Development of biscuit made from potato flour variety Parda Pastusa (*Solanum tuberosum* L.)

Elaboración de galletas a base de harina de papa de la variedad Parda Pastusa (*Solanum tuberosum* L.)

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Abstract

Potato is considered the fourth more important crop in the world, its consumption has passed from fresh product to industrial products, in that sense the objective of the present study was to determine the maximum level of substitution of the wheat flour with potato flour of the variety parda pastusa (*Solanum tuberosum*), in the preparation of fermented sweet cookie. A completely random experimental design was carried out, where the study factor was at levels of replacement, 30%, 40% and 50%, the response variables were evaluated: sensory (color, flavor, texture and acceptability) and proximal chemical (dry matter, protein, ash and fat). Variance analysis was use to find significant differences. No statistically significant differences in color, texture and acceptance, while in the variable flavor difference was 0% and 30% substitution, was decreased in protein and fat in: (7.42%, 17.40%, 23.62%) and (25.65%, 42.59%, 55.87%) respectively, while the dry matter and ash increased by (3.83%, 4.95%, 5.62%) and (13.14%, 17.71%, 23.43%) respectively. The cookie with 30% substitution evidence a good acceptance and use commercially, higher percentages are not recommended.

Key words: Chemical proximal, fermented sweet biscuit, percentage, substitution.

Resumen

La papa (*Solanum tuberosum* L.) se considera el cuarto cultivo más importante en el mundo y su consumo ha pasado de producto fresco a producto laborado en forma industrial. En el estudio se determinó el nivel máximo de sustitución de la harina de trigo por harina de papa de la variedad Parda Pastusa en la elaboración de galletas fermentadas dulces. Se utilizó un diseño completamente al azar, donde el factor de estudio fueron el nivel de sustitución, 0%, 30%, 40% y 50%, y las variables de respuesta: sensoriales (color, sabor, textura y aceptabilidad) y químicas proximales (materia seca, proteína, ceniza y grasa). No se encontraron diferencias ($P > 0.05$) en color, textura y aceptación; mientras para la variable sabor fue diferente en los niveles 0% y 30% de sustitución. Para los niveles de sustitución se encontraron, respectivamente, reducciones en contenido de proteína en 7.42%, 17.40% y 23.62%, y de grasa en 25.65%, 42.59% y 55.87%; mientras que la materia seca aumentó 3.83%, 4.95% y 5.62% y el contenido de ceniza en 13.14%, 17.71% y 23.43%, respectivamente. Con la sustitución de 30% se produjeron galletas de buena aceptación mientras que niveles mayores no son recomendables.

Palabras clave: Galleta dulce fermentada, porcentaje, químico proximal, sustitución.

Introduction

Potato (*Solanum tuberosum* L.) is considered as the fourth most important crop in the world after rice, wheat and corn (Navarre *et al.*, 2011), according to Woolfe (1987) is a source of protein of high biological value, has a favorable ratio of caloric and total protein, and is an important source of vitamins and minerals (Pyler, 1973; Andre *et al.*, 2007). According to FAO (2009) world consumption of this food is shifting from fresh food products to industrial products in frozen, fried, chips, flour, among others.

Potato flour, according Yadav et al. (2006) presents great versatility, functions as enhancer of flavor and color, is used as a thickener and has begun to break into the baked goods. Greene and Bovell-Benjamin (2004) estimated at 10% the maximum level of substitution of wheat flour by potato flour in bread making. Ceron et al. (2011) found that when potato flour from the variety Parda Pastusa is used, the level of substitution can be 20%, and can even reach 30%.

This work aimed at evaluating the maximum level of substitution of wheat flour by potato flour from the variety Parda Pastusa for production of fermented sweet cookies, considering their physical, sensory, and chemical characteristics, and the product acceptance.

Materials and methods

Location

The research was conducted at the Pilot plant of the Faculty of Agroindustrial Engineering, University of Nariño at Torobajo, Pasto (Nariño), located at 2,527 meters above sea level, average temperature 14 °C and a relative humidity of 70%.

Raw material

For the preparation of the cookies, potato variety Parda Pastusa was used, provided by a commercial company in the municipality of Pasto with less than 24 hours after being harvested, selected and classified according to Colombian Technical Standard (NTC 341) for potato consumption. Other inputs used were special bakery wheat flour, sugar, margarine, milk, eggs, salt, emulsifiers, fresh yeast, baking soda and water.

Preparation of potato flour

Before the production of flour, potatoes were conditioned by washing and peeling using an Indumatic tuber peeler, and subsequent immersion in sodium bisulfite at a concentration of 100 ppm (Berestain *et al.*, 1990), in order to prevent enzymatic browning favored in the drying operation. They were then cut to 2 mm-thick slices and dried in a tray dryer built by Industrias Quimicas FIQ Ltda., at 40 °C for 6 h and at 50 °C for additional 6 h with air velocity of 5 m/s, till constant moisture content between 10% to 12% was achieved. Temperatures were applied in accordance with the recommendations of Chemkhi (2005) and Rodríguez-Sandoval *et al.* (2012). Once dry, the potatoes were passed by a hammer mill and then through a screen model PS-35 series 1182 with sieves 80 - 100 A.S.T.M.E. for 5 min, according to the Colombian Technical Standard NTC 267 for wheat flour; according to the Standard at least 98% of flour must pass through a sieve of 212 μm. The weighing of samples and the determination of performance were made in an analytical balance Precisa 310M of 3000 g with accuracy of ± 0.01g (Swiss).

Preparation of Cookies

The formula for making cookies was taken from the study of Reátegui *et al.* (2001) (Table 1) and Colombian Technical Standard (NTC-1241) for production of fermented sweet cookies, following these steps: (1) the ingredients were weighed in a 2 kg balance according to the recommended percentages (Table 1); (2) the ingredients were mixed using a mixer Thunderbird with capacity up to 25 kg to obtain a homogeneous mass; (3) the obtained mass was cut into portions of 35 g and the pieces

Table 1. Ingredient percentages in bread production

Ingredient	Percentage
Flour	100
Yeast	0.5
Margarine	15
Sugar	20
Salt	1
Sodium bicarbonate	1
Soy lecithin	3
Milk	15
Egg	15
Water	According to flour absortion

Table 2. Formulations used and evaluated (calculation based on 1000 grams of flour) in the production of bread

Raw material	Formulations (substitution percentages wheat flour for potato flour)			
	0%	30%	40%	50%
Wheat flour (g)	1000	700	600	500
Potato flour (g)	0	300	400	500
Yeast: fresh (g)	5	5	5	5
Margarine (g)	150	150	150	150
Sugar (g)	200	200	200	200
Salt (g)	10	10	10	10
Sodium bicarbonate (g)	10	10	10	10
Soy lecithin (g)	30	30	30	30
Milk (g)	150	150	150	150
Eggs (g)	150	150	150	150
Water (g)	According to flour absortion			
Total raw material (g)	1705	1705	1705	1705

were placed in a fermentation chamber for 60 minutes; and (4) finally they were placed in a gas kiln Turbo 2000 Imos at 150 °C for 30 min and cooled to room temperature, packaged and stored.

Experimental design

The study factor evaluated was the level of substitution of wheat flour by potato flour; for this, the results obtained by Cerón *et al.* (2011) in making bread from wheat flour, were taken as basis, but using higher percentages of replacement (wheat flour / potato flour) as follows: C1 (100: 0), C2 (70:30), C3 (60 : 40) and C4 (50:50) (Table 2). An univariate categorical completely randomized design with four levels and three replicates was used, in order to determine the effect of potato flour content on the sensory response (color, flavor, texture and acceptability) and proximal chemical (dry matter, was used protein, fat and ash) variables. The experimental design and data analysis was done with Statgraphics © Plus centurion version XV.II program, whereby the variance analysis and comparison test was performed using Fisher's LSD at 5% level of significance.

Sensory evaluation and proximal analysis

The sensory preference test was conducted with 15 trained people who had available samples cookies made with wheat flour and potato flour as a partial substitute. The preference results were evaluated by the hedonic scale method proposed by Anzaldiia (1994), where the characteristics of color, flavor, texture and acceptability were rated according to the scale: I like it a lot = 5, I like it = 4, I am indifferent = 3, it disgusts me = 2, and it disgusts me a lot = 1.

In specialized laboratories of the University of Nariño, proximal chemical analyses to the potato flour and the cookies

with different percentages of this flour. The analyzes were dry matter, ash, fat and protein, according to the method of food analysis proposed by Bernal (1998).

The evaluation of the durability of the cookies with potato flour was determined by the method described by Reategui *et al.* (2001); for this, the cookies were stored for 60 days at room temperature of 14 °C and relative humidity of 70%, after which parameters as pH and moisture were determined, which are early indicators of change (Reátegui *et al.*, 2001).

Results and discussion

Flour field

The yield of potatoes after mechanized peeling was 87.58% ± 6.33%, meaning that about 12% of the variety Parda Pastusa is unusable peel, while the initial dry matter content (total solids) was of 27.41 ± 3.62%, parameters that influence the performance for producing flour. These results are similar to those found by Koduvayur *et al.* (2010).

Physical characteristics of the cookies

As the percentage of replacement increases, cookies tend to have fractures and increase its hardness. Singhy *et al.* (2003) found that potato flour has a higher resistance to fracture and Ho et al. (2005) in cookies made with unconventional flours, found that as the level of substitution increased, also increased the fragility of the cookies.

In the present study we found that flour substitution values > 50% in the dough favor the fragility of cookies, which difficult handling and molding (Figure 1) as a result of the low-gluten content in this composite flour. Moreover, lower water absorption was observed when the substitution percentages increased (wheat flour / potato flour: 100: 0 (40%), 70:30 (27%), 60:40 (20%) and 50:50 (15%). After baking cookie loses between 12% and 15% moisture.

The cookies were baked at 150 °C for 30 min and lost between 12% and 15% moisture and as the percentage of potato flour increased, the cookies were susceptible to burning, especially in the part in direct contact with the baking tray (Figure 2).

Sensorial characteristics

The best color rating was for the cookies without potato flour, which was due to the absence of burned areas, however the degree of rating was not different (P > 0.05) between evaluators (Figure 3).

The taste of the cookies with 30% potato flour had the highest rating (4.2 – I like), while the cookies without potato flour obtained the lowest score (indifferent) (Figure 4) compared with those in which a substitution level of 30% (P < 0.005) was

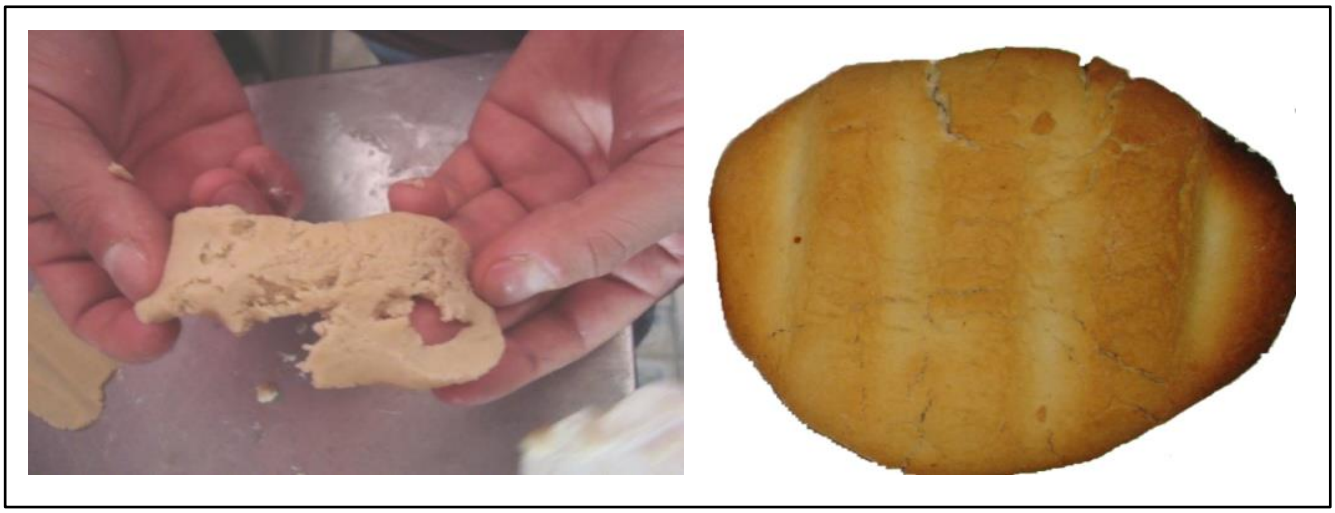

Figure 1. Effects of substitution with potato flour in the cookies

Figure 2. Effects of substitution with potato flour after baking

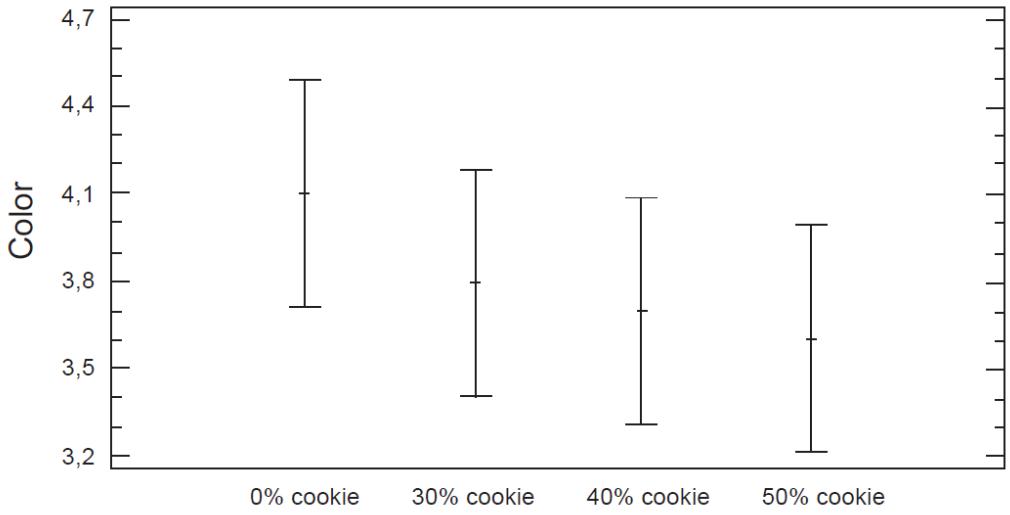

Figure 3. Averages diagram and intervals at 95% of the Fisher LSD for the variable color.

used.

Cookies without potato flour obtained the best score in the characteristic texture, while cookies with 50% potato flour received the lowest rating because of the fragility; however no differences (P > 0.05) between cookies due to replacement levels were found (Figure 5).

Cookies with 30% potato flour were the most accepted by the evaluators with a score of 4.05 (I like) and 60% acceptability in all its features, while with 50% substitution were the least accepted, though the differences were not were significant (P > 0.05) (Figure 6).

At the end an overall assessment was made taking into account all the properties or response variables evaluated: color, taste, texture and acceptability as shown in Figure 7. The preferred or best score was obtained by cookies with 30% wheat flour replacement by potato flour; the results of the sample with 30% substitution are presented in Table 3.

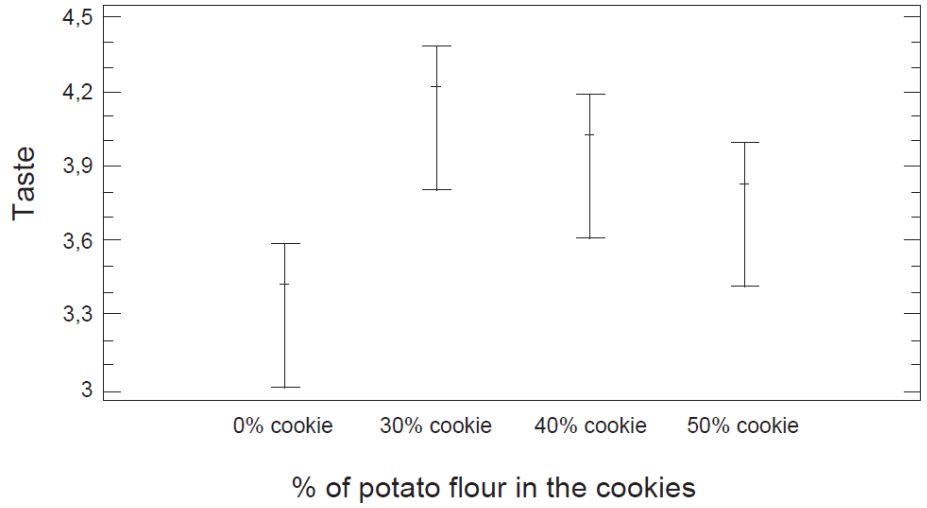

Figure 4. Averages and intervals for the least significant difference at 95% for the variable taste.

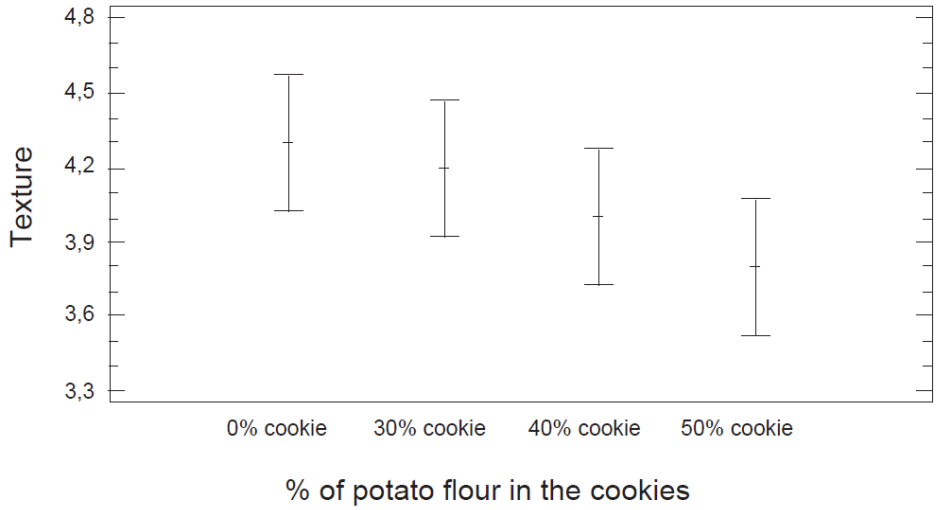

Figure 5. Average diagram and intervals for Fisher's least significant difference at 95% for the variable texture.

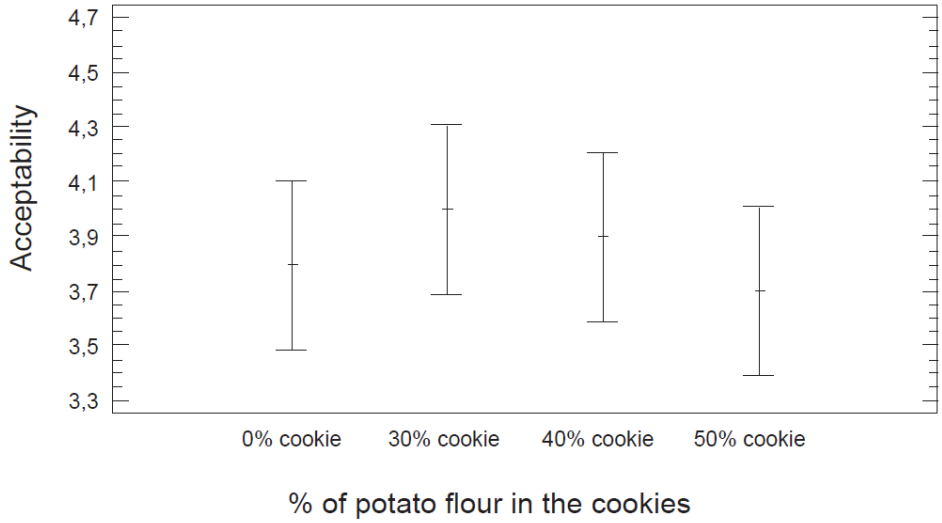

Figure 6. Average diagram and intervals for Fisher's least significant difference at 95% for the variable acceptability.

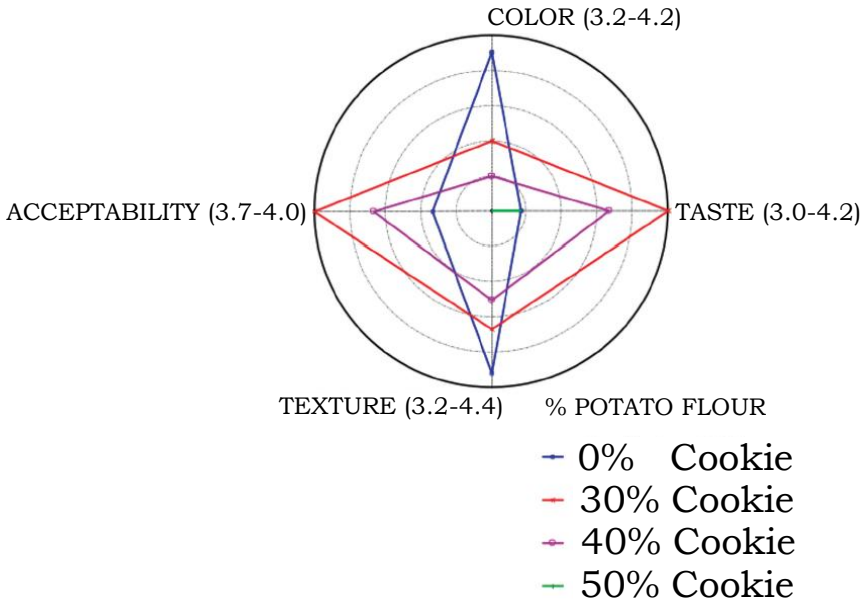

Figure 7. Overall assessment averages for the sensory scores.

Table 3. Results of the hedonic test in cookies with 30% potato flour.

Acceptance (%)	Characteristic			
	Color	**Flavor**	**Texture**	**Acceptability**
I like it	68.42	92.86	88.10	85.00
Indifferent	31.58	7.14	7.14	15.00
It disgusts me	0.00	0.00	4.76	0.00

Proximal analysis

Regarding the composition of the flours (Table 4), the highest protein content was found in wheat flour, exceeding in 45.95% the protein content of potato flour. The protein value of wheat flour in this study is higher than that found by Escobar *et al.* (2009); but lower than that found by Moiraghi *et al.* (2005), which could be attributed to the origin of the raw material.

For potato flour, protein levels were similar to those observed by Pineda and Vazquez (2010) and the baking laboratory of the Universidad Nacional Agraria La Molina (2008). According Bonierbale *et al.* (2004) the quality of the potato tuber is related to the chemical composition and factors such as variety, climate, management systems, season and crop zone, origin, method of storage and postharvest handling.

In the produced cookies, as the percentage of replacement increases, the percentages of protein and fat tend to decrease (Table 5). According to Maldonado and Pacheco (2000), the tendency is to obtain a calorie reduction via substitution of fats, however in this study a calorie reduction was evidenced by flour replacement. Moreover, dry matter and ash increased with increasing levels of flour substitution.

Durability

At all levels of substitution, both the moisture content and pH of the flours in the cookies did not vary between 30 and 60 days after prepared (Table 6), similar results to those found by Garcia and Pacheco (2007) on cookies made with arracacha flour and Reátegui *et al.* (2001) in cookies made with unconventional flours.

Table 4. Proximate analysis of potato and wheat flour (g/100g). In percentages

Component	Potato flour*	Wheat flour*
Moisture	10.92 ± 1.11	11.50 ± 0.53
Raw protein	7.40 ± 0.51	10.80 ± 0.82
Fat	0.85 ± 0.09	1.36 ± 0.12
Ash	3.38 ± 0.28	0.60 ± 0.08

*Average values (n = 5) ± standard deviation

Table 5. Proximate analysis of cookies with different levels of substitution of wheat flour by potato flour (g/100g).

Component	Cookie (0%*)	Cookie (30%*)	Cookie (40%*)	Cookie (50%*)
Dry matter	83.57 ±1.86	86.78 ±1.88	87.73 ± 0.96	88.27 ± 1.65
Protein	12.55 ±1.25	11.63 ±0.45	10.35 ± 0.86	9.57 ± 0.86
Fat	20.77 ±1.26	15.45 ±0.76	11.93 ± 1.06	9.17 ± 0.96
Ash	1.75 ±0.11	1.98 ±0.16	2.06 ± 0.14	2.16 ± 0.11

*Average values (n = 5) ± standard deviation

Table 6. Changes in moisture and pH content in cookies with different percentages of potato flour, 30 and 60 days after prepared.

Parameter	30% Cookie		40% Cookie		50% Cookie	
	Days					
	30*	60*	30*	60*	30*	60*
Moisture %	13.38±2.12	13.4±1.73	12.41±2.23	12.42±1.89	11.85±1.16	11.89±2.64
pH (18 °C)	6.82±0.96	6.80±0.87	6.78±0.58	6.80±0.64	6.83±0.37	6.82±0.048

*Average values (n = 5) ± standard deviation

Conclusions

- Cookies made with 30% substitution of wheat flour by potato flour var. Parda Pastusa, showed the highest degree of preference in the evaluation tests.
- The results confirm the possibility of using potato flour from the var. Parda Pastusa as a partial substitute for wheat flour in the cookie industry.
- Flour substitution levels greater than 50% results in a poor quality product, friable and of poor durability.

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