

Improvement of the Nutritional Value of Rice Biscuits with Some Vitamins and Minerals Using Soy Flour and Strawberry Powder

ABSTRACT

Aims: The purpose of this paper is to develop a biscuit incorporated with defatted soy flour and strawberry powder to enhance its nutritional value of it.

Methodology: The proportion of rice flour and defatted soy flour were 25% and the level of strawberry powder used for making biscuit samples was 0, 5, 10 and 15% respectively. The biscuits were evaluated for their quality based on proximate analysis, physical properties and sensory evaluation.

Results: Based on chemical analysis protein, fiber content and β -carotene level increased with increasing the amount of strawberry powder. The most preferred products were that with 25% defatted soy flour and 10 per cent strawberry powder. It is noticed that 100gm of biscuits with 20% defatted soy flour and 10% strawberry powder provide 4-8 years-old children with 44% of their needs of protein, 20.23% of their needs of iron, 19.06% of zinc and 48.01% of folate.

Conclusion: The addition of both defatted soy flour and strawberry powder as a flour replacer in gluten-free biscuits improves its nutritional value without affecting its physical properties and consumer acceptance.

Keywords: [gluten-free biscuits; rice flour; defatted soy flour; strawberry powder]

1. INTRODUCTION

Biscuits are ready to eat, convenient and inexpensive food products containing digestive and dietary principles of vital importance. It is also said to be an essential bakery confectionery, dried down to low moisture content and mostly rich in fat and sugar and consequently of high energy content. They are used at all times as snacks (Hussein et al., 2006).

Rice is the seed of the grass species *Oryza sativa* (Asian rice) or *Oryza glaberrima* (African rice). As a cereal grain, it is the most widely consumed staple food for a large part of the world's human population, especially in Asia. (FAOSTAT, 2019).

Soybean (*Glycine max*) is a species of legume widely grown for its edible bean, which has numerous uses. Soy protein is essentially identical to the protein of other legume seeds and pulse (Wolf, 2012). It is one of the most important leguminous species because of its functionality, high nutritional value, and health benefits. (Ren et al., 2006; Eke-Ejiofor and Williams, 2016). Defatted soybean flour is a significant and cheap source of protein for animal feeds and many prepackaged meals. Zaker et al., 2012 suggested that composite flour technology for wheat supplementation with protein-rich materials, like soybean, could be a way to overcome malnutrition around the world.

Strawberry plant is a member of the *Rosaceae* family and the genus *Fragaria*. The fruit usually wasted can be utilized for preparation of various value-added products, which are of commercial importance from the industrial as well as health point of view. Together with

vitamin C, strawberry is one of the richest natural sources of folate; its content is considered in the range of 20 to 25 mg/100 g Fresh Weight (FW). Moreover, the strawberry, although to a lesser extent, is a source of several other vitamins, such as thiamin, riboflavin, niacin, vitamin B6, vitamin K, vitamin A and vitamin E (**Giampieri et al., 2012**).

The purpose of this paper is to develop a biscuit incorporated with defatted soy flour and strawberry powder to enhance the nutritional value of it.

2. MATERIAL AND METHODS

2.1. Materials

Rice flour, defatted soy flour, strawberry and other ingredients were purchased from the local market in Cairo, Egypt. Chemicals were of analytical reagent grade.

2.2. Methods

2.2.1. Preparation of Fruit Powder

Strawberry fruits were washed and cut into thin slices. Slices were directly immersed in a 1% NaCl solution, and then, immersed in a solution containing sodium meta-bisulphite (1%) and citric acid (0.5%) for 3 min (**Shih et al., 2009**). Strawberry slices were dried at 55 °C. The dried slices were milled into flour and sieved (315 µm) into powdered form. The powder was then packed into polyethylene bags and kept at -20 °C for further analysis.

2.2.1. Preparation of Biscuits

The blends and formula of control biscuits and another suggested formula to make biscuits were made according to **Wade (1988)** with some modifications; the formula is shown in Table (1).

Table 1: Formula of Biscuits

Ingredient (g)	Control (1)	Control (2)	F1	F2	F3
Rice flour	100	75	70	65	60
Sugar	30	30	30	30	30
Margarine	25	25	25	25	25
Mono-glyceride	3	3	3	3	3
Xanthan	1	1	1	1	1
Baking powder	5	5	5	5	5
Dry milk	5	5	5	5	5
Defatted Soy Flour	-	25	25	25	25
Strawberry Powder	-	-	5	10	15

The dough was sheeted to a thickness of about 3 mm using Atlas Brand rolling machine. The sheeted dough was cut into a round shape using a 45 mm diameter cutter and baked on an aluminum tray in an electric oven at 180°C for 15 minutes. The biscuit was cooled for 30 minutes, packed in polyethylene bags and stored at 20°C±2 at room temperature

2.2.4. Proximate analysis of ingredients and products

Rice flour, defatted soy flour, strawberry powder and biscuits were analyzed for moisture, protein, ash, fat and crude fiber according to the methods of **AOAC (2005)**. Total carbohydrate was calculated by difference. Total calories were calculated by the formula of **James (1995)** as follows:

$$\text{Total calories (K cal)} = \text{Fat} \times 9 + \text{Protein} \times 4 + \text{Total carbohydrate} \times 4.$$

Minerals content was determined in the diluted solution of ash raw materials and their blends using the atomic absorption spectrophotometer (3300 Perkin-Elmer) as described in by **AOAC (2012)**.

Vitamin A (B Carotene) was determined using (HPLC) (**Danish Official, 1996 a**). Vitamin B1 (Thiamin) and B2 (Riboflavin) were determined using (HPLC) as mentioned by (**Danish Official, 1996 b**). At Regional Center for Food and Feed (RCFF), Agricultural Research Centre, Giza, Egypt.

2.2.5. Physical characteristics of biscuits

Biscuits were evaluated for the weight (g), thickness (mm), diameter (mm) and spread ratio as described by **Gaines (1991)**. The spread ratio was calculated from the ratio of diameter to the thickness and calculated using the following equation:

Spread ratio = Diameter / Thickness

2.2.4 Hardness of Biscuits

Biscuit hardness was determined using a Texture Profile Analyzer (TPA) according to the **AACC method (2002)**.

2.2.5 Sensory Evaluation of Biscuits

Biscuit samples were organoleptically evaluated for their sensory characteristics according to the method of **Larmond (1982)**. Samples were scored for color, flavor, crispiness, texture and overall acceptability by ten panelists from Food Technology Research Institute.

2.2.6 Statistical analysis

Data obtained from the study were analyzed using statistical package for social sciences (SPSS16.0 software) and expressed as mean \pm standard deviation. One-way analysis of variance (ANOVA) was applied to assess any significant change in study parameters, and Duncan's multiple range test was applied to assess the group's inter difference. The level of significance was 5%.

3. RESULTS AND DISCUSSION

3.1 Chemical Composition of Raw Materials

The analysis showed 0.57% fat; 6.95 % protein; 0.20 % fiber; 0.60 % ash and 91.68 % carbohydrates for rice flour. These results on rice flour were in agreement with work by **Omran and Hussien (2015)**; who reported that rice flour had 7.78% proteins; 0.21% crude fiber; 0.66% ash, and 91.36% carbohydrates. While **Thanaa et al. (2019)** reported that rice flour had 7.75 proteins; 0.23% crude fiber; 0.62% ash, and 91.18% carbohydrates. The results for rice flour were partly in agreement with **Cameron and Wang (2005)** found that milled rice flour had 6.60 to 9.30% protein, Fat content was in the range of that of **Srivastava et al. (2012)**. While fiber and ash contents are low in rice flour, these results agree with the work by **Sakr and Hussien (2017)**.

Results of table (2) indicated that the defatted soy flour protein was 47.01% and ash was 5.5%, these results are lower than the work by **Zaker et al. (2012)** who reported values of 62.73% for protein and 6.43% for ash. The results about the composition of defatted soy flour revealed that it is rich in protein content, which justifies its utilization as a novel ingredient in nutritional food preparations. The fat content was 1.22%, the fat remaining in defatted soy flour reveals the superior efficiency of the oil extraction process, while the 5.5 % of total ash reveals high mineral content. Crude fiber reached 2.90%; while carbohydrate was 62.61 %. Results also in the same table showed that defatted soybeans flour exhibited the highest amount of iron (9.24 mg/100g) and Zinc (Zn) (2.46 mg/100g). The results are slightly lower than those reported by **Shalaby et al. (2018)**. They reported iron to be (11.49 mg/100g) and Zinc (Zn) to be (10.35mg/100g). Defatted soybeans flour had the highest content in K (1.878 g/100g). **Turab (2017)** stated that the mineral composition of partially defatted soybean flour comprises around (25.62 mg/100g), (4.56 mg/100 g) and (274.07 mg/100 g) of iron, zinc and calcium respectively. While strawberry powder contains (4.75 mg/100g) of iron and (1.63 mg/100g) of zinc. These results are in line with those reported by **Giampieri et al. (2012)**.

Results also in the same table showed that defatted soybeans flour and strawberry powder had a high amount of folic (305.4, 221.3 ug/100g) and niacin (2.61, 2.09 mg/100g) respectively. Results of this study agree with those reported by **Andhale et al. (2020)** and **Giampieri et al. (2012)**.

Table 2: Chemical Composition of Raw Materials

	Rice Flour	Defatted Soy Flour	Strawberry Powder
Moisture (%)	9.54±0.05 ^b	7.25±0.15 ^c	11.00±0.12 ^a
Fat (%)	0.57 ±0.03 ^c	1.22±0.02 ^b	1.48±0.03 ^a
Protein (%)	6.95±0.15 ^b	47.01±0.10 ^a	2.40±0.05 ^c
Ash (%)	0.60±0.01 ^c	5.50±0.18 ^a	3.63±0.04 ^b
Crude Fiber (%)	0.20±0.03 ^c	2.90±0.15 ^b	6.82±0.13 ^a
Dietary Fiber (%)	0.23±0.02 ^c	1.33±0.10 ^b	9.20±0.07 ^a
Carbohydrate (%)	91.68±1.12 ^a	43.37±0.86 ^c	85.67±1.15 ^b
Vitamins			
Carotene (mg/100 g)	-	4.00±0.03 ^b	37.51±0.11 ^a
Folic Acid (ug/100g)	4.00±0.01 ^c	305.4±1.15 ^a	221.3±1.19 ^b
Thiamin (mg/100 g)	0.14±0.03 ^c	0.69±0.05 ^a	0.18±0.01 ^b
Riboflavin (mg/100 g)	0.02±0.01 ^c	0.25±0.03 ^b	0.64±0.05 ^a
Niacin (mg/100 g)	2.45±0.11 ^b	2.61±0.15 ^a	2.09±0.13 ^c
Vitamin B6 (mg/100 g)	0.44±0.05 ^b	0.57±0.07 ^a	0.55±0.08 ^a
Minerals			
Calcium (mg/100g)	10.3±1.19 ^c	241.00±1.12 ^a	175.12±0.15 ^b
Iron (mg/100g)	1.58±0.01 ^c	9.24±0.05 ^a	4.75±0.10 ^b
Zinc (mg/100g)	0.95±0.03 ^c	2.46±0.07 ^a	1.63±0.02 ^b
Magnesium (mg/100g)	35.01±0.15 ^c	209.15±0.75 ^a	90.91±0.14 ^b
Sodium (mg/100g)	1.1±0.02 ^c	20.12±0.03 ^a	9.10±0.05 ^b
Potassium (mg/100g)	76.3±0.25 ^c	358.05±1.15 ^b	1509.1±0.30 ^a

*Values are means of three replicates ±SD, on a dry weight basis. ** Total carbohydrates were calculated by difference. Numbers in the same row followed by the same letter are not significantly different at 0.05 level.

3.2 Proximate Composition of Biscuits

Table -3- shows the proximate composition of biscuits produced from rice flour, defatted soybean flour and strawberry powder.

Protein content ranged from 4.82% to 8.47%. The result of this study revealed that protein content significantly increased with the addition of 25% defatted soy flour from 4.82% to 8.47%. The results are in line with the work by **Banureka and Mahendran (2009)** and **Gayas et al. (2012)**. The increase in protein content may be due to the addition of soybean flour in the biscuits. **Akubor and Ukwuru (2005)** said that soybean is a high protein legume and the incorporation of soy flour increases the protein content in the biscuits. Further addition of strawberry powder resulted in a non-significant decrease in protein content. This may result from the low content of protein in strawberry powder.

Fat content ranged from 17.76% to 17.93% fat content increased with the addition of soy flour and strawberry powder. Results of this study revealed that fat content slightly increased with the addition of 25% defatted soy flour from 17.76% to 17.90%. These results are in line with the findings of **Banureka and Mahendran (2009)** who reported the fat content of the biscuits increased from 14.6 to 24.0% with the increase in soybean flour from 0 to 25%. Further addition of strawberry powder resulted in a non-significant increase. These results are in line with the findings of **Sakr and Hussien (2017)** who reported a value of 18.81% - 18.83% for biscuits produced from rice, chickpeas flour and date.

Ash content ranged from 0.72% to 1.83%. The result of this study revealed that ash content increased with the addition of 25% defatted soy flour and the increase in the level of strawberry powder. Our results are higher than the work by **Eke-Ejiofor and Williams (2016)**. They reported ash in rice biscuits supplemented with defatted soy flour to range between 2.31 to 2.72 for 20 to 30% soy flour. **Sanni et al. (2006)** reported that the ash content of a food material could be used as an index of mineral constituents of the food because ash is the inorganic residue remaining, after the water and organic matter have been removed by heating in the presence of an oxidizing agent.

Fiber content ranged from 0.11% to 1.84%. The fiber content of biscuits produced agrees with the findings of **Saker and Hussien (2017)** with values ranging between 0.79% and 1.21%. The total crude fiber content significantly increased in biscuit samples with substitution level of strawberry powder, this may be due to the higher content of these nutrients in strawberry powder. These results are in line with work by **Sindhu et al. (2016)** who reported that the different level of carrot pomace powder increased the total crude fiber content significantly in biscuit samples.

Carbohydrate content ranged from 76.59% to 69.93% with a sample with 25% defatted soy flour and 15% strawberry powder as the lowest and control as the highest. The result of this study showed that an increase in substitution levels decreased the carbohydrate content. The results of biscuits produced agree with the findings of **Sindhu et al. (2016)**. However, the high protein and low carbohydrate content of composite biscuits is an indication that the biscuits may serve as a functional food for groups with special caloric and glycemic requirements such as obese or diabetic people (**Eke-Ejiofor and Williams 2016**). **Akubor and Ukwuru (2005)** suggested that soy thereby has a greater potential in overcoming protein-calorie malnutrition in the world.

Table -3-: Proximate Composition of Biscuits

Treatment	Protein (%)	Fat (%)	Ash (%)	Crude Fiber (%)	Carbohydrate (%)
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Control (1)	4.82± 0.16 ^b	17.76± 0.02 ^b	0.72± 0.02 ^e	0.11± 0.01 ^e	76.59± 0.03 ^a
Control (2)	8.47± 0.03 ^a	17.90 0.04 ^a	1.12± 0.03 ^d	0.83± 0.02 ^d	71.81± 0.16 ^b
F1	8.44± 0.06 ^a	17.91 0.08 ^a	1.44± 0.04 ^c	1.17± 0.02 ^c	71.12± 0.15 ^c
F2	8.36± 0.03 ^a	17.92± 0.01 ^a	1.63± 0.03 ^b	1.52± 0.05 ^b	70.49± 0.13 ^d
F3	8.35± 0.01 ^a	17.93 0.04 ^a	1.83± 0.02 ^a	1.84± 0.03 ^a	69.93± 0.10 ^e

*Values are means of three replicates ±SD, numbers in the same column followed by the same letter are not significantly different at 0.05 level.

3.2 Vitamin and Mineral Content of Biscuits

Table -4- shows the vitamin content of biscuits produced from rice flour, defatted soybean flour and different levels of strawberry powder. Data show a significant increase in vitamins with the addition of 25% defatted soy flour and different levels of strawberry powder.

Table -4-: Vitamin Content of Biscuits

Treatment	Carotene (mg/100 g)	Folic acid (ug/100g)	Thiamine (mg/100 g)	Riboflavin (mg/100 g)	Niacin (mg/100 g)	Vitamin B6 (mg/100 g)
Control (1)	0.64± 0.14 ^e	3.04± 0.05 ^e	0.08± 0.01 ^b	0.04± 0.02 ^d	1.54± 0.02 ^b	0.25± 0.02 ^c
Control (2)	1.55± 0.17 ^d	63.93± 0.03 ^d	0.17± 0.02 ^a	0.08± 0.01 ^c	1.56± 0.01 ^a	0.28± 0.02 ^b
F1	6.75± 0.11 ^c	78.94± 0.04 ^c	0.17± 0.03 ^a	0.11± 0.01 ^b	1.56± 0.05 ^a	0.30± 0.01 ^{ab}
F2	8.36± 0.25 ^b	96.04± 0.02 ^b	0.17± 0.02 ^a	0.12± 0.02 ^b	1.56± 0.01 ^a	0.30± 0.01 ^{ab}
F3	10.81± 0.13 ^a	115.06± 0.05 ^a	0.17± 0.03 ^a	0.16± 0.01 ^a	1.56± 0.02 ^a	0.32± 0.02 ^a

*Values are means of three replicates ±SD, numbers in the same column followed by the same letter are not significantly different at 0.05 level.

All vitamins increased with the addition of defatted soy flour; β-carotene increased from 0.64 to 1.55 mg/100 g, thiamine 0.08 to 0.17 mg/100 g, riboflavin 0.04 to 0.08 mg/100 g and vitamin B6 0.25 to 0.28 mg/100 g. Folic acid increased from 3.04 to 63.93 mg/100 g. This may be due to the high content of vitamins in defatted soy flour. These results agree with the work by **Shalaby et al. (2018)**. They reported a slight increase in beta-carotene, B1 and B2 in complementary infant food.

Further addition of strawberry powder resulted in a further increase in vitamin content, β-carotene increased from 1.55 to 10.81 mg/100 g, riboflavin 0.08 to 0.16 mg/100 g and vitamin B6 0.28 to 0.32 mg/100 g. While Folic acid increased from 63.93 to 115.06 ug/100 g. This may be due to the high content of vitamins in strawberry powder. These results agree with the work by **Giampieri et al. (2012)**.

Table -5-: Mineral Content of Biscuits

Treatment	Ca (mg/100 g)	Fe (mg/100 g)	Zn (mg/100 g)	Mg (mg/100 g)	Na (mg/100 g)	K (mg/100 g)
Control (1)	15.43± 0.05 e	0.27± 0.02 e	0.65± 0.03 c	20.54± 0.40 e	6.83± 0.08 e	32.54± 0.04 e
Control (2)	58.74± 0.01 d	1.74± 0.03 d	0.91± 0.02 b	66.76± 0.50 d	10.05± 0.13 d	105.55± 0.19 d
F1	67.04± 0.04 c	1.84± 0.04 c	0.94± 0.03 ab	68.56± 0.05 c	13.34± 0.04 c	115.91± 0.17 c
F2	75.42± 0.02 b	2.03± 0.06 b	0.95± 0.04 ab	70.41± 0.02 b	16.65± 0.08 b	123.23± 0.07 b
F3	84.75± 0.03a	2.13± 0.02 a	0.97± 0.01 a	72.22± 0.09 a	19.94± 0.03 a	134.52± 0.02 a

*Values are means of three replicates ±SD, numbers in the same column followed by the same letter are not significantly different at 0.05 level.

Table -5- shows the mineral content of biscuits produced from rice flour, defatted soybean flour and different levels of strawberry powder. Data show a significant increase in minerals with the addition of 25% defatted soy flour and different levels of strawberry powder.

All minerals increased with the addition of defatted soy flour, calcium increased from 15.43 to 58.43 mg/100g, iron from 0.27 to 1.74 mg/100g, zinc 0.65 to 0.91 mg/100g, magnesium 20.54 to 66.76 mg/100g, sodium 6.83 to 10.05 mg/100g and potassium 32.54 to 105.55 mg/100g. These results agree with the work by **Omoba and Omogbemile (2013) and Ndife et al. (2014)**. This increase may be due to the high mineral content of defatted soy flour (Table 2).

Table 5, also shows the effect of further substitution of rice flour with strawberry powder on the mineral composition of biscuits. Calcium increased from 58.43 to 84.75 mg/100g, iron from 1.74 to 2.13 mg/100g, zinc 0.91 to 0.97 mg/100g, magnesium 66.76 to 72.22 mg/100g, sodium 10.05 to 19.94 mg/100g and potassium 105.55 to 134.52 mg/100g. This increase may be due to the mineral content of strawberry powder (Table 2). These results agree with the work by **Aya Sakhaneh (2021)**.

3.3 Physical Properties of Biscuits

The physical properties of biscuits are important for both manufacturers and consumers. Table 6 shows the results of the evaluation of biscuits prepared from the mixture of rice flour, defatted soy flour and strawberry powder for several physical characteristics.

Table - 6 -: Physical Properties of Biscuits

Treatment	Weight (g)	Diameter (mm)	Thickness (mm)	Density (g/mm ³)	Spread Ratio D/T
Control (1)	6.01±0.02f	43.95±0.02a	6.08±0.01a	0.41±0.09 e	7.22±0.02 c
Control (2)	7.10±0.03e	43.90±0.07d	6.52±0.09b	0.57±0.02 d	6.73±0.03 b
F1	7.71±0.05d	43.81±0.05e	6.54±0.04d	0.61±0.03 c	6.69±0.05 b
F2	8.25±0.03c	43.60±0.01c	6.60±0.07e	0.65±0.07 b	6.60±0.03 a
F3	8.50±0.05c	43.20±0.05b	6.66±0.05c	0.68±0.08 a	6.48±0.02 a

*Values are means of three replicates ±SD, numbers in the same column followed by the same letter

are not significantly different at 0.05 level.

Results show a significant increase in the weight of biscuits after the supplementation of defatted soy flour and strawberry powder. Weight increased from 6.01 to 7.10 g with the addition of defatted soy flour. The addition of defatted soy flour increased the weight, this agrees with the work by **Omoba and Omogbemile (2013)**. The incorporation of strawberry powder resulted in a further increase in weight, **the** results agree with the work by **Saker and Hussien (2017)**.

The diameter of biscuits decreased from 43.95 mm to 43.90 mm. The results agree with the work by **Omoba and Omogbemile (2013)**. The incorporation of strawberry powder resulted in a further decrease in diameter from 43.90 to 43.20 mm. The decreasing trend was directly proportional to the increasing level of strawberry powder substitution. The results also show a significant decrease in the diameter of biscuits after the supplementation of defatted soy flour and strawberry powder. **These** results agree with the work by **Fahim et al. (2020)** and **Omran and Hussien (2015)**. The decrease in the diameter of biscuits was suggested, by **Ajila et al. (2008)**, to be due to the increase in fiber contents, which in our case is strawberry powder, which is a rich source of fiber (6.82 g/100g) compared with 2.90 g/100g for defatted soy flour and 0.23 g/100g for rice.

The thickness of biscuits also increased significantly from 6.08 to 6.66 mm with the addition of defatted soy flour and strawberry powder. The addition of defatted soy flour increased from 6.08 to 6.52 mm. This agrees with the work by **Zaker et al. (2012)**. They attributed this increase to the better binding strength of soy protein. While the addition of strawberry powder resulted in a further increase in thickness from 6.52 to 6.66 mm. **Previous** results agree with the work by **Omran and Hussien (2015)** and **Saker and Hussien (2017)**.

The same is true for the spread ratio which decreased linearly whereas, density increased similarly. **Kissell and Yamazaki (1975)** explained this that non-wheat high protein flours or any other ingredient which absorbs water during dough mixing will reduce the spread ratio because the water available in such a system would be insufficient to dissolve sugar during baking, increasing the viscosity and resulting in lower spread ratio. **Vieira et al. (2007)** established that the spread ratio is strongly correlated to the water absorption capacities of the flour.

3.4 Texture Profile of Biscuits

Texture's importance in the consumer acceptance of bakery products is highly recognized. Hardness is the most important in the evaluation of baked goods, because of its close association with the human perception of freshness (**Karaoğlu and Kotancilar, 2009**).

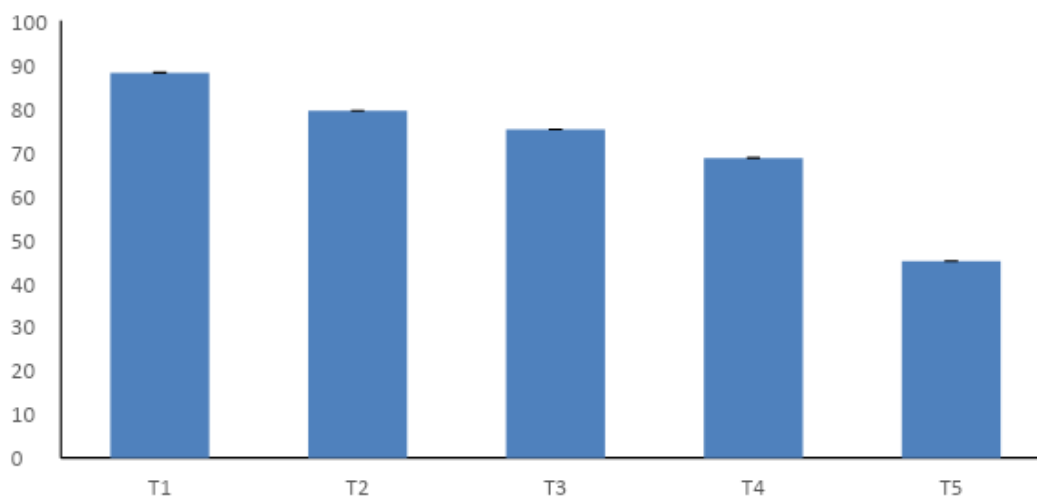


Fig 1: Hardness of Biscuits

*Values are means of three replicates, numbers with the same letter are not significantly different at 0.05 level.

Hardness is illustrated in Fig. 1. Significant differences in hardness were observed between substituted and control biscuits; the addition of defatted soy flour resulted in a high decrease in the hardness (from 88.1 to 75.11 N). These results agree with the work by **Zaker et al. (2012)**. They reported that defatted soy flour incorporated biscuits reported to have a lower hardness. This could be attributed to the high water binding capacity of defatted soy flour. While the further addition of 5% strawberry powder resulted in a less decrease in hardness (75.11 to 68.61 N). Further, an increase in strawberry powder level from 5% to 15% results in a further decrease in hardness (68.61 to 45.25 N respectively). **The above** results agree with the work by **Omran and Hussien (2015)** who reported that the hardness of cookies is much affected by the composition of flour. Results are also comparable with the work of **Uysal et al. (2007)**, **Toma et al. (2009)** and **Qaisrani et al. (2014)**. Also, the decrease in hardness may be because of the high fiber content of both defatted soy flour and strawberry powder.

3.5 Sensory Evaluation of Biscuits

The preference for the products, in terms of the sensory parameters used in assessing the product. Biscuits produced from different ingredients of defatted soy flour and strawberry powder were sensory-evaluated and compared with control biscuits (100% rice flour) (Table 7).

Treatment	Appearance (20)	Taste (20)	Texture (20)	Color (20)	Flavor (20)	Overall (100)
Control (1)	16.27±0.07 ^d	17.25±0.03 ^c	17.96±0.05 ^c	17.50±0.04 ^c	18.06±0.02 ^c	69.48±0.31 ^d
Control (2)	17.25±0.02 ^c	17.25±0.03 ^c	17.98±0.06 ^c	17.55±0.04 ^c	18.02±0.02 ^c	88.05±0.24 ^c
F1	18.25±0.06 ^b	17.95±0.07 ^b	18.87±0.05 ^b	18.55±0.04 ^b	19.10±0.04	92.72±0.52 ^b
F2	18.95±0.05 ^a	18.97±0.04 ^a	19.10±0.06 ^a	18.70±0.02 ^a	19.13±0.03	94.85±0.10 ^a
F3	18.25±0.06 ^b	18.90±0.02 ^a	18.87±0.05 ^b	19.25±0.04 ^a	19.25±0.04	94.52±0.52 ^a

*Values are means of ten replicates \pm SD, numbers in the same column followed by the same letter are not significantly different at 0.05 level.

As shown in Table 7, the overall acceptance and other parameters of the biscuits were affected by the additives. Biscuits with 25% defatted soy flour and 10% strawberry powder had the highest score in all parameters, except flavor where 15% strawberry powder had the highest score. Such data are in line with **Aya Sakhaneh (2021)** findings.

Therefore, it could be recommended to produce gluten-free biscuits with good quality and acceptable sensory quality attributes with the addition of 20% defatted soy flour and 10 % strawberry powder.

3.6 Nutritional Evaluation of Biscuits

The percentages of the recommended dietary allowances (% RDA) provided from 100g of biscuits, for children 4-8 years, are shown in table -8-. It could be observed that supplementation of biscuits with 25% defatted soy flour covers up to 44.57% of protein requirement, 17.43% of the iron requirement, 18.13% of zinc and 5.87% of calcium. The addition of strawberry powder increases the folate, calcium, iron and zinc provided by biscuits to 57.53, 8.47, 21.36, and 19.46%, respectively.

Table 8: Percentages of the Recommended Dietary Allowances Provided from Gluten-Free Defatted Soy Flour and Strawberry Biscuits for Children (4-8 years)

Treatment	Protein (% RDA)	Folate (% RDA)	Calcium (% RDA)	Iron (% RDA)	Zinc (% RDA)
Control (1)	25.08 ^c	1.52 ^a	1.54 ^a	2.70 ^e	13.13 ^d
Control (2)	44.57 ^a	31.97 ^d	5.87 ^d	17.43 ^d	18.13 ^c
F1	44.43 ^a	39.48 ^c	6.70 ^c	18.36 ^c	18.87 ^b
F2	44.00 ^b	48.01 ^b	7.54 ^b	20.23 ^b	19.06 ^{ab}
F3	43.94 ^b	57.53 ^a	8.47 ^a	21.26 ^a	19.46 ^a

(Food and Nutrition Board, Institute of Medicine, & National Academies, 2004)

*Numbers in the same column followed by the same letter are not significantly different at 0.05 level.

4. CONCLUSION

The potential of strawberry fruit powder as a flour replacer in gluten-free biscuits was studied. Increasing substitution levels increased the ash and dietary fiber in the product. The most preferred product was that with 20% defatted soy flour and 10% strawberry powder. It is noticed that 100g of biscuit with 25% defatted soy flour and 10% strawberry powder provides 4-8 years-old children with 44% of their needs of protein, 20.23% of their needs of iron, 19.06% of zinc and 48.01% of folic acid. This will help in the utilization of strawberry fruit while micronutrients and fiber present in the strawberry fruit will provide some nutritional and health benefits for consumers.

REFERENCES

- **AACC** Approved Method of American Association of Cereal chemists. Approved Methods the AACC published by the American Association of Cereal Chemists. **2002**; 13th edition. Inc. St. Paul, Minnesota, USA.
- **Ajila C, Leelavathi K, Rao UP.** Improvement of dietary fiber content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. *J Cereal Sci*; **2008**; 48:319–326
- **Akubor PI and Ukwuru MU.** Functional properties and biscuit making potential of soybean and cassava flour blends. *Plant Foods for Human Nutrition*, **2005**; 58 (3): 1-12. DIO [10.1023/B:QUAL.0000040344.93438.df](https://doi.org/10.1023/B:QUAL.0000040344.93438.df)
- **Andhale, R.R., Patil, R.N., Katkade, M.B., Dagadkhair, A.C. and Bhavsar, G.J.,.** Formulation and Quality Evaluation of Multigrain Bhakari Premix Fortified with Defatted Soya Flour. *Our Heritage*; **2020**; 68(30), 8105-8117.
- **AOAC** Official Methods of Analysis of the Association of Official Analytical Chemists. **2005**; 18th Edition, Washington DC.
- **AOAC** Official Methods of Analysis of the Association of Official Analytical Chemists. **2012**; 19th Edition, Washington DC.
- **Aya Sakhaneh,** Evaluation of some Vegetables and Fruits as Fat Replacers in Some Healthy Bakery Products. M.Sc. Thesis, **2021**; Food Science and Technology Department, Faculty of Agriculture, Alexandria University, Alexandria, Egypt
- **Banureka, VD and Mahendran, T.** Formulation of wheat-soybean biscuits and their quality characteristics. *Tropical Agricultural Research & Extension*; **2009**; 12(2), 62-66. <http://www.sljol.info/.../2259>

- **Cameron, D.K. and Wang, Y.J.** A better understanding of factors that affect the hardness and stickiness of long-grain rice. *Cereal Chem.* **2005**; 82(2): 113-119.
- **Danish Official ;1996 a.** Vitamin A, HPLC method NO,AF 255.1,3 rdeda National food Agency of Denmark.
- **Danish Official; 1996 b.** Vitamin B1 and B2 PLC method NO,.AB 189.2 -National, Af 255.1,3th rded,1996 National food Agency of Denmark.
- **Eke-Ejiofor, J. and Williams, I.** Evaluation of Defatted Soybean Flour Inclusion on the Properties of Rice Based Biscuits. *International Journal of Biotechnology and Food Science*, **2016**; 4(4), 63-71.
- **Fahim, J.S., Abd El-Moteleb, N.M. and Hussien, H.A.** Preparation of gluten free low protein cookies and crackers *Bull. Fac. Agric; Cairo Univ., 2020* 72: 13-22. DOI: [10.21608/ejarc.2021.210201](https://doi.org/10.21608/ejarc.2021.210201)
- **Gaines, C.S.** Instrumental measurement of the hardness of cookies and crackers. *Cereal Foods World.* **1991**; 36: 989-996. <http://www.sciencewebpublishing.net/ijbfs/>
- **Gayas, Bazilla; Rama Nath Shukla, Beena Munaza Khan.** Physico - Chemical and Sensory Characteristics of Carrot Pomace Powder Enriched Defatted Soy flour Fortified Biscuits. *International Journal of Scientific and Research Publications*, **2012**; 2(8), 1-
- **Giampieri, F., Tulipani, S., Alvarez-Suarez, J.M., Quiles, J.L., Mezzetti, B. and Battino, M.** The strawberry: Composition, nutritional quality, and impact on human health. *Nutrition*, **2012**; 28(1), 9-19. doi:10.1016/j.nut.2011.08.009
- **Hussein, H.M, Hussein. M.M, El-Damohery. S.T.** The effect of natural formulated functional biscuits on an elderly bone health. *Journal of Medical. Science*, **2006**. 6:937-943.
- **James, C.S.** General Food Studies. In: *Analytical Chemistry of Foods*, Blachie Academic and Professional, London, New York, Tokyo, Chapter 6, p 135. **(1995)**
- **Karaoğlu, M.M. and Kotancilar, H.G.** Quality and textural behaviour of par-baked and rebaked cake during prolonged storage. *International Journal of Food Science and Technology*, **2009**; 44(1), 93-99. <https://doi.org/10.1111/j.1365-2621.2007.01650.x>
- **Kissell LT, Yamazaki WT.** Protein enrichment of cookie flours with wheat gluten and soy flour derivatives. *Cereal Chem.*, **1975**; 52, 638-649.
- **Larmond, E.** Laboratory methods of sensory evaluation of food. Research branch. Canada Department of Agriculture Publications. **(1982)**
- **Ndife, J., Kida, F. and Fagbemi, S.,** Production and quality assessment of enriched cookies from whole wheat and full fat soya. *European Journal of Food Science and Technology*, **2014**; 2(1), pp.19-28.
- **Omoba, O.S. and Omogbemile, A.** Physicochemical properties of sorghum biscuits enriched with defatted soy flour. *British Journal of Applied Science & Technology*, **2013**; 3(4), 1246.
- **Omran A.A. and Hussien H.A.** Production and Evaluation of Gluten-Free Cookies from Broken Rice and Sweet Potato. *Advances in Food Sciences*, **2015**; 37(4),184-191.
- **Qaisrani, T.B., Butt, M.S, Hussain, S. and Ibrahim, M.** Characterization and utilization of psyllium husk for the preparation of dietetic cookies. *Inter. J. Modern Agric.*, **2014**; 3(3): 81- 91.
- **Ren H, Liu H, Endo H, Takagi Y, Hayashi T.** Anti-mutagenic and anti-oxidative activities fumd in Chinese Traditional Soybean fermented products Furu. *Food Chem.* **2006**; 95.71-76.

- **Sakr, A.M. and Hussien, H.A.** Nutritional quality of gluten free biscuits supplemented with sweet chickpeas and date palm powder. *International Journal of Food Science and Nutrition*, **2017**; 2(1), 128-134.
- **Sanni OL, Adebowale AA, Filani TA, Oyewole OB, Westby A.** Quality of flash and rotary dried fufu flour. *J. Food Agric. Environ.* **2006**; 4: 74-78.
- **Shalaby, M.T., Abou-Raya, M.A., Ibrahim, F.Y. and Mohamed, S.I.** Chemical and Sensory Assessment for some Complementary Food for Older Infants. *Journal of Food and Dairy Sciences*, **2018**; 9(8), 297-304.
- **Shih, M.C., Kuo, C.C. and Chiang, W.** Effects of drying and extrusion on colour, chemical composition, antioxidant activities and mitogenic response of spleen lymphocytes of sweet potatoes. *Food Chem.* **2009**; 117: 114-121.
- **Sindhu, H., Saloni, S., Harshavardhan, K., Mounika, B., Kalyani, D., Pavankumar, N.S. and Narayana, M.V.** Development of biscuit incorporated with defatted soya flour and carrot pomace powder. *IOSR J ENV SCI, Toxicol Food Tech*, **2016**; 10(3),27-40.
- **Srivastava, S., Genitha, T.R. and Yadav, V.** Preparation and quality valuation of flour and biscuit from sweet potato. *J Food Process Tech.* **2012**; 3: 192.
- **Thanaa M. Amer; Shams, SR. Omima and Hanan A. Hussien.** Production and Evaluation of Gluten Free Biscuits Supplemented with Chickpeas and Carob. *J. Biol. Chem. Environ Sci*, **2019**; 14(3), 57-71.
- **Toma, A., Omary, M.B., Marquart, L.F., Arndt, E.A., Rosentrater, K.A., Burns-Whitmore, B., Kessler, L., Hwan, K., Sandoval, A. and Sung, A.** Children's acceptance, nutritional and instrumental evaluations of whole grain and soluble fiber enriched foods. *J. Food Sci.* **2009**; 74: 139-146.
- **Turab S.Z.S.** Studies on production of partially defatted soybeans flour and its utilization in chapati. M.Sc. Thesis, College of food technology Vasantrao Naik Marathwada Krishi Vidyapeeth parbhani-431,402. **(2017)**.
- **Uysal, H., Bilgiçli, N., Elgün, A., NurHerken, E. and Demir, M.K.** Effect of dietary fiber and xylanase enzyme addition on the selected properties of wire-cut cookies. *J. Food Eng.* **2007**; 78: 1074-1078.
- **Vieira MA, Tramonte KC, Podestá R, Avancini SRP, Amboni RDMC, Amante ER.** Physicochemical and sensory characteristics of cookies containing residue from king palm (*Archontophoenix alexandrae*) processing. *Int. J Food Sci. Tech.*, **2007**; 43, 1534-1540.
- **Wade, P.,** Biscuits, cookies and crackers", *The Principle of Craft*, Vol. 1, Elsevier Applied Science, London. **(1988)**.
- **Wolf WJ** Legumes: Seed Composition and Structure, Processing Into Protein Products and Protein Properties. United States Department of Agriculture. Retrieved February 17, 291-314. **(2012)**.
- **Zaker, Aleem M.D., Genitha, T.R. and Hashmi, S.I.** Effects of defatted soy flour incorporation on physical, sensorial and nutritional properties of biscuits. *Journal of Food Processing and Technology*, **(2012)** 3(04), 1-4. <http://www.omicsonline.org/2157-7110/...>