

**The reusing technology of guava peel, pulp and core for cookies elaboration****A tecnologia do reaproveitamento da casca, polpa e núcleos de goiaba para a elaboração de biscoitos**

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**ABSTRACT**

The objective of this study was to develop highly nutritious cookies from flour made with guava peel, pulp and cores, obtained by drying and milling the different parts of the fruit, and to test the acceptance by potential consumers. The treatments contained flour made from guava peel, pulp and core in the following percentages: 5.0%, 10.0%, 15.0% and 20.0%. Sensory analysis was performed using a preference-ranking test. The experimental results were subjected to statistical analysis, which showed a preference for guava cookies with 5% peel and core flour. The cookies made with guava pulp flour showed no significant differences among the treatments. The analysis of fibers showed that all the cookies may be considered to have a large amount of fibers. Therefore, the use of residues from the guava juice and jam industries may be commercially viable in the production of cookies, including the previously unexplored possibility of using guava pulp in the development of a new product.

**Keywords:** Sensory, Analysis, Residues, Nutritional value.**RESUMO**

O objetivo deste estudo foi desenvolver biscoitos altamente nutritivos a partir de farinha feita com casca de goiaba, polpa e núcleos, obtidos por secagem e moagem das diferentes partes da fruta além de testar a aceitação pelos potenciais consumidores. Os tratamentos continham farinha feita de casca de goiaba, polpa e núcleo nas seguintes porcentagens: 5,0%, 10,0%, 15,0% e 20,0%. A análise sensorial foi realizada utilizando um teste de classificação de preferência. Os resultados experimentais foram submetidos à análise estatística, que mostrou preferência por biscoitos de goiaba com 5% de farinha de casca e núcleo. Os cookies feitos com farinha de polpa de goiaba não mostraram diferenças significativas entre os tratamentos. A análise de fibras mostrou que todos os cookies podem ser considerados como tendo uma grande quantidade de fibras. Portanto, o uso de resíduos das indústrias de suco de goiaba pode ser comercialmente viável na produção de cookies, incluindo a possibilidade anteriormente inexplorada de usar polpa de goiaba no desenvolvimento de um novo produto.

**Palavras-chave:** Sensorial, Análise, Resíduos, Valor nutricional.**1 INTRODUCTION**

Guava fruits have high nutritional value, with high concentrations of iron, vitamin C, sugars and tannin. Guava leaves and peel also contain, in smaller quantities, lipids, phosphorus, calcium and vitamins A, B1 and B2. Guava is one of the most important

fruits in the subtropical and tropical regions, not only due to its nutritional value but also because of its excellent acceptance for fresh consumption and for industrial use as well as its ability to grow under unfavorable climate conditions<sup>[1];[2]</sup>.

Brazilian industries, searching for greater productivity and a better competitive edge in the national and international markets, are attempting to improve the economic situation of product development by avoiding losses during product processing. One alternative to meet the demand and to put forth new products is the use of complete array of raw materials during produced. Studies regarding food of plant origin have been emphasizing the characteristics and profiles of the nutrients found in plant seeds as an alternative source of protein for human diet<sup>[3]</sup>. Fruit residues may be used as a food supplement that may add nutrients that are lost to the conventional diet due to processing or industrialization<sup>[4]</sup>. Because guava peels are composed mostly of carbohydrates, proteins and pectins, they may be used for flour production.

The idea of producing composite flours to be used for pastry and bread baking is not new. The technical and economical viability of using mixed flour in food has been widely demonstrated, and these types of flour are used in the industry. Some food-production programs have been developed in Brazil with the goal of replacing or reducing the amount of animal protein in the diet by replacing it with plant proteins, which have lower production costs<sup>[5]</sup>.

Cookies are widely consumed, have a long shelf life and are well-accepted, especially by children, and have been formulated in such a way as to enrich them or transform them into sources of fibers or proteins, due to the current high demand for better-quality diets<sup>[5]</sup>.

With this in mind, the present study had the objective of developing highly nutritious cookies by using different percentages of flour made with guava peel, pulp and seeds and of evaluating the acceptance of these cookies by potential consumers with the aid of sensory tests.

**2 MATERIALS AND METHODS****2.1 PREPARATION OF THE RAW MATERIALS AND FLOUR PRODUCTION**

A total of 60 kg of guava (*Psidium guajava* L.) of the red *Pedro Sato* cultivar were acquired in April 2008 from the CEASA in Goiânia, Goiás State, Brazil. To collect a homogeneous sample, the fruits were selected based on their weight, size, appearance (healthy fruits), shape (uniform) and degree of fruit maturation (ripe fruits) defined by a yellow peel color, as observed visually.

The fruits were washed, sanitized with a 150 ppm sodium hypochlorite solution and dried with paper towels. The fruits were then divided into two groups and manually fractioned using stainless steel knives for the subsequent drying of the following parts: peel, core and pulp.

The fractions of each group were dried separately in a forced-air Marconi kiln at 55°C for 72 hours. The fractions were then pre-ground in a Siemens industrial blender and ground in a Marconi mill to produce the flour<sup>[6]</sup>. The flour was then stored in high-density polyethylene plastic bags, hermetically closed and vacuum packed, at room temperature.

**2.2 COOKIE PRODUCTION**

Common wheat flour, manioc starch and other ingredients used to make the cookies were obtained from local stores in Goiânia city, Goiás state (GO), Brazil.

The reference formula followed Soares Júnior et al.<sup>[7]</sup>, with some modifications detailed in Table 1.

Table 1. Concentration of flour (g) using to make the cookies.

Percentage*	Guava Flour**	Wheat Flour	Manioc Starch
5%	30.0 g	140.0 g	70.0 g
10%	60.0 g	120.0 g	60.0 g
15%	90.0 g	100.0 g	50.0 g
20%	120.0 g	80.0 g	40.0 g

\*Percentages calculated in relation to the total weight of the cookies (600 g).

\*\* The same percentages of peel, pulp and core were used.

The cookies made for this study varied in the concentration of guava flour used to replace wheat flour and manioc starch. The wheat flour and manioc starch used in the

control cookies were partially replaced by guava flour made from each of the raw materials (peel flour, pulp flour and core flour) in concentrations of 5.0%, 10.0%, 15.0% and 20.0% relative to the total mass of the formula. The other ingredients were kept constant <sup>[7]</sup>.

### 2.3 PHYSICOCHEMICAL ANALYSES

The physicochemical analyses were performed at the Laboratory of Analysis, Research and Consulting in Foods, Drinks, Environment and Fuel (Laboratório de Análise, Pesquisa e Consultoria em Alimentos, Bebidas, Meio-Ambiente e Combustível – LABM), located in Belo Horizonte, Minas Gerais. The following characteristics were analyzed in triplicate, as established by the Institute Adolfo Lutz <sup>[8]</sup>: loss by drying (moisture content) upon direct drying in a kiln at 105°C; levels of proteins, lipids, sugars, reducing sugars, non-reducing sugars, soluble and insoluble dietary fibers, based on the gravimetric enzyme method; incineration residue (ash); and starch analysis according to the AOAC <sup>[9]</sup>.

### 2.4 SENSORY EVALUATION

The sensory analysis was performed in the laboratory of the Food Technology Sector of the School of Agronomy and Food Engineering of the Federal University of Goiás (Universidade Federal de Goiás – UFG). The preference ranking of the cookies with regard to the overall impression was tested. The analyses were performed on a team of 50 untrained tasters using the preference test by multiple comparison <sup>[10]</sup>.

The test was conducted over three days, always 48 hours after the cookies were produced, and the cookies made with different percentages of each type of flour (peel, pulp or core) were evaluated on different days.

### 2.5 STATISTICAL ANALYSES

Analysis of variance followed by Tukey's test, at a 5% significance level, was employed to compare the means obtained in the physicochemical analyses using the Statistical Analysis System <sup>[11]</sup> software.

**3 RESULTS AND DISCUSSION****3.1 MASS AND YIELDS**

The total mass of the flour used was 3.052 kg (Table 2), and its yield relative to the total guava mass was 5.09%. The seemingly low yield is due to the high moisture content of the guava (84.35%); this moisture was removed in the process of drying to obtain the flour. Silva<sup>[12]</sup> observed a yield of 11.49% for passion-fruit flour.

Table 2. Mass of the different types of guava flour.

Flour type	Weight
Peel	695 g
Pulp	1333 g
Core	1024 g

The formulations used to produce the cookies had a yield of approximately 80%, and the average final weight of the cookies was of 4.5 g  $\pm$  0.3 g.

**3.2 PHYSICOCHEMICAL ANALYSES**

According to the nutritional labeling standards of the Health Surveillance Agency, the values of some components of the (hypothetical) standard cookie were obtained based on the ingredients used, as shown in Table 3.

Table 3. Solids composition of the standard cookie

Component	Quantity
Carbohydrates	76 g*
Proteins	4.7 g*
Lipids	22 g*
Fibers	NA**
Mineral Residue (Sodium)	782 mg*

\* Values per 100 g of cookies; \*\*Value not available (NA)

The cookies were quite crunchy, as also shown by their low moisture level. Some tasters mentioned a buttery flavor of the cookies, which could be due to greater homogenization of the mass with the aid of the electric mixer.

The physicochemical analyses were only performed on the cookies with 5% of guava flour that were selected as the preferred cookies in the sensory analysis. The results of the physicochemical analyses are shown in Table 4.

Among the cookies analyzed here, the one made with core flour had the highest moisture, possibly because this is the part of the fruit with the greatest amount of water. It is known that some fibers, such as pectin, retain water due to their gelation capacity, and this capacity is affected by the concentration of sugars<sup>[13]</sup>. It is likely that the greater moisture of the cookie made from core flour is also due to the greater quantity of pectin.

The moisture levels of all the cookies were below 6%, below the maximum 14.0% level established by the current legislation<sup>[14]</sup>.

The amount of fixed mineral residues was similar among the three types of cookies. The maximum value of fixed mineral residues permitted by the legislation is 3.0%<sup>[14]</sup>.

There were no significant differences in the amount of proteins ( $p > 0.05$ ) among the different types of flour, but this amount was greater than that of the standard cookie (4.7%).

The amount of total lipids did not differ, at the 5% level, between the cookies made with peel and pulp. However, the cookies made with core flour had a lower value (17.87%) than the other cookies, and all the cookies had fewer total lipids than the reference value (22.0%).

The amount of total carbohydrates did not significantly differ between the pulp and core samples. The greatest amount of starch was observed in the cookies made with guava pulp flour, followed by the cookies made with guava peel flour. The amount observed in the reference cookie was 76% most likely because wheat flour has more carbohydrates than guava flours. Starch, which is part of the composition of grains, is one of the most important sources of calories in the human diet<sup>[15]</sup>. Therefore, although the amount of calories was not analyzed, it can be assumed that the cookies with more starch have higher caloric content.

The greatest amount of total sugars was observed in the core-flour cookie, even though this cookie had the smallest quantity of reducing sugars. There were no significant differences between the peel and pulp cookies regarding this last parameter. It may

therefore be affirmed that the cookie made from core flour has a greater concentration of sucrose (non-reducing sugar). In contrast, the peel has very little sucrose, as may be observed from the total sugar amount shown in Table 5.

According to Decree no. 27, of 13/01/98, of the Health Surveillance Secretary of the Ministry of Health of Brazil, ready-to-eat products with a high amount of fibers are those that have at least 6 g fibers.100 g<sup>-1</sup>. According to Silva; Silva; Chang<sup>[16]</sup>, cookies made with mixed wheat and *jatobá* (*Hymenaea courbaril*) flour had 4.1 to 6.5% of total dietary fibers (on a dry basis). Wang; Cabral; Fernandes<sup>[17]</sup> created cookies with increasing levels of wheat and soybean hull flour and found 6.7 to 11.79% of gross dietary fibers (on a wet basis).

Santos et al.<sup>[18]</sup> made biscuits with cassava flour and passion fruit, where they obtained results of dietary fiber (3.59%) and protein (4.68%), obtaining high potential for acceptance and commercialization.

Table 4. Percentage composition of the cookies containing 5% of guava flour

Parameters	Treatments*		
	Peel	Pulp	Core
Moisture	4.57 ± 0.06	3.93 ± 0.06	5.80 ± 0.00
Proteins (N x 6.25)	5.30 ± 0.00	5.27 ± 0.06	5.33 ± 0.15
Total Lipids	19.03 ± 0.15	19.07 ± 0.15	17.87 ± 0.38
	Total (by difference)	60.30 ± 0.30	61.63 ± 0.15
	Reducing sugars, in glucose	3.10 ± 0.00	3.23 ± 0.06
	2.43 ± 0.12		
Carbohydrates			
	Total sugars, in glucose	17.03 ± 0.06	25.56 ± 0.40
	29.83 ± 0.42		
	Starch	29.37 ± 0.42	31.70 ± 0.40
	Total	8.30 ± 0.17	7.70 ± 0.27
	6.83 ± 0.15		
Fibers	Insoluble	6.87 ± 0.15	6.00 ± 0.10
	Soluble	1.43 ± 0.06	1.70 ± 0.17
			1.83 ± 0.06
Mineral Residue		2.50 ± 0.00	2.40 ± 0.10
			2.30 ± 0.00

\* Results shown as the mean ± standard deviation. Source: author data, 2016.



## 3.3 SENSORY ANALYSIS

Among the cookies made with different concentrations of guava peel, pulp and core flour, the ones with the lowest concentration of guava peel and core flour were preferred. The cookies made from the guava pulp flour did not show significant differences between the concentrations, but the sample with the highest score, and thus the preferred cookie, was made with 5% guava flour, as shown in Table 5.

Table 5. Mean scores and the *Newell* and *MacFarlane* test for sensory evaluation of the cookies made with guava flour.

Raw material	Concentration of the flours used to make the cookies *			
	5%	10%	15%	20%
Peel	159 <sup>a</sup>	119 <sup>b</sup>	108 <sup>b</sup>	113 <sup>b</sup>
Pulp	129 <sup>a</sup>	123 <sup>a</sup>	124 <sup>a</sup>	121 <sup>a</sup>
Core	157 <sup>a</sup>	111 <sup>b</sup>	97 <sup>b,c</sup>	132 <sup>a,b,c</sup>

Source: author data, 2016.

<sup>a,b</sup> The same letters on the rows indicate that the samples are not significantly different ( $p > 0.05$ ) according to the *Newell* and *MacFarlane* table. \*

In the sensory analysis, the tasters found that the “bitter” taste became more evident with increasing concentration of peel flour. In addition, this flour resulted in a darker color compared to the cookies made from the other types of flour, possibly due to the tannin content.

According to Salinas<sup>[15]</sup>, some fruits have an intense astringent taste. Among the substances that may be responsible for this flavor are tannins, a mordant substance capable of precipitating proteins. Tannins have a bitter flavor that is attenuated by the action of enzymes, becoming astringent. It is not known how exactly these reactions occur, but it is known that these compounds share this characteristic with other phenolic compounds.

For the cookies made with core flour, a greater concentration of core flour resulted in greater adhesiveness (adhering to the teeth) most likely because of the higher moisture and glucose concentration. All these characteristics were more pronounced in the cookies with a higher concentration of core flour and may explain the preference for cookies with lower concentrations because these had a smoother texture.

Ferreira et al.<sup>[19]</sup> replacing 10% of WF(wheat flour) with JPF(Formulation of biscuits with flour of jabuticaba peel). These authors obtained a cookie with good physical properties, and, based on their acceptance test, they obtained scores of 3.68, 2.95 and 4.21 for appearance, flavor and texture, respectively.

Bertagnolli et al.<sup>[20]</sup>, In their study on acceptance of cookies made with Guava peel flour (GPF), where they verified in the sensory analysis satisfactory acceptance of Cookies containing 30% of GPF in relation to the attributes of aroma, flavor and texture. Cookies containing 50% and 70% GPF, received satisfactory acceptance in relation to aroma alone.

According to Mariani, et al.<sup>[21]</sup>, developed biscuits with rice bran and soybean meal (FEFS) as a substitute for wheat flour, where they verified the acceptability of cookies in alternative treatments.

Padilha, & Basso,<sup>[22]</sup> used mango residue flour, passion fruit and jaboticaba to make biscuits, where they received notes above five in relation to all attributes (color, flavor, texture and aroma), thus indicating a Good acceptance by the tasters. Zago et al.<sup>[23]</sup> developed cookie formulations partial flour substitutes (FT) and oatmeal (AF) by jaboticaba shell flour (FJC) where the sensory analysis results were obtained regarding the acceptance of the product in appearance categories of texture , flavor and odor.

#### 4 CONCLUSION

Fruit peel and core flours are good alternatives in the production of foods for bakeries because the use of these residuals adds value to the product and is an important environmental factor. Pulp flour is a new alternative component of baked goods. Based on the results obtained in this study, the cookies made with a 5% concentration of guava peel, core and pulp flour may be considered a good source of dietary fibers. The cookies have high fiber content, giving a functional appeal to this product and enriching its nutritional value.

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