

Centesimal and mineral analysis of cupcakes base meal of leaves and stems of ora-pro-nobis (*Pereskia aculeata*)

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Abstract

Food and nutrition are basic requirements for the ascension and protection of human health. However, food education is a slow process. Therefore, the use of unconventional vegetables as food, such

as *Pereskia aculeata*, a cactaceae rich in essential proteins and used to fight against malnutrition is encouraged. The objectives of this study were to determine the bromatological composition of cupcakes made of leaves and stems of *P. aculeata*, as well as to characterize the nutrients and minerals present therein. Four recipes were tested: natural cupcake; with dry leaves flour; with leaf+stem flour; and with fresh leaves. The levels of moisture, ashes, proteins, dietary fibers, lipids, total carbohydrates, total caloric value, and minerals were determined. Cupcakes made with *P. aculeata* flour are a consuming alternative with excellent nutritional value. Cupcakes prepared with dry leaf flour presented high protein (7.69%) content and those with leaf meal+stem presented a higher dietary fiber content (8.55%). However, both presented satisfactory results for the phosphorus, sodium, magnesium, copper, and zinc minerals. Therefore, the cupcakes with dry leaf flour and leaves+stem, due to their nutritional qualities, are the most suitable option for consumption.

Keywords: Cactaceae. Non-conventional food plant. Cake. Chemical composition. Nutritional value.

Resumo

Análise mineral e centesimal de cupcake a base de farinha de folhas e caule de ora-pro-nobis (*Pereskia aculeata*)

A alimentação e nutrição são requisitos básicos para ascensão e proteção da saúde do ser humano, no entanto a educação alimentar é um processo lento. Por isso do incentivo para o uso alimentar de

PANCs como *Pereskia aculeata*, cactácea rica em proteínas e utilizada no combate à desnutrição. Os objetivos desse estudo foram determinar a composição bromatológica de cupcakes elaborados com farinha de folhas e caules de *P. aculeata*, caracterizando os nutrientes e minerais presentes. Foram testadas quatro receitas: cupcake natural; com farinha de folhas secas; com farinha de folhas+caule; com folhas frescas. Foram determinados os teores de: umidade, cinzas, proteínas, fibras alimentares, lipídeos, carboidratos totais, valor calórico total e minerais. Os cupcakes elaborados com farinha de *P. aculeata* são uma alternativa de consumo com excelente valor nutricional. Os cupcakes preparados com farinha de folhas secas apresentaram alto teor de proteínas (7,69%) e os de farinha de folhas+caules maior teor de fibras alimentares (8,55%). No entanto, ambos apresentaram resultados satisfatórios para os minerais fósforo, sódio, magnésio, cobre e zinco. Desta forma, os cupcakes com farinha de folhas secas e folhas+caule, devido suas qualidades nutricionais, são os mais indicados para consumo.

Palavras-chave: Cactaceae. Planta alimentícia não-convencional. Bolo. Composição química. Valor nutricional.

Introduction

Proper food and nutrition are some of the basic requirements for health's ascension and protection, enabling a better human growth and development, with life quality and citizenship (SILVA; CAMARGO, 2006). An insufficient ingestion of some nutrients affects one in every four persons in the world, mostly from underdeveloped countries. Consequently, several foods are used to strengthen the

diet, such as wheat flour, salt, milk, butter, and sugar (SILVA JÚNIOR et al., 2010). Although a nutritional education would be the ideal method, it is a slow process, requiring several years to present results. The use of drug supplements, however, is the quickest way to solve the problem of nutritional deficiency, but its results are not always the ones we expect, since they usually have an unpleasant taste and present side effects (FISBERG, 1996).

In this context, the purpose of encouraging the use of unconventional plants and/or vegetables (PANCS) as food, such as the *P. aculeata* Mill., is to change the relation man versus food, including, therefore, a more nutritious, healthier, and tastier food in our diet (ROCHA et al., 2008). *Pereskia aculeata*, popularly known as ora-pro-nobis, which in Latin means, “pray for us,” is a plant that belongs to the Plantae kingdom and Cactaceae family. It has a high use potential and is grown marginally and rudimentary (KINUPP; BARROS, 2008).

This species is found from Bahia down to Rio Grande do Sul, and it is considered a rustic and resilient plant, growing in different kinds of soil. It is a fact that it can be used to fight malnutrition and for veterinary purposes, including as food for cattle and other animals (SARTOR et al., 2010). It is also rich in essential amino acids and vegetable protein of about 25% to 35% in dry base. However, its scientific studies are scarce (KINUPP; LORENZI, 2014).

We believe that the consumption potential of this species in a daily food diet is extremely important because, besides having nutrients for a healthy diet, with the increase of its consumption, its grown would automatically increase too (RIBEIRO et al., 2014). The absence of toxicity in its leaves makes of the *P. aculeata* an important source for human nutrition. It can be consumed as stews and soups,

as flour to make pies, doughs, cookies, breads, and cakes, all with a high protein level (OLIVEIRA et al., 2015; TAKEITI et al., 2009).

The small cakes called cupcakes were created in UK in 1828. They are also known as fairy cakes because this cake recipe is measured in cups and then baked. The creation of cupcakes was a revolutionary fact because it reduced the cooking time and was easy to measure the ingredients that were used (SMITH, 2004).

The consumption of unconventional vegetables like the *P. aculeata* is still not very encouraged. Therefore, we need to take action to increase its consumption (ROCHA et al., 2008). The lack of information of the public regarding the nutritional value of the *P. aculeata* and its preparation poses a natural restriction to its consumption (ROCHA et al., 2008).

Therefore, and with the purpose of offering a product with greater nutritional quality and that is accessible to most of the public, we engaged in studying the bromatological composition of cupcakes made with *P. aculeata* leaf and stem flour and dry leaves, with the purpose of identify and quantify the nutrients present in the species.

Material and Methods

The vegetal material of *Pereskia aculeata* was collected in Curitiba-PR, on the coordinates 25°38'29.28" of South latitude and 49°29'61.47" of West longitude. According to the Köppen classification, the region's climate is of the Cfb type, that is, a climate classified as moist temperate, with a mean temperature of the hotter month above 10°C, with smooth summers and winters with frequent frosts and a tendency of rain concentration in the summer months,

however, without a defined dry season. Dry samples of the species were deposited in the Federal University of Paraná's (UFPR) herbarium, receiving the classification no UPCB 75848.

Pereskia aculeata leaves and stems were collected to make flour, which would be used in food processing. The vegetable material was duly washed three times in distilled water and placed in storage at 60°C for 24 hours. To make 100 g of flour, 1 kg of *P. aculeata* leaves was necessary.

To make the cupcakes, the four following recipes were tested: cupcake without *P. aculeata* flour addition (natural cupcake); using dry leaf flour (CF); cupcake made with dry leaf+stem flour (CFC); cupcake made with fresh leaves (CFR), using 36 g of flour in each mixture (Table 1); and then it was ground and stored in a freezer at -20°C for future food producing, excepting the dry leaves. To make the dough, we used ingredients like wheat flour, eggs, butter, sugar, vanilla essence, and baking powder, which were bought in commercial establishments of the city of Curitiba (PR), at the quantities described in Table 1.

Table 1. Ingredients used to make natural cupcake (CN), and cupcakes with *Pereskia aculeata* leaf flour (CF), with leaf+stem flour (CFC), and with fresh leaves (CFR), Curitiba (PR), 2015.

Ingredients		CN	CF	CFC	CFR
		Quantity			
Wheat Flour	g	120	84	84	84
Eggs	g	150	150	150	150
Butter	g	150	150	150	150
Vanilla Essence	ml	7	7	7	7
Baking Powder	g	12	12	12	12
<i>Pereskia aculeata</i>	g	-	36	36	36

The bromatological analyses were performed at the Laboratory of Non-Wood Forest Products of Embrapa Forests, located in Colombo (PR), and performed according to the Official Methodologies of Adolfo Lutz Institute (BRASIL, 2008) and the data were expressed in percentages in dry base (determined by the greenhouse method until constant weight). The analyses were performed in triplicate so each data would correspond to the mean of three repetitions.

As to the nutritional composition, excepting the total dietary fibers and total carbohydrates, all other elements (moisture, ashes, lipids, and proteins) were performed in triplicate, according to the official methodology of Adolfo Lutz Institute (SARTOR et al., 2010). The samples' moisture was determined in about 5 g of sample, which remained for 12 hours in a greenhouse at a temperature of 105°C. The ashes, representing the total of minerals, were determined by calcining about 2 g of sample in the muffle at 550°C for three hours. The percentage of ashes was obtained through the multiplication of the sample ashes' mass (g) by 100 and then by dividing this result by the sample's mass (g).

The lipids were determined in 1.5 g of sample using ethyl ether as an extracting solvent during the period of six hours, in Extractor Soxhlet. The obtained ethereal extract was placed in a greenhouse set in 70°C for one hour to remove the remains of the solvent, followed by its cooling in a dry environment and then weighted. The level of lipids was calculated through the multiplication by 100 of the lipid mass and this result was divided by the sample's mass (g). Total proteins were obtained in 0.5 g of sample through the micro Kjeldahl method, which quantifies the sample's level of total nitrogen. The protein percentage was calculated through the multiplication of the total nitrogen percentage by the conversion factor of 6.25.

The dietary fibers were determined through the gravimetric enzymatic method with 1 g, which consists in hydrolyzing starch to obtain the proteins through the use of the protease, heat stable alpha-amylase, and amyloglucosidase (glucoamylase) enzymes.

The total caloric value, in kcal, was determined considering the conversion factor of 4.0 for proteins and carbohydrates, and 9.0 for lipids. The macronutrient and micronutrients minerals were determined by the Laboratory of Soil Chemistry and Fertility, of the Federal University of Paraná, in Curitiba (PR).

Results and Discussion

The chemical composition data of the cupcakes in dry base showed that the variables ashes, lipids, proteins, and fibers presented a significant difference at the level of 5% and 1% of probability (Table 2).

Moisture is an important quality index because it can affect the sample's characteristics and the product's preservation, and its high level allows the activity of microorganisms and enzymes, which changes the sample's sensory characteristics (MORGANO et al., 2008). According to the results obtained, the cupcakes did not present any significant difference, with moistures of 74.51%, 75.18%, 74.31%, and 80.95% for the natural cupcakes, and for the cupcakes with leaf flour, with leaf+stem flour, and fresh leaves, respectively.

When we compare the moisture of this study's cupcakes with the cakes made by Rosa et al. (2011) which included *ora-pro-nobis* fresh leaves in their dough, we noticed that the moisture of the cupcakes made here was superior to the cakes of the aforementioned authors, which obtained a moisture that varied from 22.41% to

33.63%. Regarding the ashes, the higher level was found in the natural cupcake (2.30%) and in the one made with dry leaf flour (2.37%), while the cupcakes made with fresh leaves presented the lower level (0.67%) (Table 2). Since the ashes are linked to the presence of mineral salts, we also noticed higher levels of most minerals in the natural and in the dry leaf flour cupcakes, and lower mineral levels in the fresh leaf cupcake (Table 2).

Table 2. Percentage of ashes, lipids, fibers, total carbohydrates (CT), and total caloric value (VCT - kcal 100 g⁻¹) of the cupcakes with and without addition of *Pereskia aculeata* flours or fresh leaves, Curitiba (PR), 2015

DRY BASE					
	CN ^a	CF ^b	CFC ^c	CFR ^d	Variation Coefficient (%)
Ashes (%)	2.30a	2.37a	1.47bc	0.67c	10.61
Lipids (%)	24.70b	26.54b	32.46a	34.94a	8.36
Proteins (%)	6.58a	7.69a	7.21a	6.17a	8.73
Fibers (%)	5.88b	5.41b	8.55a	4.50b	9.94
CT (%)	60.54	57.99	50.31	53.72	
VCT (kcal 100 g⁻¹)	490.78	501.58	522.22	554.02	

Statistically, means followed by the same letter in the line are not different from the 5% level of significance.

^aNatural cupcake (CN); ^bCupcake with leaf flour (CF); ^cCupcake with leaf+stem flour (CFC); ^dCupcake with fresh leaves (CFR).

Rosa *et al.* (2011) made cakes with different *P. aculeata in natura* leaf percentages, and the one made with 30% of fresh leaves presented the higher ash level of 2.59%, a value that is similar to the dry leaf flour cupcake (2.37%) found herein. A diet's lipids are important to the growth, development, and maintenance of health, and their level varies according to the type of food, from which fruits and leafy vegetables are among the foods with lower levels (0.1–1.2% of the fresh composition) (AUED-PIMENTEL; ZENEBON, 2009).

The natural cupcakes and the ones made with *P. aculeata* presented lipid values, in dry base, of 24.70% to 34.94%, values that are superior when compared with the work of Rosa *et al.* (2011) who made the cakes with the addition of different percentages of fresh *Pereskia* leaves, resulting in a lipid level variation from 10.38% to 13.07%. The higher lipid level presented herein is probably related to the other ingredients used to prepare the recipes.

The high lipid level found in the analyzed cupcakes is a negative aspect, since these foods cannot be used in hypocaloric diets and with lipid restriction (ROCHA *et al.*, 2008). The level of proteins seen in the cupcakes made with dry leaf flour was numerically superior to the other cupcakes (7.69%), even though there was no statistic difference in comparison with the natural cupcake (6.58%), with the leaf+stem flour cupcake (7.21%), and with the fresh leaf cupcake (6.17%) (Table 2).

The cupcakes, when made with leaf+stem flour and dry leaves, presented a protein level increase of approximately 9% to 14%, respectively. Silva Júnior *et al.* (2010), studied breads with 5% and 10% of leaf flour of *P. aculeata* and presented an increase of 3% to 6%. The cupcakes with and without *P. aculeata* addition presented protein levels inferior to the work of Rosa *et al.* (2011) whose purpose was to increase the nutritional quality of cakes with 10% (11.42%), 20% (10.73%), 30 (11.03%), and 40% (12.05%) of *P. aculeata* fresh leaves. However, in these authors' work, no significant difference was found in these treatments in comparison with conventional cakes (11.53%). Herein, the same response pattern was found, when the cupcakes with *P. aculeata* present no difference from the natural cupcakes (Table 2).

According to the National Sanitary Surveillance Agency (2005) an adult should daily ingest about 50 g of proteins (daily), and a food

can be considered protein-rich when, in a 100-g portion, it provides about 20% of the daily intake. Therefore, considering the results analyzed herein, the cupcakes would provide between 6 to 7 g of an adult's daily needs. The results obtained in the chemical classification of the foods presented a higher percentage of dietary fibers in the *P. aculeata* leaf+stem flour cupcakes, with 8.55% (Table 2). According to the Ministry of Health (2005) the daily recommendation of fiber intake for an adult is of 25 g a day⁻¹; ergo, the daily intake of 100 g of the cupcake with addition of leaf+stem flour would correspond to, approximately, 34.20% of the daily recommendation.

Dietary fibers affect the bowel movement speed, the colon pH, and the production of subproducts of important physiological functions (BERNAUD; RODRIGUES, 2013). Usually, a low dietary fiber intake is linked to constipation and weight gain (VITOLLO *et al.*, 2007).

A food may be considered fiber-rich if it has a minimum of 6% for solids of the product (ANVISA, 2005). Therefore, the natural cupcake, as well as the cupcakes made with dry leaf flour and fresh leaves cannot be considered a good fiber source. Fiber-rich foods have a lower energetic density when compared with fat-rich foods. Therefore, the lack of energy (calories) in the organism could be satisfied by fiber-rich foods (BERNAUD; RODRIGUES, 2013).

Differently from the results hereof, the cakes made with different percentages of *P. aculeata* fresh leaves presented a fiber level increase with the cakes' leaf percentage increase. Actually, an addition of just 10% of leaves increased the fiber level in 227.93% in comparison with the cake that did not use any leaf (ROSA *et al.*, 2011).

Regarding the total caloric value, we noticed that the cupcakes presented a value between 490.78 kcal 100 g⁻¹ and 554.2 kcal 10 g⁻¹. This means that, in a regular diet of 2000 Kcal, about 100 g of the

cupcake would represent from 24.54% to 27.70% of the daily recommendation. The intake of foods with low caloric value is indicated for health and to control obesity (ALMEIDA *et al.*, 2014). However, the entire food context should be analyzed, because a food with low total caloric value is not always the most indicated for consumption due to its inferior nutritional value. Consequently, we noticed that the natural cupcake, although it has the lower total caloric value (490.78 kcal 100 g⁻¹), when compared with the other cupcakes, it presents inferior nutritional values.

Regarding the carbohydrate level, the analyzed cupcakes present values between 50.31% and 60.54% (Table 2). The minimum quantity of carbohydrates necessary is of 130 g a day⁻¹ for men and women over 19 years old (ANVISA, 2005). Consequently, the intake of 100 g of the cupcakes would provide between 38.70% and 46.57% of an adult's daily recommendations. On the other hand, the minerals exert an important task in the peculiar development and good health of the human body, and are essential for the good functioning thereof. However, their daily intake quantity is usually low (GONDIM *et al.*, 2005).

The daily mean recommendation of the *Dietary Reference Intakes* (DRI) of some minerals for men and women between 9 and 70 years old is of 1,160 mg of calcium; 975 mg of phosphorus; 9.5 mg for men and 13 mg for women of iron; 360 mg of magnesium for men and 300 mg for women; 830 mg of copper; 2 mg of manganese; 9.5 mg of zinc for men and 8.5 for women; 1.3 mg of sodium; 4.6 mg of potassium (ANVISA, 2005). When we analyzed the cupcakes, the higher values of most evaluated minerals were found in the cupcakes made with dry leaf flour (Table 3).

Therefore, considering the daily mean recommendation, the intake of cupcakes made with dry leaf flour in the quantity of approx-

imately 100 g a day⁻¹ would satisfy in 23.20% the necessity of calcium; 67.24% of phosphorus; 7.89% of iron for men and 10.79% for women; 52.17% and 43.47% of magnesium for man and women, respectively; 11.53% of manganese; 79.69% and 71.30% of zinc for man and women, respectively; 0.22% of sodium, and, finally, 0.14% of potassium (Table 3).

Table 3. Levels of the phosphorus (P), sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) minerals in the natural cupcake (CN), and in the cupcakes with *Pereskia aculeata* leaf flour (CF), with leaf+stem flour (CFC), and with fresh leaves (CFR), Curitiba (PR), 2015.

Minerals	CN	CF	CFC	CFR	Variation Coefficient (%)
P	1.41 ab	1.45 ab	1.52 a	1.21 b	6.64
Na	0.66 a	0.59 ab	0.62 a	0.45 b	8.98
K	1.17 c	3.25 a	2.59 b	1.24 c	5.53
Mg	0.18 b	0.69 a	0.49 a	0.14 b	23.28
Ca	2.88 b	5.00 a	1.80 c	0.16 d	9.67
Cu	10.96 a	10.96 a	13.84 a	12.00 a	43.85
Fe	59.38 b	120.40 a	64.13 b	77.39 b	15.46
Mn	9.74 b	17.34 a	13.13 b	19.58 a	9.53
Zn	12.24 a	11.92 a	11.88 a	9.48 a	19.74

Statistically, means followed by the same letter in the line are not different from the 5% level of significance by Tukey's Test

Analyzing the phosphorus, the cupcakes made with leaf+stem flour (1.52 g kg⁻¹) are different only from the fresh leaf cupcakes (1.21 g kg⁻¹). This low availability of phosphorus in vegetable-originated foods is linked to how it is available in foods (GONÇALVES *et al.*, 2007). Although the phosphorus acts with the calcium and play the role to keep bones, teeth, heart, and blood vessels in good shape, phosphorus-rich foods should be reduced (TELLES; BOITA, 2015). However, it is difficult to completely eliminate them,

since these foods are also protein and calcium sources, which are essential to the organism (NERBASS *et al.*, 2010).

Regarding the sodium, the natural cupcake presented a higher level of 0.66 g kg^{-1} . However, it was not different from the dry leaf cupcake (0.59 g kg^{-1}) and from the one made of leaf+stem flour (0.62 g kg^{-1}) (Table 3). The World Health Organization recommends a maximum daily intake of 2000 mg of sodium (ANVISA, 2005). Therefore, all cupcakes are within the recommendation limit and may be considered satisfactory. Foods with low sodium level are the most indicated for a healthy nutrition, since sodium is a component of salt and there are several evidences that relate the excessive salt intake to hypertension (SATO *et al.*, 2009).

The cupcake made with dry leaf flour was the one that presented a higher level of potassium, with 3.25 g kg^{-1} . Potassium is a mineral that affects the muscles and nerves and that, in high levels, in humans, causes signs of muscle weakness, locked leg sensation, besides irregular heartbeats, which may manifest frequently. Therefore, it is important that the kidneys are healthy, since the excess of ingested potassium is filtered through the urine (TELLES; BOITA, 2015). Consequently, a diet rich in food of a high potassium level is important. However, we should be alert regarding its excess, since the desired level of plasma potassium should be lower than 5.5 mmolc L^{-1} (TELLES; BOITA, 2015).

Analyzing the calcium levels, the dry leaf flour cupcake was the one that presented higher levels (5.00 g kg^{-1}) when compared with the others. Calcium is an essential nutrient, and its daily necessity varies according to the age, being higher in periods of rapid growth (PEREIRA *et al.*, 2009). Calcium shows its relevance in leafy vegetables, which may be considered a good source, satisfying the daily needs of 0.8 g (ANVISA, 2005).

The analyzed cupcakes presented values of copper that vary from 10.96 mg kg⁻¹ to 13.84 mg kg⁻¹. Therefore, there was no significant difference between them (Table 3). Ergo, they can be considered rich in copper. This mineral has a regulating function on the immunological system, and in serious malnutrition cases, this micronutrient is reduced, which may result in immunological disorders and in the susceptibility increase to infections (MACÊDO *et al.*, 2010). We should underscore that copper is a mineral that has its fair share in foods, and that its deficiency is quite rare in humans (KOURY; DONANGELO, 2007). This micronutrient's daily intake is of 900 µg (SILVA JÚNIOR *et al.*, 2010).

Regarding the iron, we know that its deficiency is the most common around the world, that it advances in several stages, and that it may happen due to the fact that the insufficient iron diet intakes prevail (KOURY; DONANGELO, 2007; SATO *et al.*, 2009). Therefore, there should be more guidance regarding the intake increase of natural sources of iron and of foods that favor this mineral's absorption (SATO *et al.*, 2009). The iron levels of the analyzed foods were superior in the leaf flour cupcake, with 120.40 mg kg⁻¹.

Manganese is important because it is used in energy production. Cupcakes made with *P. aculeata* leaf flour presented 17.34 mg kg⁻¹ of manganese and were not different from the ones made with fresh leaves, with 19.58 mg kg⁻¹ of Mn. Zinc is a mineral that is spread all over the human body but in small dosages. Its deficiency is related to serious pathological cases that are manifest mostly due to nutritional deficiency (HAMBIDGE *et al.*, 2008). To fulfill these needs, the main food sources are bovine meats, fishes, poultry, milk, cheeses, seafood, wholegrain cereals, wheat germ, beans, nuts, almonds, and pumpkin seed (DOMEN *et al.*, 2008).

The zinc daily recommendation is of 8 mg for women and 11 mg for men (ANVISA, 2005). According to the results obtained herein, all analyzed cupcakes can be considered good zinc sources, and there was not difference between them (Table 4).

Conclusion

At last, we want to underscore that the cupcakes made with *Pereskia aculeata* flour are a consumption alternative with functional properties and with an excellent nutritional value, considering that the species is a protein-rich vegetable and that it is used to fight malnutrition. And since it presents similar results for the phosphorus, sodium, magnesium, copper, and zinc minerals, with good nutritional qualities, besides presenting a good quantity of fibers and proteins, the cupcakes made with *Pereskia aculeata* dry leaves and dry leaf+stem flour are the most indicated for consumption.

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