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PHYSICO CHEMICAL NUTRITIONAL AND SENSORY PROPERTIES OF CAKE BASED ON BROKEN RICE AND SWEET POTATO COMPOSITE FLOUR

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ABSTRACT: This study aimed to examine the effects of incorporating sweet potato flour at different concentrations on the physical and quality characteristics of gluten-free cakes, and develop new sweet potato-enriched broken rice cake formulations for celiac patients. Cakes were made from broken rice flour by completely replacing wheat flour with broken rice flour. Also,broken rice flour was replaced in cake treatments with sweet potato flour at rates of 10, 20 and 30%, respectively, for cake. The results showed that cake produced from 30% sweet potato flour had the highest values in ash, and fibre contents, but had lower caloric values compared with control (100% broken rice flour) cake. Physical properties were significantly decreased by increasing the addition levels of sweet potatoes flour, and 30% replacement was the lowest one. Cake hardness decreased with increasing levels of sweet potatoes flour, and 30% sweet potato cake had the lowest values. The lightness of cake decreases significantly whereas, the yellowness of cake increased with increasing the proportion of sweet potato flour. The sweet potato cake was more acceptable than those made from broken rice flour only (control). The sensory evaluation results showed that sweet potatoes flour at 20% replacement is the most acceptable ones in cake treatments with reference to overall acceptability, colour and texture.

Key words: Cake, broken rice,sweet potato flour, sensory evaluation gluten-free.

INTRODUCTION

In the case of celiac disease (CD), an autoimmune condition, eating gluten causes the small intestine to launch an immune response that results in the loss of epithelial cells (**Atlasy *et al.*, 2022**). Eating wheat (gluten), rye (secaline), barley (hordene), and their hybrids causes it to occur. In addition, it is a chronic condition that affects 0.5% to 5.6% of people worldwide on average (e.g., Turkey, Tunisia, and Egypt) (**Machado, 2023**). To be cured, CD patients must maintain a lifelong gluten-free (GF) lifestyle. Gluten-free bread (GFB) dough has a consistency similar to cake batter and is typically more liquid than wheat dough. It also generally cannot be moulded. As a result, creating GFB calls for a different approach. Wheat flour can be substituted with a variety of GF flours and starches, including rice, maize, and sweet potato (**Elzoghby *et al*, 2023**).

Since over 1% of the world's population has gluten intolerance, the demand for gluten-free goods is rising. To avoid the symptoms of the condition, celiac patients must always consume gluten-free foods (avoidable grains include wheat, rye, oat, triticale, and barley) (**Shevkani *et al*. 2015**). However, as gluten contributes significantly to the ideal texture, sensory qualities, and overall quality of bakery goods, eliminating it from these goods results in inferior quality. The development of high-quality gluten-free products is therefore difficult, and many of the gluten-free items available on the market are of

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low quality and nutritional value and have a bad taste and mouthfeel (**Gularte *et al.*, 2012**). Hydrocolloids, such as gums, proteins, and fibres, may be added to gluten-free products to improve its quality attributes (**Singh *et al*., 2016**).

The majority of gluten-free products are often derived from refined starches or low-dietary fibre flours. Due to its preventative properties against chronic diseases like some types of cancer, cardiovascular diseases, diabetes, and gastrointestinal disorders, dietary fibre consumption is advised (**Figuerola *et al*., 2005**). It has been advised to increase dietary fibre intake to 25–30 g/day. As a result, eating foods high in fibre has drawn more attention. Fibre integration may be able to benefit people who are lacking in fibre (**Fernandez-Gine's *et al.*, 2003**). Breakfast cereals and bakery goods perform best in terms of fibre enrichment (**Gularte *et al*., 2012**). In the past, nutritional fibres from cereals were frequently employed in bakery goods, but today's health-conscious consumers are paying more attention to juice industry by-products (**Ayala-Zavala *et al.*, 2011**). Vegetable fibres offer greater nutritional quality than those found in cereals due to their higher amount of bioactive compounds and soluble and total fibres, better ability to hold water and oil, lower content of phytic acid, and lower caloric value (**Singh *et al.*, 2016; Larrauri, 1999**). Dietary fibres have functional qualities as well as health advantages, such as a high capacity for attracting and holding water. They are the perfect constituent to improve gel formation and viscosity due to their viscoelastic responsiveness and high yield stress at low solid concentrations (**Salehi *et al*., 2016**).

The main ingredients in baked goods are refined wheat flour (*Triticum* spp.), oil, sugar, and flavourings of choice. This results in the promotion of high energy density foods that are lacking in nutrients necessary for health, such as protein, dietary fibre, and bioactive substances (**Pessanha *et al.*, 2021**). Cake are the best target snacks as food product development has progressed from routine manufacture to the combination of components for nutritional benefit (**Akoja and Coker, 2018**). Additionally, wheat grain has drawbacks due to the high foreign exchange rate in nations with poor climatic conditions for agriculture as well as the problem of celiac disease (**Olawoye and Gbadamosi, 2020**). However, local crops might be used to lessen the substantial importation of wheat grains, and using gluten-free flour in the manufacture of cake could improve nutrition and boost consumption.

More than 65% of people in the planet use rice (*Oryza sativa* L.) as their primary food. In addition to maize and wheat grains, rice was the third most produced crop in 2020–2021, with roughly 509.87 million tonnes (**Wafaa *et al.*, 2019; Fehrenbach *et al*., 2022**). About 15–25% of the broken rice byproducts created during the rice milling and polishing process. With the benefits of low cost and widespread availability, broken rice is employed as a value addition to many food industrial uses (**Yihui *et al*., 2022**). Due to its delicate flavour, white colour, quickly absorbed carbs, and lack of sodium and calcium that is ideal for Celiac disease patients, broken rice flour is a preferred ingredient to produce gluten-free items (**Liyanaarachchi, 2021**). However, if the varieties are combined with the long grain and medium grain classifications, there may be significant variances in commercial rice flour. The procedures employed to prepare the rice flour may also affect the quality of the flour. Additionally, a variety of elements have an impact on the characteristics of the rice flour's starch, resulting in rice flour with various physicochemical and functional characteristics (**Rosniyana *et al*., 2016**).

Furthermore, because broken rice flour lacks gluten protein, it cannot be used unaltered in baked goods. Additionally, a variety of ingredients should be used to extend the shelf-life and improve the nutritional and sensory qualities of broken rice products (**Seung *et al.*, 2012; Su-Kyung *et al*., 2018; Ma Edelwina, 2020**). Different conventional and unconventional treatments could be used to increase the physicochemical and functional qualities of broken rice flour (**Amal, 2016**). For instance, rice cakes can be eaten as a quick meal when they are prepared using unconventional techniques such steaming, boiling, puffing, frying, and flaking.

After wheat, rice, and maize, the potato, a tuber that originated in the Andes (**Singh *et al.*, 2020**), is the fourth most significant agricultural crop produced worldwide. The United Nations' Food and Agriculture Organisation (FAO) said that global potato output has generally increased in recent years, reaching 370,436,581 tonnes in 2019. Even though it is produced in more than 100 countries, China and India account for roughly 40% of the total production (**FAO, 2019**). There are currently more than 4000 varieties of potatoes recognised, with the *Solanum tuberosum* L. being the most frequently grown (**Burlingame *et al.*, 2009**). According to **Pathak *et al*. (2018)**, the potato processing sector produces a lot of waste, mostly peel, fried goods, screen solids, and wastewater. Depending on the chosen peeling method, the potato peel by-product can account for up to 10% of the total potato waste (**Liang *et al*., 2014**) and between 15% and 40% of the fruit (**Sepelev and Galoburda, 2015**). This by-product, which is of no use to the feed industry, would make an intriguing raw material for the recycling sector because, after being processed using environmentally friendly methods, the molecules it yields would have favourable characteristics for both human health and a variety of industrial uses (**Dos Santos *et al*., 2016; Benkeblia *et al*., 2020**).

The cornerstone of baked foods, cakes has a long history and is popular with consumers throughout (**Zhang and Wu, 2008**). The addition of vitamins, minerals, polyphenols, and fibre from dietary sources is thought to be an effective way to create meals with high nutritional value (**Li *et al.*, 2020**). Cakes can be nutritious, have a light and fluffy texture, convenience, and variety. By supplementing and fortifying cake and cakes with a variety of proteins, lipids, and mineral sources, the nutritional content of these foods can be increased (**Induja and Vandana, 2012**). In place of wheat, rice flour made from broken grains will produce a variety of dishes with distinctive features while enhancing the local rice value chain. Furthermore, unlike wheat, rice is a gluten-free grain that has a high proportion of digestible carbs and low levels of salt (**Rai and Chopra, 2018**). This makes it desirable to prevent wheat allergies and celiac disease, particularly in infants, when creating gluten-free diets (**Arendt and Dal Bello, 2011**). This study aimed to examine the effects of incorporating sweet potato flour at different concentrations on the physical and quality characteristics of gluten-free cakes, and develop new sweet potato-enriched with broken rice cake formulations for celiac patients.

MATERIALS AND METHODS

Materials and Reagents

Broken rice was obtained from a local rice mill in Zagazig City, Egypt. Sweet potato and baking ingredients were purchased from the local market in Zagazig City, Egypt. Chemicals were of analytical reagent grade.

Ingredients

The ingredients such as Wheat flour (72% extraction) broken rice flour, sweet potato flour icing sugar, salt, egg, margarine ,vanilla ,baking powder, water were purchased in the local market Zagazig City, Egypt. The hydrocolloids carboxymethylcellulose(CMC) was purchased from El- Ashir of Ramadan City, Egypt.

Methods

Sweet Potato and Broken Rice Preparation

Preparation of sweet potato flour

Ipomoea batatas L. samples, which have orange flesh, were cleaned and manually cut into thin slices using a knife. Slices were submerged in a solution of citric acid (0.5%) and sodium meta-bisulphite (2000 ppm) for 1-2 minutes (**Shih *et al*., 2009**). Slices of sweet potato were dried for 12 hours at 45–50°C. The dried pieces were ground into flour and powdered using sieving. After that, the flour was placed in polyethylene bags and maintained at -20 $^{\circ}$C for additional testing.

Preparation of broken rice flour

After soaking, dried rice grains were used to make broken rice flour (*Oryza sativa* L.) using the dry milling method (**Shin *et al.*, 2010**). The rice grains were repeatedly washed, soaked in water for one hour, then dried at 45 to 50^{o}C for six hours in a tray dryer until a crack appeared in the grains. A flour mill (Saral Systems, Ahmedabad) was used for milling. To obtain finer flour, the resulting flour was sieved. It was then placed in polyethylene bags and stored at -20°C for additional analysis.

Preparation of gluten free blends different composite flour

Samples were prepared by partially substituting of broken rice flour (BRF) by different ratios of sweet potato flour to prepare different blend samples which used in preparation of gluten free cake samples.

Preparation of cake

The cake was made using the creaming mixing technique. Wheat flour (50 g), egg (40 ml), icing sugar (50 g), salt (0.4 g), margarine (30 g), water (20 ml), baking powder (1.75 ml), and vanilla (0.5 ml) were the ingredients taken into consideration for the manufacture of the control cake. Initially, a mixer bowl (Prestige, India) with a speed setting of 1200 rpm was used to beat together the ingredients for the dough for 5 minutes. Next, combine the egg, vanilla, and batter properly with a mixer set to 2400 rpm. Then, add margarine and the mixture of flour samples made from broken rice and sweet potato, along with theCMC (1%) mixture, and thoroughly combine for 10 minutes. The batter was then evenly put into the cupcake cases..

Baking and storage of cake

The prepared cake sample was placed in a Tefal baking pan (19 cm 9 cm) and baked in a convection oven at 180°C for 35–40 minutes. The cake sample had varying concentrations of broken rice flour and sweet potato flour. Each pan was rotated twice by °180 (after 5 and 10 minutes) to ensure even baking. After baking, the cake was taken out of the pan, wrapped in a clear plastic wrap to shield it from moisture and microbes, and left to cool at room temperature for 24 hours.

Proximate Analysis of Ingredients

Broken rice flour, sweet potato flour and wheat flour (72% extraction) were analyzed for moisture, protein, ash, fat and crude fibre according to the methods of **AOAC (2012)**. Total carbohydrate was calculated by difference.

Physical Properties of Cake

The weight of gluten free cake was determined after cooling for one hour. Gluten free cake volume was measured by rape seed displacement method as described by A.A.C.C. (2000) gluten free cake Specific volume of cake was calculated by dividing volume of the cake (cm^3) by their weights (g).

Functional Properties of Wheat Flour, Broken Rice Flour and Sweet Potato Flour

By employing the techniques recommended by **Beuchat (1977)**, the water holding capacity and oil holding capacity of the samples were determined. In a pre-weighed centrifuge tube, the flour or mix (1 g) will be vortexed for 30 minutes with distilled water (10 mL). The sample will be centrifuged for 25 min. at 3000 g after 30 min. of standing at room temperature. After the supernatant had been completely removed, the sediments were weighed. The flour/blend (0.5 g) will be homogenised with canola oil (5 mL) in a pre-weighed centrifuge tube and proceeded with as outlined for WHC in order to determine OHC. WHC and OHC calculated as follows:

WHC or OHC (%)= W2-W1*100/W0

Where,

W0 is the weight of the sample

W1 is the weight of centrifuge tube plus sample

W2 is the weight of the centrifuge tube plus sediments.

Texture Profile Analysis of Cake

With certain revisions to **Peng *et al*. (2010)** description, the texture parameter of cake samples was assessed objectively using a texture analyzer, the CT3 Texture Analyzer, in accordance with method 74-09 (**AACC, 2000**). It is possible to use one slice of cake that is 25mm thick or two slices that are each 12.5mm thick. Set up a cylindrical probe with a 36 mm diameter and a 2 mm/s test speed. Testing took place in the middle of the cake pieces to avoid non-representative crumb areas. The sample underwent a 50% deformation and a 5g trigger load. TACT-PRO Software was used to automatically record the parameters (graph and data).

Chemical Analysis of Cake

Moisture, protein, ash, crude ,fat and crude fiber content were determined according to the method described in **AOAC (2012)**. Available

Table A. Cake samples formula

Treament	Blends (%)		
	Wheat flour (W.F)	**Broken rice flour (BRF)**	**Sweet potato flour (SPF)**
100% WF (C)	100	0	0
100%BRF (T0)	0.0	100	0
90%BRF+10%SPF (T1)	0.0	90	10
80%BRF+20%SPF (T2)	0.0	80	20
70%BRF+30%SPF (T3)	0.0	70	30

carbohydrates content of the sample was calculated by the difference as mentioned by **Fraser and Holumes (1959)**.

% Available carbohydrates (on wet basis) = (% Moisture +%Ash + %Fat +%Protein + %Fiber).

The approximate energy of biscuits was calculated according to the (Noack, 1974) as follows:

Total energy (K.cal/100g) = 4 (%carbohydrate + % protein) +9 (%fat).

Minerals Content

Minerals quantification of cakes was carried out by Atomic Absorption Spectrophotometer (type AAnalyst 400, Perkin–Elmer, Waltham, MA, USA) after sample digestion with HCl as described by **Gupta *et al*. (2011)**.

Color Measurement of Cake

Utilizing a portable chroma metre (Minolta, Tokyo, Japan, model CR200). L*, a*, and b* values were used to measure colour, with b* standing for the degree of yellow-blue colour (a* greater positive b* value indicates more yellow). The a* value indicates the level of red-green colour; a larger positive a*value denotes a redder colour. L* represents lightness and has a value between 0 and 100. A typical white and black plate was used to calibrate the colorimeter (**Nabil *et al*., 2020**).

Pasting Properties

A starch cell (Physica Smart, Starch Analyzer-Anton Paar) connected to a CR/CS rheometer (RheoLab QC, Anton Paar, GmbH, Germany) and a tried-and-true approach were used to assess the pasting properties (**Jayakody *et al*., 2007**). An equilibrated sample (4% *W/W*) was heated from 50 to 95°C at 6°C/min, maintained at 95°Cfor 5 min, then cooled to 50°C at 6°C/min, maintained at 50°C for 2 min. For the first ten seconds, the speed was 960 rpm, and for the reminder of the experiment, it was 160 rpm. The peak time, peak viscosity, holding strength, setback, and ultimate viscosity of each sample were acquired graphs from which the pasting characteristics of each sample were deduced.

Sensory Evaluation of Cake

Organoleptic evaluations were performed on samples of prepared gluten-free cake to assess its overall acceptability, flavour, aroma, colour (crumb and crust), and proe structure. According to the **Bozdogan *et al*. (2019)** approach, panellists were also told to avoid eating, drinking, smoking, and chewing gum for 30 minutes prior to the testing session and to rinse their mouths with water.

Statistical Analysis

The analytical data were analyzed using SPSS 16.0 software. Means and standard deviations were determined using descriptive statistics. Comparisons between samples were determined using analysis of one-way variance (AN OVA) and multiple range tests. Statistical significance was defined at (P≤ 0.05).

RESULTS AND DISCUSSION

Physico-Chemical Analysis of Wheat, Sweet Potato and Broken Rice Flours

The physico-chemical analysis of broken rice, wheat, and sweet potato flours are shown in Table 1. Ash, fat, and fibre concentrations were the highest in sweet potato flour (3.43, 1.84, and

Table 1. Physico-chemical analysis of wheat, sweet potato and broken rice flours*

Component	Flour type used		
	WF	BRF	SPF
Moisture	13.07±0.24 a	10.53±0.65 b	5.68±0.44 c
Crude protein	11.39±0.26 a	6.40±0.22 b	3.87±0.38 c
Crude lipids	1.37±0.03 b	0.43±0.04c	1.84±0.06 a
Total ash	0.50±0.02 b	0.55±0.05b	3.43±0.54 a
Crude fiber	0.34±0.04 b	0.11±0.01 c	8.76±0.96 a
Carbohydrates	86.40±2.12 b	90.51±1.86 a	82.10±2.04 c
WHC (%)	141.24±3.18 c	168.13±2.94 b	173.09±1.85 a
OHC (%)	145.98±2.54 a	139.21±3.14 b	115.28±3.42 c

8.76%), respectively. The highest protein and moisture concentrations (11.39 and 13.07%) were found in wheat flour. Broken rice flour had the least amount of fat and fibre (0.43 and 0.11%), but the largest percentage of carbohydrates (90.91%). Our findings for broken rice flour were somewhat consistent with those of **Dahab (2006)**; who found that, broken rice containg 7.68% proteins, 0.27% crude fibre, 0.36% ash, and 90.81% capacity). Milled rice flour included 6.60 to 9.30% protein, 0.18 to 0.50% fat, and 19.60 to 27.00% amylose, according to **Cameron and Wang's (2005)**. The amount of fat matched that of **Srivastava *et al*. (2012)**. Sweet potato flour had a protein value of 3.87%. Sweet potato flour's carbohydrate content (91.90%) was comparable to **Singh *et al*. (2008) and Ahmed *et al.* (2010)** findings. Wheat flour had 86.40% carbs, 0.34% crude fibre, 0.50% ash, and 11.39% proteins. The moisture, protein, fat, ash, and fibre concentrations of wheat flour were determined to be 11.66, 12.54, 1.44, 0.58, and 0.92 g/100g, respectively, in **Hanem Abd El Moneem *et al*. (2021)** study. According to **Taher-Maddah *et al.* (2012)**, the extent of foreign materials, impurities, varieties, different processing and measuring methods, and differences in cultivars and growing conditions (such as geographic, seasonal variations in climate and soil characteristics) may all contribute to the variation in chemical composition.

The holding water and oil capacity are shown in Table 1, and it is obvious that sweet potato flour had the highest values with 173.09% WHC and 115.28% OHC, followed by broken rice flour with 168.13% WHC and 139.20% OHC, respectively. **Eleazu and Ironua (2013)** indicated that the range of the wate rholding capacity they had observed was from 149 to 471%. According to **Uthumporn *et al.* (2015)** the high water-holding capacity of flour can be attributed to the hydroxyl groups of cellulose in fibre, which can form hydrogen bonds with free water molecules to increase their capacity to hold water. Both red and white sweet potato flours had limited oil absorption capabilities, according to **Osundahunsi *et al.* (2003)**. According to **Omran and Hussien (2015)**, the physical trapping of oil and the binding of fat to the polar chain of protein are the key factors contributing to the mechanism of fat absorption.

Pasting Properties for the Flour Blends

The Rapid Visco-Analyser (RVA) is a quick and easy-to-use tool for measuring the viscosity of starch/flour dispersion during and after cooking in a temperature/time profile. It replicates cooking procedures and produces outcomes that are quite similar to those of the finished product. Peak duration (8.08-12.40 min), pasting temperature (57.40-66.90°C), peak (54.12-2628), trough (63.42-80.92), breakdown (31.12-1261 RVU), final viscosity, (40.40-2424 RVU), and setback (-177.7-204.20 RVU) viscosities were the ranges of values obtained for pasting properties

(Table 2). Peak viscosity, final viscosity, setback viscosity, breakdown viscosity, and peak duration were all considerably (p≤ 0.05) decreased by replacing BRF with SPF (10–30%). The pasting temperature of BRF was unaffected by SPF substitution, despite values gradually rising as the level of substitution rose. The findings of **Rungsardthong *et al*. (2021)** on rice flour substituted with 20, 30, 40, and 50% SPF flour were comparable to the findings of BRF with substitution of SPF in that they showed an increase in peak time, peak, breakdown, final, and setback viscosities as well as a decrease in peak temperature.

Peak viscosity is defined as the ability of starch-based meals to swell shortly after heating but before physical breakdown (**Sanni *et al*., 2006; Adebowale *et al*., 2008**). Tuber starches, such as sweet potato, potato, and cassava starch, often have a larger swelling power than cereal starches (**Kolaric *et al.*, 2020; Zhang *et al.*, 2018**).

According to **Kayode *et al*. (2019)**, the degree of starch degradation, starch components (amylose and amylopectin), and starch concentration are the main variables that could affect peak viscosity. Therefore, the absence of gluten and the low starch content of the cashew apple fibre may be to blame for the reduction in peak and ultimate viscosities of the composite flours. The combination of SPF' oil and protein with broken rice flour's starch, according to **Rungsardthong *et al*. (2021)** may have contributed to the lower peak temperatures of their flour blends. Trough viscosity, which assesses a paste's capacity to endure breakdown during cooling, is the lowest viscosity value in the constant temperature phase of the rapid visco-analyser (RVA) (**Adebowale *et al*., 2005; Adebowale *et al.*, 2008**).

Increasing heat and shear stress stability of the flours during cooking is indicated by a decrease in the breakdown viscosity of rice flours substituted with SPF. According to **Kayode *et al.* (2019)**, final viscosity gauges how stable a starch-based food material's paste is after chilling. Because of this, the reduction in final viscosity of wheat flours substituted with cashew apple fibre is a sign that the composite flour's gel strength and elasticity have decreased.

According to **Onimawo and Akubor (2012)**, setback viscosity is the estimated viscosity at which retrogradation, which is frequently characterised by the reorganisation of starch molecules, takes place. The setback viscosity gauges how easily meals with a starch basis retrograde while chilling. This study's findings on cashew apple fiber-substituted wheat flours show lower setback viscosities, which point to the flours' increased resistance to retrogradation and, as a result, reduced staling rate's products.

Peak time refers to the time frame during which cooking is anticipated to be finished. Therefore, compared to wheat flour that is 100% wheat, wheat flour substitutes made with cashew apple fibre would require less cooking time and energy. Pasting temperature is the lowest cooking temperature at which starch granule swelling first causes viscosity to be noticed (**Ekunseitan *et al*., 2017**). According to **Adebowale *et al.* (2008)**, at this temperature, 90% of the starch granules should have irreversibly swollen in hot water without losing their crystallinity or birefringence.

Higher pasting temperatures, as shown for wheat flours substituted with cashew apple fibre, indicate higher energy costs, lower component stability, a stronger tendency to gelatinize, and lower swelling characteristics of the starch granules in the flours (**Kayode *et al*., 2019**).

Chemical Composition of Cake Samples

Initially, replacing wheat flour with broken rice flour reduced the contents of all total solids (protein - fat - ash - fiber - carbohydrates) in the resulting cake and decreased these contents by increasing the replacement percentage (Table 3). The results of this study agree with those observed by **Eyenga *et al*. (2020), Motawei *et al*. (2022) and Kumar *et al*. (2023)** when they by replacing wheat flour with broken rice flour in baking products to produce gluten-free baking products.

The substitution considerably enhanced the moisture content of the cakes (P ≤0:05), which ranged from 23.86 for T0 (control) to 26.92/100 g for T3 (30% SPF). We then see that the moisture content is greatly increased by the addition of sweet potato flour to the formulation. The ability of the SPF flours we utilised to absorb water

Table 2. Pasting properties of wheat, broken rice and sweet potato composite flours

Parameter	Treatment*						LSD
	100% WF	100% BRF	100% SPF	90% BRF+10 % SPF	80% BRF+20 % SPF	70% BRF+30 % SPF	
Peak viscosity (cP)	2628.0a	577.30b	54.12f	435.7c	265.7d	151.8e	71.52
Peak Time (min)	12.40a	10.90c	7.3e	11.5b	8.6d	8.08d	0.954
Pasting Temperature (°C)	65.60d	66.90a	65.30e	66.1c	57.4f	66.5b	0.258
Peak Temperature (°C)	94.80a	94.8a	82.30b	94.9a	94.6a	94.7a	0.981
Holding Strength (min)	18.20b	18.1b	23.0a	17.7c	17.6c	16.7d	0.754
Breakdown (cP)	1261.0b	3808.0a	31.12f	158.5d	175.9c	85.6e	12.051
Final Viscosity (cP)	2424.0b	3019.0a	40.40f	613.3c	213.0e	159.1d	48.021
Setback from Peak (cP)	204.20b	2754.0a	13.72d	-177.7e	52.65c	-7.24e	36.50
Setback from Trough (cP)	1163.0a	-789f	0.00e	454.8b	37.08d	73.46c	28.620

would directly contribute to this increase. In fact, the functional characteristics of the compound flours discussed above in the characterization of the flours demonstrate that the broken rice-sweet potato flours have a high capacity for absorbing water in comparison to controls, and that this capacity rises with substitution.

With substitution, the ash content of the cakes likewise considerably rose (P≤0:05), ranging from 0.54 g/100 g of cake T0 (100% BRF) to 0.72 g/100 g of cake T3 (30% SPF). In comparison to the value reported in cakes by **Bozdogan *et al*. (2019)** (1.58 g/100 g), the values obtained are lower. Between cake T0 (control) and cake T3 (30% SPF), the fibre content in the cakes considerably increased with substitution (P≤ 0:05), ranging from 0.27 g/100 g to 0.83 g/100 g. The fat content of the cakes was unaffected by substitution; the findings for cake fat contents were consistent with those of **Kirbas *et al*. (2019)**. Protein content ranged from 7.48 for cake T0 (rice control) to 5.91 g/100 g for cake T3 (30% SPF), and it significantly decreased with substitution (P ≤ 0:05). This decline can be brought on by the proportion of SPF falling. In comparison to the value reported by **Kirbas *et al.* (2019)**, the values obtained are greater.

Cakes' carbohydrate content increased noticeably with substitution (P ≤ 0:05). Cake T0 (100% SPF) had the lowest carbohydrate content (49.94 g/100 g), while cakes T3 had the highest (54.22 g/100 g). **Omran and Hussien (2015)** reported a similar trend of rising carbohydrate content. Regarding the addition of malted sweet potato flour during biscuit manufacture. With substitution, the cake's energy content likewise increased significantly (P ≤ 0:05), ranging from 363.33 kcal/100 g for cake T0 (the control) to 370.82 kcal/100 g for cake T3 (30% SPF). **Omran and Hussien (2015)** also noted a similar pattern of rising energy content.

Minerals Content of Cakes

The sodium content in the cakes significantly increased with substitution (P≤0:05) and ranged from 115.66 mg for cake T0 to 195.01 mg/100 g for cake T3.

With substitution, the calcium content of the cakes was considerably increased (P 0:05), ranging from 135.11 mg/100 g for cake T0 (control) to 186.84 mg/100 g for cake T3 (30% SPF). Both the transmission of nerve impulses and the process of muscle contraction both involve calcium. It contributes to the process of blood coagulation as well as the metabolism of several hormones. In the growth stage, a calcium deficit causes rickets, and in adults, it causes osteomalacia (**Cianferotti, 2022**) The cakes made from broken rice-sweet potato flour mixture would be helpful for boosting bone density and lowering calcium deficiency.

Table 3. Chemical composition of cake made from wheat, broken rice and sweet potato composite flours

Treatment*	Chemical composition (% on wet weight basis)						Energy Kcal/100 g
	Moisture	Protein	Ash	Crude fiber	Fat	Total carbs.	
C	22.46bc	8.17a	0.63ab	0.36d	15.05a	53.34ab	381.49a
T0	23.86 b	7.48b	0.54b	0.27e	14.85b	49.94c	363.33c
T1	25.22 ab	6.97c	0.58b	0.46c	14.68bc	51.33b	365.30bc
T2	25.99ab	6.42c	0.65ab	0.70b	14.61bc	52.41ab	366.79bc
T3	26.92a	5.91d	0.72a	0.83a	14.48c	54.22a	370.82b
LSD at 0.05	1.164	0.469	0.088	0.127	0.280	1.353	5.00

Mean values in the table in the same line followed by different letters are significantly different (P < 0.05). LSD: least significant difference.
C: Cake manufacture with wheat flour (72% ext.). T0: Cake manufacture with 100 % broken rice flour.
T1: Cake manufacture with 90 % broken rice flour + 10% sweet potato flour.,
T2: Cake manufacture with 80 % broken rice flour + 20% sweet potato flour.
T3: Cake manufacture with70 % broken rice flour + 30% sweet potato flour

With substitution, the iron content of cake dramatically rises (P≤0:05). Cake T3 has the highest score (2.97 mg/100 g), while cake T0, the control cake, has the lowest level (1.11 mg/ 100 g). Red blood cell production is also aided by iron. Additionally, it facilitates electron transfer processes, fixes nitrogen for the formation of deoxyribonucleic acid, and transports oxygen (**Brissot *et al.*, 2019**).

With substitution, the zinc concentration likewise rises dramatically (P ≤ 0:05). Cake T3 has the highest score (1.85 mg/100 g), while cake T0, the control, has the lowest level (1.18 mg/100 g). Zinc contributes to the catalytic and metabolic functions of almost 300 enzymes by forming their active sites. Additionally, it helps with the secretion of digestive enzymes and the storage and release of insulin (**Chasapis *et al.*, 2020**). Sample T3 contains the most zinc of the three cake.

With substitution, the manganese content of the cake also increased significantly (P ≤ 0:05), rising from 10.04 mg/100 g for cake T0 (the control) to 28.06 mg/100 g for cake T3 (30% SPF). The creation of sex hormones and the proper operation of the neurological system are both influenced by manganese. The cake T3 (30% SPF) that is best for consumption is then. With substitution, the potassium content in the cakes also increased significantly (P≤0:05), going from 88.18 mg/100 g for cakeT0 (the control) to 419.54 mg/100 g for cakeT3.Along with substitution comes an increase in magnesium concentration. This increase is actually the result of the inclusion of sweet potato in the formulation; **Badila *et al.* (2009)** demonstrated that the sweet potato was high in potassium with a content of 243 mg/100. Potassium is crucial for lowering blood pressure. Consequently, potassium-rich cake T3 is advised for hypertension patients.

The amount of magnesium in the cakes similarly rose considerably with substitution (P ≤ 0:05), and varied from 113.25 mg/100 g for cakeT0 (control) to 141.65 mg/100 g for cake T3. Magnesium is essential for the body's metabolic processes, including those that preserve muscle, enhance neuronal function, keep the heart rate constant, and control blood sugar (**Dent and Selvaratnam, 2022**). The most advantageous cake T3 would then be in terms of magnesium intake.

With substitution, the potassium content in the cakes also increased significantly (P ≤ 0:05), going from 88.18 mg/100 g for cakeT0 (the control) to 419.54 mg/100 g for cakeT3.Along with substitution comes an increase in magnesium concentration. This increase is actually the result of the inclusion of sweet potato in the formulation; **Badila *et al.* (2009)** demonstrated that the sweet potato was high in potassium with a content of 243 mg/100. Potassium is crucial

for lowering blood pressure. Consequently, potassium-rich cake T3 is advised for hypertension patients.

The copper content of the cake increased dramatically with substitution, as shown in Table 4, and varied from 0.32 mg/100 g for cake T0 (the control) to 0.81 mg/100 g for cake T3 (30% SPF). Numerous enzymes and chemical processes involve copper in their operation. It is crucial for the myocardium's (the heart muscle's) correct operation and is involved in the oxidation of glucose. By influencing mood, sleep, memory, and attention, copper affects the quality of cartilage, the mineralization of bones, and the modulation of neurotransmitters. Additionally, iron metabolism and the immune system are also impacted by copper (**Davis and Mertz,1987**). With an intake of 0.81 mg/100 g, cake T3 (30% SPF) would be a decent source of copper.

The United States Department of Agriculture (**USDA, 2018**) developed the necessary daily intake (RDI) levels for minerals in foods designed for human consumption. The recommended daily intake (RDI) for children is 0.34 mg of copper, 1.2 mg of manganese, 7 mg of iron, 3 mg of zinc, 500 mg of calcium, 80 mg of magnesium, 3000 mg of potassium, and 1000 mg of sodium. For copper, manganese, iron, zinc, calcium, magnesium, potassium, and sodium, 100 g of cakeT0 (control) would provide 88.83%, 75.67%, 84.15%, 70.9%, 6%, 40%, 6.13% and 25.4% of the dietary reference intakes, respectively. The intake of these cakes will greatly improve the children's RDI. The results of this study are comparable to those found by **Ariyo *et al.* (2022) and Roger *et al*. (2022)** who found that substitution of wheat flour with sweet potato flour increased all minerals content of cake.

Color Measurement Of Cake

Initially, replacing wheat flour with broken rice flour increased the L* values but reduced a*, and b* values in the resulting cake .The results of this study agree with those observed by **Eyenga *et al.* (2020), Motawei *et al.* (2022) and Kumar *et al*. (2023)** when they by replacing wheat flour with broken rice flour in baking products to produce gluten-free baking products.

The broken rice cake samples' colour values for the crust and crumb were examined independently (Tables 5 and 6). The SPF-broken rice enhanced cakes differed from each other in terms of the L*, a*, and b* values for crust and crumb colour ($p \leq 0.05$). Regardless of the fibre source, adding SPF made the cake's crust and crumbs less light ($p\leq 0.05$).

Ingredients, processes, and ingredient process interactions, such as Maillard or caramelization reactions, all have an impact on the colour of baked goods (**Gularte *et al.*, 2012**). All samples tested had positive a* values (red hues), with the exception of the crust and crumbs from the control and 10% SPF-containing cakes. With more SPF added, the a* value for crust and crumb colour increased ($p \leq 0.05$).

All of the samples had positive b* values, which indicate a colour along the yellow axis. The findings demonstrated that adding more SPF considerably raised the b* value of the crust and crumb ($p \leq 0.05$). This can be attributable to the original SPF pigments' yellowish colour. Similar to this, **Matos *et al.* (2014)** observed that the initial pigmentation of materials utilised for protein enrichment was the cause of the variations in crumb colour characteristics of muffins. **Omran and Hussien (2015)** discovered that adding sweet potato flour to broken rice cake reduced the L* values but enhanced the a*, and b* values in the finished cake.

Physical Quality Of Cake

During baking, air bubbles that were trapped inside the cake mixture expand as a result of the higher temperature and chemical leavening. In other instances, coalescence is seen in addition to starch gelatinization and protein denaturation, all of which help to build the cake structure (**Yang and Foegeding, 2010**).

Initially, replacing wheat flour with broken rice flour decreased the volume of the cake .Table 7, illustrate the physical properties of the gluten free broken rice cakes prepared by replacing broken rice flour with different SPF at 10%, 20%, and 30% concentration. The volume of bakery products is an important parameter affecting consumer preferences. In this study, addition of SPF increased the volume of the cake ($p\leq 0.05$) (Table 7). However, when 10%

Table 4. Minerals content of cake made from wheat,broken rice and sweet potato composite flours

Treatment*	Minerals content of cake (mg/100g on wet weight basis)								
	Na	Ca	P	Fe	Zn	Mn	Mg	K	Cu
C	131.28e	144.60d	196.08e	1.38bc	1.31c	6.68e	112.90d	151.85d	0.41c
T0	115.66d	135.11e	260.55d	1.11c	1.18d	10.04d	113.25d	88.18e	0.32d
T1	140.31c	152.20c	284.36c	1.74b	1.30c	15.37c	121.78c	186.45c	0.44c
T2	171.85b	163.93b	294.32b	2.43ab	1.53b	19.94b	130.70b	297.1b1	0.66b
T3	195.01a	186.84a	332.89a	2.97a	1.85a	28.06a	141.65a	419.54a	0.81a
LSD at 0.05	5.357	3.682	7.021	0.862	0.264	2.731	3.543	8.925	0.079

Mean values in the table in the same line followed by different letters are significantly different (P < 0.05). LSD: least significant difference.
C: Cake manufacture with wheat flour (72% ext.). T0: Cake manufacture with 100 % broken rice flour.
T1: Cake manufacture with 90 % broken rice flour + 10% sweet potato flour.,
T2: Cake manufacture with 80 % broken rice flour + 20% sweet potato flour.
T3: Cake manufacture with70 % broken rice flour + 30% sweet potato flour

Table 5. Color measurement of crust cake made from whaet ,broken rice and sweet potato composite flours

Treatment*	Color parameters of crust cake		
	L*	a*	b*
C	59.30b	17.33cd	18.94cd
T0	63.94a	15.25d	14.96d
T1	54.80c	18.37c	19.64c
T2	49.66d	20.50b	21.34b
T3	46.22e	23.78a	25.85a
LSD at 0.05	**3.080**	**2.240**	**1.897**

Table 6. Color measurement of crumb cake made from wheat ,broken rice and sweet potato composite flours

Treatment*	Color parameters of crumb cake		
	L*	a*	b*
C	73.96 b	2.05d	8.47d
T0	77.65 a	1.17e	6.48e
T1	69.61c	4.82c	9.77c
T2	66.11d	7.28b	11.17b
T3	64.86e	9.46a	13.42a
LSD at 0.05	**1.240**	**0.429**	**1.538**

Mean values in the table in the same line followed by different letters are significantly different (P < 0.05). LSD: least significant difference.
C: Cake manufacture with wheat flour (72% ext.). T0: Cake manufacture with 100 % broken rice flour.
T1: Cake manufacture with 90 % broken rice flour + 10% sweet potato flour.,
T2: Cake manufacture with 80 % broken rice flour + 20% sweet potato flour.
T3: Cake manufacture with70 % broken rice flour + 30% sweet potato flour

Table 7. Physical quality of cake made from wheat,broken rice and sweet potato composite flours

Treatment*	Parameters		
	Weight (g)	Volume (cm3)	Specific volume(cm^3\g)
C	417a	762a	1.82a
T0	411a	473c	1.38b
T1	421a	532bc	1.31bc
T2	427a	560b	1.26c
T3	411a	576b	1.15d
LSD at 0.05	47.406	75.289	0.0836

Mean values in the table in the same line followed by different letters are significantly different (P < 0.05). LSD: least significant difference.

C: Cake manufacture with wheat flour (72% ext.). T0: Cake manufacture with 100 % broken rice flour.

T1: Cake manufacture with 90 % broken rice flour + 10% sweet potato flour.,

T2: Cake manufacture with 80 % broken rice flour + 20% sweet potato flour.

T3: Cake manufacture with70 % broken rice flour + 30% sweet potato flour

SPF was added to the formulation, there was no difference ($p \leq 0.05$). The specific volume and volume index of the cakes were decreased when the number of SPF sources was increased. The cake made with 30% SPF yielded the lowest specific volume values, as indicated in Table 7. The cake with 30% SPF added had the highest specific gravity and apparent viscosity values, and there was a negative association between volume, apparent viscosity, and specific gravity. It is crucial to highlight this at this time. This occurs when the apparent viscosity rises to a point where baking air bubbles are unable to expand to their full potential. The volume, softness, and texture of baked goods are directly related to the amount of air added to the batter, which may be assessed by measuring the batter density (**Eggleston *et al*., 1992**). Good batter aeration occurs during mixing when the viscosity and density of the batter are appropriate. Low-consistency batters generate low-volume cakes because they are unable to maintain air during mixing and baking, whereas higher-consistency batters may be able to control batter expansion. As it relates to the ultimate volume and texture of the cakes, the air trapped in the batter must be taken into account (**Gomez *et al*., 2007**). Researchers **Hutasoit *et al*. (2018), Li *et al.* (2020) and Chittrakorn and Bora (2021)** discovered that when the supplementation ratio increased, the specific volume of the cake manufactured with various SPFs reduced.

Sensory Evaluation Of Cakes

In order to evaluate consumer products, the field of sensory assessment applies techniques from experimental design and statistical analysis to human senses (**Kuenzel *et al.*, 2011**). The sensory evaluation of cakes made with various amounts of sweet potato flour was compared to control cakes made with 100% broken rice flour (Table 8). According to prior research on bread (**Ijah *et al*., 2014; Zheng *et al*., 2016 or 2019**), the taste panel's preference for potato cake appears to be mostly due to the bibulous rate of the potato flour being higher than that of wheat flour or broken rice flour. In comparison to regular bread, bread with potato flour kept moisture for a longer period of time, and potato flour is superior for baking low-gluten goods like cakes (**Seevaratnam *et al.*, 2012**).

Compared to those prepared just from broken rice flour, the texture of sweet potato cakes created with broken rice flour was softer and more tolerable. According to the sensory score, sweet potatoes at a 20% replacement are the most palatable option in terms of overall acceptability, colour, and texture. In sweet potato cakes, the flavour (taste and odour) score greatly improved. This might be due to common flavourings and the caramelization of free sugar during baking in sweet potato flour. These findings concur with those of **Singh *et al*. (2008) and Srivastava *et al*. (2012)**, who used sweet potatoes to make cake Additionally, the

Table 8. Sensory evaluation of cake made from wheat,broken rice and sweet potato composite flours

Treatment*	Sensory parameters					
	Taste (20)	Aroma (20)	Crumb color (20)	Crust color (20)	Pore structure (20)	Overall acceptability (100)
C	19.00a	18.29a	19.41a	18.60a	19.40a	94.70a
T0	15.50c	17.31ab	14.60d	15.50c	14.00d	76.91d
T1	18.00ab	18.60a	16.70bc	17.70ab	17.30bc	88.30b
T2	16.40bc	17.65ab	17.68b	18.53a	18.33ab	88.59b
T3	15.60c	16.39b	15.61cd	16.00bc	15.60cd	79.20c
LSD at 0.05	2.084	1.544	1.553	1.870	1.837	3.675

Mean values in the table in the same line followed by different letters are significantly different ($P < 0.05$). LSD: least significant difference.
C: Cake manufacture with wheat flour (72% ext.). T0: Cake manufacture with 100 % broken rice flour.
T1: Cake manufacture with 90 % broken rice flour + 10% sweet potato flour.,
T2: Cake manufacture with 80 % broken rice flour + 20% sweet potato flour.
T3: Cake manufacture with70 % broken rice flour + 30% sweet potato flour

substitution of more sweet potato flour resulted in substantial changes in colour, texture, flavour, and overall acceptance. However, it was discovered that the 40% optimum substitute level was the level at which consumers might find the product less acceptable (**Adeyeye and Akingbala, 2014**).

Texture Profile of Cake

Food quality and acceptance are assessed using the texture analysis (**Bourne, 2003**). According to **Yang (2016)**, it can be measured via descriptive sensory or instrumental measurements, which are referred to as subjective or objective techniques.

When a product is compressed for the first time at a 40% compression point (2.5 mm/s speed test), the hardest part of the product is measured. Due to moisture loss and starch retrogradation, it grew as storage time grew (**Lazaridou *et al.*, 2007**). The area of work during the second compression divided by the area of work during the first compression yields the cohesiveness (**Bourne, 2003**). The resilience (elasticity) measures "how well the product fights for recovering its original position" and is calculated as the area during the first compression pull divided by the area of the first compression (**Elzoghby *et al.*, 2023**). The springiness is defined as the distance recovered by the sample in height during the interval between the end of the first compression cycle and the beginning of the second compression cycle.

According to the findings in Table 9, the integration of broken rice flour had a significant ($p \leq .05$) impact on the textural profile of the cake, with the exception of gumminess. As the amount of rice flour added increases, the hardness of the cake decreased dramatically ($p \leq 0.05$), presumably as a result of the diluted gluten. According to **Chevallier *et al.* (2000)**, hydrogen bonding interactions between starch and protein are what cause the hardness. With more rice flour added, flatbread's springiness dramatically increased ($p \leq 0.05$). High springiness values will be connected with high-quality bread since it is related to fresh and elastic products (**Matos and Rosell, 2012**). With regard to cohesion, it was found to considerably ($p \leq 0.05$) rise with the addition of more broken rice flour. A substance's cohesiveness, which indicates the internal cohesion of the material, is measured by how frequently it can be deformed before rupturing. High cohesiveness bread is favoured because it forms a bolus when chewing rather than crumbling or cracking (**Jan-on *et al.*, 2021**). Low cohesiveness bread is more prone to crack or crumble. By adding more broken rice flour, the cake's gumminess and chewiness were reduced. Lower chewiness means that the extrudates crumble like a biscuit when you bite into them. **Matos *et al.* (2012)** discovered equivalent outcomes for gluten-free loaves.

Table 9. Texture profile of cake made from wheat,broken rice and sweet potato composite flours

Treatment*	Parameters						
	Hardness (N)	Cohesiveness	Adhesiveness g·cm	Resilience	Springiness (mm)	Chewiness (g·cm)	Gumminess (N)
C	28.34a	0.37a	5.0b	0.10b	10.57c	1299.00b	12.05a
T0	14.92e	0.26b	7.0a	0.09b	11.71b	600.00e	5.03c
T1	20.77b	0.34ab	2.00d	0.14a	22.75a	2028.00a	8.74b
T2	19.92c	0.33ab	1.00e	0.13a	11.87b	1002.00c	8.27b
T3	17.39d	0.25b	4.00c	0.10b	11.43b	642.00d	5.50c
LSD at 0.05	1.258	0.042	0.857	0.032	0.584	15.358	0.215

Mean values in the table in the same line followed by different letters are significantly different ($P < 0.05$). LSD: least significant difference.
C: Cake manufacture with wheat flour (72% ext.). T0: Cake manufacture with 100 % broken rice flour.
T1: Cake manufacture with 90 % broken rice flour + 10% sweet potato flour.,
T2: Cake manufacture with 80 % broken rice flour + 20% sweet potato flour.
T3: Cake manufacture with70 % broken rice flour + 30% sweet potato flour

Table 9 shows how fibre sources affect the gluten-free cakes made with broken rice flour's textural qualities. Generally speaking, the softer the cake, the lesser the hardness and chewiness. The resistance of sweet potato cake was much higher than that of wheat and broken rice cake ($p \leq .05$), although the hardness and chewiness were both significantly lower. The elasticity did not differ significantly. This outcome is in line with a prior study (**Zhang *et al.*, 2019**).

Conclusion

The goal of the current study was to determine the value of enriched broken rice cakes made without gluten and with sweet potatoes as a healthy and sensible meal additive. As a result, sweet potatoes are full of numerous essential elements. It can be utilised in the formulation of cakes, a popular bakery item all over the world. The finest addition might be to replace the broken rice flour with 30% sweet potato flour. On the other hand, because all of the sensory quality aspects of the cake were higher compared to control, replacing the broken rice flour with 30% sweet potato might be regarded as the best addition. With an increase in the amount of sweet potato flour, the cake's lightness reduces noticeably while its yellowness increases. Different sweet potato mixtures could be used to make broken rice cakes that are suitable for celiac disease sufferers, especially when the sweet potato content is 30% or higher.

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الخصائص الفيزوكيميائية والغذائية والحسية للكيك المصنع من الدقيق المركب من كسر الأرز والبطاطا الحلوة

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هدفت هذه الدراسه الي دراسه تاثير دمج دقيق البطاطا الحلوه بتركيزات مختلفه علي الخصائص الفيزيائيه والجوده للكيك الخالي من الجلوتين وتطوير تركبيات كيك جديده من كسر الارز ومدعمه بالبطاطا الحلوه لمرضي الاضطرابات الهضمية. حيث تم صنع الكيك من دقيق كسر الارز عن طريق استبدال دقيق القمح بدقيق كسر الارز تماما .كم تم استبدال دقيق كسر الارز بدقيق البطلطا الحلوه بمعدلات 10، 20 و30 %علي التولي .حيث اوضحت نتائج البحث ان الكيك المنتج من دقيق البطاطا الحلوه بنسبه 30%كانت له اعلي القيم في محتواه من الرماد والالياف ولكن كانت قيم السعرات الحراريه اقل مقارنه من الكيك المصنوع من عينه المقارنه (دقيق كسر الارز100%) وكان هناك انخفاض معنوي بالخواص الفيزيائيه وذلك بزياده مستويات دقيق البطاطا الحلوه وكان الاستبدال 30% هو الادني .كما انخفضت صلابه عينات الكيك في وقت واحد مع زياده مستوي دقيق البطاطا الحلوه وكانت عينات الكيك المحتويه علي 30% من دقيق البطاطا الحلوه اقل القيم .كما حدث تناقص في لون الكيك الفاتح بشكل ملحوظ بينما ازداد اصفرار الكيك مع زياده نسبه دقيق البطاطا الحلوه. وكان الكيك المصنوع من دقيق البطاطا الحلوه اكثر قبولا من الكيك المصنوع من دقيق كسر الارز فقط (عينه المقارنة). كما اظهرت نتائج التقييم الحسي ان البطاطا الحلوه عند استبدالها بنسبه 20% كانت هي الاكثر قبولا مع الاشاره الي القبول العام واللون والملمس.

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