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EVALUATION OF DOUGH CHARACTERISTICS AND QUALITY OF EGYPTIAN BALADY BREAD CONTAINING MILLET FLOUR

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ABSTRACT

This work aims to evaluate the chemical composition of whole and sieved millet flours compared with wheat flour and assess the rheological properties of the resultant doughs by substitution of wheat flour with different ratios of millet flour (0-10-15-20-25 and 30%), as well as physical and sensorial characteristics of the produced Egyptian Balady bread. Chemical composition of whole millet, sieved millet and wheat flour (72%extraction) showed that both whole millet and sieved millet flours had higher contents of protein, fat, magnesium, phosphorus and manganese compared to wheat flour. The rheological characteristics measured by (Farinograph and Extensograph) showed that increasing millet level in dough led to adverse effect on most rheological characteristics. Physical properties of the produced balady bread illustrated that bread sample of 10% millet flour had insignificant reduction in specific volume compared with control sample. Bread samples of all studied treatments were sensory accepted, but the bread sample of 10% millet flour was not significantly different from the control sample. The results of the present study confirm the potential for substitution of wheat flour by millet flour (the best ratio is 10%) aiming to improve the nutritional value of balady bread in terms of protein, fat and some minerals as well as maintaining acceptable level of physical and sensorial attributes.
***Keywords*:** wheat, millet blends, chemical composition, balady bread, rheological properties, physical characteristics sensory attributes,

Introduction

The challenges of the 21st century, such as climate changes, water scarcity, increasing world population, rising food prices, and other socioeconomic impacts are expected to result in great threats to agriculture and food security worldwide, especially for the poorest people who live in arid and sub-arid regions (Saleh *et al.*, 2013).

Cereals and cereal products are staple foods in most human diets McKevith *et al.* (2004). The importance of cereals and cereal products is also supported by the fact that global food security depends to the greatest degree on cereal production, which yearly amounts to approximately 2600 million tons FAO, (2019). Consumption of whole grain cereal products is associated with higher diet quality and nutrient-dense foods delivering protein, lipids, B vitamins (including thiamin, niacin, riboflavin), vitamin E, and minerals (calcium, magnesium, potassium, phosphorus, iron, and sodium) (O'Neil *et al.*, 2010).

Excessive dependence of the African nations on wheat importation led to a loss in foreign earnings and protein-energy malnutrition (PEM), which is one of the major challenges encountered by the continent in the production of staple foods (Temba *et al.*, 2016). Baking with wheat flour alone does not provide the required amino acids in bread because wheat flour limited concentration of lysine and does not contain methionine (Mubaiwa *et al.*, 2017 and Saleh *et al.*, 2013).

Millet is one of the most important drought-resistant crops and the 6th cereal crop in terms of world agriculture production. (Devi *et al.*, 2014). It has several advantages such as drought resistance, insect resistance, short growth duration, and high yield. Itcontains a variety of carbohydrates, proteins, fats, vitamins and minerals, and other essential nutrients, as well as abundant phytochemicals, which are associated with antioxidant properties and inhibit the action of malignant cell proliferation Devi *et al.* (2014).

Millet contains significant amounts of methionine (2.5%) (Saleh *et al.*, 2013), some minerals and bioactive compounds. Millets have nutraceutical properties in the form of antioxidants which have positive effect on human health such as lowering blood pressure decreasing, risk of heart disease, prevention of cancer and cardiovascular diseases, diabetes and decreasing tumor cases etc Singh *et al.* (2016).

Substitution of wheat flour with millet flour for bread production may be useful in improving the nutritional value of the bread and may also reduce the excessive dependence on wheat and thus, reduce the cost of wheat importation. Man *et al.* (2016) evaluated the quality of bread making by substituting wheat flour with different proportions of millet flour (0, 10, 20, and

30% the bread with millet flour and the control sample were subjected to physic chemical and organelptic analyses they noticed that addition of millet flour in bread making improved physco chemical and sensory attributes. Bread volume and crumb structure were accepted by panalists, they concluded that addition of 30% millet flour in bread formulation led to an accepted product by consumers.

Therefore, this study was carried out to evaluate the chemical composition of millet flour compared to wheat flour and assess the rheological properties of the resultant doughs and sensory characteristics of wheat Balady bread produced by addition of millet flour

Material and Methods

Materials

- Millet Shandaweel 1 was obtained from Filed Crops Institute, Agricultural Research Center Ministry of Agriculture, Giza, Egypt.
- The other ingredients used for bread making (72% extraction wheat flour, yeast and salt) were purchased from local market, Giza, Egypt,

Methods

Processing of Millet Flour

According to method Olapade *et al*., 2011 was used. Millets were manually cleaned by washing in clean water using local and decanted by sedimentation, draining and drying in cabinet drier at 50^{o}C for 6h. The resulted dried millets were milled into flour using hammer mill (2014 hot model PC 120) and sieved to pass through 0.2mm mesh.

Bread Making:

Egyptian Balady bread was baked using six composite flour blends of sieved millet flour and wheat flour(extraction 72%) as follows: control **(**0: 100%), (10:90), (15:85), (20%:80%), (25%:75%), and (30%: 70%), respectively. Balady bread was prepared by mixing 100 g of the previous composite flour blends with 0.5 g of active dry yeast, 1.5 g of sodium chloride, 75–80 ml of water and mixing by hand for about 6 min to form the dough. The dough was left to ferment for 1 h at 30°C and 85% relative humidity, and was then divided into 125 g pieces. The pieces were arranged on a wooden board that had been sprinkled with a fine layer of bran and were left to ferment for about 45 min at the same temperature and relative humidity. The fermented dough were flattened to about 20-cm in diameter. The flattened loaves were proofed at 30–35°C and 85% relative humidity for 15 min and baked at 280°C for 5 min. The loaves were allowed to cool at room temperature for 2 h before being packed in polyethylene bags and stored at room temperature for further analysis (Hesham *et al.,* 2007).

Rheological properties of Dough

The effect of substitution of wheat flour with different levels of millet flour (10, 20and 30%) on rheological proportion of dough was determined by Farinograph (Model Type No: 81010 (31, 50 and 63 rpm), ©Brabender® OHG, Duisburg, 1979, Germany) according to the standard methods (A.A.C.C., 2000). Parameters measured were water absorption (WS), dough development time (DDT), dough stability (DS) and mixing tolerance index (MTI). The elastic properties of dough with different levels of flours were measured using Extensograph according to the standard (A.A.C.C. 2000) method. The parameters studied were resistance to extension (R), extensibility (E), ratio figure (R/E) and energy (Area).

Functional properties of wheat millet flour blends:

Determination of bulk density

According to Oladele and Aina (2007) was used for the determination of bulk density. Flour sample (50 g) was weighed into 100 ml measuring cylinder. The measuring cylinder was then tapped continuously until a constant volume was obtained. Bulk density (g/cm^3) was calculated using the formula:

Bulk Density = Weight of sample / Volume of sample after tapping g /ml

Determination of dispersibility

According to Kulkarni *et al.* (1991) dispersibility was determined. The flour sample (10 g) was weighed into a graduated cylinder. Water was added to the make up to 100 ml mark. It was shaken vigorously, and allowed to stand for 3 h. The volume of settled particles was recorded.

Determination of water absorption capacity

According to Diniz and Martin (1997) Water absorption capacity (WAC) of sample was determined with some modifications. About 0.5 g of the sample was dissolved with 10 ml of distilled water in centrifuge tubes and vortexed for 30 s. The dispersions were allowed to stand at room temperature for 30 min, centrifuged at 3000 rpm for 25 min. The supernatant was filtered with Whatman No 1 filter paper and the volume retrieved was accurately measured. The difference between initial volumes of distilled water added to the sample and the volume obtained after filtration was determined. The results were reported as ml of water absorbed per gram of sample.

Water Absorption Capacity = Amount of water absorbed / Weight of sample.

Determination of oil absorption capacity

By method AOAC (2005) Oil absorption capacity (OAC) was determined. About 1 g of the sample (W0) was weighed into pre-weighed 15 ml centrifuge tubes and thoroughly mixed with 10 ml (V1) of refined pure groundnut oil using vortex mixer. Samples were allowed to stand for 30 min. The sample-oil mixture was centrifuged at 3000 rpm for 20 min. Immediately after centrifugation, the supernatant was carefully poured into a 10 ml graduated cylinder, and the volume was recorded (V2).

Oil absorption capacity (milliliter of oil per gram of sample) was calculated.

FC = (VF / V1)× 100

Determination of swelling index

Method Ukpabiand Ndimele (1990) was used. The swelling index (SI) of the samples was determined by putting 25 g of each sample in a 250 ml measuring cylinder. Distilled water (150 ml) was added and allowed to stand for four hours before observing the level of swelling. The swelling index was calculated.

SI = volume after soaking –volume before soaking

Weight of sample

Determination of swelling capacity

Calculate swelling capacity (SC) by gel obtained from swelling index was used :

%SC = weight of wetge / weight of sample * 100

Chemical composition

Moisture, crude protein, fiber, ash and ether extract (fat) were determined by the standard procedures described in the A.O.A.C. (2005). While, total carbohydrates were calculated by difference.

Energy value

Total calories were calculated according to the method of Mahgoub (1999) using the formula as shown in the following equation:

Total energy (kcal/100g) =[(%carbohydrate × 4)+ (% protein× 4) + (% fat ×9)].

Determination of minerals: The minerals (Ca, Mg, K, P, I, Mn, Zn) were determined according to the method described by **A.O.A.C. (2005)** using the dry ashing method for the preparation of samples. The Perkin Elmer (Model 4100Z1 Atomic Absorption spectrophotometer) was used for the determination.

Sensory evaluation of bread:

According to Meilgaard, Civille *et al.* (2007) Sensory evaluation of bread samples was performed using nine point hedonic scale twenty panelists were selected for sensory analysis. panelists from staff members from of Department of plant production, Unit Food processing of Desert Research Center and doctors Department of Food Science Faculty of Agriculture Zagzig University. Balady breads were evaluated for taste, odor, crust color, crump color dark to light, consistency, Acceptability (1 represented dislike extremely, 4-5 represented acceptable and 8-9 represented like extremely).

Statistical analysis

The data were statistically analysed according to (SAS, 2003) using one -way classification. All data percentages were transformed to their arc-sin values before analysis and differences among treatment means were determined by Duncan's New Multiple Range test (Duncan, 1955).

Results and Discussion

The chemical composition of Whole Millet flour, Sieved Millet flour and Wheat flour (72% extraction) is tabulated in Table 1.

Table 1: Proximate chemical composition (%) of whole, sieved millets and Wheat flours

Sample	Moisture	Protein	Fat	Ash	Fibers	Total Carbohydrate	Energy
Wheat flour (Extract 72%)	14.24	13.50[b]	1.73b	1.47	0.85b	83.30a	402.57
Whole Millet flour	14.33	16.05a	5.00a	2.11	2.53a	76.82b	416.00
Sieved Millet flour	14.02	15.21ab	4.89a	1.71	0.64b	78.19b	417.61
Probabilities	NS	*	**	NS	**	***	NS

[a, b] ....Means in the same column in each classification bearing different letters differ significantly (P≤0.05).
NS = Not significant*= (P≤0.05) **= (P≤0.001) ***= (P≤0.0001)

The presented data in Table (1) showed that, whole millet flour had the highest contents of protein (16.05%), fat (5.01%), ash (2.11%) and fiber (2.53 %). While, wheat flour (72% extraction) possessed the lowest contents of protein (13.5%), fat (1.73%) and ash (1.47 %), Sieved millet flour laid between them, with protein content 15.21%, fat content 4.89% and ash content 1.71%.

The opposite situation was observed for total carbohydrates, where, wheat flour recorded that highest value (83.30%) while the lowest value was related to the whole millet flour (76.82%).

These findings are in agreement with different results reported by Abd El-kader, 2016, Ghorbel *et al.,* 2009 Himanshu *et al.,* 2018, Nadia, 2013. Saleh *et al.*, 2013 and Lansakara *et al.,* 2016 who found that moisture content of millet and wheat flours ranged from 14.22 to 14.64 and from 14.24 to 14.78%, respectively, protein content ranged from 15 to 16.10 and from 10.01 to 12.55%, respectively, ash content ranged from 1.67 to 2.20 and from 1.67 to 2.68 %, respectively, fat content ranged from 4.80 to 5.80 and from 1.64 to 1.96%, respectively, and total carbohydrates ranged from 55 to 79.84 and from 70.88 to 81.83 %, respectively.

Concerning the energy values, sieved millet flour had the highest value (417.61 k cal/100gm) followed by whole millet flour (416 k cal/100gm), and wheat flour (402.57 k cal/100gm). This may be due to the higher contents of fat and carbohydrates.

Minerals content of wheat flour, whole millets flour and sieved millet flour

The minerals content of wheat, whole millets and Sieved millet flours were demonstrated in Table (2).

The highest mineral concentration in whole millet flour, was phosphorus with 585.42 mg/100g followed by potassium 513.22 mg/100g magnesium with 225.50 mg/100g followed calcium 56.20 mg/100g and Iron 16.12 mg/100g compared to those found in wheat flour (318.67, 495.73, 168.5, 47.5 and 9.2 mg/100g,, respectively).

As for Sieved millet flour, the highest value was phosphorus with 517.25 mg/100g followed by potassium 473.55 mg/100g magnesium with 203.25 mg/100g followed by calcium 43.75 mg/100g and Iron with 8.14 mg/100g. These results agree with those reported by M. Abd El-Kader (2016) who found potassium, magnesium, and iron contents of millet were 504.45, 195.31, 3.01 mg/100g, respectively. While those of wheat flour were 518.84, 149.23 and 3.01 mg/100g, respectively.

Rheological attributes

Farinograph Characteristic

The results of Farinograph parameters of wheat flour (72% extraction) blends with 10%, 15% and 20% of sieved millet flour are given in Table (3).

Table 2 : Minerals content (mg100g) of wheat, whole millets and sieved millet

Mineral	Wheat flour (72% extraction)	Whole Millet flour	Sieved Millet flour
Calcium	47.5	56.20	43.75
Magnesium	168.5	225.50	203.25
Potassium	495.73	513.22	473.55
Phosphorus	318.67	585.42	517.25
Iron	9.2	16.12	8.14
Manganese	2.20	3.97	3.75
Zinc	5.15	6.95	4.81

Table 3 : Farinographic Characteristics for the Wheat flour (extract 72%) fortified with sieved millet flour

Samples name	Farinograph Characteristics				
	Water absorption% (W.A)	Arrival time (Min)	Dough Development (*D.D.T*) (Min)	Stability time (*D.S.T*) (Min)	Degree of Softening (*S.D*) (B.U)
Wheat flour	69.0	1.0	2.5	12.0	25
Sieved Millet flour	--	--	--	--	--
90% wheat flour + 10 sieved millet flour	68.5	1.0	1.5	11.0	30
85% wheat flour + 15% sieved millet flour	65.0	1.0	1.5	11.0	50
80%wheat flour + 20% sieved millet flour	64.4	1.0	1.5	10.5	50

The effect of replacement of wheat flour with millet flour at 10%, 15% and 20% on dough mixing properties was measured by farinograph and results are presented in Table (3). The water absorption had an important role in gluten distribution and the formation of network structure of mixed dough. It was observed that there was inverse relation of water absorption and addition ratio of millet flour which might be due to that wheat flour had more fiber and sugars which retained more water. Rosell *et al.* (2001) reported that the differences in water absorption are mainly caused by the greater number of hydroxyl groups which exist in the fiber structure and allow more water interactions through hydrogen bonding.

Wheat flour exhibited high water absorption (69%) but by increasing addition level of millet (from 10 to 15 and 20%) the water absorption decreased to 68.5, 65.0 and 64.4, respectively.

Regarding the dough development time wheat flour recorded the highest value 2.5 min. which affected negatively by substitution of wheat by different ratios of millet flour (10 %, %15 and 20%) with constant value (1.5 min) for all substitution ratios.

Dough stability time, which is an index of dough strength, was found to decrease with increase in level of millet flour in the blend. Dough stability time for wheat flour was 12.0 min but substitution of wheat flour by 10 – 15 and 20% sieved millet resulted in lower values (11.0, 11.0 and 10.5min,respectively).

The degree of softening, which denotes the elastic proportion of dough followed a different pattern. Degree of softening was lowest for control treatment 25 comparing to the other ratios(90:10, 85:15, 80:20) which recorded 30, 50, 50 B.U respectively.

Wheat flour exhibited high water absorption, dough development time and dough stability which decreased with the millet flour substitution. Saha *et al.* (2011) illustrated similar farinographic characteristics in their observations on influence of millet variety on dough rheology. Lorenz and Dilsaver (1980) have also observed a decrease in water absorption in wheat and proso millet blend. Carson and Sun (2000) noticed that the water absorption capacity and dough stability of the composite flour decreased significantly with the increase in the level of sorghum. There was weakening of dough, due to the addition of sorghum, which could be due to decreased wheat gluten content (dilution effect) and competition between the proteins of sorghum and wheat flour for water (Deshpande *et al.,* 1983; and Rao and Rao, 1997).

Extensograph Characteristic

The results of Extensiograph parameters of wheat flour (72% extraction) and wheat flour blends with 10%, 15% and 20% of sieved millet flour are given in Table (4).

The presented data showed that, elasticity of wheat dough (control) was 540 B.U but elasticity decreased with increasing the substitution ratios of wheat flour by sieved millet flour. Meanwhile, the highest reduction was that in sample with 20% sieved millet (180 B.U).

Table 4 : Extensograph Characteristics for the Wheat extract 72% Fortified with Sieved Millet Flour

Samples name	**Extinsograph Characteristics**			
	Elasticity (B.U)	**Extensibility (mm)**	**P.N**	**Energy (cm^2)**
Wheat flour	540	165	3.27	94
Sieved Millet flour	--	--	--	--
90% wheat flour + 10 sieved millet flour	220	135	1. 48	58
85% wheat flour + 15% sieved millet flour	200	135	1.63	54
80% wheat flour + 20% sieved millet flour	180	135	1.33	43

From the same Table, it could be noticed that addition of millet flour to wheat flour caused a decrease in the extensibility. Results of wheat flour dough, and different blends (90:10- 85:15 - 80:20) were165, 135, 135, 135 mm, respectively.

The energy values of dough prepared with different studied treatments were decreased compared to the energy value of 100% wheat flour.

Concerning proportion number (P.N) of dough, it could be noticed. That P.N was decreased as a result of substitution of wheat flour by millet flour, but the highest decrease was recorded for 20% millet flour.

Conclusion, it was easy to notice that the increased level of millet to wheat flour obtained negative impact on rheological properties. The farinograph properties depended on millet flour portions in mixtures. The increase of the amount of millet flour resulted in constant in dough development time along with lower water absorption and dough stability which was due to weakening of the protein network. Extensibility and resistance to extension decreased as the level of millet flour increased in the sample.

Functional Properties

The results of the functional properties of the composite flour are presented in Table (5).

The bulk density (BD) for control and all blends ranged from 0.63to 0.72g/ml Increase millet ratio led to significant reduction of bulk density. The bulk density of the millet flours increased logarithmically with the increase in moisture content, in the moisture content range studied. It increased from 483.1–523.4, 486.5–530.8, 502.6–534.9, 511.2–550.8, and 508.4–551.7 and 498.3–541.8 kg/m3, respectively, for the flours of barnyard millet, finger millet, foxtail millet, kodo millet, little millet and poroso milletR. Viswanathan (2007). According to Bamigbola *et al.* (2016) obtained bulk density of 0.70 g/ml for 100% wheat flour, and 0.63 - 0.90 g/ml for composite flours consisting 65.66–77% wheat flour, 29% plantain flour, 5.33% tigernut flour and 77% wheat flour, 20% plantain flour, 3% tigernut flour respectively. high bulk density is a desirable characteristic for the packaging of food materials of highnutrient contents (Hassan *et al.,* 2013). Low density, however, has been found to be useful in the formulating complementary foods (Akpata and Akubor, 1999).

The dispersibility of the composite flour ranged from 26 – 30ml, where increasing millet flour level had unsystematic changes in dispersibility. Eke-Ejiofor (2015) resulted that high dispersibility enhanced better reconstitution of starch in water to give fine and constituent paste.

The WAC ranged from 1.6 to 5.2%.High WAC is useful in product bulking and consistency. Increased millet content led to decrease the WAC.

The OAC of the composite flour ranged from 1.6% to 5.2%.Increase in millet content accounted for sample noticed decrease the OAC. High OAC products are better flavor retainer (Chandra and Samsher, 2013)

The foaming capacity ranged from 1.07 to 1.17 %, while, the swelling capacity ranged between 6.96 and 7.08 g/g. Increase in millet content accounted for sample the foam and swelling capacities were increased of blended composite flour.

Physical quality of produced balady bread samples

The data of loaf weight, loaf volume, and specific loaf volume of the bread containing different ratios of millet are tabulated in Table (6)

From the previous data in Table (6), it can be seen that as the substitution level of millet increased, the loaf volume and specific volume were decreased significantly comparing to control sample (with one exception related to Specific Volume of balady bread sample with 10% millet flour which decreased insignificantly). The decrease in loaf volume was found due to dilution effects of gluten with addition of non-wheat flour such as millet flour (Shittu *et al.,* 2007). Leading that to decrease in gluten proportion which responsible for maintaining the viscoelastic property of balady bread dough which ensures the increased volume of wheat bread. Rai *et al.* (2011) and Ballolli *et al.* (2014) also noticed a decrease in loaf volume with a progressive increase in the proportion of non-gluten flour such as maize meal and rice flour and foxtail millet flour, respectively.

Sensory evaluation of Bread Millets

The sensory parameters of the produced balady bread by substitution of wheat flour with different ratios of sieved millet flour were evaluated and the obtained results are tabulated in Table (7).

As concerns the results of sensory evaluation of bread produced using different studied treatments in Table (7), it could be noticed that, control sample (100% wheat flour)recorded the highest values for all sensory attributes (except consistency) comparing with the other studied treatments. In the same time Balady bread sample with 10 % millet flour recorded insignificant reduction in all studied sensory parameters (except consistency, which increased significantly) comparing to control sample.

On the other hand, increasing the ratio of wheat substitution by millet flour led to reduce the recorded values of all studied sensory parameters.

The presented data in table (7) obviously illustrated that, samples of all studied treatments are sensory accepted (where the recorded values of all parameters ranged between 6.96 and 8.67)

Table 5 : Functional Properties of Whole millet, Sieved millet and Wheat flours functional Properties of Whole millet flour, Sieved millet flour and Wheat flour

SN	Wheat (%)	Millet (%)	BD (g/ml)	Disp. (Ml)	WAC (%)	OAC (%)	FC (%)	SC (g/g)	SI (g/g)
1	100	00	0.69a	28.00	1.55a	0.77a	52.11a	6.96a	0.88a
2	90	10	0.63b	30.00	1.48b	0.75ab	42.44b	6.50b	0.44c
3	85	15	0.62b	26.00	1.45b	0.74bc	38.22c	5.35c	0.38cd
4	80	20	0.60c	28.00	1.44b	0.73bcd	33.14d	4.99d	0.36d
5	75	25	0.58d	27.00	1.40c	0.72cd	29.33e	4.11e	0.40cd
6	70	30	0.56e	26.00	1.36d	0.71d	26.21f	3.88f	0.40cd
7	00	100	0.55e	30.00	0.88e	0.63e	3.12g	2.55g	0.64b
Probabilities			***	NS	***	***	***	***	***

[a, b] ....Means in the same column in each classification bearing different letters differ significantly .
NS = Not significant***= (P≤0.0001)
BD = Bulk density, Disp. = Dispensability, WAC =Water absorption capacity, OAC = Oil absorption capacity, FC = Foam Capacity, SC = Swelling Capacity, SI = Swelling Index

Table 6: Effect of blend ratio of millet on loaf weight, loaf volume, and specific loaf volume of balady bread.

Blend	Weight (g)	Volume (cm^3)	Specific Volume (cm^3) /g
Control	101.00^{b}	298.00^{a}	2.95^{a}
10%	101.00^{b}	292.00^{b}	2.89^{ab}
15%	102.00^{ab}	284.00^{c}	2.78^{bc}
20%	103.00^{ab}	276.00^{d}	2.67^{cd}
25%	103.50^{a}	268.00^{e}	2.59^{d}
30%	104.00^{a}	261.00^{f}	2.51^{d}
Probabilities	*	***	***

[a, b] ....Means in the same column in each classification bearing different letters differ significantly (* = P≤0.05 and***= P≤0.001).

Table 7 : Sensory evaluation of balady bread produced by substitution of wheat flour with different ratios of sieved millet flour

Sensory Attribute / Blend	Taste (9)	Odor (9)	Crust color (9)	Crumb color (9)	Consistency (9)	Acceptability (9)	Total score
Control	8.17^{a}	8.35^{a}	8.25^{a}	8.28^{a}	8.18^{b}	8.25^{a}	49.54^{a}
10% Millet	8.07^{a}	7.96^{ab}	8.06^{ab}	7.90^{b}	8.67^{a}	8.13^{a}	48.79^{b}
15% Millet	7.77^{b}	7.79^{bc}	7.65^{b}	7.75^{c}	7.81^{c}	7.75^{b}	46.52^{c}
20% Millet	7.55^{c}	7.45^{c}	7.08^{c}	6.96^{d}	6.99^{d}	7.20^{c}	43.23^{d}
25% Millet	7.02^{d}	7.39^{c}	6.58^{cd}	6.89^{d}	6.66^{e}	6.81^{d}	41.35^{e}
30% Millet)	6.70^{e}	6.66^{d}	6.86^{d}	5.94^{e}	6.26^{f}	6.48^{f}	38.90^{f}
Probabilities	***	***	***	***	***	***	***

[a, b] ....Means in the same column in each classification bearing different letters differ significantly (P≤0.05).
NS = Not significant ***= (P≤0.0001)

Conclusion

From the previous results in this study it could be concluded that, potential substitution of wheat flour by millet flour (the best ratio is 10%) to improve the nutritional value of Balady bread (in terms of protein, fat and some minerals) as well as maintaining acceptable level of physical and sensorial attributes.

References

AACC. (2000). Approved Methods of the AACC, t.E.; Methods 46–30, 30–10, 44–19,08-01, 54–30, The American Association of Cereal Chemists, St. Paul, MN. 10th Ed

Ahmed S.M. Saleh, Qing Zhang, Jing Chen, and Qun Shen (2013). Millet Grains: NutritionalQuality, Processing, andPotential Health Benefits. Food Science and Food Safety vol.12.

Aiyesanmi, A.F. and Oguntokun, M.O. (1996). Nutrient composition of Diocleareflexa seed an underutilized edible legume. Rivista

Akpata, M.I. and Akubor, P.I. (1999). Chemical composition and selected functional properties of sweet orange (*Citrus sinesis*) seed flour. Plant Food Hum. Nutri. 54, 353–362.

Ali, M.A.M.; El-Tinay, A.H. and Abdalla, A.H. (2003). Effect of fermentation on the in vitro protein digestibility of pearl millet. Food. Chem., 80(1): 51–4.

Anju, T. and Sarita, S. (2010). Suitability of foxtail millet (*Setaria italica*) and barnyard millet (*Echinochloa frumentacea*) for development of low glycemic index biscuits, Malays. J. Nutr. 16(3): 361–368.

AOAC (2005). Official Methods of Analysis, 18th ed. Association of Analytical Chemist, Washington D.C, pp. 4 1966:23.

Ballolli, U.; Malagi, U.; Yenagi, N.; Orsat, V. and Gariepy, Y. (2014). Development and quality evaluation of foxtail millet [*Setaria italica (L.)*] incorporated breads. Journal of Agricultural Science 27(1): 52–54.

Bamigbola, Y.A.; Awolu, O.O. and Oluwalana, I.B. (2016). The effect of plantain and tigernut flours substitution on the antioxidant, physicochemical and pasting properties of wheat-based composite flour Cogent Food Agric.; 2(1).

Capriles, V.D. and Arêas, J.A.G. (2014). Novel Approaches in Gluten-Free Bread making: Interface between Food Science, Nutrition, and Health. Comprehensive Reviews in Food Science and Food Safety 13(5): 871-890.

Carson, L.C. and Sun, X.S. (2000). Breads from white grain sorghum: Rheological properties and baking volume with exogenous gluten protein. Application of Agricultural Engineering, 16: 423-429.

Cauvain, S.P. and Young, L.S. (2007). Technology of bread making. ISBN 978-3-319-14687-4 (eBook) DOI 10.1007/978-3-319-14687-4

Chandra, S. and Samsher, (2013). Assessment of Functional Properties of different flours. Acad. J. 8(38): 4849–4852.

Dayakar, R.B.; Bhaskarachary, K.; Arlene Christina G.D.; Sudha, D.G.; Vilas, A.T. (2017). Nutritional and Health benefits of Millets. ICAR_Indian Institute of Millets Research (IIMR) Rajendranagar, Hyderabad, PP 112.

Deshpande, S.S.; Rangnekar, P.D.; Sathe, S.K. and Salunkhe, D.K. (1983). Functional properties of wheat-bean composite flours. Journal of Food science, vol: 48,issue 6

Devi, P.B.; Vijayabharathi, R.; Sathyabama, S.; Malleshi, N.G. and Priyadarisini, V.B. (2014). Health benefits of finger millet (*Eleusine coracana L.*) polyphenols and dietary fiber: A review. J. Food Sci. Technol. 2014, 51: 1021–1040.

Diniz, A.M. and Martin, A.M. (1997). Optimization of nitrogen recovery in the enzymatic hydrolysis of dogfish (*Squalus acanthias*) protein: Composition of the hydrolysates. Int. J. Food Sci. Nutri. 48: 191–200.

Duncan, D.B. (1955). Multiple ranges and multiple F-test. Biometrics, 11: 1-42.

Eke-Ejiofor (2015). Physico-chemical and pasting properties of starches from cassava, sweet potato and three leaf yam and their application in salad cream production. Int. J. Biotechnol. Food Sci. 3(2): 23–30.

Erukainure, O.L.; Okafor, J.N.; Ogunji, A.; Ukazu, H.; Okafor, E.N. and Eboagwu, I.L. (2016). Bambara-wheat composite flour: rheological behavior of dough and functionality in bread. Food Sci. 4(6): 852-857.

FAO (2019). FAO Cereal Supply and Demand Brief. World Food Situation. Cereal production and inventories to decline but overall supplies remain adequate. Available online: http://www.fao.org/worldfoodsituation/csdb/en/

Ghorbel, R.E.; Kamoun, A.; Neifar, M. and Chaabouni, S.E. (2009). Optimization of new flour improver mixing formula by response surface methodology. Food Process Engineering. doi:10.1111/ j.1745 4530. 2008. 00270.x.

Gopalan, C.; Ramashastri, B.V. and Balasubramanium, S.C. (2004). Nutritive Value of Indian Foods. ICMR, New Delhi.

Gupta N.; Srivastava, A.K. and Pandey, V.N. (2012). Biodiversity and Nutraceutical Quality of Some Indian Millets. Proceedings of the National Academy of Sciences, India Section B: Biological Sci.; 82(2): 265-273.

Hassan, H.A.; Mustafa, A.I. and Ahmed, A.R. (2013). Effect of incorporation of decorticated pigeon pea (*Cajanus cajan*) protein isolate on functional, baking and sensory characteristics of Wheat (*Triticum aestivum*) biscuit. Adv. J. Food Sci. Technol. 5(8): 976–981.

Hesham, A.E.; Hussein, A.S. and Mostafa, B.E. (2007). Rheological Properties and Quality Evaluation of Egyptian Balady Bread and Biscuits supplemented with flours of ungerminated and germinated Legume seeds or Mushroom. Pol. J. Food Nutr. Sci. 57(4) : 487–496.

Himansh, M.C.; Sachin, K.S. and Arya, S.S. (2018). Nutritional and Nutraceutical Properties of Millets: A Review. Clinical Journal of Nutrition and Dietetics. Vol 1. Issue 1 .

Klopfenstein, C.F. and Hoseney, R.C. (1995). "Nutritional properties of sorghum and millets". In *Sorghum and*

Millets Chemistry and Technology, Edited by: Dendy, D.A.V. Vol. 125, St Paul, Minn: American Association of Cereal Chemistry.

Kulkarni, K.O.; Kulkarni, D.N. and Ingle, U.M. (1991). Sorghum malt based weaning food formulation preparation, functional properties and nutritive values. Food Nutri. Bull. 13(14): 322–327.

Lansakara, L.H.M.P.R.; Liyanage, R.; Perera, K.A.; Wijewardana, I.; Jayawardena, B.C. and Vidanarachchi, J.K. (2016). Nutritional composition and health related functional properties of *Eleusine coracana* (*Finger Millet*). Procedia Food Science, 6: 344 – 347.

Lorenz, K. and Dilsaver, W. (1980). Rheological properties of food application of proso millet flours. Cereal Chemistry, 57: 21-24.

Lyon, D.J. (2008). Producing and marketing proso millet in the Great Plains. University of Nebraska Extension Circular #EC137. Lincoln, NE.

Mahgoub, S.E.O.; Ahmed, B.M.; Ahmed, M.M.O. and Wlagib, E.A.A. (1999). Effect of traditional Sudanese processing of kisra bread and hulumur drink on their thiamine, riboflavine and mineral contents. Food Chem.;67:129-133

Maktouf , S.; Jeddou, K.; Moulis, C.; Hajji, H.; Remaud-Simeon, M and Raoudha, E. (2016). Evaluation of dough rheological properties and bread texture of pearl millet-wheat flour mix. J Food Sci Technol 53(4): 2061–2066.

Man, S.; Păucean, A.; Muste, S.; Pop, A. and Mureşan, E. A. (2016). Quality Evaluation of Bread Supplemented with Millet (*Panicum miliaceum* L.) Flour. Bulletin UASVM Food Science and Technology 73(2).

Manal Haggag Abd El- Kader (2016). Egyptian Seven Seeds Bread Middle East J. Appl. Sci.; 6(2): 403-410.

McKevith, B. (2004). Nutritional aspects of cereals. Br. Nutr. Found. Nutr. Bull. 29:111–142.

Meilgaard, M.C.; Civille, G.V. and Carr, B.T. (2007). Sensory evaluation techniqes4th ed. New York: CRC Press, L.L.C. millets. Sorghum and millets: chemistry and technology, 125-168.

Mubaiwa, J.; Fogliano, V.; Chidewe, C. and Linnemann, A.R. (2017). Hard-tocook phenomenon in Bambara groundnut (*Vigna subterranean (L.)* Verdc.) processing: options to improve its role in providing food security. Food Rev Int., 33: 167–194.

Nadia, H.A. (2013). Effect of Supplementation with Millet Flour on Tortilla Quality .journal of life sciences and Technologies vol:1 no :1

NIN. (2003). Nutritive value of Indian Foods, Ed Gopalan and Deosthale, National Institute of Nutrition, Hyderabad.

Noorfarahzilah, M.; Lee, J.S.; Sharifudin, M.; Mohd, F.A. and Hasmadi, M. (2014). Applications of composite flour in development of food products. Int Food Res J.; 21:2061–2074

O'Neil, C.E.; Nicklas, T.A.; Zanovec, M. and Cho, S. (2010). Whole-Grain Consumption Is Associated with Diet Quality and Nutrient Intake in Adults: The National Health and Nutrition Examination Survey, 1999–2004. J. Am. Diet Assoc. 110: 1461–1468.

Oladele, A.K. and Aina, J.O. (2007). Chemical composition and functional properties of flour produced from two varieties of tigernut (*Cyperus esculenta*). Afr. J. Biotechnol. 6: 2473–2476.

Olapade, A.A.; Aworh, O.C. and Oluwole, O.B. (2011). Quality Attributes of Biscuit from Acha (*Digitaria exilis*) Flour Supplemented with Cowpea (*Vigna unguiculata*). African Journal of Food Science and Technology (ISSN: 2141-5455) 2(9): 198-203.

Parameswaran, K. and Sadasivam, S. (1994). Changes in the carbohydrates and nitrogenous components during germination of proso millet (*Panicum miliaceum*). Plant Foods Hum. Nutr., 45: 97–102.

Rai, S.; Amarjeet, K.; Singh, B. and Minhas, K.S. (2011). Quality characteristics of bread produced from wheat, rice and maize flours. Journal of Food Science 49: 786–789.

Rao, S.J. and Rao, G.V. (1997). Effect of incorporation of sorghum flour to wheat on chemical, rheological and bread characteristics, Journal of Food Science and Technology, 34: 251-254.

Rosell, C.M.; Rojas, J.A. and Benedito de Barber, C. (2001). Influence of hydrocolloids on dough rheology and bread quality. Food Hydrocolloids, 15(1): 75-81.

Saha Supradip, Gupta, A.; Singh, S.R.K.; Bharti, N.; Singh, K.P.; Mahajan, V. and Gupta, H.S. (2011). Compositional and Varietal Influence of Finger Millet Flour on Rheological Properties of Dough and Quality of Biscuit", Food Science and Technology, 44, No. 3,

Saleh, A.S.M.; Zhang, Q.; Chen, J. and Shen, Q. (2013). Millet grains: nutritional quality, processing, and potential health benefits. *Compr. Rev. Food Sci. Food Saf.* 12: 281–295.

SAS (2003). Statistical Analysis System, User's Guide, Statistics, SAS Institute Carry, North Carolina.

Shittu, T.A.; Raji, A.O. and Sanni, L.O. (2007). Bread from composite cassava-wheat flour: I. Effect of baking time and temperature on some physical properties of bread loaf. Food Research International 40: 280–290.

Shukla, K. and Srivastava, S. (2011). Evaluation of finger millet incorporated noodles for nutritive value and glycemic index. Journal of Food Science and Technology, 42(2): 1-8.

Singh, S. and Singh, E. (2016). Potential of Millets: Nutrients Composition and Health Benefits. J. of Sci. and Innovative Res. 5(2): 46-50.

Skerget, M.; Kotnik, P.; Hadolin, M.; Hras, A.; Simonic, M. and Knez, Z. (2005). Phenols, proanthocyanidins, flavones and flavonols in some plant materials and their antioxidant activities. Food Chem. 89: 191-198.

Stojceska, V.; Butler, F.; Gallagher, E.; Keehan, D. (2007). A comparison of the ability of several small and large deformation rheological measurements of wheat dough to predict baking behaviour. J. Food Eng.; 83: 475–482.

Teena, R.; Rakhi, S.; Dinkar, B K.; Ashutosh, U. and Thangalakshmi, S. (2019). Review on finger millet: Processing and value addition. The Pharma Innovation J. 8(4): 283-291.

Temba, M.C.; Njobeh, P.B.; Adebo, O.A.; Olugbile, A.O.; Kayitesi, E. (2016). The role of compositing cereals with legumes to alleviate protein energy malnutrition in Africa. Int J. Food Sci. Technol. 51: 543–554.

Thathola, A.; Srivastava, S. and Singh, G. (2011). Effect of foxtail millet (*Setaria italica*) supplementation on serum glucose, serum lipids and glycosylated hemoglobin in type 2 diabetics. Diabetologia Croatica, 40(1): 23-28.

Truswell, A.S. (2002). Cereal grain and coronary heart disease. Eur J.Clin Nutr. 56(1): 1–4.

Ukpabi, U.J. and Ndimele, C. (1990). Evaluation of the quality of gari produced in Imo State. Niger. Food J. 8: 105–109.

Vidya, S.; Ravi, R. and Bhattacharya, S. (2012). Effect of thermal treatment on selected cereals and millets flour doughs and their baking quality. Food Bioprocess. Tech. 6: 1218–1227.

Viswanathan, R. (2007). Bulk density and friction coefficients of selected minor millet grains and flours. Journal of Food Engineering 81(1):118-126

Zeba, A.N.; Delisle, H.F.; Renier, G.; Savadogo, B. and Baya, B. (2012). The double burden of malnutrition and cardiometabolicrisk widens the gender and socio-economic health gap: a studyamong adults in Burkina Faso. Public Health Nutrition, 15: 2210–2219.