Rev Esp Nutr Hum Diet. 2026; 30(3):e2821
doi: 10.14306/renhyd.30.3.2821 [ahead of print]
Freely available online - OPEN ACCESS

Revista Española de Nutrición Humana y Dietética

Spanish Journal of Human Nutrition and Dietetics

RESEARCH–*post-print version*

This is the version accepted for publication. The article may undergo stylistic and formatting changes.

Physicochemical and sensory characteristics of sponge cakes with addition of potato and sweet potato peel flours

Características fisicoquímicas y sensoriales de bizcochos con adición de harinas de cáscara de patata y batata

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Received: 14/04/2026; Accepted: 21/05/2026; Published: 25/06/2026

Assigned editor: Amparo Gamero Lluna, Departamento de Medicina Preventiva y Salud Pública, Ciencias de la Alimentación, Toxicología y Medicina Legal, Facultad de Farmacia y Ciencias de la Alimentación, Universitat de València, Valencia, España.

CITE: Borgo MA, Lencina M, Larrosa VJ. Physicochemical and sensory characteristics of sponge cakes with addition of potato and sweet potato peel flours. Rev Esp Nutr Hum Diet. 2026; 30(3):e2821. doi: 10.14306/renhyd.30.3.2821 [ahead of print].

ABSTRACT

Introduction: The agro-industrial processing of potatoes and sweet potatoes generates large amounts of peel residues, which are often discarded despite their nutritional value. These by-products represent a potential source of dietary fiber and bioactive compounds, and their valorization aligns with sustainability and circular economy strategies

Methods: Potato peel flour (PPF) and sweet potato peel flour (SPF) were obtained through drying and milling processes. Their physicochemical and functional properties were evaluated, including moisture, water activity, fiber, ash, color, bulk density, water and oil absorption capacities, and total phenolic content (TPC). Subsequently, these flours were incorporated as a 10% replacement for wheat flour in sponge cakes, and the resulting products were assessed for physicochemical and sensory characteristics

Results: Both flours exhibited low moisture (<10%) and water activity (<0.50). SPF showed higher fiber, ash, water absorption capacity, and TPC levels compared to PPF. Incorporation into sponge cakes significantly increased fiber content and firmness without negatively affecting sensory acceptability. The SPF formulation showed the highest phenolic content (21.5 ± 0.80 mg GAE/100 g), while the PPF formulation achieved higher flavor scores. All samples scored above the midpoint on the hedonic scale**.**

Conclusions: Potato and sweet potato peel flours demonstrate strong potential as functional ingredients in bakery products. Their incorporation improves the nutritional profile of foods while contributing to food waste reduction and the development of more sustainable food systems.

Keywords: Potato peel flour; Sweet potato peel; Sponge cake; Phenolic compounds; Food waste valorization.

RESUMEN

Introducción: El procesamiento agroindustrial de papas y batatas genera grandes cantidades de residuos de cáscara, que a menudo se desechan a pesar de su valor nutricional. Estos subproductos representan una fuente potencial de fibra dietética y compuestos bioactivos, y su valorización se alinea con las estrategias de sostenibilidad y economía circular.

Metodología: Se obtuvieron harina de cáscara de papa (HCP) y harina de cáscara de batata (HCB) mediante procesos de secado y molienda. Se evaluaron sus propiedades fisicoquímicas y funcionales, incluyendo humedad, actividad de agua, fibra, cenizas, color, densidad aparente, capacidad de absorción de agua y aceite, y contenido total de fenoles (CTF). Posteriormente, estas harinas se incorporaron como sustituto del 10% de la harina de trigo en bizcochos, y se evaluaron las características fisicoquímicas y sensoriales de los productos resultantes.

Resultados: Ambas harinas presentaron baja humedad (<10%) y baja actividad de agua (<0,50). La HCB mostró mayores niveles de fibra, cenizas, capacidad de absorción de agua y CTF en comparación con la HCP. Su incorporación a los bizcochos aumentó significativamente el contenido de fibra y la firmeza sin afectar negativamente la aceptabilidad sensorial. La formulación HCB presentó el mayor contenido fenólico (21,5 ± 0,80 mg GAE/100 g), mientras que la formulación HCP obtuvo puntuaciones de sabor más altas. Todas las muestras obtuvieron puntuaciones superiores al punto medio en la escala hedónica.

Conclusiones: Las harinas de cáscara de patata y boniato demuestran un gran potencial como ingredientes funcionales en productos de panadería. Su incorporación mejora el perfil nutricional de los alimentos, a la vez que contribuye a la reducción del desperdicio alimentario y al desarrollo de sistemas alimentarios más sostenibles.

Palabras clave: Harina de cáscara de patata; Cáscara de boniato; Bizcocho; Compuestos fenólicos; Valorización de residuos alimentarios.

MENSAJES CLAVES/KEY MESSAGES

- Peel flours improved fiber and phenolic content in sponge cakes.
- Sweet potato peel flour had the highest functional and nutritional value.
- Peel flours showed low moisture and high-water absorption capacity.

All sponge cake samples maintained good sensory acceptability.

INTRODUCCIÓN

Potato (*Solanum tuberosum L.*) is one of the main vegetables consumed worldwide and constitutes an important component of the human diet[1]. In Argentina, it is the most widely consumed vegetable, and between 20 % and 30 % of the total production is allocated to industrial processing for the production of frozen pre-fried batons, fried chips, and mashed potatoes[2]. Typically, the starchy portion is utilized, while the peel, depending on the peeling method, accounts for between 15 % and 40 % of the vegetable's weight and is discarded as waste in the processing industry, despite being a source of fiber and phenolic compounds[1,3].

Sweet potato (*Ipomoea batatas L.*) is the third most important root crop worldwide, following potato and cassava. In Argentina, although its consumption is lower than that of potatoes, the orange- fleshed Gem variety is valued by consumers for its sweet taste and high yield[4]. This crop plays an important socio-economic role; however, only about 10% of the national production is directed to industrial processing, primarily for the production of traditional sweet potato jelly, as well as frozen pre-fried batons and fried chips. Similar to potatoes, sweet potato peels are commonly discarded during processing, despite being an important source of dietary fiber and bioactive compounds[5,6].

Overall, fruit and vegetable residues such as peels, seeds, and pulps are rich in carbohydrates, polysaccharides, proteins, vitamins, minerals, and antioxidants. Although frequently treated as waste, these by-products represent a potential resource for the development of value-added foods[7]. In response to increasing concerns about the environmental impact of food wastecoupled with the low dietary fiber intake observed in the Argentine population[8], the application of drying technologies, such as solar, vacuum, freeze, or microwave drying, has become a viable strategy for producing functional powders that can be incorporated into baked products[9] not only promotes sustainability but also enhances the nutritional profile of processed foods.

Sponge cakes, baked products with a porous structure and classified as foam-type cakes[10], are among the most widely consumed bakery items globally, appreciated mainly for their ready-to-eat format, availability in various varieties, and affordable price. Their preparation allows the use of composite flours combined with dehydrated vegetable ingredients, presenting a strategy to develop products with high fiber content [11]. The incorporation of powders derived from fruits, vegetables, or agro-industrial by-products in sponge cake formulations not only improves nutritional value but also affects their physicochemical, sensory, and technological properties. According to Salehi and Aghajanzadeh [12], fiber-rich ingredients have a high-water absorption capacity, increasing the final product's moisture content. However, their addition can decrease cake volume and yield a firmer texture, while contributing to higher levels of polyphenols, and crude fiber.

This study proposes the valorization of potato and sweet potato peels as sources of dietary fiber and bioactive compounds for incorporation into sponge cakes. This approach promotes sustainability by utilizing agro-industrial waste while enhancing the nutritional value of food products. The objectives were to: i) characterize these by-products through physicochemical and functional analyses for flour production; and ii) evaluate the effect of their incorporation on the physicochemical and sensory properties of sponge cakes. It was hypothesized that peel flours would increase fiber and phenolic compound content without negatively affecting sensory acceptance.

METHODS

Preparation of potato and sweet potato peel flours

Potato (Solanum tuberosum L., cv. Innovator) and orange-fleshed sweet potato (Ipomoea batatas L., cv. Gem) peels were obtained by manual peeling (1.5 mm thickness), washed, soaked in 5% acetic acid for 15 minutes, and dried at 60 °C for 5 hours until constant weight. The dried material was milled (KN 295 Knifetec™, FOSS, Denmark) to approximately 0.2 mm and stored in polypropylene bags.

Moisture, crude fiber, and ash contents were determined according to AOAC methods (2005): oven drying at 105 °C (method 925.09), sequential acid-alkaline digestion (method 962.09), and incineration at 525 °C (method 923.03), respectively. Water activity (Aw) was measured using a LabSwift-aw device (Novasina, Switzerland) after 40–50 minutes of equilibration.

Bulk density was determined following Akter et al.[3] with slight modifications, calculated as sample weight divided by its volume in a 100 mL graduated cylinder. Water absorption capacity (WAC) and oil absorption capacity (OAC) were assessed by mixing 1 g of sample with 10 mL of distilled water or sunflower oil, respectively, followed by vortexing, 30-minute standing at 25 °C, and centrifugation at 3000 rpm for 20 minutes (Heal Force®, Neofuge 15R, China). Results were expressed as grams of absorbed water or oil per gram of dry sample, calculated using Equation (1).

$$WAC \ or \ OAC = \frac{(P_2 - P_1)}{P_0} \quad (1)$$

Where P_0 is weight of the dry sample (g), P_1 is weight of the tube plus the dry sample (g) and P_2 is weight of the tube plus the sediment (g).

Color parameters (L*, a*, b*) were measured using a portable colorimeter (Hunter Lab, MiniScan EZ, USA), D65 illumination and a 2° observer. During measurement, the sample was placed in a black box to prevent light interference with the optical beam[11]. From these values, chroma (C*) and hue angle (°hue) were calculated using Equations (2) and (3):

$$C^* = \sqrt{a^2 + b^2} \quad (2)$$

$$h^\circ = arctan\left(\frac{b}{a}\right) \quad (3)$$

Determination of Total Phenolic Compounds

Phenolic extraction was performed following Shepelev et al.13 with minor modifications. Ten grams of peel flour were mixed with 100 mL of an ethanol-water solution (4:1, v/v) and subjected to microwave-assisted extraction (Bioevopeak, China) at 20% power for 15 minutes. The extract was then centrifuged at 10000 rpm for 15 minutes and filtered. This procedure was repeated three times, and the combined supernatants were collected for subsequent analysis.

Total soluble phenolic content was determined according to Singh et al.[14] with slight modifications. 10 µL of extract was combined with 120 µL of distilled water, 100 µL of Folin–Ciocalteu reagent (0.25 N), and 200 µL of 7.5% (w/v) sodium carbonate solution, followed by homogenization with an additional 1,500 µL of distilled water. The mixture was incubated in the dark at 40 °C for 30 minutes, and absorbance was measured at 765 nm using a spectrophotometer (Ultrospec 2100pro, Biochrom Ltd., Cambridge, UK). Results were expressed as milligrams of gallic acid equivalents (GAE) per 100 g dry weight, based on a gallic acid standard calibration curve.

Formulation sponge cakes

Sponge cake formulations (Table 1) were based on a traditional Genoise recipe. Three formulations were prepared: a control (100% wheat flour), SC-PPF (10% substitution with potato peel flour), and SC-SPF (10% substitution with sweet potato peel flour). All ingredients used for sample preparation, including refined type 0000 wheat flour (Ramírez, Molino Harinero de Ramírez S.A., Argentina), sugar (Ledesma, Grupo Ledesma, Argentina), fresh eggs (Clara Huevo, Grupo El Fresno S.R.L., Argentina), and vanilla essence (Alicante, La Virginia S.A., Argentina), were obtained from local retail markets. To prepare the sponge cakes, eggs and sugar were whipped until a stable, aerated mixture formed. Sifted flours were gradually incorporated by folding to preserve aeration. Portions (30 g) were placed in circular molds (8.5 cm in diameter × 4 cm in height) and baked in a convection oven at 170 °C for 10 minutes. After baking, samples were unmolded and cooled at room temperature for 15 minutes before further analysis. The 10% substitution level was selected based on preliminary trials, as higher levels reduced gluten content, negatively affecting cake volume and sponginess. Additionally, increased water retention led to denser batters, while higher concentrations produced stronger residual flavors, compromising the sensory acceptability of the final product.

Table 1. Formulation (%) of sponge cake.

Ingredients	Control	SC-PPF	SC-SPF

Egg	43.25	43.25	43.25
Sugar	26.50	26.50	26.50
Wheat flour	28.00	25.20	25.20
Potato peel flour	0.00	2.80	0.00
Sweet potato peel flour	0.00	0.00	2.80
Vainilla essence	2.25	2.25	2.25

Determination of physicochemical, color, and texture characteristics of sponge cakes

Moisture content (%), crude fiber (%), water activity (Aw), and total phenolic compounds of the sponge cake samples were determined according to the official AOAC methods (AOAC, 2005) previously described. Color measurements of the sponge cake samples (crumb only and including crust) were conducted as described in Section 2. Based on the values obtained for L*, a*, and b* parameters of the sponge cake crust in the CIELAB color space, the browning index (BI), as defined in Eq. (4), is an appropriate indicator for assessing the browning extent in sweet baked products, was calculated using Equation (4):

$$BI = 100 * \left(\frac{0.31 * x}{0.172}\right) \quad (4)$$

$$x = \frac{(a + 1.175L)}{(5.645L + a - 3.012b)}$$

The textural properties were determined using a texture analyzer (Instron 3342™, USA). Cylindrical cake samples (2.5 cm in diameter and 2 cm in height) were cut from the center of each formulation and placed on the equipment platform for analysis. A cylindrical probe with a diameter of 12.5 mm was used to compress the samples to 50% of their original height at a speed of 1 mm/s. The maximum penetration force (Fmax), expressed in Newtons (N), was determined and defined as the resistance of the sample to penetration.

Sensory evaluation of the sponge cakes

Sensory evaluation was conducted with 80 adult panelists (>18 years) at the Faculty of Bromatology, National University of Entre Ríos, following ISO 8589 (2007)[15] standards. Each participant received three sponge cake samples (5 × 5 cm), prepared on the same day, randomly coded and served on white plates. Panelists evaluated color, flavor, taste, texture, and overall acceptability using a nine-point hedonic scale (1 = dislike extremely; 9 = like extremely). Water was provided between samples for palate cleansing. The study was approved by the Institutional Ethics Committee (EXP_FBRO-UER:0000034/2025).

Statistical Analysis

All tests were performed in triplicate, and results are presented as mean ± standard deviation. Statistical analysis was conducted using the statistical software InfoStat® version 2000 (Universidad de Córdoba, Córdoba, Argentina). Data were analyzed by analysis of variance (ANOVA), and when significant differences were detected, Fisher's Least Significant Difference (LSD) test was applied at a 95% confidence level ($p < 0.05$). Sensory data were analyzed using repeated measures ANOVA followed by Least Significant Difference (LSD) ($p < 0.05$).

RESULTS

Physicochemical characteristics, functional properties and color of the flours

Supplementary Figure S1 presents an image of the sponge cakes obtained in this study. Table 2 summarizes the physicochemical properties of the flours, including moisture, crude fiber, ash content, and water activity (Aw). PPF showed higher moisture content than SPF ($p < 0.05$), although both remained below 10%. SPF exhibited significantly higher fiber and ash contents ($p < 0.05$). Aw values were below 0.5–0.6 for both flours. Additionally, bulk density, WAC, OAC, and TPC were higher in SPF than in PPF ($p < 0.05$).

Table 2. Physicochemical characteristics and functional properties of the flours.

Characteristics	PPF	SPF
Moisture (%)	8.23 ± 0.01^{b}	6.38 ± 0.11^{a}

Crude fiber (%)	11.9±0.82[a]	60.1±0.12[b]
Ash (%)	4.20±0.07[a]	8.29±0.03[b]
Aw	0.35±0.00[a]	0.41±0.01[b]
Bulk density (g/ml)	0.59±0.001[a]	0.70±0.00[b]
WAC (g/g)	3.11±0.06[a]	3.34±0.01[b]
OAC (g/g)	2.09±0.31[a]	2.21±0.13[a]
Total Phenolic (mg GAE/100 g DW)	17.6±0.34 [a]	27.7±1.30[b]

Values represent the mean ± standard deviation. Different letters in the columns indicate significant differences according to Fisher's LSD test ($p < 0.05$). DW, dry weight. GAE: gallic acid equivalents

Table 3 summarizes the CIE-Lab color parameters (L*, a*, b*), C*, and °hue of the flours. PPF showed significantly higher lightness (L*) than SPF ($p < 0.05$). The a* value was significantly higher in SPF, whereas the b* value was higher in PPF ($p < 0.05$). The chroma (C*) values also differed significantly between samples ($p < 0.05$), with PPF exhibiting higher color saturation. No significant differences were observed in °hue between the flours ($p > 0.05$).

Table 3. Instrumental color parameters (L*, a*, b*), C*, and °hue of the flours.

Properties	PPF	SPF
L*	63.3±0.00[b]	45.7±0.04[a]
a*	5.47±0.02[a]	6.80±0.02[b]
b*	20.4±0.05[b]	19.4±0.01[a]
C*	21.15±0.05[b]	20.57±0.01[a]
° hue	75.05±0.04[a]	75.05±0.04[a]

Values represent the mean ± standard deviation. Different letters in the columns indicate significant differences according to Fisher's LSD test ($p < 0.05$).

Physicochemical characteristics and color and texture of sponge cakes

Table 4 summarizes the physicochemical characteristics of the sponge cakes, including moisture, crude fiber, water activity (Aw), and total phenolic content (TPC). The incorporation of PPF and

SPF significantly increased moisture and crude fiber compared to the control ($p < 0.05$). SC-SPF showed higher moisture and fiber contents than SC-PPF ($p < 0.05$). No significant differences in Aw were observed among samples, with values around 0.88. Regarding TPC, the SPF-containing sponge cake exhibited significantly higher values than SC-PPF ($p < 0.05$), indicating a greater contribution of phenolic compounds from sweet potato peel flour.

Table 4 summarizes color parameters (L*, a*, b*), browning index (BI), and firmness of the sponge cakes. The incorporation of PPF and SPF significantly affected both crust and crumb color ($p < 0.05$). Reformulated samples showed lower L* values, indicating darker products, with SC-SPF exhibiting the darkest crust. The a* values increased and b* values decreased compared to the control ($p < 0.05$). For crumb color, control samples had the highest L* values, while SC-PPF and SC-SPF showed lower values and higher a* values, particularly in SC-SPF ($p < 0.05$). BI values were higher in reformulated samples ($p < 0.05$), indicating increased browning. Firmness also increased significantly in SC-PPF and SC-SPF, with the highest values observed in SC-SPF.

Table 4. Physicochemical characteristics and color and texture measurements of sponge cakes

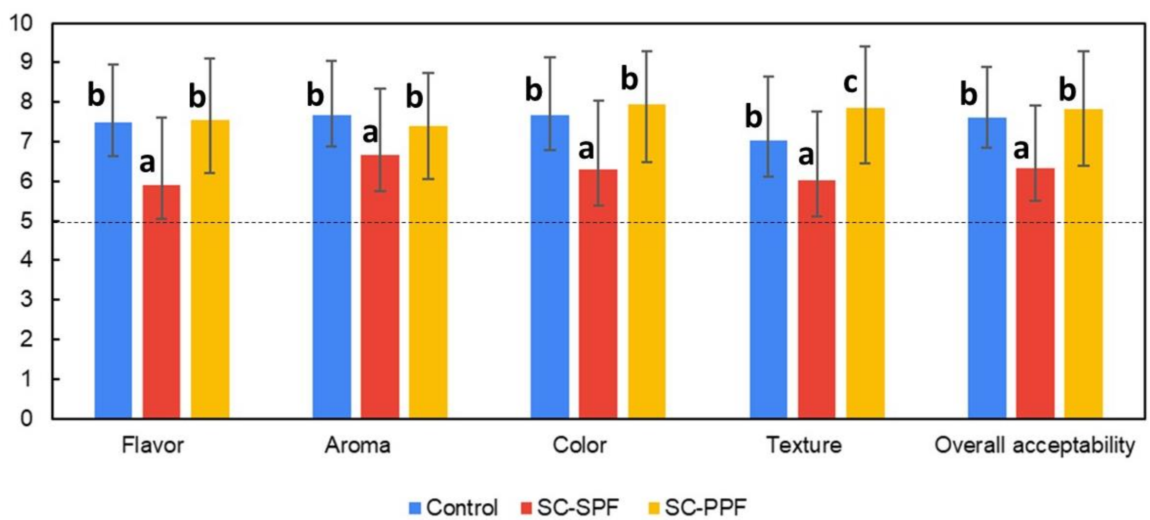
Characteristics	Control	SC-PPF	SC-SPF
Moisture (%)	24.6±0.00[a]	67.2±0.57[b]	70.7±0.99[c]
Crude fiber (%)	0.64±0.01[a]	6.75±0.85[b]	15.8±0.96[c]
Aw	0.88±0.01[a]	0.87±0.01[a]	0.88±0.00[a]
Total Phenolic (mg GAE/ 100 g DW)	ND	14.50±1.25 [a]	21.50± 0.80 [b]
L* crust	82.04±0.00[c]	57.04±1.69[b]	53.51±1.19[a]
a* crust	6.57±0.00[a]	8.28±0.21[b]	8.08±0.36[b]
b* crust	41.89±0.00[c]	36.82±1.02[b]	33.26±0.59[a]
L* crumb	92.33±0.41[c]	69.18±0.99[b]	59.99±0.39[a]
a* crumb	-2.49±0.04[a]	0.38±0.03[b]	2.92±0.02[c]
b* crumb	30.77±0.12[c]	23.96±0.24[a]	28.11±0.08[b]
BI	74.75±0.00[a]	107.52±0.74[c]	102.71±3.15[b]
Firmness (N)	0.73±0.06[a]	1.31±0.08[b]	2.54±0.2[c]

Values represent the mean ± standard deviation. Different letters in the columns indicate significant differences according to Fisher's LSD test ($p < 0.05$). DW, dry weight. GAE: gallic acid equivalents.

Sensory evaluation of the sponge cakes

Sensory evaluation results (Figure 1) showed that all samples scored above the midpoint (5) for color, aroma, texture, flavor, and overall acceptability. Among the reformulated samples, SC-PPF achieved the highest ratings, particularly for flavor, and showed values comparable to the control in most attributes. In contrast, SC-SPF received the lowest scores across all parameters. Statistical analysis revealed SC-SPF showed significantly lower scores than both the control and SC-PPF samples for flavor, color, texture, and overall acceptability. No significant differences were observed between SC-PPF and the control for flavor, aroma, color, and overall acceptability, while SC-PPF showed significantly higher texture scores than the other formulations ($p < 0.05$). Overall, SC-PPF was the most accepted formulation, followed by the control, while SC-SPF exhibited the lowest overall acceptability.

Figure 1. Sensory attributes of the evaluated sponge cake samples



Different letters within the same sensory attribute indicate significant differences ($p < 0.05$). Values are expressed as mean ± 95% confidence interval.

DISCUSSION

The moisture values obtained in this study were below the recommended 12–15% limit for powdered foods, which is associated with improved stability and shelf life16. The crude fiber content in PPF was comparable to that reported by Akter et al.[3], confirming consistency with previous research, whereas SPF exhibited considerably higher levels than those reported by Admasu et al.[17] for orange-fleshed sweet potato flour. These differences may be attributed to variations in cultivar, agroclimatic conditions, and agricultural practices[18]. The low Aw values observed further ensure product stability, as higher values could promote chemical and enzymatic reactions, as well as microbial growth, leading to product deterioration[19]. From a sustainability perspective, the utilization of PPF and SPF contributes to reducing agro-food by-product waste[20], while their incorporation into widely consumed baked goods may enhance nutritional quality, particularly by increasing fiber content. Since refined wheat flour is typically low in fiber, the use of these flours represents a valuable strategy to improve fiber intake. According to Argentine regulations, foods containing less than 2 g of fiber per 100 g are considered low in fiber[21], highlighting the functional potential of these ingredients in bakery formulations.

In addition to their compositional attributes, the functional properties of these flours play a key role in their technological applicability. Bulk density, which influences packaging, handling, and transportation, was lower in PPF than in SPF, likely due to differences in fibrous structure and particle arrangement. Variations in initial moisture content may also contribute to these differences[3]. The results obtained are consistent with those reported by Akter et al.[3], although lower than values documented by Jeddou et al.[16] and Admasu et al.[17]. Water absorption capacity was higher in SPF, which can be explained by its greater fiber content and the abundance of hydroxyl groups that enhance water binding through hydrogen bonding[22]. This property suggests improved moisture retention in food systems. In contrast, the similar oil absorption capacity observed in both flours indicates comparable performance in terms of flavor retention and texture, which is desirable in bakery products[17]. Furthermore, oil retention may contribute to extending product shelf life by reducing moisture migration.

Regarding bioactive compounds, the TPC values confirmed the presence of phenolic compounds in both flours, although at lower levels than those reported in the literature. For potato peel, Hsieh et al.[23] reported a TPC of 86.3 mg/100 g in freeze-dried samples, while Albishi et al.[24] documented concentrations as high as 824 mg/100 g in the Innovator variety. In the case of sweet potato peel, Anastácio and Carvalho[25] reported values ranging from 102 to 621 mg GAE/100 g dry weight, and Anastácio et al[26] obtained values up to 1187 ± 0.69 mg GAE/100 g under optimized extraction conditions. These discrepancies may be attributed to differences in botanical origin, postharvest handling, drying conditions, particle size, and extraction efficiency.

Color is also a key quality attribute influencing consumer acceptance. The differences observed in color parameters may affect the visual characteristics of final products, such as sponge cake crumb. The higher redness (a*) in SPF is likely associated with carotenoid pigments typical of sweet potato varieties, particularly the Gem cultivar. Although differences in chroma indicate variations in color intensity, the absence of differences in hue suggests that both flours share similar chromatic tones within the yellow–green spectrum.

When incorporated into sponge cakes, these flours significantly influenced physicochemical properties. The increase in moisture observed in the reformulated samples, particularly in SC-SPF, can be attributed to the higher water retention capacity of dietary fiber, which reduces moisture loss during baking. The higher crude fiber content in SC-SPF compared to SC-PPF reflects the composition of the corresponding flours, indicating effective transfer of this component to the final product. Although sponge cakes are typically high in sugar and should be consumed in moderation, the incorporation of peel flours significantly enhances their nutritional profile. However, Aw values around 0.88 indicate susceptibility to microbial growth, which may limit product shelf life[10,19].

The higher TPC observed in SC-SPF may be attributed to the greater concentration of phenolic compounds in sweet potato peel, suggesting its potential as a functional ingredient to enhance antioxidant properties in bakery products. Nevertheless, both peel flours demonstrated their potential as sources of bioactive compounds, supporting the development of value-added formulations.

The incorporation of peel flours also affected color and texture[25]. The darker appearance of SC-PPF and SC-SPF may be associated with the intrinsic color of the flours and enhanced browning reactions during baking, consistent with previous reports[3]. The increase in a* values and decrease in b* values indicate a shift toward reddish-brown tones. The higher BI values suggest an intensified browning effect, likely due to both natural pigmentation and enhanced Maillard reactions driven by higher levels of reducing sugars and amino acids[28].

Regarding texture, the increased firmness observed in SC-PPF and SC-SPF can be explained by the higher fiber content, which is associated with increased product hardness[29]. The higher firmness of SC-SPF may be linked to its greater water absorption capacity, resulting in a more compact structure[30]. The denser crumb structure observed in the reformulated samples may also be due to the interference of dietary fiber with gas retention during baking, limiting expansion, as well as reduced gluten content in the formulations30.

Finally, sensory evaluation indicated that SC-PPF achieved higher acceptance than SC-SPF, suggesting better suitability for product development. The lower scores observed in SC-SPF may be related to its higher fiber content, which can negatively affect texture and flavor perception. These results are consistent with previous findings reported by Akter et al.[3]. A limitation of the present study lies in the characterization of the sensory panel. Although the use of 80 untrained panelists is appropriate for consumer acceptability studies, it limits the ability to perform fine discrimination among specific sensory attributes and restricts the interpretation of the results to overall consumer perception rather than descriptive sensory analysis. From a formulation perspective, although SPF provides greater nutritional benefits, further optimization, such as adjusting substitution levels, reducing particle size, or applying flavor-masking strategies, may be necessary to improve its sensory appeal.

CONCLUSION

The production of flours from potato and sweet potato peels represents a sustainable approach to valorize agro-industrial by-products and reduce food waste. These flours exhibited low moisture and water activity, contributing to product stability and extended shelf life, along with notable levels of crude fiber and ash, particularly in sweet potato peel flour (SPF). Regarding functional properties, both flours showed suitable bulk density, water absorption capacity (WAC), and oil absorption capacity (OAC), supporting their applicability in bakery systems. Additionally, both flours contained measurable levels of phenolic compounds, highlighting their potential as functional ingredients.

The incorporation of peel flours at a 10% substitution level significantly increased dietary fiber content in sponge cakes, especially in the SPF formulation. Sensory evaluation indicated that all samples were acceptable, with scores above the midpoint of the hedonic scale. SC-PPF showed higher flavor acceptance and overall similarity to the control, while SC-SPF presented lower scores. Furthermore, the addition of peel flours enhanced the total phenolic content of the final products, with SPF contributing the greatest increase.

Overall, these results support the sustainable use of food waste and the development of functional bakery products with potential industrial application.

ACKNOWLEDGMENTS

The authors would like to sincerely thank all the participants who took part in the sensory evaluation for their time, willingness, and valuable contributions. Their participation was essential for the development of this study.

AUTHORS' CONTRIBUTIONS

M. A. B.: Formal analysis, Investigation, Methodology, Data curation, Validation, Software, Writing – original draft, Writing – review and editing. M. L.: Formal analysis, Investigation, Methodology, Data curation, Software, Writing – original draft. V. J. L.: Formal analysis, Investigation, Methodology, Funding acquisition, Supervision, Validation, Writing – review and editing. All authors contributed to critical revision of the manuscript.

FUNDING

This research was funded by the collaboration of the University National of Entre Ríos. Experiments were funded as part of the project PID 9136.

CONFLICTS OF INTEREST

The authors state that there are no conflicts of interest when writing the manuscript

DATA AVAILABILITY

Data will be provided upon request to the corresponding author.

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