Effect of partial replacement of wheat flour by different sources on the quality parameters of dough and hard sweet biscuits

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ABSTRACT

The main target of this work is to throw light on the replacement effect of wheat bran (WB), oat flour (OF) and Unripe banana flour (UB) at different levels instead of the physical, chemical and organoleptic properties of hard sweet biscuit. The obtained results showed gradual decrease in biscuit diameter (cm) by the increasing levels of either OF or UBF, but it was gradually increased with WB. In contrary, thickness (cm) and biscuit weight (gm) were progressively increased by the increasing levels of all tested samples. In addition, when the wheat flour replaces by either WB or OF, the biscuits were characterized by higher protein, ash and fiber contents more than the control sample, with lower total carbohydrates and caloric values. On the other side, the biscuits produced with UBF are characterized by lower contents of both ether extract and caloric value, and the higher content of both ash and fiber contents than the control sample. Moreover, no significant differences were observed in all organoleptic properties of tested biscuits with either WB or UBF up to 20% or with OF up to 75%. In conclusion, the replacement of wheat flour by WB, OF and UBF in biscuit caused increase in protein, except UBF, crude fiber and ash contents, in addition decrease in carbohydrates and caloric value in biscuit without any affecting on sensorial and physical properties.

Keywords: Dough, Hard Sweet biscuit, Wheat bran, Oat flour, Unripe banana flour, Physicochemical, Organoleptic properties.

INTRODUCTION

In many countries of the world, biscuit is one of the most important bakery products for children and adults due to its varied tastes, low cost and long shelf life. The increasing demand for natural and functional food products and healthy led to improve the nutritive value of biscuits and functionality by modifying its nutritive composition. It can nowadays be consumed as snacks, dietary products, staple foods, luxury gifts, infant foods, etc., and with additions of cream and chocolate, etc., they boundary with confectionery (Manley, 2011).

Wheat bran is the major by-product of wheat processing that contains an assortment of active substances and it is a good source of dietary fiber. In recent years, the physical and chemical characteristics of dietary fiber such as solubility, viscosity, ferment-ability, and water holding have been well illustrated. Dietary fiber is confirmed to be beneficial to human health in many ways including lowering postprandial glycemic index, lowering the risk of cardiovascular disease, maintaining the gastrointestinal function, metastatic disease, and colon cancer as human's seventh largest nutrients (kovatcheva-Datchary *et al*., 2015). High fiber biscuits were developed by Gupta and Tiwari (2014) by using the incorporating of refined wheat flour and wheat bran for human consumption. The blends of ground wheat bran increased the contents of proximate compositional constituents of refined flour. Also, the results of organoleptic properties showed that the mix of wheat bran in blends of refined wheat flour up to 20% for improving biscuits was found most suitable.

Oats are an excellent food for reducing the risk of heart disease and lowering cholesterol because of the high soluble fiber content. Nearly one third of the total fatty acids present in oats are polyunsaturated which are required for good health. Oats are rich in minerals, B vitamins and antioxidant avenanthramide. Oat bran is rich in ß-glucan, and these viscous polysaccharides lower the rate of carbohydrate and lipid absorption. Oats are a perfect choice for diabetics and people who are conscious about their weight. The phenolic compounds in oats are bioavailable and have anti-atherogenic, anti-inflammatory, and antioxidant properties (Bratt *et al*. 2003; Dykes *and* Rooney, 2007). Moreover, the important nutritional attributes of oats relate to the lowering of sugar and blood cholesterol. Oat contains a high percent of desirable complex carbohydrates which have been linked to decrement incidence of different types of cancers. The presence of total and free sugars in oats is very low versus the other cereal grains (Lambo *et. al*., 2004).

Unripe bananas, most produced in different Latin American countries, are a source of carbohydrates and nutritionally pleasant bioactive compounds. There is an overabundant of production and large quantities of fruits are lost during commerce, as a consequence of deficient postharvest handling. New economic strategies are considered for bananas as a food ingredient. Banana flour is a starchy food that contains a high percentage of indigestible compounds such as resistant starch (17.5%), and non-starch polysaccharides, included in the dietary fiber (14.5%) content (Juárez-García *et al*., 2006). Moreover, banana is usually eaten either as additional food or as a whole meal. Banana is usually consumed fresh at the full ripe stage as it is the most popular cultivar. The green bananas are likewise boiled, toasted or fried and eaten with oil, vegetable soup or stew. Processing of green bananas into flour is one of the means of postharvest preservation of the crop. Nutritionally, the banana pulp is rich in carbohydrates, vitamin C, A, B6, and mineral elements such as potassium, magnesium, phosphorus and iron, but low in protein content and sodium (Inyang and Ekop, 2015).

This research was carried out to try to formulate a special biscuit which is characterized by low-fat/low-calorie, high protein and high-fiber, by studying the influence of a partial replacement of wheat bran, oat flour and unripe banana flour at different levels, instead of wheat flour (72% extraction), on the rheological properties of prepared biscuit doughs. Also, their effects on the physical (diameter, sickness, weight and spread ratio), chemical (crude protein, ether extract, ash, crude fiber and caloric value) and the organoleptic quality (color, taste, odor, crunchiness and overall acceptability) properties of hard sweet biscuit produced.

MATERIALS AND METHODS

Materials:

Wheat flour (72% extraction):

Wheat flour (72% extraction) was employed to produce hard sweet biscuit under investigation; it was obtained from Five-Stars Milling Company, SuezGovernorate, Egypt.

Wheat flour replacement:

Wheat bran:

Wheat bran used in this investigation was purchased from a cereals and supplies store in Nasr City, Cairo, Egypt.

Oat flakes:

Oat flakes were purchased from the local market in Nasr City, Cairo, Egypt. Oat flakes as a wheat flour replacer were produced by Lino Company, Giza, Egypt.

Unripe banana fruit:

Unripe banana fruit (*Musa sp*) was purchased from a local fruit market at a green stage.

Other ingredients:

All other ingredients used for preparing dough of hard sweet biscuits such as sucrose, shortening (palm oil), skimmed milk powder, vanillin extract, ammonium bicarbonate, sodium bicarbonate and salt (sodium chloride) were purchased from the local market in Helwan City, Cairo, Egypt.

Chemicals and reagents:

All chemicals and reagents were obtained from El-Gumhouria Trading Chemicals and Drugs Co. Egypt.

Methods:

Experimental treatments:

Preparation of wheat bran

Wheat bran used in this investigation was thoroughly cleaned by removing dust, dirt and admixture of other grains. The cleaned wheat bran was ground by using a laboratory disc mill to particles passing through a 60 mesh sieves which is similar to the same size of wheat flour to be blended. All composites were sifted through a 60 mesh sieves to obtain uniform mixing (Gupta and Tiwari, 2014).

Preparation of oat flour:

Oat flakes were ground by using a laboratory disc mill to particles passing through a 60 mesh sieves.

Preparation of unripe banana flour:

Unripe banana fruits were hand-peeled and sliced into pieces of about 5–10 mm thickness. The slices were treated with 0.3–0.5% citric acid for 30 min., and then dried in a hot air oven with a motor fan at 50 °C for 12 h till their moisture content reached 10-14 %. The dried slices were ground by using a laboratory disc mill to particles passing through a 60 mesh sieves. The flour was stored in an air and moisture- tight container at room temperature for further use and analysis (Rodríguez-Ambriz *et al*., 2008).

Preparation of blends of wheat flour replacers and wheat flour:

Wheat flour used was replaced by different ratios individually of wheat bran, oat flour and unripe banana flour. The flour mixtures were individually blended and homogenized, then packed in polyethylene bags, tightly closed and kept at room temperature (25±5°C) for further analysis and processing. The produced blended flours investigated are shown in Table (1).

Processing of hard sweet biscuits:

The brand of hard sweet biscuit was formed and baked according to the method described by Sudha *et al*., (2007).

Biscuit was prepared as follows:

The fat and sucrose were first blended using a laboratory mixer model (2010) for 10 min at room temperature (25±5°C). Sodium bicarbonate, ammonium and vanilla are dissolved in a portion of water and added to the prepared cream mixture. As the creaming process continued, the rest of the dry ingredients were stirred together and alternately added to the cream mixture. The entire prepared dough was rolled out onto a tin plate of uniform thickness and cut using a round mold (5.1 cm in diameter). Bake the dough pieces in greased pans at 230°C for 7 minutes in an air oven model (2005). After baking, the biscuits were left to cool for 30 min at room temperature and packed into polypropylene bags and stored at room temperature (25±5°C).

Analytical methods of the hard sweet biscuits.

Physical properties of hard sweet biscuits:

Weight of sample: the weight of prepared biscuit samples was recorded after cooling for 1 hour using a sensitive balance (0.1g), according to Johnson (1990).

Spread ratio: according to Sai-Manohar and Haridas-Rao (1997) the diameter cm (D) and thickness mm (T) of six biscuits were measured in millimeter by replacing their edge to edge and by stacking one above the other, respectively. To obtain the average, measurements were made by rearranging and re-stacking biscuits. The spread ratio was calculated by dividing diameter (D) by thickness (T).

The spread ratio = diameter (D) / thickness (T).

Chemical composition of wheat flour and tested bakery products:

Moisture, crude protein, lipid (ether extract), ash and crude fiber contents of hard sweet biscuit samples were determined according to the methods described by AOAC (2016). Total carbohydrates were calculated by differences as follows:

% NFE = 100- the sum of (% moisture + % protein + % fat + % ash + % fiber).

The energy values (calories) were calculated theoretically according to FAO/WHO (1985).

Sensory evaluation of all tested hard Sweet Biscuits:

A panel of ten members of staff of the Food Science and Technology Department, Faculty of Agriculture in Cairo, Al-Azhar University, was asked to evaluate the quality of all tested biscuits by using a composite scoring test. The standard recipe which is processed from 72 % extraction wheat flour was used as the control. The tested samples were coded to avoid any bias. The tested biscuit samples were presented in a randomized order to the panelist to evaluate the appearance, color, taste, odor and crispness using a scale ranged from 9 as excellent to 1 as very poor. For statistical analysis, the original sensory panel data were transformed to a new scale as described by Amerine *et al*. (1965).

Statistical analysis:

Data were subjected to the proper statistical analysis as the technique of analysis of variance (ANOVA) of completely randomized design as mentioned by Gomez and Gomez (1984). Treatments means were compared using the Least Significant Difference (LSD) at 0.5% level.

Test as outlined by Waller and Duncan (1969). Computation was done using computer software Spss v17

The data were statistically analyzed by using the Statistical Package for Social Science (SPSS) computer program software; (version 20.0 produced by IBM Software, Inc. Chicago, USA) of completely randomized design as described by Gomez and Gomez (1984). The obtained results are expressed as mean ± standard error (SE) of three replicates data in all experiments, while the obtained data of sensory evaluation was expressed as mean ± standard error (SE) of total scores by ten panelists. The statistical was performed by using a one-way analysis of variance

(ANOVA) followed by Duncan's multiple range tests according to the procedure of Armitage (1971).

RESULTS AND DISCUSSIONS

Chemical composition of wheat bran, oat flour and unripe banana flour as compared with tested wheat flour.

Chemical composition of tested wheat flour versus wheat bran, oat flour and unripe banana flour was determined, and the obtained data are shown in Table (3).

As illustrated in the obtained results in Table (3), it could be indicated that the moisture content in all tested samples ranged from 9.92 to 13.80%. On the other side, the highest content of crude protein was found in wheat bran (17.08%), followed by oat flour (14.0%), while unripe banana flour had the lowest content of crude protein (3.80%). Furthermore, oat flour had the highest content of ether extract (lipid content), which recorded 5.11%, followed by wheat bran (4.62%), while the lowest content of ether extract was found in unripe banana flour (0.85%). Moreover, the higher ash content was found in wheat bran (5.26%), followed by unripe banana flour (2.48%), while the lower content of ash was found in wheat flour (0.56%). On the other hand, the higher content of crude fiber was found in oat flour (11.14%), followed by wheat bran (10.91%), while wheat flour had the lowest content of crude fiber (0.71%), in addition, unripe banana flour had a moderate amount of crude fiber which was recorded to be 6.42%. The nitrogen free- extract (NFE) was calculated by difference (%protein+%lipid+%ash+%fiber - 100), where it was recorded the highest calculated in wheat flour (88.23%), followed by unripe banana flour (86.45%), while the lowest calculated of NFE was recorded in wheat bran (62.13%).

From the previous discussion in Table (3), it could be concluded that wheat bran and oat flour are characterized the higher contents of crude protein, fiber and ash as compared with wheat flour. On the other hand, the unripe banana flour is characterized by the higher contents of fiber and ash, but it is the lower content of crude protein than that found in the tested wheat flour.

Effect of partial replacement of wheat flour by different levels of wheat bran, oat flour and unripe banana flour on physical properties of hard sweet biscuit.

The effect of wheat flour replacement by different ratios of wheat bran, oat flour and unripe banana flour on the physical properties of hard sweet biscuits produced, such as diameter (cm), thickness (mm), weight (g), and spread ratio (which calculated as the average of diameter/thickness of the produced biscuits) were evaluated, and the obtained results are presented in Table (4).

As illustrated in the obtained results (Table 4), it could be observed that slight gradually decreased in diameter (cm) as the replacement level of wheat bran increased from 10 to 20%, where the diameter of biscuit decreased from 6.22 to 6.07cm as the replacement level of wheat bran increased from 10 to 20%. On the other side, the control sample had the highest diameter (6.38cm) when compared to the biscuit samples with wheat bran at different levels. On the contrary, the thickness (mm) was progressively increased as the replacement level of wheat bran increased from 10 to 20% in biscuit produced, whereas it was increased from 3.43 to 3.59 cm, versus 3.22 cm recorded in the control sample. Likewise, the spread ratio was gradually decreased as the replacement level of wheat bran increased, where it decreased from 1.81 to 1.69 as the wheat bran increased from 10 to 20% in biscuits. While, the spread ratio in biscuit samples at different levels of wheat bran was lower than that recorded in the control sample (1.98). These results may be due to the increase in dietary fiber and protein percentage with increasing level of wheat bran because dietary fiber and protein have more water- binding power (Ganorkar and Jain, 2014). The present results are on the line with the findings of Sudha *et al.* (2007) who reported that the gradual decrease in the diameter of biscuits when the wheat bran increased from 10 to 40%, the diameter decreased from 55.0 to 52.8 (mm) as compared with the control sample (55.3 mm). In contrast, the spread ratio was a gradual decrease from 8.30 to 7.73 when the wheat bran increased from 10 to 40% in biscuit formula.

As given in the obtained data in Table (4), it could be noticed that the weight (g) of biscuit produced with wheat bran was gradually increment from 10.24 to 10.70 g as the replacement levels of wheat bran increased from 10 to 20%; respectively, when compared with the control sample which recorded 10.14 g. These results are in agreement with the data obtained by Gupta and Tiwari (2014) which showed that when increasing the percentage of wheat bran in the formula for biscuit making, the weight (g) increased significantly (p≤0.05).

Concerning the effect of partial replacement of oat flour on the physical properties of biscuit produced, as given in Table (4), it could be remarked that when the replacement level of oat flour increased from 25 to 75% in the formulation of biscuit produced, the diameter (cm) and thickness (mm) were gradually increased, where the diameter was increased from 6.48 to 6.67 cm, and the thickness was also increased from 3.30 to 3.66 cm. The same behavior was also observed in the weight (g) of the biscuit, whereas the weight was increased from 10.49 to 10.78 (g) as increasing the replacement ratio of oat flour from 25 to 75%. On the other hand, the spread ratio in 25% oat flour sample was nearly (1.96) compared to that recorded in the control sample (1.98). When the replacement level of oat flour increased to 50 and 75% in biscuits, the spread ratio decreased when compared with the control sample and 25% oat flour sample, whereas it was recorded 1.82 in both 50 and 75% oat flour samples. The present results are in accordance with those obtained by Zaki and Hussien (2018); they showed that the biscuit thickness is considerably increased with the increasing level of oat flour; this effect may be due to the higher fiber content in oat flour as well as the emulsifying properties as reported by Ballesteros *et al*. (2014). While, the biscuit diameter increased significantly as compared to the control sample as affected with oat flour.

With regards to the effect of unripe banana flour on the physical properties of biscuits, as illustrated in the obtained results in Table (4), it could be also demonstrated that when adding the unripe banana flour to biscuit making instead of wheat flour at any ratio, the diameter of biscuit produced was more than that obtained with the control sample, also the increasing levels of unripe banana flour led to gradual increase in biscuit diameter. Where the diameter of biscuit increased from 6.59 to 6.71 cm as increase the unripe banana flour from 10 to 20%, versus to 6.38 cm in the control sample. On the other side, the highest thickness was observed in biscuits with 20% unripe banana flour (3.34 mm), while the biscuit thickness with 10 and 15% was near to that found in the control sample, where it recorded 3.21 and 3.26 mm in both samples; respectively, versus 3.22 mm with the control sample. These results are coincidental with those found by Sangroula (2018).

Furthermore, the weight of biscuit was gradually increased as the replacement level of unripe banana flour increased from 10 to 20%, which increased from 10.07 to 11.08 g; respectively.

Effect of partial replacement of wheat flour by different levels of wheat bran, oat flour and unripe banana flour on chemical properties of biscuit.

The effects of partial replacement of wheat flour by different levels of wheat bran, oat flour and unripe banana flour on gross chemical composition such as moisture, crude protein, ether extract, ash content, crude fiber and free nitrogen extract (Available carbohydrates), as well as calculated caloric values of hard sweet biscuit produced in comparison with the control sample are represented in Table (5).

As shown in the obtained results (Table 5), it could be exhibited that gradual increase in protein content as increasing levels of wheat bran from 10 to 20% and oat flour from 25 to 75%, but the increasing level of protein content was higher in tested samples with oat flour than that obtained in tested samples with wheat bran, whereas the highest content of protein content recorded 75% oat flour biscuit sample (14.24%) when compared with the control sample (9.35%). These results may be due to the higher replacement (from 25 to 75%) of oat flour than wheat bran in biscuit making. On the other side, the protein was progressively decrease when the unripe banana flour increased from 10 to 20% in biscuit making, where it decreased from 8.17 to 6.80% versus 9.35% in the control sample (without any replacement of wheat flour). These results may attribute to the low content of protein in unripe banana flour as compared with wheat flour.

The same behavior was also observed in ether extract which was progressively increased as the replacement level increased in both tested biscuit samples with wheat bran and oat flour. On contrary, ether extract content gradually decreased as the replacement level of unripe banana flour increased in biscuit produced when compared with the control sample.

Likewise, the same results were also exhibited in crude fiber content in both tested biscuit samples with wheat bran and oat flour, also the fiber content gradually increased as the unripe banana flour increased from 10 to 20%, where it was increment from 1.26 to 1.87% versus to 0.68% in the control sample.

The fiber content increased from 1.54 to 4.18% and from 2.76 to 7.80% as the increasing levels of wheat bran and oat flour from 10 to 20% and from 25 to 75%; respectively. The higher content of crude fiber in tested samples with oat flour compared with that obtained in the samples with wheat bran may be due to the proportion percentage of oat flour in biscuit.

As illustrated in the obtained data in Table (5), it could be remarked that the ash content in all tested samples with wheat bran, oat flour and unripe banana flour was more than that found in the control sample (0.50%), also when the replacement levels of all tested materials increase, the ash content gradually increased in biscuit produced. Furthermore, the highest content of ash was recorded in biscuit sample with 20% wheat bran (1.90%). This result may be due to the high content of ash in wheat bran.

As given in the same Table, it could be observed that calculated free nitrogen extract (NFE) (Available carbohydrates content) gradually decrease as the replacement levels increased of either wheat bran or oat flour, but the decreasing level of (NFE) was more obvious with oat flour, where it was decreased from 66.07 to 55.86% versus 72.18% in the control sample. In contrast, carbohydrates content was increased as the replacement level increased from 10 to 20% of unripe banana flour, which increase from 73.75 to 75.67%. Finally, the caloric value was progressively decreased as increasing the replacement levels of wheat bran, oat flour and unripe banana flour, excepted with 25% out flour (484.31 Kcal/100g), but the highest decrease was recorded with unripe banana flour, where it was decreased from 481.58 to 475.70 Kcal/100g with wheat bran, and from 484.31 to 471.45 Kcal/100g with oat flour, and also, from 472.23 to 462.24 Kcal/100g with unripe banana flour. The present results are in accordance with the data obtained by Xhabiri *et al*. (2016); Tripathi and Tripathi (2018) who also investigated the effect of wheat bran on the chemical composition of sweet biscuits, Moreover, Youssef *et al*. (2016); Zaki and Hussien (2018) also investigated the impact of oat flour on chemical properties of biscuit.

From the previous discussion, it could be concluded that when the wheat flour is replaced by either wheat bran or oat flour, the biscuits produced are characterized by higher protein, ash and fiber contents than those obtained in the control sample (100% wheat flour), with lower total carbohydrates and caloric values. On the other side, the biscuits produced with unripe banana flour were characterized by lower contents of both ether extract and caloric value, and the higher content of both ash and fiber contents than that obtained with the control sample, also the caloric values in the tested biscuit samples with unripe banana flour were lower than those obtained with either wheat bran and oat flour.

Effect of partial replacement of wheat flour by different levels of wheat bran, oat flour and unripe banana flour on organoleptic evaluation of sweet biscuits produced.

The effect of partial substitution of wheat flour by different ratios of wheat bran, oat flour and unripe banana flour on sensory quality properties of sweet biscuits produced such as color, taste, odor, appearance, crunchiness and overall acceptability was investigated. The obtained results are recorded in Table (6).

From the obtained results for color property as shown in Table (6), it could be noticed that there are no significant differences ($P>0.05$) between the judging score for color property of hard sweet biscuit with either wheat bran or unripe banana flour at 10 and 15%, also with 25 and 50% oat flour when compared with the control sample. On the other side, significant differences were observed between the judging score for color property of hard sweet biscuit with the control sample and the tested samples with 20% of wheat bran or unripe banana flour and 75% oat flour.

From sensory evaluation results for taste, odor and crunchiness in Table (6), it could be observed that no significant difference was observed in judging score of taste, odor and crunchiness properties between the control sample and all the tested biscuit samples with wheat bran, oat flour and unripe banana flour, except the tested sample with 20% wheat bran in odor property. Furthermore, the tested samples with 10 and 15% wheat bran, 25% oat flour and 10% unripe banana flour in taste property, and 10% wheat bran or unripe banana flour in odor property, also 50 or 75% oat flour and 10% unripe banana flour in crunch property recorded judging scores more than that found with the control sample.

From the same data in the former Table, it could be mentioned that the same trend was also observed in sensory judging scores of the tested organoleptic properties such as appearance and overall acceptability of the tested hard sweet biscuits as compared with the control sample, whereas no significant differences were found among the tested biscuit samples with different levels of wheat bran, oat flour and unripe banana flour with the control sample., except the tested samples with 20% wheat bran and 75% oat flour in appearance property, also with 20% wheat bran in overall acceptability. Thereupon, the tested samples with 10% unripe banana flour in appearance property, 10 and 15% unripe banana flour in overall acceptability property recorded the judging score more than that recorded with the control sample.

From the obtained data in Table (6), it could be also observed that as increasing the replacement levels of all tested samples (wheat bran, oat flour and unripe banana flour), the judging scores gradually decreased in the most organoleptic properties, but no significant differences in the most judging scores were observed in the most sensory properties of tested hard sweet biscuits. The present results about using the wheat bran as a replacement of wheat flour in biscuit making was also investigated by Gupta and Tiwari (2014) who reported that the results of the organoleptic properties showed that the mixing of wheat bran in blends of refined wheat flour up to 20% for improving biscuits was found most suitable. In addition, the effect of oat flour on the organoleptic properties of biscuits was also studied by Zaki *et al*. (2018) who concluded that oat flour could be used with whole meal wheat flour to prepare cake and biscuit characterized by its good sensorial properties. The sensory evaluation of biscuits in all samples was acceptable, but the sample which contained oat flour had superior sensory characteristics. Also, the present results are in agreement with the data obtained by Youssef *et al*. (2016). Moreover, the data obtained with unripe banana flour in our study are in accordance with those reported by Yadav *et al*. (2012); Norhidayah *et al*. (2014) and Adeola *et al*. (2020).

As the previous discussion in Table 6, it is worth to mention that the replacement of wheat flour by wheat bran, oat flour and unripe banana flour, especially with unripe banana flour, to biscuits formula caused good sensory properties and better acceptability when compared with the control sample (100% wheat flour).

Finally, the replacement of wheat flour with wheat bran, oat flour and unripe banana flour in biscuit makes an increase in protein, except unripe banana flour, crude fiber and minerals (ash) contents, in addition, decrease in carbohydrates and caloric value in biscuit produced without any affecting on sensorial and physical properties

CONCLUSION:

Finally, it could be concluded that the replacement of wheat flour (72% extraction) in biscuits produced by wheat bran or oat flour or unripe banana flour has lead to an increase in protein (except the tested sample with unripe banana flour), ash, and crude fiber contents with diminution in total carbohydrates and little decrease in caloric values as these wheat replacers in biscuits making. In addition, no significant alteration in physical properties and sensory quality attributes as this replacement in the tested biscuits produced, especially when used of either wheat bran or unripe banana flour up to 15%, and 50% of oat flour instead of wheat flour. The present results are recommended with the utilization of WB or OF or UBF in production of hard sweet biscuit as a good source of protein, fiber, minerals with diminution in the carbohydrates and the calories.

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Table 1: Blending ratios of wheat bran, oat flour and unripe banana flour with refined wheat flour.

Blends					
Wheat flour and unripe banana flour blend		Wheat flour and oat flour blend		Wheat flour and wheat bran blend	
Wheat flour replacement%	Unripe Banana Flour adding %	Wheat flour replacement%	Oat flour adding %	Wheat flour replacement%	Wheat bran adding %
100	0.0	100	0.0	100	0.0
90	10	75	25	90	10
85	15	50	50	85	15
80	20	25	75	80	20

Table 2: ingredients recipe of the processed hard sweet biscuit

Ingredients	Weight (g)	%
Wheat flour	500	58.80
Sucrose	180	21.10
Shortening (palm oil)	140	16.40
Skimmed milk powder	20	2.30
Ammonium bicarbonate	3.0	0.35
Sodium bicarbonate	4.0	0.47
Sodium chloride (salt)	2.0	0.23
Vanillin extract	1.0	0.11
Water as required	75-85	

Table 3: Chemical composition of wheat bran, oat flour and unripe banana flour as compared with tested wheat flour on dry weight basis (Means ±SE).

Chemical composition (%)	Wheat flour	Different sources used		
		Wheat bran	Oat flour	Unripe banana flour
Moisture	13.80±0.90	10.42±1.02	10.21±1.42	9.92±0.98
Crude protein	9.40^{c}±0.40	17.08^{a}±2.08	14.0^{b}±1.12	3.80^{d}±0.50
Ether extract	1.10^{b}±0.10	4.62^{a}±0.98	5.11^{a}±0.66	0.85^{b}±0.13
Ash content	0.56^{d}±0.08	5.26^{a}±0.64	1.82^{c}±0.08	2.48^{b}±0.46
Crude fiber	0.71±0.12	10.91^{a}±1.22	11.14^{a}±1.84	6.42^{a}±0.74
NFE	88.23	62.13	67.93	86.45

NFE: Nitrogen Free Extract was calculated by difference.
The obtained results are represented the mean of triplicate determination • LSD: Least Significant Difference (at p ≤ 0.05).

Table 4: Effect of partial replacement of wheat flour by different levels of wheat bran, oat flour and unripe banana flour on physical properties of hard sweet biscuit (Means ±SE).

Physical properties	Control sample	Wheat flour replacement by different sources (%)								
		Wheat bran			Oat flour			Unripe banana flour		
		10%	15%	20%	25%	50%	75%	10%	15%	20%
Diameter (cm)	6.38^{c} ±0.61	6.22^{d} ±0.25	6.17^{de} ±0.41	6.07^{e} ±0.32	6.48^{bc} ±0.64	6.56^{b} ±0.22	6.67^{a} ±0.51	6.59^{b} ±0.35	6.64^{a} ±0.21	6.71^{a} ±0.38//
Thickness (mm)	3.22^{f} ±0.11	3.43^{c} ±0.21	3.49^{bc} ±0.24	3.59^{a} ±0.31	3.30^{de} ±0.12	3.51^{b} ±0.32	3.66^{a} ±0.22	3.21^{f} ±0.25	3.26^{ef} ±0.11	3.34^{d} ±0.30
Weight (g)	10.14^{i} ±0.02	10.24^{g} ±0.03	10.50^{f} ±0.02	10.70^{d} ±0.02	10.49^{f} ±0. 005	10.58^{e} ±0.01	10.78^{c} ±0.02	10.07^{h} ±0.02	10.91^{b} ±0.04	11.08^{a} ±0.02
Spread ratio (D/T)	1.98^{ab}	1.81^{cd}	1.76^{d}	1.69^{e}	1.96^{b}	1.87^{c}	1.82^{cd}	2.05^{a}	2.03^{a}	2.00^{ab}

**The obtained results are represented the mean of triplicate determination • LSD: Least Significant Difference (at p ≤ 0.05).

Table 5: Effect of partial replacement of wheat flour by different levels of wheat bran, oat flour and unripe banana flour on chemical composition (%) of hard sweet biscuits (Means ±SE).

Chemical composition (%)	Control sample	Chemical components (%) **								
		Replacement level (%)								
		Wheat bran			Oat flour			Unripe banana flour		
		10%	15%	20%	25%	50%	75%	10%	15%	20%
Moisture	4.76 ±0.21	4.21 ±0.07	4.40 ±0.08	3.82 ±0.13	3.67 ±0.05	3.80 ±0.05	3.68 ±0.06	4.60 ±0.05	4.80 ±0.05	4.46 ±0.06
Crude protein	9.35[f] ±0.20	9.87[e] ±0.14	10.56[d] ±0.12	10.92[c] ±0.24	10.90[c] ±0.28	12.45[b] ±0.12	14.24[a] ±0.08	8.17[g] ±0.09	7.41[h] ±0.05	6.80[i] ±0.11
Ether extract	17.29[f] ±0.46	18.26[e] ±0.25	19.25[d] ±0.13	20.07[b] ±0.20	19.62[c] ±0.32	20.15[b] ±0.26	21.26[a] ±0.14	16.06[g] ±0.55	15.45[h] ±0.36	14.70[i] ±0.42
Ash	0.50[f] ±0.01	0.89[c] ±0.04	1.14[b] ±0.06	1.90[a] ±0.05	0.65[e] ±0.02	0.75[d] ±0.05	0.84[c] ±0.08	0.76[d] ±0.04	0.88[c] ±0.07	0.96[bc] ±0.03
Crude fiber	0.68[h] ±0.01	1.54[f] ±0.05	2.87[d] ±0.10	4.18[c] ±0.11	3.76[d] ±0.12	5.63[b] ±0.24	7.80[a] ±0.15	1.26[g] ±0.11	1.61[ef] ±0.09	1.87[e] ±0.10
*Nitrogen free extract	72.18[ab] ±0.57	69.44[b] ±0.57	66.18[c] ±1.01	62.93[d] ±0.17	65.07[c] ±0.42	61.02[e] ±0.51	55.86[f] ±0.20	73.75[a] ±0.14	74.65[a] ±0.28	75.67[a] ±0.41
Calories (Kcal/100g)	481.73[a]	481.58[a]	480.21[a]	476.03[b]	480.46[a]	475.23[b]	471.74[c]	472.22[c]	467.29[d]	462.18[e]

**The obtained results are represented the mean of triplicate determination * has been calculated by difference. • LSD: Least Significant Difference (at p ≤ 0.05). The chemical composition of biscuits is calculated on dry weight basis.

Table 6: Sensory characteristics of produced hard sweet biscuit as affected by replacement of wheat flour by different levels of wheat bran, oat flour and unripe banana flour (Means ±SE).

Wheat flour replacers / Sensory properties	Control sample	Organoleptic properties scores									LSD
		Wheat bran			Oat flour			Unripe banana flour			
		10%	15%	20%	25%	50%	75%	10%	15%	20%	
Color	8.15 ±0.24	7.92 ±0.39	7.80 ±0.29	6.72 ±0.28	7.97 ±0.35	7.75 ±0.31	7.45 ±0.26	8.10 ±0.25	7.88 ±0.26	7.58 ±0.28	0.43
Taste	8.08 ±0.35	8.20 ±0.29	8.14 ±0.26	7.85 ±0.31	8.14 ±0.24	8.05 ±0.33	7.70 ±0.23	8.10 ±0.17	7.95 ±0.25	7.80 ±0.18	0.41
Odor	8.45 ±0.19	8.56 ±0.32	8.05 ±0.28	7.65 ±0.32	8.45 ±0.30	8.14 ±0.33	8.20 ±0.18	8.68 ±0.18	8.41 ±0.17	8.28 ±0.27	0.45
Appearance	8.50 ±0.19	8.14 ±0.31	8.08 ±0.24	7.64 ±0.25	8.08 ±0.21	8.35 ±0.19	7.90 ±0.26	8.65 ±0.30	8.47 ±0.20	8.19 ±0.17	0.39
Crunchiness	8.20 ±0.32	8.10 ±0.31	7.95 ±0.30	7.84 ±0.35	8.11 ±0.26	8.41 ±0.36	8.23 ±0.37	8.34 ±0.20	8.14 ±0.20	7.91 ±0.21	0.38
Overall acceptability	8.35 ±1.03	8.23 ±1.23	8.41 ±1.03	7.90 ±1.19	8.38 ±1.17	8.15 ±1.17	8.25 ±0.86	9.05 ±0.74	8.65 ±0.67	8.15 ±0.74	0.37

* LSD: Least Significant Difference (at p≤0.05) for rows. The obtained results are represented the mean of judging scores of 10 panelists.

تأثير الاستبدال الجزئى لدقيق القمح بمصادر مختلفة على دلائل الجودة لعجينة ومنتج البسكويت الصلب

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يهدف هذا البحث الى إلقاء الضوء على تأثير الاستبدال الجزئى لدقيق القمح بنخالة القمح (الردة) ودقيق الشوفان والموز غير الناضج بمستويات مختلفة بدلا من دقيق القمح (استخلاص 72%)على الخصائص الفيزيائية والكيميائية والحسية لعينات البسكويت المنتجة. وقد أظهرت النتائج المتحصل عليها للخصائص الفيزيائية حدوث انخفاض تدريجى فى قطر البسكويت بزيادة مستويات الإحلال لدقيق الشوفان أو دقيق الموزغير الناضج ، ولكن حدوث زيادة تدريجية فى حالة نخالة القمح. على العكس من ذلك، بزيادة مستويات الإحلال، أدى ذلك لزيادة قيم كلا من سمك ووزن البسكويت المختبر وانخفضت نسبة القابلية للفرد لجميع العينات. بالإضافة لذلك ، عنداستبدال دقيق القمح إما بنخالة القمح أو دقيق الشوفان فان البسكويت المنتج يتميز بارتفاع محتواه من البروتين والرماد والألياف أكثر من العينة الكنترول (100% دقيق قمح) مع انخفاض قيم الكربوهيدرات والسعرات الحرارية. كما تميز البسكويت المصنع بدقيق الموز غير الناضج بانخفاض محتواه من كل من قيمة الدهون وقيم السعرات الحرارية بالاضافة لارتفاع محتواه من الرماد والألياف الخام مقارنة بالعينة الكنترول وقد تميزت العينات المحتوية على دقيق الموز غير الناضج بانخفاض محتواها من السعرات الحرارية عن تلك المتحصل عليها فى حالة نخالة القمح أو دقيق الشوفان. علاوة على ذلك لم يلاحظ وجود فروق معنوية فى جميع خواص الجودة الحسية لعينات البسكويت المحتوية على دقيق الموز غير الناضج بنسبة تصل الى 20% أو مع دقيق الشوفان بنسبة تصل الى 75%.

الكلمات الاسترشادية: العجين، البسكويت الصلب ، نخالة القمح ، دقيق الشوفان ، دقيق الموز غير الناضج ، الخصائص الفيزيائية والكيميائية والحسية.