Improve the Nutritive Value of Produced Cake by Replacement Wheat Flour with Pearl Millet Flour

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Abstract

Bakeries occupy an important position in human nutrition locally and globally. The result of gap between production and consumption for wheat, the government are imported wheat from different countries. Millets are widely grown in the semiarid tropics of Africa and Asia. It serves as a major food component in various traditional foods such as bread, porridges and snack foods. In this study replacement wheat flour (72% ext.) with pearl millet flour for manufacture the blends of cake. (10% pearl millet flour + 90% wheat flour, 20% pearl millet flour + 80% wheat flour, 30% pearl millet flour + 70% wheat flour and 100% pearl millet flour). The chemical composition, rheological properties, textures, staling, microbiological examination and sensory properties of produced cake and during the storage period of 8 days at 25 ± 1 °C were done. The results showed that a clear and noticeable improvement of all characteristics of produced cake, which was the increase of ash, protein, fiber, fat and carbohydrate compared to the control sample. Therefore, the study recommended that using the pearl millet flour for the manufacture of bakery products.

Keywords: Millet- chemical composition- rheological properties– microbiological examination – cake

Introduction

Cakes are an important bakery product category alongside breads. Cakes can be defined as being aerated and chemically leavened bakery products **(Kahraman *et al.*, 2008)** .Cakes are the most consumed bakery product attributable to interesting items and are constantly utilized as a part of celebrations and also in happy festivals **(Hafez *et al.*, 2012 and Zhang *et al.*, 2012).**

Bakery products are extensively consumed and therefore particular requirements for their quality characteristics have been established. Especially for cake, shape, color and texture are important for consumers. Shelf-life of bakery products is mainly limited by staling. Staling is a process of chemical and physical changes including moisture redistribution, drying, starch retrogradation, increased firmness and fragility, as well as loss of aroma and flavor **(Amigo *et al.*, 2016).**

The flour which is used to make cakes are generally derived from wheat grain with lower protein content compared with the wheat flour used to make bread. This flour is responsible for the unique texture and appearance properties of cakes. The baking properties of flour into cakes have been investigated to some extent in the past and these researches have mainly focused on exploring the role of flour components on the baking properties of cake either for their starch fractions or their gluten forming fractions **(Wilderjans *et al*., 2008).**

Rajiv *et al.* (2011) studied the effect of replacement of wheat flour with 0, 20, 40, 60, 80 and 100% finger millet to make cake incorporation of finger millet flour, which is a good source of minerals, increases the nutritive value of cake and also it is a value addition to the finger millet.

Millet grains account for about one sixth of the total food grain production hold an important place in the food grain economy of India. On the other hand, India is the largest producer of millet grains, producing about 33-37% of a total of 28 million tones of the world production. Finger millet constituted about 81 per cent of the minor millets produced in India and the rest by kodo millet, foxtail millet and little millet, **(Pradhan *et al*., 2010)**. Millet contains about 65 - 75% carbohydrates, 5 - 10% protein and 15 - 20% dietary fiber **(Chethan and Malleshi 2007)**. It is a good source of minerals (2.5-3.5%) especially calcium, iron and phosphorous **(Subba and Muralikrishna 2001).** Millet is considere to have the highest calcium content of cereal grains, at about 344 mg/100g **.**There are many polyphenols found in millet, and in combination with the dietary fiber, millet is known to have several health benefits such as antioxidant, antimicrobial and hypocholesterolaemic properties **(Devi *et al*., 2011)**.Furthermore, millet is gluten free.

Pearl millet may be used as a low cost and nutritional ingredient in infant foods and functional food products such as beverages, custard and soup mixes etc. Due to its gluten free nature, pearl millet can be successfully used in breads, cookies or breakfast items. Utilization of pearl millet flour in food product preparation significantly improved the nutritional quality by contributing to higher protein, ash and mineral content (iron, calcium and phosphorus). Products prepared from the pearl millet flour had similar sensory profiles however they differed significantly from traditional products in key attributes such as taste, aroma, and overall acceptability indicating that products prepared from pearl millet were highly acceptable **Florence Suma (2012)**. This study has shown a potential use of inexpensive and underutilized pearl milled flour in the preparation of cake.

Materials and Methods:

Materials

Wheat flour (72% extraction): was obtained from local market, Zifta, Algarbia, Egypt.
Baking Ingredients: milk, salt, sugar, eggs, oil, vanilla and baking powder were purchased from local market, Zifta, Algarbia, Egypt.
Pearl millet (*Pennisetum glaucum*): was purchased from local market, Zifta, Algarbia, Egypt.

Methods

Preparation of cake:

Cake was prepared by mixing wheat flour and pearl millet flour , oil , butter, sugar , fresh whole egg , baking powder , milk , vanilla as shown in **Table (1)**.The mixture was whipped until got smooth. Then baked in an electric oven (Mac.pan, Italy) at 200±5ºC about the dough transferred to greased pan and was baked for 25 min. then was cooled at room temperature **AACC (2002)** and **Sharoba *et al.* (2013)**.

Table 1. *Replacement pearl millet flour with wheat flour (72% ext.) in production cakes.*

Treatment No.	Blends
Control (1)	**100% wheat flour**
E1	**90% wheat flour+ 10% pearl millet flour**
E2	**80% wheat flour+ 20% pearl millet flour**
E3	**70% wheat flour+ 30% pearl millet flour**
Control (2)	**100% pearl flour**

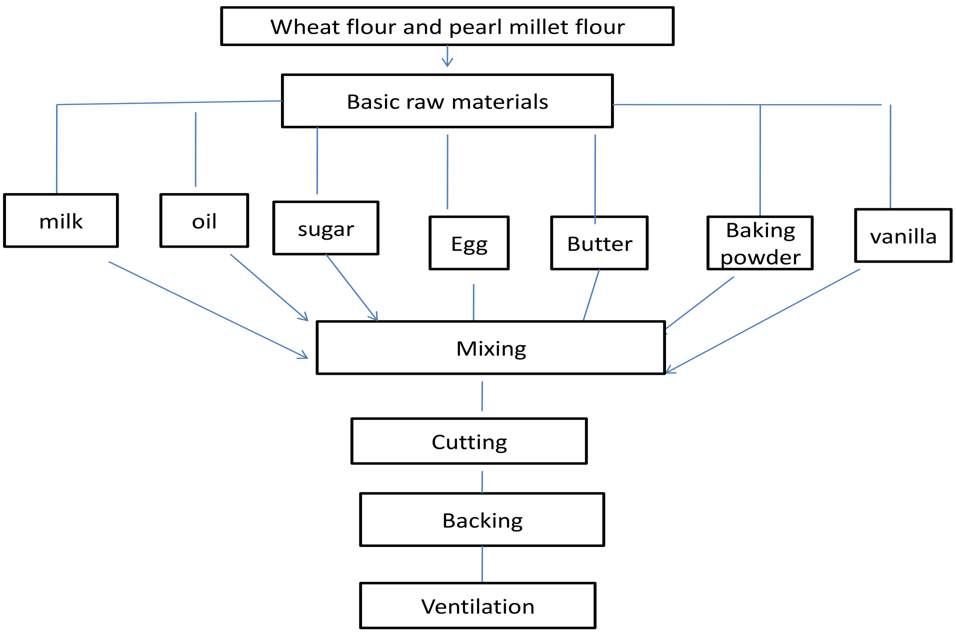

Fig. (1): Processing of Cakes using different levels from pearl millet, and mixing to wheat flour (72% ext).

Chemical analysis:

Moisture, protein, ash, crude fiber, ether extract, starch and reducing and non reducing sugars contents were determined according to the methods described in **AOAC (2016).** Total carbohydrates were calculated by difference.

Energy Value = (% Protein × 4) + (% Carbohydrate × 4) + (% Fat × 9).

Rheological properties:

Farinograph test:

The farinograph (877563 Brabender farinograph germany HZ 50) was used to study the hydration and mixing characteristics of the dough according to **AACC (2002)**.

Extensograph test:

Extensograph test was carried out according to the method described in the **AACC (2002)** using an extensograph type: 4821384 (Brabender Extensograph Germany HZ 50).

Mixolab test:

Mixolab analysis was carried out at the water absorption level determined by the consistograph following the **AACC (2000).**

Physical analysis of cakes:

Texture measurements (mechanical properties) of cakes:

Mechanical properties of cake and stored at room temperature (25±1°C) for 8 days mechanical properties measured at 0,2,4,6 and 8 days were performed with a Universal Testing Machine Cometech (B type, Taiwan) operated at a crosshead speed of 100 mm min-1. The shear force needed to cut the sample (5cm diameter) with a flat ended probe (2.5mm thickness) was registered. All measurements were performed at ambient temperature (25±5°C) according to **Caballero *et al.* (2007).**

Microbiological examination:

Preparation of samples for microbiological examination:

Ten grams of each sample were homogenized with 90 ml of sterile saline solution (9 g NaCL/L distilled water). The suspension was shacked by shaker for 5 minutes to give 0.1 dilutions. Then different dilutions (1: 10^{-1} to 1: 10^{-6}) were prepared to be used for microbiological examination according to **(U.S. Food and Drug Administration, 2001).**

Total viable bacterial count, Moulds and yeasts and Coliform bacteria count:

Total viable bacterial count, Moulds and yeasts and Coliform bacteria count were counted according to the method described by the methodology of **(APHA, 1992).**

Sensory evaluation of cakes:

Produced cake was evaluated according to the method described by **AACC (2002)** A group of graduate students in Food Technology Department, Faculty of Agriculture, Moshtohor, Benha University. Cake samples were left to cool at room temperature for 1 hr. after baking. Then cake was cut with a sharp knife and subjected to panel test general appearance (10), drumming (10), crust color (10), crumb color (10), taste (10), thawing in the mouth (10), cohesion (10) height (10), textures (10) , odor (10) and overall acceptability was calculated (100).

Statistical analysis:

ANOVA was applied on data of organoleptic evaluation of produced cake which were treated as data for complete randomization design by using Microsoft Excel 2010 least significant difference (L.S.D.) was calculated at 0.05 level of significance according to **Levine *et al.* (1999).**

Results and Discussion:

Chemical composition of pearl millet flour:

Chemical composition of pearl millet flour are shown in **Table (2).** These results show that medium pearl millet flour contained are 11.21% moisture, 11.07 % protein, 5.88% fat, 1.39% fiber and 1.48 % ash and 68.96 % total carbohydrates respectively.

These results are nearly in agreement with those reported by **Florence Suma (2012)**. All the results indicated that the pearl millet flour which is agood source protein and fat increases the nutritive value of cake.

Table 2. Chemical composition of both pearl millet flour and wheat flour.

Material	Moisture	Fat	Protein	Ash	Crude fiber	Available carbohydrate	Energy
Pearl millet flour	**11.21**	**5.88**	**11.07**	**1.48**	**1.39**	**80.18**	**420.44**
Wheat flour 72%	**13.98**	**1.17**	**10.88**	**0.51**	**0.05**	**87.39**	**403.61**

Rheological properties of pearl millet flour:

Concerning dough rheology, it is well known that the farinograph parameters indicate the most important properties in this dough. The rheological properties of dough have an immediate impact on functionality of dough; therefore, it may be used as reliable predictors of its behavior during the baking process as well as the quality of the final product.

Effect of replacement wheat flour with pearl millet flour on rheological properties:

Farinograph parameters:

The farinograph properties of replacement wheat flour with pearl millet flour containing different levels of pearl millet flour are shown in **Table (3).**Water absorption of the pearl millet flour sample was the highest compared with other treatments being (65%), while it was for the control sample 59.1 %. It could be observed that with increasing the amount of pearl millet flour, there was a decrease in the water absorption. These results are in agreement with those reported by **Lorenz and Dilsaver (1980).** The decrease in water absorption and dough development time of the finger millet flour blend is attributed to the lowering of the gluten content in the blends as a result of incorporation of the millet flour that is gluten free**. (Aprodu and Banu, 2014 and Maktouf *et al.*, 2016)** reported that increasing the level of millet flour to wheat flour caused to decrease of the development time in dough formulations. **Gavurnikova *et al.* (2011)**.

Data obtained in **Table (3)** indicated that the replacement of wheat flour with pearl millet flour lowered the stability time of dough. The highest time observed in blend sample that contained 10% pearl millet flour. Increasing the level of pearl millet flour decreased the dough stability time as comparing with the control sample.

Table 3. Farinograph properties of pearl millet flour and replacement wheat flour with pearl millet flour.

Sample (No.)	Water Absorption %	Arrival time (min)	Dough Development (min)	Stability time (min)	Degree of softening (B.U)
Control	**59.1**	**1.5**	**2**	**13**	**30**
E1	**58**	**1.0**	**1.5**	**12.5**	**20**
E2	**56.5**	**1**	**1.5**	**7.5**	**90**
E3	**54.8**	**2**	**2.5**	**7.5**	**90**
E4	**65**	**1.5**	**2**	**2**	**0**

E1: 90% wheat flour +10% pearl millet flour **E2:** 80% wheat flour +20% pearl millet flour
E3: 70% wheat flour +30% pearl millet flour **E4:** 100% pearl millet flour

Extensograph parameters:

The results in **Table (4)** shows effect of replacement wheat flour with pearl millet flour at different levels to mean flour on extensograph parameters. Data indicated that resistance to control sample flexibility was 390 B.U. There are changes in elasticity with the effect of replacement wheat flour with pearl millet flour intermediate flour. The elasticity was gradually decreased with the addition of pearl millet flour increased flexibility to 300 B.U. It decreased from the addition of pearl millet flour as it became180 B.U.

The extensibility (E) showed a value of 75 mm for control (wheat flour 72%ext.). The addition of 10% pearl millet flour + 90% wheat flour reached to the highest value being 135 mm. The relative number was dependent on the results of (R) and (E). Therefore, a similar relationship was found of the relative number (R / E) of the dough. The data in **Table (4)** also showed that the additions decreased the relative number (R / E) as compared with the sample control. Data in **Table (4)** showed that the effect of replacement wheat flour with pearl millet flour on Elasticity, extensibility, (E), the extension resistance (R) and the ratio between them as well as the energy. In terms of energy, control resulted in the highest value (52), while the pearl millet flour sample was the lowest value (6).

Table 4. Extensograph properties of pearl millet flour and replacement of wheat flour with pearl millet flour.

Blends	Elasticity (B.U)	Extensibility (mm)	Proportional Number	Energy (Cm2)
Control	**390**	**75**	**5.20**	**52**
E1	**180**	**135**	**1.33**	**43**
E2	**260**	**95**	**2.47**	**42**
E3	**200**	**100**	**2.00**	**33**
E4	**90**	**35**	**2.57**	**6**

E1: 90% wheat flour +10% pearl millet flour E2: 80% wheat flour +20% pearl millet flour
E3: 70% wheat flour +30% pearl millet flour E4: 100% pearl millet flour

Effect of replacement wheat flour with pearl millet flour on Mixolab parameters:

Date in **Table (5)** shows the effect of replacement wheat flour with pearl millet flour at different levels. The mixolab curve is divided into five different stages, in the first stage (C1). The dough development values show a rise in the flour treatment with enzymes, which decreased slightly in the second phase (C2) and ranged from 0.437to 0.508 Nm compared with the torque value in control sample is 0.552 Nm The third phase (C3), which is called starch gluten at this stage and the product during heating from 1.98Nm in the control sample to 1.877 Nm in the sample of (E1).In the first phase (C1), the effect replacement wheat flour with pearl millet flour was found on the values of dough development and Stage three (C3) in control sample and decreased in all samples when increased the value of pearl millet flour in the samples These results are in agreement with those reported by **Sharma *et al.* (2017).**

The fourth phase (C4) of 1.788 Nm in control sample and decreased in samples added to pearl millet flour compared to a control sample ranging from 1.735 to 1.137 Nm. the amount of pearl millet flour in the samples increases the amylase activity decreases leading to lower breakdown and hence viscosity is increased. These results are in agreement with those reported by **Goswami *et al*. (2015)**.

The effect of replacement wheat flour with pearl millet flour to improvers the nutritive value of cake product:

In this part of the effect of replacement wheat flour with pearl millet flour by add 10% pearl millet flour +90% wheat flour, 20% pearl millet flour +80% wheat flour, 30% pearl millet flour +70% wheat flour and 100% pearl millet to make cake and all the quality characteristics chemical, microbiological, and sensory of cake and finally measure freshness of the product were studied.

Effect of storage period at room temperature (25±1□C) on chemical composition of produced cake by replacement of wheat flour with pearl millet flour:

Chemical composition is great importance in judging the quality of the cake product. The moisture, ash, protein, fat, fiber and available carbohydrate contents of cake made by replacement wheat flour with pearl millet flour were determined. Data in **Table (6)** show the moisture content in control sample was higher than that of E1, E2, E3 and E4 samples, due to its retention of water. These results are in agreement with those reported by **Rajive *et al.* (2011).**

Table 5. Effect of replacement wheat flour with pearl millet flour on Mixolab parameters.

Parameters	Control	E1	E2	E3
Stability	**9.55**	**9.77**	**10.00**	**10.20**
Absorption	**6**	**5**	**3**	**1**
Mixing	**5**	**5**	**4**	**5**
Gluten+	**5**	**4**	**2**	**3**
Viscosity	**7**	**7**	**6**	**7**
Amylase	**8**	**7**	**5**	**7**
Retrogradation	**7**	**5**	**3**	**4**
C1(Nm)	**1.137**	**1.12**	**1.087**	**1.084**
C2(Nm)	**0.552**	**0.508**	**0.438**	**0.437**
C3(Nm)	**1.89**	**1.877**	**1.752**	**1.823**
C4(Nm)	**1.788**	**1.735**	**1.502**	**1.606**
C5(Nm)	**2.702**	**2.363**	**1.833**	**2.121**

E1: 90% wheat flour +10% pearl millet flour **E2:** 80% wheat flour +20% pearl millet flour
E3: 70% wheat flour +30% pearl millet flour

Table 6. Effect of storage period at room temperature (25±1□C) on chemical composition of produced cake by replacement wheat flour with pearl millet flour during storage at 25±1□C for 8 days.

Chemical Attributes	Storage periods (days)					
	Blends	**zero**	**2**	**4**	**6**	**8**
Moisture (%)	**Control**	**24.15**	**23.56**	**21.26**	**19.89**	**17.34**
	E1	**23.51**	**21.70**	**19.74**	**18.54**	**16.99**
	E2	**22.86**	**20.91**	**19.56**	**18.24**	**16.44**
	E3	**22.21**	**19.99**	**18.55**	**17.13**	**16.00**
	E4	**17.69**	**15.14**	**13.18**	**11.30**	**9.98**
Ash (%)	**Control**	**0.99**	**1.11**	**1.20**	**1.29**	**1.41**
	E1	**1.04**	**1.21**	**1.31**	**1.39**	**1.48**
	E2	**1.14**	**1.26**	**1,31**	**1.41**	**1.51**
	E3	**1.20**	**1.29**	**1.39**	**1.46**	**1.59**
	E4	**1.99**	**2.01**	**2.17**	**2.29**	**2.36**
Fat (%)	**Control**	**16.39**	**16.03**	**15.20**	**14.09**	**12.99**
	E1	**16.58**	**16.19**	**15.40**	**14.55**	**13.29**
	E2	**16.73**	**16.30**	**15.99**	**15.10**	**14.06**
	E3	**17.12**	**16.99**	**16.02**	**15.57**	**14.49**
	E4	**18.19**	**17.99**	**17.47**	**16.98**	**16.02**
Protein (%)	**Control**	**11.39**	**11.00**	**10.86**	**9.99**	**9.10**
	E1	**11.58**	**11.19**	**10.99**	**10.42**	**9.99**
	E2	**11.73**	**11.49**	**11.01**	**10.58**	**10.08**
	E3	**11.94**	**11.66**	**11.29**	**10.79**	**10.21**
	E4	**13.19**	**12.99**	**12.10**	**11.57**	**11.01**
Crude fiber (%)	**Control**	**0.57**	**0.60**	**0.68**	**0.76**	**0.99**
	E1	**0.70**	**0.81**	**0.90**	**0.99**	**1.01**
	E2	**0.83**	**0.99**	**1.01**	**1.11**	**1.24**
	E3	**0.97**	**1.10**	**1.15**	**1.28**	**1.39**
	E4	**1.89**	**1.99**	**2.00**	**2.19**	**2.59**
Available carbohydrate (%)	**Control**	**46.48**	**47.69**	**50.79**	**53.96**	**58.16**
	E1	**46.59**	**48.90**	**51.65**	**54.10**	**57.23**
	E2	**46.70**	**49.05**	**51.12**	**53.57**	**56.67**
	E3	**46.56**	**48.98**	**51.60**	**53.77**	**56.30**
	E4	**47.04**	**49.88**	**53.07**	**55.67**	**58.04**

E1: 90% wheat flour +10% pearl millet flour **E2:** 80% wheat flour +20% pearl millet flour
E3: 70% wheat flour +30% pearl millet flour **E4:** 100% pearl millet flour

Effect of storage periods at room temperature (25±1°C) on microbiological quality of produced cake by replacement wheat flour with pearl millet flour:

The total viable bacterial count is widely used as an indicator microbiological quality of cake. Data in **Table (7)** showed that on the basis of observations of microbial growth whereby molds have started to grow on the 4th day of storage the pearl millet cake base stored at room temperature, however was seen to be TPC on the 8th day of storage. Based on this study, TPC count increased during storage period of 8 days at room temperature. This happened because the room temperature (25°C ± 2°C) is the optimum conditions for growth. These results are in agreement with **Chaudhari1 *et al.* (2017).** Temperature that allows growth of microorganism and this temperature also fall below the danger zone temperature which is 4.4-60ºC. Leaving food out too long at room temperature can cause bacteria to grow to dangerous levels that can cause illness because the bacteria grow most rapidly in danger zone temperature, which doubling in number in as little as 20 minutes **(United States Department of Agriculture., Food Safety and Inspection Service, 2013).**

Table 7. Microbiological quality of produce by cake included replacement wheat flour with pearl millet flour (CFU/g).

Storage period (days)	Total bacterial count				
	Control	**E1**	**E2**	**E3**	**E4**
0	ND*	ND*	ND*	ND*	*ND
4	9×10	13×10	16×10	20×10	35×10
6	2×10^{1}	3.2×10^{1}	3.9×10^{1}	4.2×10^{1}	5.1×10^{1}
8	2.5×10^{2}	3.5×10^{2}	5×10^{2}	5.9×10^{2}	9×10^{2}
Molds and yeasts					
0	**Less than 15**	**Less than 15**	**Less than 15**	**Less than 15**	**Less than 15**
4	15×10	23×10	30×10	33×10	60×10
6	100×10	2.5×10^{2}	3.4×10^{2}	5.5×10^{2}	10×10^{2}
8	4.7×10^{2}	5.6×10^{2}	7.5×10^{2}	9×10^{2}	40×10^{2}
Coliform group					
0	ND**	ND**	ND**	ND**	ND**
4	ND**	ND**	ND**	ND**	ND**
6	ND**	ND**	ND**	ND**	ND**
8	ND**	ND**	ND**	ND**	ND**

ND*: Not detected

4.4.3. Sensory evaluation of produced by cake with replacement wheat flour with pearl millet flour:

Sensory evaluation is important criteria in evaluation cake quality. Data in **Table (8)** indicated that there are significant differences ($p \leq 0.05$) between all samples. The obtained data indicated that the pearl millet flour are giving marked ($p \leq 0.05$) improvement in height compared with control sample.

Table 8. Sensory evaluation of produced cake by replacement wheat flour with pearl millet flour.

Characteristics	Cake blends					
	Control	**E1**	**E2**	**E3**	**E4**	**LSD**
Appearance	8.22± 0.446ab	8.38± 0.334c	8.61± 0.230b	7.94± 0.307c	4.94± 0.673ac	0.6220
Drumming	9.33± 0.280b	8.66± 0.213b	8.83± 0.202b	8.55± 0.258b	6.05± 0.725ad	0.5665
Crust color	9.05± 0.235b	8.72± 0.239b	8.27± 0.239b	7.88± 0.332c	4.94± 0.585d	0.5140
Crumb color	8.72± 0.277b	8.33± 0.242b	8.11± 0.254b	7.61± 0.344c	4.94± 0.585d	0.5295
Taste	8.77± 0.366c	8.22± 0.357c	8.83± 0.245b	8.27± 0.350c	5.61± 0.479ab	0.5347
Thawing in the mouth	8.77± 0.318c	8.50± 0.282b	8.44± 0.293b	8.38± 0.380c	5.77± 0.629ac	0.5852
Cohesion	9.33± 0.213b	9.16± 0.202b	9.05± 0.205b	8.88± 0.311c	5.38± 0.737ad	0.5709
Height	9.16± 0.217b	9.27± 0.157a	9.50± 0.121a	9.38± 0.216b	7.05± 0.494ab	0.4004

Table 8. Cont.						
Texture	9.33± 0.161a	9.16± 0.145a	9.05± 0.189a	8.94± 0.261b	6.22± 0.533d	0.4299
Odor	8.72± 0.441ab	9.11± 0.169a	8.94± 0.189a	8.77± 0.274b	6.88± 0.529d	0.5144
Overall acceptability	88.61± 3.593cd	88.61± 1.896bd	89.77± 1.729bd	87.61± 2.359ac	62.55± 6.452e	5.3155

E1: 90% wheat flour +10% pearl millet flour E2: 80% wheat flour +20% pearl millet flour
E3: 70% wheat flour +30% pearl millet flour E4: 100% pearl millet flour

Effect of replacement wheat flour with pearl millet flour on texture measurement (mechanical properties) of produced during storage period:

Data in **Table (9)** showed that the replacement of wheat flour with pearl millet flour presented very similar hardness values to each other, even higher than those for the control sample. In these samples the hardness values also increased with storage time, indicated that the crumb develops far less firmness over time and demonstrating the effectiveness of the pearl millet flour in maintaining freshness.

An increase in chewiness was observed in E1 and E3 samples compared with the control sample which indicates a low degree of softness and chewiness is one of the texture parameters easily correlated with sensory evaluation. A gradual increase in hardness according to **Ramesh (2014)** an increase in cake hardness was reported by **Lee *et al*. (2004)** springiness was increased in E2 sample while, it decreased in control sample. A subjective evaluation of springiness is normally made by consumers and consists of slightly pressing the piece of food, by hand or with the mouth, and verifying how easily it returns to the original size.

Regarding springiness change during storage in **Table (9)** an increase was observed during in 10% and 30% pearl millet flour and decrease in 20% and 100% pearl millet flour in comparison with the control sample. An increase in chewiness was observed in chitosan chewiness in comparison with the control sample which indicates a low degree of softness and crispness chewiness is one of the texture parameters easily correlated with sensory analysis through trained panels. A gradual increase in hardness observed when replacement wheat flour with pearl millet flour , the pearl millet flour negative effect could be due to the increase in hardness **Ramesh (2014)** Both, gumminess and chewiness are parameters dependent on hardness. Therefore, their values, both in fresh and storage cakes, followed a similar trend than that of hardness. A subjective evaluation of springiness is normally made by consumers and consists of slightly pressing the piece of food, by hand or with the mouth, and verifying how easily it returns to the original size.

Table 9. Effect of storage period at room temperature (25±1□C) of produced cake by replacement of wheat flour with pearl millet flour on texture measurement (mechanical properties):

Mechanical properties	**Cake blends**				
	Control	**E1**	**E2**	**E3**	**E4**
Zero time					
Hardness Cycle 1	**17.96 N**	**26.53 N**	**22.03 N**	**24.14 N**	**43.46N**
Adhesiveness	**0.70 mJ**	**0.20 mJ**	**0.20 Mj**	**0.30 mJ**	**0.90 mJ**
Resilience	**0.25**	**0.26**	**0.23**	**0.22**	**0.09**
Hardness Cycle 2	**15.30 N**	**21.78 N**	**18.51 N**	**20.05 N**	**26.44 N**
Cohesiveness	**0.61**	**0.55**	**0.52**	**0.55**	**0.22**
Springiness	**6.28 mm**	**6.49 mm**	**5.69 mm**	**6.58 mm**	**4.13 mm**
Gumminess	**11.02 N**	**14.64 N**	**11.36 N**	**13.29 N**	**9.62 N**
Chewiness	**69.20 mJ**	**95.00 mJ**	**64.60 mJ**	**87.40 mJ**	**39.70 mJ**
4 Days					
Hardness Cycle 1	**24.62N**	**35.54 N**	**8.53 N**	**13.62 N**	**15.04 N**
Adhesiveness	**0.20 mJ**	**0.20 mJ**	**0.50 mJ**	**1.10mJ**	**1.80mJ**
Resilience	**0.25**	**0.21**	**0.14**	**0.16**	**0.12**
Hardness Cycle 2	**21.51 N**	**29.05 N**	**6.55 N**	**10.69 N**	**11.20 N**
Cohesiveness	**0.57**	**0.50**	**0.38**	**0.39**	**0.32**
Springiness	**5.55 mm**	**7.65 mm**	**1.11 mm**	**2,78 mm**	**2.50mm**
Gumminess	**14.13 N**	**17.93 N**	**3.22 N**	**5.26 N**	**4.82N**
Chewiness	**78.40mJ**	**137.2 mJ**	**3.60 mJ**	**14.60mJ**	**12.10mJ**

E1: 90% wheat flour +10% pearl millet flour **E2:** 80% wheat flour +20% pearl millet flour
E3: 70% wheat flour +30% pearl millet flour **E4:** 100% pearl millet flour

Conclusions

The supplementation of the pearl millet flour showed a significant improvement each of the properties. Specific height has increased with every treatment, though it the replacement wheat flour with pearl millet flour was a highly effective. Increased protein and fat replacement wheat flour with pearl millet flour add all of the treatments replacement wheat flour with pearl millet flour showed a noticeable positive change in the rheological properties. All of these changes culminated in the sensory evaluation, which showed a significant approbation for replacements compared with the control sample.

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تحسين القيمة التغذويه للكيك الناتج من إستبدال دقيق القمح بدقيق الدخن

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تحتل منتجات المخابز موقع مهم فى تغذية الإنسان محليا وعالميا. ونظرا لوجود فجوة بين الإنتاج والإستهلاك تلجأ الدوله إلى إستيراد أقماح من دول مختلفة. يزرع الدخن على نطاق واسع فى المناطق الجافة وشبة الجافة فى أسيا وإفريقيا. وهومكون غذائي رئيسي فى الأطعمة التقليدية المختلفة مثل الخبز والوجبات الخفيفة والعصيدة . ويعتبر دقيق الدخن اللؤلؤي الصنف المستخدم على نطاق واسع فى كل من أسيا وإفريقيا. وفى هذه الدراسة تم إستبدال دقيق القمح إستخراج 72% بدقيق الدخن اللؤلؤي فى انتاج الكيك بمستويات 10%، 20%، 30% و100% دقيق دخن وذلك لزيادة القيمة التغذويه للكيك المصنع. كما تضمنت الدراسة التعرف على خصائص الكيك المصنع من حيث التركيب الكيمائي ، الخصائص الريولوجية، ثوابت القوام ، الأمان الميكروبيولوجى والتقييم الحسى خلال فترة التخزين لمده 8 أيام على درجة حرارة الغرفة (25 ± 1°م) .أظهرت النتائج ان هناك تحسن واضح فى زيادة القيمة التغذويه للكيك فى نسب كل من البروتين،الدهن، الرماد ، الألياف والكربوهيدرات مقارنه بعينة الكنترول . لذلك توصى الدراسة بزراعه محصول الدخن وإستخدام دقيق الدخن اللؤلؤي فى تصنيع منتجات المخابز وذلك لزيادة القيمة التغذويه لهذه المنتجات.

الكلمات المساعدة: دقيق الدخن – الكيك – الخصائص الريولوجية –ثوابت القوام– التركيب الكيماوى– الأمان الميكروبيولوجى– الصفات الحسية