids and/or multivalent cations or minerals such as Fe, Zn, and Ca in foods [45]. Also, Mosharraf [46], Kadiri [47] and Li et al. [48] reported that Wheat bran is the outer layer of the wheat kernel and an excellent source of dietary fiber (DF), which contains several nutrients such as starch, protein, fat, minerals, and vitamins.

4. CONCLUSION

From this study it is obtained that, germination and fermentation are two bioprocessing important on stability of active components of puff pastry, hence from results functional components increased by fermentation bran cell and germination whole meal flour, volume increased with increased replacement of percentage of germination flour and fermentation bran, while specific volume increased of control. Sensory attributes achieved high score for pate from two bioprocessing. The hardness decreased in all puff pastry from functional components treatment. Phenolic compound and antioxidant value had highest from fermentation bran during storage period. Also, phenolic compounds and antioxidant levels had highest in puff pastry made from fermentation bran with 2.5% yeast in storage period. The mineral content had highest values in all treatment compared with the control. It is concluded that, germination and fermentation are successful

improvers for stability functional puff pastry (pate functional).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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