*J. Agric. Sci. Mansoura Univ., 34 (12): 11101 - 11114 , 2009*

# STUDIES ON SOME BAKERY PRODUCTS FORTIFIED WITH BARLEY AND SORGUM FLOUR

**El-Sherif, Sanaa A. and M. N. Kenawi**
**Food Science Department, Faculty of Agriculture,Minia University, Minia, Egypt.**

## ABSTRACT

This study was undertaken in an attempt to use some flour substitutes in bakery production such as cakes and biscuits. Fifteen formulas of cakes and biscuits were prepared. The control formula contained only wheat flour ; the other formulas wheat flour was replaced with barley or sorghum flour substitutes at different levels (15, 20, 25, 30, 35, 40 and 100 % of each).

Wheat flour had the lowest (WAC) value of only 202.89. The (WAC) values of wheat flour rose from 211.36 - 231.18g water/100 g when replaced at levels of 15 % - 40 % of barley flour and ranged from 210.35 - 230.65g water/100 g when replaced at levels of 15% - 40 % of sorghum flour.

Barley flour had the highest value (159.60g oil/100 g sample) of oil absorption capacity (OAC) followed by sorghum flour which had the second highest value (136.56) of (OAC). On the other hand, wheat flour had the lowest (OAC) value (111.63). The (OAC) values of wheat flour ranged to 114.37 - 128.96 g oil/100 g when replaced at levels of 15 % -40%, of barley flour and, 113.78 - 120.96 g oil/100 g when replaced at levels of 15 % -40%, of sorghum flour.

The specific gravity of cake batters ranged between 0.92 to 0.97. The specific gravity values of batter containing 100 % wheat flour showed the highest values. Replacement with barley or sorghum flour increased the porosity of the cake.

Wheat flour had the highest values of bulk density (0.61g/ml ), while barley flour had the lowest values of bulk density (0.44g/ml ). Blending of barley flour or sorghum flour in wheat flour led to the decrease of the bulk density value of wheat flour.

The obtained data for the chemical composition of the cakes were moisture (12.92 - 16.60%), protein (8.87 - 10.51%), total lipids (21.66 - 24.00%) and carbohydrates (63.86 - 67.11%). The energy values of cakes ranged between 487.90 to 495.55 Kcal/ 100 g calculated on a wet weight basis .

The obtained data for the chemical composition of the biscuits were moisture (1.37 - 2.27.60%), protein (6.96 - 8.14%), total lipids (14.66 - 16.52%) and carbohydrates (63.86 - 67.11%). The energy values of biscuits ranged between 466.15 and 475.22 Kcal/ 100 g calculated on a wet weight basis .

Adding barley or sorghum flour to cake formulas as flour substitutes resulted in no significant differences ($P<0.01$) in the sensory characteristics (taste, color, texture, flavour , appearance and overall acceptability ) in the cakes and biscuits. The panelists in this study found all the samples to be acceptable

The results suggest that barley and sorghum flour can be successfully used as flour substitutes in producing cake and biscuits of high quality which are highly nutritive at a reasonable cost.

# INTRODUCTION

The main problem facing the bakery industry in Egypt is the limited availability of wheat flour. Blending wheat flour with other kinds of available flours, e.g. barley or sorghum, will contribute to a lowering of cost.

The use of non-wheat flours would extend wheat supplies and has been previously investigated with composite in bakery products.

Barley and sorghum are an important cereal crop grown in Egypt as well as in many developing countries and are potenially suitable for use in composite flours.

Many investigations used barley or sorghum flours in bakery products because of their nutritive value benefits (high fibre, low gluten) and economic benefits (low cost) (Ragee and Abdel-Aal, 2006, Schober etal, 2005, Raiz, 1999 and Kalra and Jood, 2000).

Barley is unique among cereals because of its high concentration of soluble dietary fibre, particulary mixedlinked 1→3.1 → 4 β- Dglucans. This matrial has been studied in connection with its hypocholesterolemic effects in animals and humans (Raiz, 1999 and Kalra and Jood, 2000 ).

Several studies have indicated the possibility of incorporating barley or sorghum in wheat flour at varios levels for bakery products ( Badi etal,1976, Hart *et al.*, 1970 and Hulse *et al.,* 1980 ).

Cakes have become traditional food in many countries. Their varieties in form ana taste combined with long shelf life and convenience of use has perpetuated their popularity.

In biscuit-making the main ingredients are flour, water, sugar and salt. Varying the preportions of these ingredients many produce avariety of shapes and texture. The quality of biscuits is governed by the nature and the quality of ingredients used. The cereal component is variosly enriched by two major ingredients, fat and sugar, but therafter the variety is almost endless (Manley, 1991).

Biscuits have low moisture content. The low moisture content ensures that biscuits are generally free from mirobiological spoilage and confers along shelf life on the products , provided of course , that they are protected from uptake of moisture from adamp atmosphere or damp surroundings. Their low moisture content also gives biscuits arelatively high energy density compared with other baked goods.

Biscuits can serve as impotant carriers of nutrients, particularly for child feeding programs, military rations and also for different groups of different social levels ( FAO/ WHO UNICEF, 1969 ).

Biscuits are a very popular and favourable snack among children, due to the long shelf life, large scale production and distribution as well as agood eating quality ( Tsen *et al.*, 1973 ).

The characteristics of freshly baked cake may vary due to many factors, including the ingredients used, baking pans and oven temperature. (Daniel, 1978).

The objective of this study was to see the effect of the incorporation of barley or sorghum on the physical , chemical and sensory charactristics of some bakery products ( cakes and biscuits ).

# MATERIALS AND METHODS

**Materials:**

**Ingredients of cake:**

Wheat flour (72 % extraction rate) was obtained from Minia Mills Co., Minia. Barley and sorghum were obtained from a farmer at the Faculty of Agriculture, Minia University and milled in Minia Mills Co., Minia

Sugar, eggs, vegetable oil, baking powder and vanilla were purchased from the local market in Minia, Egypt.

**Methods:**

**Chemical analysis:**

Moisture, protein, fat and ash in the experimental samples were measured according to (AOAC, 1995).

**Physical measurements:**

Physical measurements of batter cakes such as specific gravity was determined by (Campbell *et al.*, 1979). Porosity of cake formulas was determined according to the method of Yakobe (1980).

**Functional properties:**

**Bulk density (BD):**

The bulk density of the sample was calculated and expressed as g/ml (Jones and Tung, 1983).

**Oil absorption capacity (OAC):**

The fat absorption capacity was calculated and expressed as a percentage of original weight (Hulse *et al.*, 1977) or as the volume of oil absorbed per gram of sample (Lin *et al.*, 1974).

**Water absorption capacity (WAC):**

The WAC was determined according to (Hulse *et al.*, 1977).

**Cake formulas baking:**

The ingredients and flour substitutes (barley flour and sorghum flour) which were used at the level ranges 0 (control), 15, 20, 25, 30, 35 , 40, and 100 % are shown in Table (1).

**Cakes preparation:**

Cakes were made according to Rosenthal, (1995). The formulations presented in Table (1).

Control biscuit dough was prepared according to the formula in Table (2) (Manohar and Rao, 1997). The supplemented biscuits were prepared using the same formula except for replacing the wheat flour with barley or sorghum flour at 15, 20, 25, 30, 35, 40 and 100 % levels.

**Table (1): formula prepared with different levels of flour substiutes.**

| Formula \ Content | Wheat | Barley | Sorghum | Sugar | Water | Whole Egg | Fat (oil) | Baking Powder | Vanilla |
|---|---|---|---|---|---|---|---|---|---|
| Control cake (100 % wheat flour) | | - | - | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 15 % barley flour | 119 | 21 | - | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 20 % " " | 112 | 28 | - | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 25 % " " | 105 | 35 | - | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 30% " " | 98 | 42 | - | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 35 % " " | 91 | 49 | - | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 40 % " " | 84 | 56 | - | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 100 % " " | - | 140 | - | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 15% sorghum flour | 119 | - | 21 | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 20 % " " | 112 | - | 28 | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 25 % " " | 105 | - | 35 | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 30 % " " | 98 | - | 42 | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 35% " " | 91 | - | 49 | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 40 % " " | 84 | - | 56 | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |
| 100% " " | - | - | 140 | 140 | 31.0 | 120 | 70 | 7.0 | 0.2 |

**Table (2): Formulation of biscuit.**

| Ingredient | Amount (g) |
|---|---|
| Wheat flour | 100.00 |
| Powdered sugar | 30.00 |
| Shortening | 20.00 |
| Sodium chloride | 1.00 |
| Sodium bicarbonate | 0.50 |
| Ammonium bicarbonate | 1.00 |
| Baking powder | 0.30 |
| Water | 16 – 19 ml |

**Preparation of biscuits:**

The biscuit was prepared, packed, cooled for 30 minutes, packaged in polyethylene bags and stored under dissication (Vatsala and Rao, 1991; Manohar and Rao, 1997).

**Evaluation of biscuit:**

**Physical characteristics:**

Biscuits were evaluated for height (cm), width (cm), spread ratio and spread factor which were calculated according to Manohar and Rao (1997) .

**Energy values (Kcal/100g):**

Energy values were calculated as reported by Greenfield and Southgate (1992).

**Sensory evaluation:**

Sensory evaluation for the color, texture, taste, flavour , appearance and overall acceptability were used according to (Moskowitz ,1974).

**Statistical analysis:**

Ten experienced judges participated in this test, and the data were analyzed using statistical analysis system (SAS, 1994).

# RESULTS AND DISCUSSION

**Functional properties**

The term functionality is defined as: "Any property of food or food ingredient except its nutritional value that affects its utilization", the most common functional properties that food industries require in new protein ingredients are: solubility, water absorption and oil absorption.

**Bulk density (BD):**

The bulk density values (g/ml) of wheat flour, barley flour, sorghum flour and their blends are given in Table (3). Wheat flour had the highest values of bulk density (0.61g/ml),while barley flour had the lowest values of bulk density (0.44g/ml). Blending of barley flour,sorghum flour in wheat flour led to the decrease of the bulk density value of wheat flour. This decrease was proportional to both the value of bulk density and the amount of barley flour and sorghum flour used to replace the wheat flour. However, bulk density values of 0.57- 0.48 g/ml were obtained for wheat flours containing 15-40% barley flour, and BD values were 0.58-0.53 g/ml when wheat flours contained 15-40% sorghum flour.

**Oil absorption capacity (OAC):**

Data in Table (3) revealed that barley flour had the highest value (159.60g oil/100 g sample) of oil absorption capacity (OAC) followed by sooghum flour which had the second highest value (136.56) of (OAC). On the other hand, wheat flour had the lowest (OAC) value (111.63) among all the studied samples. However, blending of barley flour and sorghum flour in samples enhanced its ability to absorb oil. The (OAC) values of wheat flour ranged to 114.37 - 128.96 g oil/100 g when replaced at levels of 15% - 40%, of barley flour and 113.78 - 120.96 g oil/100 g when replaced at levels of 15 % -40%, of sorghum flour.

Generally, it can be observed from the results in Table (3) that, the relationship between bulk density and (OAC) of the studied samples is irreversible. Dench (1982) also found the relationship between bulk density and (OAC) of winged bean isolate was an irreversible relationship. Kinsella *et al.* (1985) reported that it is probable that most of the oil held by protein is actually physically entrapped and therefore the amount is influenced mainly by the surface area and bulk density of the protein preparation.

**Water absorption capacity (WAC):**

The data in Table (3) shows the water absorption capacity (WAC) values of wheat flour, barley flour , sorghum flour and their blends. From this table, it can be seen that barley flour had the highest (WAC) value, 291.23 g water/100 g, and sorghum flour powder had the second highest (WAC) value, 290.84. On the other hand, wheat flour had the lowest (WAC) value, 202.89. From the table it can also be seen that the addition of barley flour or sorghum flour to the wheat flour enhanced its ability to absorb water. The (WAC) values of wheat flour became 211.36-231.18g water/100 g when replaced at levels of 15 % - 40 % barley flour and ranged to 210.85 - 230.65g water/100 g when replaced at levels of 15% - 40 % sorghum flour

**Table (3): Bulk density (BD), oil absorption capacity (OAC) and water absorption capacity (WAC) of wheat flour, barley flour, sorghum flour and their blends.**

| Samples | Bulk density (g sample/ml) | Oil absorption capacity (g oil/100g) | Water absorption capacity** (g water/100g) |
|---|---|---|---|
| Control cake (100 % wheat flour) | 0.61 | 111.63 | 202.89 |
| 15 % barley flour | 0.57 | 114.37 | 211.36 |
| 20 % ,, ,, | 0.53 | 119.07 | 214.37 |
| 25 % ,, ,, | 0.53 | 121.60 | 215.69 |
| 30% ,, ,, | 0.51 | 122.55 | 225.67 |
| 35 % ,, ,, | 0.49 | 123.26 | 228.39 |
| 40 % ,, ,, | 0.48 | 128.96 | 231.18 |
| 100 % ,, ,, | 0.44 | 159.60 | 291.23 |
| 15% sorghum flour | 0.58 | 113.78 | 210.85 |
| 20 % ,, ,, | 0.56 | 118.23 | 218.74 |
| 25 % ,, ,, | 0.55 | 118.98 | 219.37 |
| 30 % ,, ,, | 0.54 | 119.56 | 221.78 |
| 35% ,, ,, | 0.54 | 120.03 | 227.86 |
| 40 % ,, ,, | 0.53 | 120.96 | 230.65 |
| 100% ,, ,, | 0.52 | 136.56 | 290.84 |

**Effect of incorporation of barley flour or sorghum flour on the physical characteristics of biscuit samples:**

Various physical quality characteristics of biscuits as influenced by the incorporation of barley flour or sorghum flour are given in Table (4). The data showed a decrease in spread ratio of biscuits upon incorporation of sorghum flour. This reduction in spread ratio was proportional to the increase of the levels of the incorporated sorghum flour. Assuming the spread factor of the control to be 100%, it was found that the spread factor decreased to 98.71, 95.32, 93.42, 90.44 and 89.53% when sorghum flour was incorporated at 15, 20, 25, , 30, 35 and 40%, respectively. There was a decrease in the spread ratio and spread factor for all types of biscuits supplemented with sorghum flour, due to the increase in width and thickness of these biscuits. When barley flour was incorporated at 15, 20, 25, 30 ,35 and 40 % levels, the spread factor of the biscuits produced rose to 100.55, 101.01,102.84, 105.14 ,106.06 and 106.50% . As shown in the table, the width increased from 20.70 cm for the control biscuit to 23.20 cm for the biscuit supplemented with barley flour at the 15% level to 40 % levels.

**Physical preperties of cake samples:**

The specific gravity of the cake batters are given in Table (5).It has been reported that when egg white is whipped, it stiffens and the volume of the foam increases, so the specific gravity decreases as air is incorporated into the foam (Palmer, 1982). The values of specific gravity of batters containing 100 % wheat flour were the highest, while the other samples incorporating stiffened egg white showed lower values.

**Table (4): Physical characteristics of control and supplemented biscuit samples.**

| Biscuit samples | Width[a] (cm) | Thick-ness[b] (cm) | Spread[c] ratio | Spread[d] factor |
|---|---|---|---|---|
| Control cake (100 % wheat flour) | 20.70 | 1.90 | 10.89 | 100 |
| 15 % barley flour | 21.90 | 2.00 | 10.95 | 100.55 |
| 20 % ,, ,, | 22.00 | 2.00 | 11.00 | 101.01 |
| 25 % ,, ,, | 22.40 | 2.00 | 11.20 | 102.84 |
| 30% ,, ,, | 22.90 | 2.00 | 11.45 | 105.14 |
| 35 % ,, ,, | 23.10 | 2.00 | 11.55 | 106.06 |
| 40 % ,, ,, | 23.20 | 2.00 | 11.60 | 106.50 |
| 100 % ,, ,, | 23.40 | 2.00 | 11.70 | 107.43 |
| 15% sorghum flour | 21.50 | 2.00 | 10.75 | 98.71 |
| 20 % ,, ,, | 21.80 | 2.10 | 10.38 | 95.32 |
| 25 % ,, ,, | 21.80 | 2.10 | 10.38 | 95.32 |
| 30 % ,, ,, | 22.30 | 2.20 | 1013 | 93.42 |
| 35% ,, ,, | 22.60 | 2.30 | 9.85 | 90.44 |
| 40 % ,, ,, | 23.40 | 2.40 | 9.75 | 89.53 |
| 100% ,, ,, | 23.90 | 2.50 | 9. 56 | 87.87 |

a width of 5 biscuits in series
b thickness of 5 biscuits stacked.
c width/thickness

$$d = \frac{\text{Spread ratio of sample}}{\text{Spread ratio of control}} \times 100$$

**Porosity of cake:**

Data in Table 5 indicate that cake containing 100 % wheat flour had the lower estimated porosity of cake.Table 5 also shows that replacement with barley flour and sorghum flour increased porosity compared to that of the control.

**Chemical composition of cakes:**

The proximate composition of cakes made by using wheat flour supplemented with barley flour or sorghum flour is given in Table (6)

Moisture contents ranged between12.92 to16.60 %. It was noticed that the moisture content increased as the concentration of barley flour was increased. The same trend was observed with sorghum flour . The results showed that the incorporation of barley flour or sorghum flour into wheat flour increased the moisture and fat contents of cake samples. The higher moisture content of cakes containing barley flour or sorghum flour compared to that of the control cake might be due to the great oil and water binding properties of barley flour and sorghum flour (Table 3). Protein contents ranged from 8.87 to 10.51 % with highest value found in the formula supplemented with 100% sorghum flour. This could be due to the high initial protein content of sorghum flour. The addition of barley flour showed a decrease in protein content, 9.40% for the control, compared to 8.87 % for the cake supplemented with 100% barley flour. Fat content ranged from 21.66 to 24.00 %, with 100% barley flour scoring the highest value. The addition of either barley flour or sorghum flour to wheat flour also caused a slight decrease of ash content in the cakes produced. The control cakes had a higher slightly carbohydrate content than the supplemented cakes. This might be because the total carbohydrates were calculated by difference.

From the data in Table(6), energy values ranged between 487.90 and 495.55 Kcal / 100 g calculated by wet weight basis.

**Table 5: Effect of flour substitutes on the physical proparities of batter and cake samples.**

| Treatment | Specific gravity | Porosity |
|---|---|---|
| Control cake(100 % wheat flour) | 097 | 44.14 |
| 15 % barley flour | 0.95 | 48.14 |
| 20 % " " | 0.95 | 48.15 |
| 25 % " " | 0.94 | 51.18 |
| 30% " " | 0.93 | 51.56 |
| 35 % " " | 0.93 | 51.85 |
| 40 % " " | 0.92 | 52.18 |
| 100 % " " | 0.96 | 55.56 |
| 15% sorghum flour | 0.96 | 48.15 |
| 20 % " " | 0.95 | 49.20 |
| 25 % " " | 095 | 51.86 |
| 30 % " " | 0.94 | 52.15 |
| 35% " " | 0.94 | 55.15 |
| 40 % " " | 0.94 | 55.55 |
| 100% " " | 0.96 | 56.28 |

**Table 6: Effect of flour substitutes on the chemical composition of cake samples. (on a dry weight basis).**

| Content / Formula | Moisture % | Protein* % | Fat % | Ash % | Carbohy-** drates% | Energy value*** Kcal / 100 g |
|---|---|---|---|---|---|---|
| Control cake(100 % wheat flour) | 12.92 | 9.40 | 21.66 | 1.83 | 67.11 | 487.90 |
| 15 % barley flour | 13.85 | 9.34 | 22.38 | 1.79 | 66.49 | 490.20 |
| 20 % " " | 14.20 | 9.26 | 22.79 | 1.78 | 66.17 | 491.63 |
| 25 % " " | 14.56 | 9.18 | 23.00 | 1.77 | 66.05 | 492.55 |
| 30% " " | 15.02 | 9.11 | 23.21 | 1.76 | 65.92 | 492.60 |
| 35 % " " | 15.33 | 9.03 | 23.40 | 1.74 | 65.83 | 493.23 |
| 40 % " " | 15.55 | 8.94 | 23.79 | 1.74 | 65.53 | 494.57 |
| 100 % " " | 16.60 | 8.87 | 24.00 | 1.67 | 65.46 | 495.55 |
| 15% sorghum flour | 13.82 | 9.60 | 21.94 | 1.77 | 66.69 | 488.38 |
| 20 % " " | 14.18 | 9.78 | 22.20 | 1.76 | 66.26 | 489.21 |
| 25 % " " | 14.57 | 9.90 | 22.80 | 1.74 | 65.56 | 491.39 |
| 30 % " " | 15.02 | 10.05 | 23.34 | 1.73 | 64.88 | 493.27 |
| 35% " " | 15.29 | 10.15 | 23.58 | 1.71 | 64.56 | 494.05 |
| 40 % " " | 15.60 | 10.23 | 23.66 | 1.69 | 64.42 | 494.28 |
| 100% " " | 16.34 | 10.51 | 23.96 | 1.67 | 63.86 | 494.60 |

* T.N. x 5.7

** Carbohydrates calculated by difference by differences

*** calculated by wet weight basis.

## Chemical composition of biscuits:

The proximate composition of biscuits made by using wheat flour supplemented with barley flour or sorghum flour is given in Table (7).
Moisture contents ranged between 1.37 to 2.29 %. It was noticed that the moisture content increased as the concentration of barley flour was

increased. The same trend was observed with sorghum flour. The results showed that the incorporation of barley flour or sorghum flour with wheat flour increased the moisture and fat contents of biscuit samples. The higher moisture content of biscuits containing barley flour or sorghum flour compared to the control biscuit might be due to the great oil and water binding properties of barley flour and sorghum flour (Table 3). Protein contents ranged from 6.82 to 8.14 % with the highest value found in the formula supplemented with 100% sorghum flour . This could be due to the high initial protein content of sorghum flour. The addition of barley flour showed a decrease in protein content which was 7.34% for the control and 6.82 % in the biscuit supplemented with 100% barley flour. Fat content ranged from 14.67 to 16.52% with highest value found in 100% barley flour. The same trend was observed with sorghum flour. The addition of either barley or sorghum flour to wheat flour also caused a slight decrease of ash content in the produced biscuits.

The control biscuits had a slightly higher carbohydrate content than the supplemented biscuits. This might be because the total carbohydrates were calculated by difference. From the data in Table (7), energy values ranged between 466.15 to 475.22 Kcal / 100 g calculated on a wet weight basis. The results showed that the incorporation of barley flour or sorghum flour increased energy value and indicated that biscuits are a high energy source.

**Table 7: Effect of flour substitutes on the chemical composition of biscuit samples. (on a dry weight basis).**

| Content / Formula | Moisture % | Protein* % | Fat % | Ash % | Carbohy-** drates % | Energy value*** Kcal / 100 g |
|---|---|---|---|---|---|---|
| Control (100 % wheat flour) | 1.37 | 7.34 | 14.67 | 1.67 | 76.42 | 466.15 |
| 15 % barley flour | 1.56 | 7.27 | 15.16 | 1.54 | 76.03 | 469.00 |
| 20 % " " | 1.71 | 7.21 | 15.46 | 1.52 | 75.81 | 470.08 |
| 25 % " " | 1.81 | 7.14 | 15.72 | 1.51 | 75.63 | 471.23 |
| 30% " " | 1.92 | 7.08 | 15.92 | 1.49 | 75.51 | 472.21 |
| 35 % " " | 2.04 | 7.02 | 16.10 | 1.47 | 75.41 | 473.09 |
| 40 % " " | 2.16 | 6.96 | 16.23 | 1.44 | 75.37 | 473.76 |
| 100 % " " | 2.29 | 6.82 | 16.52 | 1.40 | 75.26 | 475.22 |
| 15% sorghum flour | 1.54 | 7.48 | 15.04 | 1.53 | 75.95 | 468.01 |
| 20 % " " | 1.69 | 7.61 | 15,32 | 1.51 | 75.56 | 468.90 |
| 25 % " " | 1.78 | 7.71 | 15.69 | 1.48 | 75.12 | 471.25 |
| 30 % " " | 1.89 | 7.82 | 15.84 | 1.46 | 74.63 | 471.98 |
| 35% " " | 2.02 | 7.91 | 15.92 | 1.44 | 74.63 | 472.86 |
| 40 % " " | 2.14 | 7.98 | 16.14 | 1.42 | 74.46 | 473.39 |
| 100% " " | 2.27 | 8.14 | 16.49 | 1.39 | 73.98 | 475.16 |

* T.N. x 5.7
** Carbohydrates calculated by difference by differences
*** calculated by wet weight basis.

## Sensory evaluation of the cakes:

The sensory quality of the studied cake samples as influenced by the incorporation of either barley or sorghum flour is shown in Table (8). Adding barley or sorghum flour to cake formulas as flour substitutes resulted in no significant differences (P<0.01) in the sensory characteristics (taste, color, texture, flavour , appearance and overall acceptability ) of the cakes.

Data in Table (8) indicated that taste scores of samples ranged from 6.71 to to 8.57. The highest taste score was recorded in samples without any additives (control), while cake containing 100% sorghum flour had the lowest taste score.

The scores of color as given in Table (8) was found to range from 7.71 to 8.57 for samples. The highest score was recorded for the control.

Texture scores of samples ranged from 6.711 to to 8.57. The lowest texture score was recorded in samples containing 100% sorghum flour (6.71). Flavour scores of samples ranged from 7.21 to 8.43 The lowest flavour score was recorded in samples containing 100% sorghum flour (7.21).

The scores of appearance as given in Table (8) was found to range from 6.14 to 8.50. The highest score was recorded in cake containing 15% sorghum flour, while cake containing 100% barley flour had the lowest appearance score.

The scores of overall acceptability as given in Table (8) was found to range from 7.10 to 8.40 in cake samples.

The organoleptic scores suggested that the panelists in this study found all the samples to be acceptable.

**Table 8: Sensory evaluation and standard deviation (SD) of of cake samples.**

| Content / formula | Taste | Color | Texture | Flavour | Appearance | Overall acceptability |
|---|---|---|---|---|---|---|
| Control (100 % wheat flour) | 8.57±0.98 | 8.57±1.13 | 8.21±1.41 | 8.43±1.27 | 8.21±1.15 | 8.40±1.05 |
| 15 % barley flour | 8.14±1.57 | 8.14±1.68 | 7.57±2.15 | 7.86±1.86 | 6.86±2.41 | 7.71±1.73 |
| 20 % " " | 8.43±1.81 | 7.79±2.12 | 7.43±2.44 | 8.00±1.92 | 7.42±2.51 | 7.81±2.08 |
| 25 % " " | 7.86±1.46 | 8.36±1.49 | 7.86±1.77 | 7.71±1.80 | 8.00±2.24 | 7.96±1.69 |
| 30% " " | 8.00±1.41 | 7.71±1.25 | 7.79±1.52 | 7.71±1.25 | 7.50±1.89 | 7.74±1.38 |
| 35 % " " | 8.21±1.52 | 7.86±1.22 | 7.71±1.60 | 8.21±1.35 | 8.07±1.64 | 8.01±1.36 |
| 40 % " " | 8.00±1.15 | 8.14±1.46 | 8.36±1.18 | 8.43.±1.13 | 8.14±1.07 | 8.21±0.95 |
| 100 % " " | 7.14±1.35 | 8.00±1.41 | 6.86±1.95 | 7.86±2.04 | 6.14±14 | 7.20±1.55 |
| 15% sorghum flour | 8.50±1.19 | 8.00±1.53 | 8.36±1.18 | 8.43±1.13 | 8.50±14 | 8.40±1.22 |
| 20 % " " | 7.71±1.70 | 7.79±1.22 | 8.57±1.39 | 7.86±1.68 | 7.79±1.73 | 7.77±1.54 |
| 25 % " " | 7.86±1.34 | 7.791.08± | 7.71±1.98 | 8.00±1.41 | 8.07± 0.73 | 7.93±0.94 |
| 30 % " " | 8.50±1.38 | 8.50±1.19 | 7.93±0.73 | 8.14±1.77 | 8.14±1.07 | 8.21±1.18 |
| 35% " " | 7.79±1.35 | 8.07±1.64 | 7.50±1.07 | 7.64±1.11 | 8.29±1.25 | 7.86±1.24 |
| 40 % " " | 8.00±1.00 | 7.93±1.54 | 7.93±1.97 | 8.36±0.95 | 8.21±1.08 | 8.08±1.19 |
| 100% " " | 6.71±1.97 | 7.86±1.68 | 6.71±2.22 | 7.21±0.99 | 7.00±2.16 | 7.10±1.58 |

**Sensory evaluation of the biscuits:**

The sensory quality of the studied biscuit samples as influenced by the incorporation of either barley or sorghum flour is shown in Table (9). Adding barley or sorghum flour to biscuit formulas as flour substitutes resulted in no significant differences (P<0.01) in the sensory characteristics (taste, color, texture, flavour, appearance and overall acceptability ) of the biscuits

Data in Table (9) indicated that taste scores of samples ranged from 5.50 to 8.19. The highest taste score was recorded in samples containing 15% sorghum flour, while cake containing 100% barley flour had the lowest taste score.

The scores of color as given in Table (9) was found to range from 5.94 to 7.94 for samples. The highest score was recorded for samples containing 15% sorghum flour.

Texture scores of samples ranged from 6.19 to to 8.25 and flavour scores of samples ranged from 5.88 to 7.87.

The scores of appearance as given in Table (9) was found to range from 6.13 to 8.06 The highest score was recorded in biscuits containing 15% sorghum flour, while biscuits containing 25% barley flour had the lowest appearance score.

The scores of overall acceptability as given in Table (9) was found to ranged from 6.15 to 7.98 in biscuit samples.

The organoleptic scores suggested that the panelists in this study found all the samples to be acceptable.

**Table 9: Sensory evaluation and standard deviation (SD) of biscuit samples.**

| Content / Formula | Taste | Color | Texture | Flavour | Appear-Ance | Over all acceptability |
|---|---|---|---|---|---|---|
| Control (100 % wheat flour) | 7.00±2.93 | 7.19±2.48 | 7.88±1.64 | 7.63±2.20 | 7.81±1.65 | 7.50±1.89 |
| 15 % barley flour | 6.38±1.60 | 6.75±1.58 | 7.25±1.04 | 5.88±1.46 | 6.63±1.06 | 6.58±1.19 |
| 20 % " " | 7.38±0.92 | 7.38±1.19 | 7.31±1.53 | 6.94±1.52 | 7.19±0.84 | 7.24±0.82 |
| 25 % " " | 6.38±1.20 | 6.56±2.16 | 6.19±1.96 | 5.94±1.74 | 6.13±1.89 | 6.24±1.84 |
| 30% " " | 7.31±0.96 | 7.63±0.92 | 8.31±0.70 | 7.87±0.64 | 8.00±0.54 | 7.83±0.58 |
| 35 % " " | 7.81±1.13 | 7.56±0.62 | 8.06±0.78 | 7.50±1.31 | 7.75±1.04 | 7.74±0.72 |
| 40 % " " | 7.56±1.29 | 7.63±0.92 | 7.50±1.07 | 7.12±0.99 | 7.50±1.07 | 7.46±0.91 |
| 100 % " " | 5.50±2.51 | 5.94±2.04 | 6.31±2.22 | 6.81±1.85 | 6.19±2.17 | 6.15±1.88 |
| 15% sorghum flour | 8.19±0.92 | 7.94±0.94 | 7.94±1.08 | 7.75±1.39 | 8.06±0.86 | 7.98±0.82 |
| 20% " " | 7.63±1.06 | 7.69±0.80 | 7.88±0.99 | 7.75±0.89 | 7.81±0.75 | 7.75±075 |
| 25 % " " | 6.75±2.25 | 7.19±1.56 | 7.63±1.06 | 6.63±2.07 | 7.44±0.98 | 7.13±1.44 |
| 30 % " " | 7.00±1.85 | 7.50±1.20 | 8.25±0.89 | 7.06±1.78 | 7.81±1.00 | 7.53±1.21 |
| 35% " " | 6.75±2.38 | 7.50±1.31 | 7.81±1.13 | 6.94±2.11 | 7.06±1.61 | 7.21±1.61 |
| 40 % " " | 6.75±2.38 | 7.06±1.61 | 7.38±1.69 | 7.13±2.23 | 7.75±1.46 | 7.21±1.79 |
| 100% " " | 6.75±2.25 | 7.19±1.69 | 6.94±1.74 | 6.44±1.95 | 7.00±1.85 | 6.86±1.78 |

## Conclusion:

The present investigation clearly suggests that barley and sorghum flour could be successfully used as flour substitutes. The produced cakes and biscuits proved to be of high quality and were generally acceptable as judged by a consumer taste panel.. Sensory evaluation showed that acceptable cakes and biscuits can be made with any of the flour substitutes used in this study. Also, it is suggested that the replacement of up to 40% levels of the flour substitutes lead to production of high quality cakes and biscuits comparable to that of control.

## REFERENCES


A.O.A.C. (1995). Association of Official Analytical Chemists Official Methods of Analysis. 16th Ed. A.O.A.C. International Washington, DC. U.S.A.229.

Badi., S.M. ; Hoseney, R. C and Casady , A.J .(1976).Pearl millet 1. Characterisation by SEM , amino acid analysis ,lipid compsition and prolamine solubility .Cereal Chem 53 : 478 -487 .

Campbell, A.M.; Penfield, M.P. and Griswold, R.M. (1979). Evaluating food by objective methods. Page 475 in: The experimental study of food 2nd ed. Houghton Mifllin. Dallas, Tx. USA.

Daniel, A.R. (1978). Cake-making methods, faults, mistakes and recipe balancing. Page 202 in: up-to-date confectionery. Appl. Sci. Pub. Ltd.

Dench, J.E. (1982). Extraction of nitrogenous material from winged bean (*Psophocarpus tetragonolopus L.*) flour and the preparation and properties of protein isolates. J. Sci. Food Agric., 33: 173-184.

FAO/ WHO/ UNICEF (1969): Protein Advisory Croup. The Australian Milk Biscuits. PAG Metting Doc. 2.7/ 4 : 1.

Greenfield, H. and Southgate, D.A.T.(1992). Food Composition Data: Production, Management and Use. Barking, UK: Elsevier Applied Science

Hart, M .R .;Graham, R. P;Gee, M. and Morgan, Jr. A.I. (1970). Bread from sorghum and barley flours. J. Food. Sci. 35: 661 – 661.

Hulse, J.H.; Rachie, K.O. and Billingsley, L.W. (1977). Nutritional standards and methods of evaluation for food legume breeders. International Development Research Center, Postal Address: Box 8500, Ottawa, Canda, Head Office: 60 Queen street, Ottawa.

Hulse, J. P.; Laing, E. M. and Pearson, O.E. (1980). Sorghum and millets: their composition and nutritive value. Academic Press, UK. P. 404.

Jones, L.J. and Tung, M.A. (1983). Functional properties of modified oil seed protein concentrates and isolates. Can. Inst. Food Sci. Technol. J., 16: 57-62.

Kalra,S.and Jood , S. (2000). Effect ofdietary barley B-glucan on cholesterol and lipoprotein fraction in rats .Journal of Cereal Science ,31 , 141-145 .

Kinsella, J.E.; Damodaran, S. and German, B. (1985). Physico-chemical and functional properties of oil seed protein with emphasis on soy proteins. In: New protein foods, Vol. 5, seed storage protein, Ed. A.M. Altschul and H.L. Wilcke, Academic Press Inc., London, New York, pp. 107-179.

Lin, M.J.Y.; Humbert, E.S. and Sosulski, F.W. (1974). Certain functional properties of sunflower meal products. J. Food Sci., 39: 368-370.

Manely, D. (1991). Technology of Biscuits, crackers and cookies. Ellis Horwood Ltd., Chichester, UK.

Manohor , R. S. and Roa , P . H . (1997 ) : Effect of mixing period and additives on the rheological characteristics of doug and quality of biscuits . J .of Cereal Science ,25 :197- 206 .

Moskowitz, H.A. (1974). Sensory evaluation by magnitude estimation. J. Food Technol. 28: 16.

Palmer, H.H. (1982). Eggs. In "Food Theory and Applications", p. 527. John Wiley and Sons, Inc., New York, USA.

Ragaee, S. and Abdel-Aal, E. M. (2006). Pasting properties of starch and protein in selected cereals and quality of their food products. Food Chemistry,
95: 9 – 18.

Riaz, M. N. (1999). Healthy baking with soy ingredients.Cereal Foods World ,44,
136-139.

Rosenthal, A.J. (1995). Application of aged egg in enabling increased substitution of sucrose by Litesse (Polydextrose) in high-ratio cakes J. Sci. Food Agric., 68: 127.

SAS (1994). SAS Users, guide statistics. SAS Institute Inc., Cary, NC.

Schober, T.; Messerschmidt, M.; Bean S. and Arendt, S. H. (2005). Gluten-free bread from sorghum: quality differences among hybrids. Cereal Chemistry. 82(4): 394 - 404

Tsen, C. C., Peters, E. M., Schaffer, T. and Hoover, W. J. (1973): High Protein Cookies. 1. Effect of Soy fortification and surfactants. Bakers, Digest, 47 (4) :34.

Vatsala ,F .N . and Roa , P . H . (1991 ) : Studies on invert syrup for use in biscuits .J . of food Sci . and Technology ,28 :149-152 .

Yakobe (1980). Review of analytical laboratory of dough and bread technology, Blovdev, VEXVI, Fotoofcet, 105.

# دراسات على تدعيم بعض منتجات الخبز بدقيق الشعير والذرة الرفيعة

**سناء الشريف ومحمد نجيب قناوى**
**قسم علوم الأغذية – كلية الزراعة جامعة المنيا – المنيا–مصر**

أجريت هذه الدراسة لمحاولة استخدام خلطات من دقيق الشعير أوالذرة الرفيعة مع دقيق القمح فى إنتاج الكيك والبسكويت. وتم إضافة دقيق الشعير أوالذرة الرفيعة فى الخلطات عند مستويات 15 ، 20 ، 30 ، 35 ، 40 ، 100 %).

وقد أظهرت نتائج دراسة الخواص الطبيعية للدقيق ارتفاع قيمة الكثافة الحجمية (BD ) لدقيق القمح.. وأدى إضافة دقيق الذرة الرفيعة أوالشعير إلى انخفاض الكثافة الحجمية.

وتبين من دراسة سعة امتصاص الماء (WAC) أن دقيق القمح أقل مقدرة على امتصاص الماء ( 202.89 مم ماء / 100جم عينة ) وزيادة سعة امتصاص الماء بإضافة كل من دقيق الشعير أوالذرة الرفيعة.. أما بالنسبة لسعة امتصاص الزيت (OAC) فقد أعطى دقيق الشعير أعلى قيمة فى هذه الصفة يليه دقيق الذرة الرفيعة مقارنة بدقيق القمح.وعند دراسة الوزن النوعى لعجائن الكيك تراوحت قيمته بين 0.92 – 0.97 وكان الوزن النوعى للعجينة المحتوية على دقيق القمح أعلى قيمة. وأدى إضافة كل من دقيق الشعير أوالذرة الرفيعة إلى زيادة مسامية الكيك مقارنة بالكنترول.

وقد أدى خلط دقيق الشعير أو الذرة الرفيعة إلى تحسين قدرة دقيق القمح على امتصاص كل من الماء والزيت .. كما وجد أن هناك علاقة عكسية بين الكثافة الحجمية وامتصاص الزيت.

وقد أشارت النتائج إلى أن التركيب الكيميائى للكيك على النحو التالى :

الرطوبة ( 12.92 – 16.6% ) ، البروتين ( 8.87 – 10.51%) ، الدهون ( 21.66 – 24.00 % ) ،الكربوهيدرات ( 63.86 – 67.11 % )

وتراوحت قيمة الطاقة الكلية للكيك بين 487.9 – 495.55 سعر حرارى / 100جم على أساسالوزن الرطب.

وكان التركيب الكيميائى لعينات البسكويت على أساس الوزن الجاف على النحو التالى :

الرطوبة ( 1.37 – 2.27 % ) ، البروتين ( 6.96 – 8.14 % ) ، الدهون ( 14.66 – 16.52 % ) ، والكربوهيدرات ( 63.86 – 67.11 % ).

بينما كانت الطاقة الكلية 466.15 – 475.22 سعر حرارى/ 100جم على أساس الوزن الرطب.

وأكدت الاختبارات الحسية عدم وجود فروق معنوية بين العينات فى كل من الكيك والبسكويت مع القابلية الحسية لجميع العينات المستخدمة.

وأثبتت النتائج أن استخدام دقيق الشعير أوالذرة الرفيعة كبدائل لدقيق القمح يؤدى إلى إنتاج كيك وبسكويت ذو جودة وقيمة غذائية وصحية عالية مع تكلفة منخفضة.

**قام بتحكيم البحث**

| | |
|---|---|
| **أ.د / مسعد عبد العزيز أبو رية** | **كلية الزراعة – جامعة المنصورة** |
| **أ.د / موسى سالم موسى** | **كلية الزراعة – جامعة طنطا** |