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# FORMULATION AND EVALUATION OF SOME HIGH FIBER PRODUCTS

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## ABSTRACT

The growing consumer demand for food with good nutritional and sensory quality has called for research to develop products using untraditional materials. Rice bran (by-product of rice milling industry) could be utilized as a source of dietary fiber. Wheat flours (82% and 72% extractions) were substituted with different levels of rice bran, *i.e.,* 5%, 10% and 15% to produce pan bread and salted biscuits. The chemical composition of raw materials and different substituted bakery products, physical properties, sensory characteristics, mineral contents, total phenolic compounds, antioxidant activity, nutritional and biological values of these bakery products were evaluated.

The obtained results indicated that rice bran could be considered as a good source of crude fiber and total dietary fiber. Total dietary fiber increased by 1.1, 1.4 and 1.6 folds for pan bread samples substituted with rice bran at levels of 5%, 10% and 15%, respectively, and the increment percentages ranged from 50.31% to 135.49% for salted biscuits samples substituted with rice bran compared with control samples. Chemical composition, physical properties and sensory evaluation of both pan bread and salted biscuits samples revealed that, the level of 10% rice bran was found to be the best replacement level without any adverse effects on physical and sensory attributes of bakery products. The presence of rice bran in substituted pan bread and salted biscuits caused an increase in all mineral contents. One serving of pan bread and salted biscuits equivalent to 100g containing 10% rice bran can be considered nutritious in terms of total dietary fiber, calorific value, phenolic contents and showed an antioxidant activity. Amino acids scores, protein efficiency ratio and biological value of bakery products were also improved by substitution with rice bran.

It can be recommended that using composite flour should be encouraged to make economic use of local raw materials and to produce high quality food products for people with special health conditions such as diabetics and elevated serum cholesterol subjects.

***Key words:*** *biological value, nutritive value, pan bread ,rice bran,total dietary fiber, salted biscuits*

## 1. INTRODUCTION

Dietary fiber intake could be easily increased by selecting food naturally high in fiber. Baked products with various high fiber additives such as biscuits, cookies, cakes and pan cake mixes have been produced to satisfy consumer demands for high fiber content in foods without sacrificing sensory quality. Egypt has been the largest rice producer in the Middle East region, averaging rough rice production of 6.812 million tons and milled rice production of 4.850 million tons in 2013, which is expected to reach in 2014 about 7.536 and 5.200 million tons for rough and milled rice productions, respectively (USDA, 2013).

Rice bran, the secondary product of rice milling industry, which contained a germ and an outer layer could be considered a rich source for nutritional components such as dietary fibers, phytic acids, vitamins B and E, γ-oryzanol and gamma amino butyric acid (GABA) compared to the ordinary rice grains. These bio-functional components were found to be in the germ and bran layers. Defatted rice bran contained 13.89% crude protein, 1.92% ether extract, 10.13% ash, 12.43% moisture, 6.03% crude fiber and 55.60% carbohydrates (Champagne *et al.,* 2004 and Jiamyangyuen *et al.*, 2005).

Dietary fiber has been shown to have important health implications in the prevention risk of chronic diseases such as cancer, cardiovascular diseases and diabetes. Dietary fiber has the ability to bind with bile acids and prevents its re-absorption in the liver, thus inhibit cholesterol synthesis. Dietary fiber's viscous and fibrous structure could control the release of glucose with time in the blood, thus helping in the proper control and management of diabetes and obesity (Brownlee, 2011 and Phillips, 2011).

Among different value added food systems, baked foods, i.e., bread, cookies, biscuits and cakes have been consumed worldwide relatively on large scale and provide an excellent opportunity to incorporate food–grade fractions from grains, legumes or other non–traditional food sources (Siddiq *et al.*,2009).

This study was designed to produce healthy pan bread and salted biscuits substituted with rice bran as a high fiber source at different replacement levels of wheat flour, *i.e*., 5%, 10% and 15%, respectively, and evaluate the chemical composition, physical properties and sensory attributes of these products to assess the best level of rice bran addition. Antioxidant activity, phenolic compounds, nutritional and biological values of these products were also evaluated.

## 2. MATERIALS AND METHODS

### 2.1. MATERIALS

Stabilized defatted rice bran (*Oryza sativa*, variety Sakha 101) was obtained from Delta Company for Rice Milling, New Damietta, Damietta Governorate, Egypt. Wheat flour (*Triticum vulgare*) 82% and 72% extractions, sugar, fats, salt, dry yeast, milk powder and improvers were bought from local market, Giza, Egypt. All chemicals and reagents used were purchased from Sigma Chemical Company (St. Louis, MO, USA).

### 2.2. METHODS

#### 2.2.1. Preparation of pan bread

Wheat flour (82% extraction) replaced with different levels of rice bran (5%, 10% and 15%) was used for the preparation of pan bread samples. The conventional straight dough process for pan bread was performed according to the routine method of the Egyptian Baking Technology Center, Giza, Egypt. The ingredients used included 100g wheat flour, 5g sugar, 5g margarine, 1g salt, 1.5g active dry yeast, 2g milk powder and 1g improvers. The ingredients were mechanically mixed for 12 min., then the dough was left to ferment for 2 hrs, then the dough was divided into equal parts of about 165g pieces, rested for 2 hrs for final fermentation, then made into loaves. The loaves were baked at 220°C for 15 min. in the baker house, all loaves were packaged in polyethylene bags after cooling and kept for analysis.

#### 2.2.2. Preparation of salted biscuits

Wheat flour (72% extraction) replaced with different levels of rice bran (5%, 10% and 15%) was used for the preparation of salted biscuit samples. Biscuit samples were prepared according to the method described in A.A.C.C. (2002). The ingredients used included 100g wheat flour, 15g margarine, 0.5g baking powder, 5g salt, 1g vanillin and 30 ml water. The dough was allowed to ferment for about 3 hr at 30°C. Biscuits were baked in continuous band oven at 230°C for 10 to 15 min. Biscuit samples were packaged in polyethylene bags after cooling and kept for analysis.

#### 2.2.3. Chemical analysis of raw materials, pan bread and salted biscuit samples

Pan bread and salted biscuit samples were dried in an oven for 24 hr at 60°C and ground to pass through a 20 mesh sieve, stored in air tight containers and kept in a freezer until analysis. Wheat flours (82% and 72% extractions), rice bran, pan bread and salted biscuits were analyzed for moisture, crude protein, crude fiber, ether extract and crude ash using the methods described in A.O.A.C. (2005). Total carbohydrates were calculated by difference. Total dietary fiber, soluble and insoluble dietary fiber contents were determined according to the method described by Asp *et al.* (1983). Mineral contents were determined in the samples using a Perkin Elmer Optima 2100 DV model (Shalton, USA) coupled with plasma spectrometer according to Barnes (1997). Total phenolic compounds were determined according to Singelton *et al.* (1999) using gallic acid as standard and the results expressed as mg gallic acid equivalent/100g. Total antioxidant activity of the tested samples against stable 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay was performed according to the method described by Karioti *et al.* (2004). Amino acids were determined using a high performance analyzer system (automatic amino acid analyzer), 7300 Beckman, HPLC according to the method described by Becker *et al.* (1981). Tryptophan was chemically determined by the method of Miller (1967).

#### 2.2.4. Physical properties of pan bread and salted biscuits

Weight of the tested samples was recorded by using sensitive balance (0.1g). Volumes were measured using rapeseed displacement method and specific volumes were calculated using the following equation: Specific volume ($cm^3/g$) = volume ($cm^3$) / weight (g). Density was calculated using the following equation: Density ($g/cm^3$) = weight (g) / volume ($cm^3$). All physical properties were measured according to the methods of A.A.C.C. (2002).

**2.2.5. Nutritive value of pan bread and salted biscuits**

The nutritive value of 100g tested samples as a source of dietary fiber was calculated considering the average Dietary Reference Intake (%DRI) for adults of dietary fiber as 25g dietary fiber/day/2000K.cal diet (Federal Register, 1993). Pan bread and salted biscuit samples could be classified as dietary fiber according to the categories proposed by Philippi (2008) to: food source (contains more than 5% of DRI of dietary fiber in a usual serving), good food source (contains between 10% and 20% of the DRI in a usual serving) and excellent food source (contains more than 20% of the DRI in a usual serving). The calorific value was calculated using the following equation: Calorific value = (% carbohydrate × 4.1) + (% protein × 4.1) + (% fat × 9.1), according to James (1995).

**2.2.6. Biological evaluation of pan bread and salted biscuits**

**1. Amino acid score**

The chemical score of the protein was calculated by expressing the amount of each essential amino acid of the tested material as percentage of the content of the same individual amino acid in reference protein of FAO/WHO pattern (FAO/WHO, 2008).

**Amino acid score =**

$$\frac{\text{g of amino acid in tested material} \times 100}{\text{g of amino acid in the FAO/WHO refernce}}$$

**2. Protein efficiency ratio (PER)**

PER value was calculated according to the following regression equation proposed by Alsmeyer *et al.* (1974) as follows: PER = 0.684 + 0.456 (Leucine) – 0.047 (Proline).

**3. Biological value**

Biological value of the tested samples was calculated according to the equation reported by Mitchell and Block (1946) as follows: Biological value (%) = 49.4 + 10.53 (PER).

**2.2.7. Sensory evaluation of pan bread and salted biscuits**

Sensory evaluation of the tested pan bread and salted biscuit samples was carried out by ten trained panelists from Special Food and Nutrition Department, Food Technology Research Institute, Giza, Egypt. Pan bread samples were evaluated for appearance (10), color of crust (15), color of crumb (15), distribution of crumb (15),taste (15), homaganity (15) and odor (15) according to Meilgaard *et al.* (2007). Salted biscuit samples were evaluated for appearance (10), color (15), thickness (15), crispiness (15), shrinkage (15), taste (15) and odor (15) according to Smith (1972).

**2.2.8. Statistical analysis**

The standard analysis of variance procedure in a completely randomized design was applied for the present data according to Gomez and Gomez (1984). Least significant difference test (LSD) was done. The level of statistical significance was set at $p < 0.05$ .

## 3. RESULTS AND DISCUSSION

**3.1. Chemical composition of raw materials**

The chemical composition of wheat flours (82% and 72% extractions) and rice bran is shown in Table (1). It could be noticed that rice bran contained the highest crude protein, ether extract, crude fiber and ash compared with wheat flours (82% and 72% extractions). Total

**Table (1): Chemical composition of wheat flours and rice bran (% dry weight basis).**

| Constituents | Wheat flour (82% extraction) | Wheat flour (72% extraction) | Rice bran |
|---|---|---|---|
| Moisture | 12.63 ± 0.17 | 11.78 ± 0.13 | 9.02 ± 0.64 |
| Crude protein | 12.49 ± 0.13 | 11.15 ± 0.10 | 13.83 ± 0.14 |
| Ether extract | 0.98 ± 0.20 | 1.38 ± 0.30 | 1.41± 0.27 |
| Crude fiber | 0.82 ± 0.41 | 0.71 ± 0.33 | 8.36 ± 0.83 |
| Total dietary fiber | 3.08 ± 0.21 | 2.92 ± 0.10 | 19.35 ± 0.36 |
| Insoluble dietary fiber | 2.07 ± 0.09 | 1.95 ± 0.12 | 12.64 ± 0.15 |
| Soluble dietary fiber | 1.01 ± 0.06 | 0.97 ± 0.05 | 6.71± 0.10 |
| Ash | 0.92 ± 0.10 | 0.56 ± 0.06 | 8.64 ± 0.33 |
| *Total carbohydrates | 84.79 ± 2.25 | 86.20 ± 2.69 | 67.76 ± 2.12 |

*Total carbohydrates = 100 - (% protein + % fat + % fiber + % ash).

dietary fiber content had the highest values in rice bran (19.35 ± 0.36%) compared with wheat flours as well as insoluble and soluble dietary fibers. However, total carbohydrates were lower than those in wheat flours,these results indicated that rice bran could be considered as a good source of crude fiber and total dietary fiber. It also contained considerable amount of crude protein. These results demonstrated the potential use of rice bran in the production of bakery products. The present results are in good agreement with the results of Doweidar *et al.* (2010) for wheat flour and Hamid *et al.* (2007) for rice bran.

### 3.2.Chemical composition of different substituted pan bread samples

Pan bread samples prepared by replacement of wheat flour (82% extraction) with rice bran at different levels (5%, 10% and 15%) were chemically analyzed and the results are shown in Table (2). The results indicated that the moisture contents of pan bread samples substituted with rice bran were higher than that of pan bread made from 100% wheat flour (control). Addition of rice bran to wheat flour (82% extraction) increased protein content of different substituted pan bread samples and the higher the level of rice bran in the bread sample, the higher the protein content. As the amount of rice bran was increased in the flour mixtures, crude fat present in their pan bread was increased in comparison with the control pan bread (100% wheat flour). The crude fiber and ash contents of pan bread samples substituted with rice bran were high compared with the control pan bread sample. Increasing the amount of rice bran in the flour mixtures caused a gradual increase in crude fiber and ash contents in pan bread samples. On the contrary, total carbohydrates decreased as the substitution levels of rice bran increased. It could be noticed that the total dietary fiber, soluble and insoluble dietary fibers were increased in pan bread samples as a result of substitution with different levels of rice bran. Total dietary fiber content increased from 3.37 ± 0.14% (control pan bread) to 5.45 ± 0.63% (pan bread sample containing 15% rice bran). Total dietary fiber increased by 1.1, 1.4 and 1.6 folds for pan bread samples substituted with 5%, 10% and 15% rice bran, respectively, compared with the control sample. Bread as processed cereal products seemed to be a part of the daily diet for most people. These products are low in fat and good sources of complex carbohydrates but they are not good sources of dietary fiber, in particular, soluble fiber (Anderson *et al.*, 1999). The obtained results indicated that rice bran could be considered as a rich source of total dietary fiber, soluble fiber and ash in pan bread making. Addition of rice bran to wheat flour increased the contents of protein, lysine and dietary fiber in bread and cookies proportionately to the level of substitution (Sharma and Chauhan, 2002).

**Table (2): Chemical composition of different substituted pan bread samples (% dry weight basis).**

| Constituents | Control pan bread (100% wheat flour) | Pan bread samples substituted with rice bran | | |
|---|---|---|---|---|
| | | 5% Rice bran | 10% Rice bran | 15% Rice bran |
| Moisture | 33.62 ± 1.24 | 35.42 ± 1.13 | 36.53 ± 1.10 | 38.12 ± 1.12 |
| Crude protein | 12.14 ± 0.16 | 12.83 ± 0.10 | 13.52 ± 0.16 | 14.14 ± 0.15 |
| Ether extract | 1.85 ± 0.63 | 1.96 ± 0.13 | 2.25 ± 0.10 | 2.63 ± 0.16 |
| Crude fiber | 1.12 ± 0.52 | 1.62 ± 0.15 | 1.92 ± 0.17 | 2.15 ± 0.11 |
| Total dietary fiber | 3.37 ± 0.14 | 3.95 ± 0.61 | 4.76 ± 0.16 | 5.45 ± 0.63 |
| Insoluble dietary fiber | 2.26 ± 0.21 | 2.65 ± 0.24 | 3.19 ± 0.13 | 3.65 ± 0.22 |
| Soluble dietary fiber | 1.11 ± 0.09 | 1.30 ± 0.10 | 1.57 ± 0.13 | 1.80 ± 0.15 |
| Ash | 1.77 ± 0.08 | 2.19 ± 0.11 | 2.63 ± 0.16 | 3.06 ± 0.11 |
| *Total carbohydrates | 83.12 ± 1.67 | 81.40 ± 1.31 | 79.68 ± 1.23 | 78.02 ± 1.62 |

***Total carbohydrates = 100 - (% protein + % fat + % fiber + % ash).**

### 3.3. Physical properties of different substituted pan bread samples

Different prepared pan bread samples were subjected to some physical measurements including: weight, volume, density and specific volume of the loaves (Table 3). The obtained results indicated that as the substitution levels of rice bran increased, weight and density of pan bread increased. On the other hand, volume and specific volume of pan bread loaves were significantly decreased with the increase of rice bran addition. The changes in the loaves volume may be due to the change in the quality and quantity of protein as a result of rice bran addition. Specific volume is a very important characteristic as it measures the loaf density, the lower the specific volume the more density and compact of the bread. The greater rising volume

**Table (3): Physical properties of different substituted pan bread samples.**

| Pan bread samples | Weight (g) | Volume (cm3) | Specific volume (cm3/g) | Density (g/cm3) |
|---|---|---|---|---|
| Control pan bread | 137.63d | 327.25a | 2.38a | 0.421d |
| 5% Rice bran | 139.15c | 321.75b | 2.31b | 0.432c |
| 10% Rice bran | 141.35b | 319.12c | 2.26c | 0.443b |
| 15% Rice bran | 146.30a | 313.50d | 2.14d | 0.467a |
| L.S.D. | 1.26 | 2.46 | 0.036 | 0.006 |

Numbers in the same column with the different letters are significantly different at $p < 0.05$

for control pan bread sample over the substituted pan bread samples probably resulted from the higher ability of gluten to trap carbon dioxide gas liberated during baking (Nielson, 2002).

### 3.4. Chemical composition of different substituted salted biscuit samples

Salted biscuit samples prepared by replacement of wheat flour (72% extraction) with different levels of rice bran (5%, 10% and 15%) were analyzed and the results are presented in Table (4). The results revealed that addition of rice bran to wheat flour increased protein content of different substituted salted biscuits and the higher the level of rice bran in biscuit sample, the higher the protein content.

It could be also noticed that the total dietary fiber, insoluble and soluble dietary fibers increased in all salted biscuit samples as a result of substitution with different levels of rice bran. The increment percentages of total dietary fiber ranged from 50.31% to 135.49% for different substituted salted biscuit samples compared with the control sample (100% wheat flour). Addition of different levels of rice bran also increased soluble and insoluble dietary fiber contents. The obtained results are in accordance with the results reported by Emperatriz (2005), who found that the content of total dietary fiber of pizza dough increased as the substitution level of stabilized rice bran flour increased.

**Table (4): Chemical composition of different substituted salted biscuit samples (% dry weight basis).**

| Constituents | Control salted biscuits (100% wheat flour) | Salted biscuits substituted with rice bran | | |
|---|---|---|---|---|
| | | 5% Rice bran | 10% Rice bran | 15% Rice bran |
| Moisture | 5.43 ± 0.16 | 6.21 ± 0.13 | 6.64 ± 0.19 | 6.87 ± 0.17 |
| Crude protein | 11.06 ± 0.11 | 11.75 ± 0.11 | 12.43 ± 0.13 | 13.15 ± 0.17 |
| Ether extract | 6.74 ± 0.10 | 6.90 ± 0.13 | 7.52 ± 0.10 | 7.84 ± 0.13 |
| Crude fiber | 0.83 ± 0.05 | 1.44 ± 0.03 | 2.67 ± 0.08 | 2.91 ± 0.09 |
| Total dietary fiber | 3.24 ± 0.10 | 4.87 ± 0.90 | 6.35 ± 0.70 | 7.63 ± 0.31 |
| Insoluble dietary fiber | 2.17 ± 0.07 | 3.48 ± 0.11 | 4.64 ± 0.17 | 5.74 ± 0.25 |
| Soluble dietary fiber | 1.07 ± 0.12 | 1.39 ± 0.16 | 1.71 ± 0.14 | 1.89 ± 0.17 |
| Ash | 1.13 ± 0.06 | 1.52 ± 0.13 | 2.03 ± 0.16 | 2.44 ± 0.11 |
| *Total carbohydrates | 80.24 ± 1.85 | 78.39 ± 2.31 | 75.35 ± 1.63 | 73.66 ± 1.45 |

*Total carbohydrates = 100 - (% protein + % fat + % fiber + % ash).

Increasing rice bran substitution to wheat flour caused a slight increase in fat content of salted biscuits samples. Fat is a vital ingredient in baked goods, providing flavor and taste as well as contributing to texture, tenderness and appearance of the products (Zoulias *et al.*, 2000). The results showed similar trend for crude fiber and ash contents of salted biscuits as that of protein. On the contrary, total carbohydrates were decreased as the substitution levels of rice bran increased. Dietary fiber from rice bran exhibited higher water and fat binding capacities and hydro-colloidal fibers have the ability to create a tridimensional matrix, holding not only water but also fat added to the formula, avoiding losses of fat and water during baking (Hamid and Luan, 2000).

### 3.5. Physical properties of different substituted salted biscuit samples

Data presented in Table (5) showed that all measured physical properties of the tested salted biscuit samples showed significant differences from the control. The results indicated that as the substitution levels of rice bran increased, weight and density of salted biscuits increased. Volume and specific volume were significantly decreased with the increase in rice bran addition. The highest increase in weight and density of salted biscuits was achieved by substitution with rice bran at the levels of 15% and 10%, respectively, compared with the control biscuit (100% wheat flour). The increase in weight of the substituted biscuit samples might be attributed to the high level of fibers in rice bran used for substitution, which increased water absorption and affected weight of the samples (Mahfouz *et al.*, 2007). The reduction of volume and specific volume might be due to the influence of rice bran replacing levels on gluten dilution of wheat flour which cause a reduction in the gluten strength and consequently on the net-work formed (Hafez, 2004).

**Table (5): Physical properties of different substituted salted biscuit samples.**

| Salted biscuits samples | Weight (g) | Volume (cm3) | Specific volume (cm3/g) | Density (g/cm3) |
|---|---|---|---|---|
| Control salted biscuits | 12.16d | 30.46a | 2.50a | 0.399d |
| 5% rice bran | 13.84c | 26.23b | 1.89b | 0.528c |
| 10% rice bran | 15.08b | 21.67c | 1.44c | 0.696b |
| 15% rice bran | 15.96a | 19.55d | 1.22d | 0.816a |
| L.S.D. | 0.75 | 2.08 | 0.19 | 0.09 |

Numbers in the same column with the different letters are significantly different at $p < 0.05$

### 3.6. Sensory evaluation of different substituted pan bread samples

Data presented in Table (6) showed the sensory evaluation of different substituted pan bread samples with different levels of rice bran. There were insignificant differences for crust color, crump color, homogenits, taste odor and overall acceptability between 5% and 10% rice bran substituted pan bread samples, while appearance and crump distribution were significantly different. There were insignificant differences for appearance between the control pan bread sample and 10% rice bran substituted pan bread sample and between control sample and 5% rice bran substituted pan bread sample for crump distribution characteristics. Substitution with rice bran at levels of 5% and 10% in pan bread making caused an improvement in odor of produced pan bread, while 15% rice bran substituted sample recorded the lowest scores for all sensory attributes and was significantly different compared with all other treatments. There was insignificant difference between 5% and 10% rice bran substituted pan bread samples for overall acceptability scores. The highest overall acceptability scores were recorded for the control pan bread, followed by either 5 % or 10% rice bran substituted pan bread samples, while 15% rice bran substituted pan bread sample recorded the lowest overall acceptability score.

### 3.7. Sensory evaluation of different substituted salted biscuit samples

Sensory evaluation of different substituted salted biscuit samples with different levels of rice bran was shown in Table (7). There were insignificant differences between 5% and 10% rice bran substituted salted biscuit samples for color and odor attributes. Addition of 15% rice bran to wheat flour caused a significant reduction in all sensory attributes of salted biscuits compared with other treatments. The differences among overall acceptability were more pronounced. There were insignificant differences for salted biscuit samples substituted with 5% and 10% rice bran, while biscuit samples containing 15% rice bran were significantly different compared with other treatments for overall acceptability scores. The lowest overall acceptability score was achieved by using 15% rice bran added to wheat flour. The low acceptability of biscuits from blends containing more than 10% rice bran was attributed to appearance, color and taste. In conclusion, chemical composition, physical properties and sensory evaluation of both pan bread and salted biscuit samples, proved that the level of 10% rice bran was the best level for substitution of wheat flour to produce these bakery products Thus, further studies was concerued with its nutritional and biological values.

### 3.8. Mineral contents of bakery products

Data presented in Table (8) showed the mineral contents of pan bread and salted biscuit samples substituted with 10% rice bran as well as the control sample. The results showed an increase in all mineral contents for both pan bread and salted biscuits substituted with 10% rice bran compared with the control pan bread and control salted biscuits (100% wheat flours of 82% and 72% extractions, respectively). Pan bread samples substituted with 10% rice bran should contribute approximately to about 3%, 9%, 5%, 3%, 64%, 24% and 13% of K, Mg, Ca, Na, Mn, Fe and Zn, respectively, of the Recommended Daily Allowances (RDA) reported by NRC (2010). Salted biscuit samples substituted with 10% rice bran contributed approximately to about 3, 4, 9, 26, 59, 15 and 9 % of K , Mg , Ca, Na, Mn, Fe and Zn, respectively, of the RDA. The present results indicated that the presence of rice bran caused an increase in all minerals in the substituted bakery products and consequently improved the nutritive value of wheat flour. The present

**Table (6): Sensory evaluation of different substituted pan bread samples.**

| Pan bread samples | Appearance (10) | Crust color (15) | Crump color (15) | Crump distribution (15) | Homogenous (15) | Taste (15) | Odor (15) | Overall acceptability (100) |
|---|---|---|---|---|---|---|---|---|
| Control pan bread | $9.1^{a}$ | $14.6^{a}$ | $13.2^{a}$ | $13.1^{a}$ | $14.0^{a}$ | $13.1^{ab}$ | $12.3^{b}$ | $89.4^{a}$ |
| 5% Rice bran | $8.1^{b}$ | $13.1^{b}$ | $12.4^{b}$ | $13.7^{a}$ | $13.6^{b}$ | $13.2^{a}$ | $13.0^{a}$ | $87.1^{b}$ |
| 10% Rice bran | $8.8^{a}$ | $13.6^{b}$ | $12.7^{b}$ | $12.3^{b}$ | $13.5^{b}$ | $13.7^{a}$ | $13.4^{a}$ | $88.0^{b}$ |
| 15% Rice bran | $7.3^{c}$ | $12.1^{c}$ | $11.3^{c}$ | $10.6^{c}$ | $11.5^{c}$ | $12.3^{c}$ | $11.2^{c}$ | $76.2^{c}$ |
| L.S.D. | 0.36 | 0.83 | 0.46 | 0.64 | 0.38 | 0.54 | 0.50 | 1.23 |

**Numbers in the same column with the different letters are significantly different at $p < 0.05$**

**Table (7): Sensory evaluation of different substituted salted biscuit samples.**

| Salted biscuits samples | Appearance (10) | Color (15) | Thickness (15) | Crispiness (15) | Shrinkage (15) | Taste (15) | Odor (15) | Overall acceptability (100) |
|---|---|---|---|---|---|---|---|---|
| Control salted biscuits | $9.1^{a}$ | $13.3^{a}$ | $13.6^{a}$ | $13.2^{a}$ | $13.3^{a}$ | $13.1^{a}$ | $13.6^{a}$ | $89.2^{a}$ |
| 5% Rice bran | $8.0^{c}$ | $12.4^{b}$ | $12.7^{b}$ | $12.8^{b}$ | $12.1^{c}$ | $12.7^{b}$ | $12.1^{b}$ | $82.8^{b}$ |
| 10% Rice bran | $8.6^{b}$ | $12.7^{b}$ | $12.4^{c}$ | $13.3^{a}$ | $12.5^{b}$ | $12.4^{c}$ | $12.6^{b}$ | $84.5^{b}$ |
| 15% Rice bran | $7.3^{d}$ | $11.2^{c}$ | $11.7^{d}$ | $10.5^{c}$ | $11.5^{d}$ | $10.7^{d}$ | $11.0^{c}$ | $73.9^{c}$ |
| L.S.D. | 0.54 | 0.43 | 0.26 | 0.15 | 0.27 | 0.21 | 0.95 | 2.34 |

**Numbers in the same column with the different letters are significantly different at $p < 0.05$**

**Table (8): Mineral contents of bakery products (mg/100g).**

| Mineral contents | Control pan bread | 10% Rice bran pan bread | Control salted biscuits | 10% Rice bran salted biscuits | RDA* |
|---|---|---|---|---|---|
| Potassium (K) | 116.30 ± 10.31 | 157.13 ± 9.12 | 136.11 ± 10.25 | 183.14 ± 11.12 | 4700 |
| Magnesium (Mg) | \20.32 ± 1.63 | 36.25 ± 1.72 | 11.65 ± 1.41 | 17.16 ± 1.53 | 400 |
| Calcium (Ca) | 45.11 ± 1.55 | 52.63 ± 1.33 | 91.84 ± 3.11 | 99.18 ± 3.65 | 1000 |
| Sodium (Na) | 39.14 ± 1.17 | 56.21 ± 1.15 | 362.60 ± 16.14 | 394.14 ± 12.63 | 1500 |
| Manganese (Mn) | 1.07 ± 0.91 | 1.48 ± 0.67 | 1.25 ± 0.41 | 1.37 ± 0.53 | 2.30 |
| Iron (Fe) | 2.78 ± 0.83 | 3.62 ± 0.71 | 1.93 ± 0.63 | 2.34 ± 0.67 | 15.00 |
| Zinc (Zn) | 0.88 ± 0.06 | 1.43 ± 0.09 | 1.03 ± 0.07 | 1.09 ± 0.05 | 11.00 |

**RDA*, Recommended Daily Allowances by National Research Council (2010).**

results are in the same line with the results reported by Abd El-Galeel and El-Bana (2012) showing the increase in mineral contents of 10% defatted rice bran substituted biscuits.

### 3.9. Nutritive value of bakery products

From the results illustrated in Tables (2 and 4) for the chemical composition of pan bread and salted biscuit samples, the nutritive value including: %DRI (Dietary Reference Intake of total dietary fiber), classification of bakery products according to the amount of fiber, soluble to insoluble dietary fiber ratio and calorific value of products were calculated. Total phenolic compounds and antioxidant activity were also measured and the obtained results are presented in Table (9). The results of the present study indicated that the % DRI of dietary fiber ranged from 12.96% for control salted biscuits sample to 25.40% for 10% rice bran salted biscuits sample. It was observed that both control pan bread and salted biscuits samples and 10% rice bran pan bread sample could be considered to be good sources of dietary fiber, while 10% rice bran salted biscuits sample could be considered as an excellent source of dietary fiber. The soluble dietary fiber (SDF) to insoluble dietary fiber (IDF) ratio is important factor for both dietary fiber and functional property. It is generally accepted that those fiber sources suitable for use as food ingredient should have an SDF/IDF ratio close to 1:2 (Jaime *et al.*, 2002). This ratio was achieved for both control pan bread and salted biscuits samples and also for 10% rice bran substituted bakery products. The calorific value of both 10% rice bran pan bread and 10% rice bran salted biscuits samples was decreased compared with control samples (100% wheat flours of 82% and 72% extractions,respectively).Dietary guidelines recommended that, total carbohydrates intake should be ≥ 130g/day and total dietary fiber intake should be 28g/2000K.cal/day (Bantle *et al.*, 2006).

Total phenolic contents of both 10% rice bran pan bread and 10% rice bran salted biscuits samples were higher than those of both control pan bread and control salted biscuits samples (Table 9). However, the total phenolic contents of 10% rice bran pan bread were higher than10% rice bran biscuits because of using wheat flour 82% extraction in pan bread making. The increment percentages were 180.70% and 188.95% for 10% rice bran pan bread and 10% rice bran salted biscuit, respectively, compared with control samples. The prepared pan bread and salted biscuits samples had sufficient amount of phenolics compared to the control samples, which have no rice bran levels due to components derived from rice bran in the substituted samples. Rice bran contained phenolic compounds including tocopherols, tocotrienols and γ-oryzanol, which have a strong correlation with rice bran antioxidant activity (Iqbal *et al.*,2005).

Concerning antioxidant activity of samples, it was observed that both 10% rice bran pan bread and 10% rice bran salted biscuits contained higher antioxidant activity than those of the control samples and the increase in antioxidant activity was141.03% and 120.53%, respectively, compared with the control samples as a result of rice bran addition. It was concluded that 100g of these bakery products could be considered nutritious in terms of total dietary fiber, phenolic contents and have an antioxidant activity. These bakery products might be used for people with special health conditions such as diabetics and elevated serum cholesterol subjects.

**Table (9): Nutritive value of bakery products provided to adults as 100g serving.**

| Nutritive value | Control pan bread | 10% Rice bran pan bread | Control salted biscuits | 10% Rice bran salted biscuits |
|---|---|---|---|---|
| % DRI* | 13.48 | 19.04 | 12.96 | 25.40 |
| Classification | Good source | Good source | Good source | Excellent source |
| SDF/IDF ratio | 1:2 | 1:2 | 1:2 | 1:2 |
| Calorific value (K.cal/100g) | 407.39 | 402.59 | 435.66 | 428.32 |
| Total phenolic contents (mg/100g) | 86.67 ± 1.73 | 243.28 ± 11.34 | 76.54 ± 1.51 | 221.16 ± 11.13 |
| Antioxidant activity (µg/ml) | 5.63 ± 0.72 | 13.57 ± 1.06 | 4.87 ± 0.84 | 10.74 ± 1.03 |

% DRI* = Total dietary fiber / 25 × 100

### 3.10. Biological value of bakery products

The amino acid contents and biological value of control pan bread and salted biscuits and those bakery products substituted with 10% rice bran were shown in Table (10). The results showed that the substitution of wheat flour with rice bran resulted in an increase in all the essential amino acids ( threonine, isoleucine,

leucine, lysine, valine, phenylalanine and methionine + cystine) compared with control pan bread and salted biscuits samples (100% wheat flour). The increase in these essential amino acids in substituted pan bread and salted biscuits was: 12.23, 19.02, 27.13, 9.98, 13.49, 14.46 and 21.68%, respectively, for 10% rice bran pan bread sample and 10.36, 5.08, 31.87, 18.34,11.61, 27.75 and 16.09%, respectively, for 10% rice bran salted biscuit samples compared with the control samples. Consequently, the total essential amino acids were increased in substituted pan bread and salted biscuits by 17.31% and 19.76%, respectively, compared with control pan bread and salted biscuits substituted with 10% rice bran. Rice bran contained a balanced spectrum of hypoallergenic nutritive protein with a well balanced amino acid composition (Hoogenkamp, 2008).

From data presented in Table (10) it could be also observed that, both protein efficiency ratio and biological value were increased in 10% rice bran substituted pan bread and salted biscuits samples compared with control samples (100% wheat flour). The increase in protein efficiency ratio was 23.05% and 28.28% for 10% rice bran substituted pan bread and salted biscuits samples, respectively. Biological value was increased by 9.14% and 10.80% for both bakery products, respectively.

**Table (10): Amino acids contents (g/16g nitrogen) and biological value of bakery products.**

| Amino acids | Control pan bread | | 10% Rice bran pan bread | | Control salted biscuits | | 10% Rice bran salted biscuits | | FAO/WHO* (2008) |
|---|---|---|---|---|---|---|---|---|---|
| | Contents | A.S. | Contents | A.S. | Contents | A.S. | Contents | A.S. | |
| Threonine | 3.76 | 25.07 | 4.22 | 28.13 | 2.22 | 14.80 | 2.45 | 16.33 | 15 |
| Isoleucine | 3.47 | 17.35 | 4.13 | 20.65 | 2.56 | 12.80 | 2.69 | 13.45 | 20 |
| Leucine | 6.23 | 15.97 | 7.92 | 20.31 | 5.93 | 15.20 | 7.82 | 20.05 | 39 |
| Lysine | 4.31 | 14.37 | 4.74 | 15.80 | 4.09 | 13.63 | 4.84 | 16.13 | 30 |
| Valine | 4.67 | 17.96 | 5.30 | 20.38 | 3.53 | 13.58 | 3.94 | 15.15 | 26 |
| Phenylalanine | 4.77 | 19.08 | 5.46 | 21.84 | 4.36 | 17.44 | 5.57 | 22.28 | 25 |
| Methionine + cystine | 3.46 | 11.53 | 4.21 | 14.03 | 3.73 | 12.43 | 4.33 | 14.43 | 30 |
| Total essential amino acids | 30.67 | 16.58 | 35.98 | 19.45 | 26.42 | 14.28 | 31.64 | 17.10 | 185 |
| Histidine | 2.92 | 29.20 | 3.38 | 33.80 | 3.28 | 32.80 | 4.17 | 41.70 | 10 |
| Tryptophan | 1.13 | 28.25 | 1.46 | 36.50 | 1.76 | 44.00 | 2.15 | 53.75 | 4 |
| Proline | 9.47 | ------ | 10.69 | ------ | 10.43 | ------ | 11.35 | ------ | |
| Protein efficiency ratio (PER) | 3.08 | | 3.79 | | 2.80 | | 3.72 | | |
| Biological value (BV %) | 81.83 | | 89.31 | | 79.94 | | 88.57 | | |

FAO/WHO/UNU* Reference protein for adults (2008).
Amino acid scores (A.S.), protein efficiency ratio (PER) and biological value (BV) were calculated by equations.

samples. The nutritional quality of protein is dependent upon the effectiveness of the test protein in meeting the amino acids requirements and the degree of retention of the component amino acids during processing (FAO/WHO, 2008). From the present results it could be observed that, the high quality protein of both pan bread and salted biscuits samples substituted with 10% rice bran was confirmed by calculating chemical scores (A.S.), which were found to be higher than the control samples. The amino acids scores showed that methionine + cystine and lysine were the first and second limiting amino acids for pan bread, while isoleucine and methionine + cystine were the first and seemd limiting amino acids for salted biscuits. However, the other amino acids gave higher scores, indicating that degree of excellence was given for pan bread and salted biscuits

## In conclusion

It could be concluded that replacement of wheat flour with 10% rice bran can be followed without any adverse effects on physical and sensory characteristics of bakery products (pan bread and salted biscuits). Both types of bakery products prepared with rice bran showed an improvement in the contents of total dietary fiber, crude fiber, ash and total phenolic contents compared with control samples. Minerals, amino acids scores, protein efficiency ratio and biological value were also improved by substitution with rice bran. It can be recommended that using composite flour should be encouraged to make economic use of local raw materials and to produce high quality food products for the populations of developing countries.

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## إعداد وتقييم بعض المنتجات عالية الألياف

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**ملخص**

أدت زيادة الطلب على الأغذية ذات الجودة الغذائية والحسية العالية الى زيادة الحاجة الى تطوير المنتجات الغذائية باستخدام مواد غير تقليدية. تعتبر ردة الأرز (منتج ثانوى نتحصل عليه من صناعة ضرب الأرز) مصدرا غنيا بالألياف الغذائية يمكن استخدامه فى تدعيم بعض الأغذية وقد تم استخدامها مع دقيق القمح استخلاص ٨٢% وكذلك استخلاص ٧٢% بنسبة احلال ٥، ١٠، ١٥% بهدف انتاج خبز القوالب والبسكويت المملح على التوالى. تم تقدير التركيب الكيماوى للمواد الخام ومختلف عينات منتجات المخابز المضاف اليها ردة الأرز، وكذلك تقدير الخصائص الطبيعية والحسية، محتويات المعادن، المركبات الفينولية الكلية، النشاط المضاد للأكسدة، القيم الغذائية والبيولوجية لهذة المنتجات.

اظهرت النتائج المتحصل عليها أن ردة الأرز يمكن أن تعتبر مصدرا جيدا للألياف الخام، الألياف الغذائية الكلية، وقد وجد أن الألياف الغذائية الكلية قد زادت بمعدل ١,١، ١,٤، ١,٦ مرة لعينات خبز القوالب وكانت النسبة المئوية للزيادة تتراوح ما بين ٥٠,٣١% الى ١٣٥,٤٩% لعينات البسكويت المملح المضاف اليها ردة الأرز بالمقارنة مع عينات الكنترول، وقد اشار التركيب الكيماوى والخواص الفيزيائية والاختبار الحسى لكل من عينات خبز القوالب والبسكويت المملح ان معدل ١٠% من ردة الأرز تعتبر أفضل مستوى للاضافة لاستبدال دقيق القمح والتى يمكن استخدامها بدون أى تاثيرات سلبية على الخصائص الفيزيائية والحسية لمنتجات المخابز، وقد ظهر أن اضافة ردة الأرز فى خبز القوالب والبسكويت المملح نتج عنه زيادة فى كل العناصر المعدنية وقد وجد أن كمية تعادل ١٠٠ جم

من خبز القوالب والبسكويت المملح والمحتوية على نسبة ١٠% من ردة الأرز يمكن اعتبارها كافيه من وجهة الألياف الغذائية الكلية، القيمة السعرية، المحتويات الفينولية ولها نشاط مضاد للاكسدة، وقد تحسنت ايضا قيم الأحماض الامينية، معدل كفاءة البروتين، القيمة البيولوجية بالاستبدال مع ردة الأرز.

يمكن التوصية بامكانية استخدام الدقيق المركب من دقيق القمح مع المصادر الغذائية الأخرى لتحقيق استفادة اقتصادية من المواد الخام المحلية ولانتاج منتجات غذائية عالية الجودة للأفراد ذوى الأحتياجات الصحية الخاصة مثل مرضى السكر والأشخاص ذوى مستويات الكوليستيرول العالية.

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