http://dx.doi.org/10.21707/gs.v11.n03a012

PRODUCTION OF FLOUR *PILOSOCEREUS PACHYCLADUS* SUBSP. *PERNAMBUCOENSIS* (FACHEIRO) AND USE AS ADDITIVE IN CEREAL BARS

JOSÉ NILDO VIEIRA DEODATO[1], DANIELLE DE SOUSA SEVERO[2], MARIA DO SOCORRO ARAUJO RODRIGUES[3], WILLIANNY MEDEIROS COSTA[4], GILCEAN SILVA ALVES[5], ALFREDINA DOS SANTOS ARAUJO[6*]

[1;3]Programa de Pós graduação em Engenharia de Processos, Centro de Ciências e Tecnologia, Universidade Federal de Campina Grande, Paraiba, Brasil
[2]Programa de Pós graduação em Engenharia de Alimentos, Universidade Federal de Santa Catarina, Florianópolis, Brasil
[4]Graduanda em Engenharia de Alimentos, Centro de Ciências e Tecnologia Agroalimentar, Universidade Federal de Campina Grande, Paraiba, Brasil
[5]Professor D. Sc. do Intituto Federal da Paraiba, Paraiba, Brasil
[6]Professor D.Sc., Centro de Ciências e Tecnologia Agroalimentar, Universidade Federal de Campina Grande, Paraiba, Brasil
**Autor para correspondência: alfredina@ccta.ufcg.edu.br*

Recebido em 07 de junho de 2015. Aceito em 08 de dezembro de 2016. Publicado em 29 de julho de 2017.

ABSTRACT - The cacti are an important element of the landscape, presenting succulent stems, covered with spines of various shapes, sizes and dimensions. The facheiro (*Pilosocereus pachycladus* subsp. *pernambucoensis*) is a xerophytic Cactaceae, sturdy, sparsely branched, dark green color, armed with sharp thorns, with large and tall isolated flowersIn the present work it was produced flour from stalk and facheiro's shield, in order to be used as an additive in proportions of 5, 10, 15 and 20% replacing the traditional flour in the production of cereal bars. The flour went through microbiological, physical-chemical and particlesize analysis, as well as the final product (cereal bar). In microbiological terms the flour presented negative results for coliforms, *Salmonella* sp and *Bacillus cereus*, however, showed colonies of yeasts and molds, not compromising the quality of the samples. As to the physical-chemical parametres they are in compliance. Thus, facheiro flour is a food that can be used in the manufacture and consumption of food to be ingested by the public.

KEYWORDS: *SEMIARID; FLOUR; CACTUS; FOOD.*

PRODUÇÃO DE FARINHA *PILOSOCEREUS PACHYCLADUS* SUBSP. *PERNAMBUCOENSIS* (FACHEIRO) E USO COMO ADITIVO EM BARRAS DE CEREAL

RESUMO - As cactáceas constituem um importante elemento da paisagem, apresentando caules suculentos, cobertos por espinhos de diversas formas, tamanhos e dimensões. O facheiro (*Cereus squamosus*) é uma Cactaceae xerófila, robusta, pouco ramificada, de cor verde-escura, armada de espinhos agudos; com flores grandes isoladas e altas. No presente trabalho produziu-se farinha a partir do caule e da casca do facheiro, com a finalidade de ser utilizada como aditivo em proporções de 5, 10, 15 e 20% em substituição à farinha tradicional, no processo de produção de barra de cereais. Foram feitas análises microbiológicas, físico químicas e granulométria da farinha, e no produto final (barra de cereais). Em termos microbiológicos a farinha apresentou resultados negativos para coliformes, *Salmonella e Bacillus cereus*, porém, apresentou de colônias de bolores e leveduras, não comprometendo a qualidade das amostras. Quanto aos aspectos físico-químicos estes estão em conformidade. Dessa forma, a farinha do facheiro é um alimento que pode ser utilizado na fabricação e consumo de alimentos a serem ingeridos pela população.

PALAVRAS-CHAVE: *SEMI-ÁRIDO; FARINHA; CACTOS; COMIDA.*

PRODUCCIÓN DE HARINA *PILOSOCEREUS PACHYCLADUS* SUBSP. *PERNAMBUCOENSIS* (FACHEIRO) Y USO COMO ADITIVO EN BARRAS DE CEREALES

Resumen - Los cactus son un importante elemento del paisaje teniendo tallos jugosos cubiertos por espinos de muchos tamaños y dimensiones. El facheiro (*Pilosocereus pachycladus* subsp. *pernambucoensis*) es un Cactaceae xerófica robusto, poco ramificado de color verde oscuro armado con espinas afiladas; con grandes flores aisladas y altos. En el presente trabajo fue producida harina del tallo y de la cáscara del *facheiro* con la meta de ser utilizada con aditivo en dimensiones de 5, 10, 15, 20% en reemplazo de la harina tradicional en el proceso de producción de galletas como *cookies*, así que se realizaronanálisis microbiológico, físico-químico y granulométrico de la harina y nodel producto final (*cookies*). En términos microbiológicos la harina tuvo resultados negativos para coliformes *Salmonella e Bacillus cereus*, cuando los parámetros físico-químicos están de acuerdo con la legislación. entonces la harina del *facheiro* es un alimentoque puede ser usado en la fabricación y el consumo de alimentos para ser ingeridos por la población.

Palaras clave: *Semiárido; Harina; Cactus; Comida.*

Introduction

Brazil is considered the third largest center of diversity of the family *Cactaceae* totaling approximately 200 species (Souza and Lorenzi 2005), and many of these species are endemic to the Caatinga, Northeastern, and require further study (Taylor and Zappi 2004).

The northeast of Brazil covers an area of 1, 548,672 km², of which 960,461 km² (62%) are considered as semiarid (Mello Netto et al. 1992, *apud* Lemos 1999). In almost every area of savanna is this hot and semi-arid climate (Köppen Bsh in).The smallness of the leaves and their mobility, the large branching from the lower part of the trunk (which gives the appearance shrubby trees) and the frequency of thorny plants (up to faveleira has thorns on the leaves) are further evidence of adaptation to a hostile environment.Some species seek to defend themselves from drought by storing water in their tissues, as with succulent plants. Cacti, bromeliads and other xerófilas may or may not occur, according to local conditions.

Physiognomic variations occur not only in different areas, but also in the same place, generating deep contrasts of landscape between the dry and rainy seasons, The most frequent cactiare mandacaru (*Cereus jamacuru*), the facheiro (*Pilosocereus pachycladus subsp. pernambucoensis*) the xique-xique (*Pilocereus gounellei*), the yarmulke (*Opuntia sp.*) and the crown-of-basking (*Melocactus bahiensis*) (Kindle 2011).

The cacti are an important element of the landscape, with succulent stems, leafless, covered with spines of various shapes, sizes and dimensions (Souza and Lorenzi 2005). The facheiro (*Pilosocereus pachycladus subsp. pernambucoensis*) is a species of this family of comprehensive occurrence in Semiarid Northeast.It is a perennial plant, shrub, robust, straight trunk with side branches, but little branched, dark green, which have sharp thorns and large flowers, and lily isolated Vegetating in the worst soil types, even the rocks where there are some sand, and resists several months of dry season, period which serves as food for cattle (Oliveira et al. 2007).

According to Lima (2006) Being a product with relatively high water content, the stem facheiro needs to be evaluated as to their behavior when subjected to drying, important processing for the commercial exploitation of agricultural products.

According Junior (2008) The economic exploitation of facheiro through flour processing and aims employment in food may represent an alternative significance ecological, economic and social for the semiarid region.

Despite this cactácea be used for a long time, especially in animal feed as a food supplement in long periods of drought that occur in the region, there is no scientific reports of its use in food in the form of processed

products made from flour.Flours of cactáceas (such as the pulp and peel, presented in this paper) can be used as an alternative to partial substitution of wheat flour in the preparation of cookies, cereal bars, cakes, and also as a source of enriching nutrients vitamins.One alternative that has gained body since the early 1970's is the use of waste (mostly husks and seeds), or the process of manufacture of flours from certain fruits as raw material for the production of certain foods perfectly possible to be included in food, such as cereal bars (Oliveira et al. 2002).

This new technology development promotes greater retention and concentration of nutritional values and higher fiber content there of.

The objective of this work was to prepare a meal from cactácea *Pilosocereus pachycladus subsp. Pernambucoensis* (facheiro) and develop cereal bars with different (concentrations) levels of flour from facheiro.

Material and methods

This work was developed in the laboratories of Vocational Technology Center (CTC - UFCG Pombal) during the period from February to April 2012.

Collection of Samples

Used as raw material for the production of flour, *Pilosocereus pachycladus subsp. Pernambucoensis* (facheiro) of the municipality of Pombal-PB. The facheiro was collected from February to April 2012. Four stems were collected approximately 4.2 m in height and 59 mm in diameter. After collection, the facheiros were packed and transported to the laboratory, then carefully separated from all the thorns, the pulp and rind, which was cut into pieces measuring 50 cm long, they were subjected to drying using circulating oven forced air brand De Leo, type A3SE, it was used the following treatments I, 60°C for 210 minutes, II 70°C of 166 minutes, III, 80°C for 135 minutes and IV 90°C for 108 minutes. The crushing of the stems was held in a wiley mill brand Splabor.

Physical-chemical and microbiological analyses

The samples were analyzed for moisture, protein, fat and starch, according to the methodology of the Adolfo Lutz Institute (2008) and sugars, determined by the anthrone method, discrito by Yemn and Willis (1954). For detection and quantification of the microbiological parameters of flour, pulp and peel facheiro at different temperatures were analyzed for the detection of coliforms 35°C to 45°C, *Escherichia coli*, yeast and mold count, total count and psychrotrophic and *Bacillus cereus* as the methodology Brazil, (2003).

Development of Cereal Bars

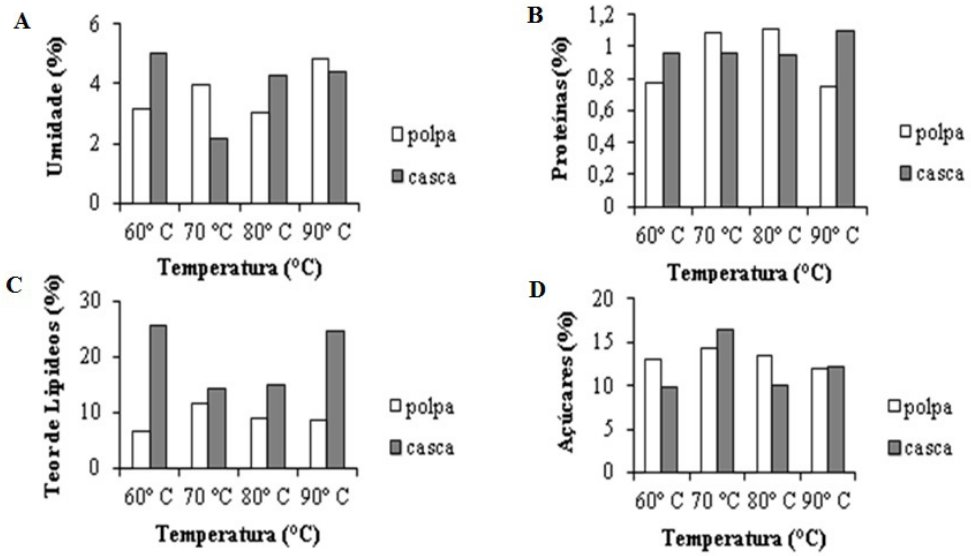
It was used the following ingredients for the formulation of the cereal bar: fine oatmeal, wheat flakes, sugar, flour, flour from facheiro (pulp and peel), Brazil nuts, sesame, linseed, hydrogenated vegetable fat (HVF) and water.In addition to the meal of pulp and peel the facheiro distributed in the following concentrations: Sample 1-95% wheat flour and 5% of the flour obtained from facheiro, Sample 2-90% flour and 10% wheat

flour facheiro, sample 3-85% wheat flour and 15% facheiro, sample 4-80% flour and 20% wheat flour facheiro. At the end of the bars were presented with an average weight of 25 g each, packed and stored wrapped in plastic film.

Results and discussion

In Figure 01 are the results of humidity (%) (a) Protein (%) (b) Lipid content (%) (c) and Sugar (%) (d) flour facheiro (pulp and peel) depending on the Drying temperature.

Figure 1 - Humidity levels (%) (a) Proteins (%) (b), Lipid content (%) (c) and Sugars (%) (d) of flour facheiro (pulp and skin) according to the Drying temperatures.



Regarding humidity (%), it is important that all samples presents ram within the standards required by Ordinance No. 554 of 08.30.1995 MAPA, which is a maximum of 13%, from 3.05 to 4, 84% to the pulp, and 2.13 to 5.00% for peeling according to the drying temperature. These values are close to those found by Lima (2006) in flour facheiro at the end (4.32%), medium (4.50%) and base (3.96%). Chiste et al. (2006) found levels of humidity in cassava flour from 5.48 to 7.59% and that these values are within the maximum allowed by law.

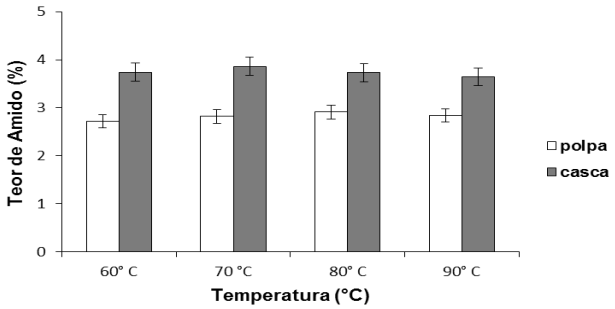
In Figure 1b are shown values of protein content (%) depending on the heat treatment applied. Among the flours analyzed in the pulp (70°C) (80°C) and the shell (90) had the highest protein concentration (1.09, 1.11 and 1.10%), respectively; than the other samples showed no difference between them, with 0.75 and 0.77% in flours pulp at 60 and 90°C and 0.95, 0.96 and 0.96% protein in flours of shells.

Lima (2006) found values of (1.88%) at butt (1.55%) and mid (1.50%) based on their study of protein flour facheiro. In Figure 1c we found that the lipid content was higher in expressively bark flour facheiro than in the pulp. The lipid content obtained is much higher than the study by (Sousa *et al.* 2008) that obtained values at most 1.91 in cassava flour.

The fact that some values were not similar, it should be analyzed samples do not belong to the same species. The sugars in flour facheiro (Figure 1d) varied from 9.83 to 16.52% in the shell to 60°C and 70 ° peel respectively. These values are higher than that found by Lima (2006), results obtained in extreminadade 5.12%, 5.86% and 3.10% in the middle of the base and also Oliveira et al. (2004) in a study of the shell mandacaru

found that the value of 6.00% of sugars.It was observed (Figure 2) that the starch of the flour facheiro are not in accordance with Brazilian law that advocates values (minimum 70%) (Brazil 1987).

Figure 2 - Values of starch content (%) of flour facheiro (pulp and peel) depending on the drying temperature.



Among the analyzed flours, showed the highest starch content was prepared from the bark obtained values between 3.64 and 3.86%.

These results are superior to those found by Lima (2006), the study on the production and storage of the flour facheiro values obtained at the end of 0.13%, 0.53% and 0.74% in the middle of the base.

Table 1 shows the results of the Microbiological analysis of flours of Facheiro (pulp and peel) depending on the temperature of drying.

Table 1 - Microbiological analysis of flours of Facheiro (pulp and peel) depending on the temperature of drying.

Flour	Microbiological parameters				
	Coliforms a 45ºC (NMP/g)	***Bacillus cereus* (UFC/g)**	**Molds and Yeasts (UFC/g)**	**Psicotróficos (UFC/g)**	***Salmonella* sp/25g**
FP 60º C	Absent	29,2 x 10^3	1,30 x 10^1	Absent	Absent
FP 70°C	Absent	16,0 x 10^3	Absent	Absent	Absent
FP 80º C	Absent	259,6 x 10^3	4,42 x 10^2	Absent	Absent
FP 90º C	Absent	342,0 x 10^3	9,50 x 10^1	Absent	Absent
FC 60ºC	Absent	4,4 x 10^3	4,56 x 10^3	Absent	Absent
FC 70ºC	Absent	Absent	3,83 x 10^1	Absent	Absent
FC 80ºC	Absent	15,4 x 10^3	1,02 x 10^3	Absent	Absent
FC 90ºC	Absent	6,4 x 10^3	3,33 x 10^0	Absent	Absent
STANDARD	10^2	3 x 10^3	-	-	Absent

From the results obtained in the microbiological analysis found in flour, pulp and peel facheiro at different temperatures showed that for coliforms at 45°C are absent, indicating that meal prepared exhibited satisfactory in the production and / or handling of food.In the analysis of *Bacillus Cereus* just no presence in the sample of FC 90ºC, the rest are above those permitted by legislation, which is 3 x 10^3UFC/g.

It was not detected the presence of *Salmonella* sp in any sample and psicotróficos flour facheiro, can be so deemed fit for human consumption.

Compared to molds and yeast samples FC 60°C and FP FC 80°C showed the contamination. The high count for yeast and mold colonies occurs by exposure to air, without any temperature control, as well as the packed product does not sound, which facilitates the deteriorating action thereof.After processing the flour of facheiro intended for the production of cereal bars at different concentrations 5%, 10%, 15% and 20%.

At first, there was the microbiological analysis, in which the samples were subjected to research the technique most probable number of coliforms at 35°C and 45°C coliforms, *Escherichia coli* and *Salmonella* sp., Using the methodology described by Brazil (2003).

Table 2 shows the results of the physico-chemical composition of the cereal bar formulated with 5, 10, 15, and 20% of flour facheiro pulp.

Table 2 - Physico-chemical composition of the cereal bar formulated with 5, 10, 15, and 20% of flour facheiro pulp.

CONSTITUENTS	FORMULATIONS			
	5%	10%	15%	20%
Moisture (%)	2,21	7,20	2,33	4,33
Proteins (%)	1,25	2,51	1,69	1,44
Lipideos (%)	14,17	22,64	28,78	27,35
pH	5,58	5,94	5,52	5,85
Acidity (g/100mL)	0,10	0,10	0,10	0,06
Soluble solids (°Brix)	19	23	24	23,5

It was found that the moisture found in cereal bars prepared with flour pulp facheiro ranged from 1.60% to 5.19%, these products can be considered of low moisture enabling a longer shelf life for products at the same time it ensures the texture characteristic of the cereal bar.How to levels of lipids observed no differences between the formulations of cereal bars. The formulations of the cereal bars showed high lipid contents. This fact is due to the high lipid content of the pulp as well as the ingredients used in its formulation.The cereal bars showed low levels of ash content, however these values are higher than those found by Brito *et al.*, (2004) who found in cereal bars homemade value of 1.13%. The soluble solids content of the cereal bars increased as the concentration of flour was high.

The amounts of proteins in cereal bars were much lower than those found by Freitas and Moretti (2006) who analyze the cereal bar functional value obtained 15.41% and less than the value found in the cereal bars market is 4 4%. The lipid content of the cereal bars prepared with flour peeling facheiro were higher than those prepared with the pulp due to the high lipid content thereof.

The remaining parameters obtained similar results to those found in cereal bars made with flour facheiro pulp. Table 3 shows the results of the physico-chemical composition of the cereal bar formulated with 5, 10, 15, and 20% of bark flour facheiro.

Table 3 - Physico-chemical composition of the cereal bar formulated with 5, 10, 15, and 20% of bark flour facheiro.

CONSTITUENTS	FORMULATIONS			
	5%	10%	15%	20%
Misture (%)	4,90	5,19	1,60	4,97
Proteins (%)	1,99	1,24	2,16	2,10
Lipídeos (%)	19,54	19,34	19,30	17,43
pH	5,90	6,08	5,77	6,01
Acidity (g/100mL)	0,13	0,10	0,10	0,10
Soluble Solids (°Brix)	16,0	25,0	35,0	35,5

Table 4 are the results for coliforms and *Salmonella* sp. and stood absent in all samples of type biscuits cereal bars prepared at concentrations of 5, 10, 15 and 20% flour pulp and peel facheiro show that no cleaning failure

occurred in processing and handling product.

Table 4 - Results of the microbiological analysis of the cereal bars.

Flour	Microbiologic Parameters	
	Coliforms a 45°C	*Salmonella* sp.
P 5%	Absent	Absent
P 10%	Absent	Absent
P 15%	Absent	Absent
P 20%	Absent	Absent
C 5%	Absent	Absent
C 10%	Absent	Absent
C 15%	Absent	Absent
C 20%	Absent	Absent

Conclusions

The samples taken from different parts (peel and pulp) of *Pilosocereus pachycladus subsp. pernambucoensis* (Facheiro) are different in moisture content, total soluble solids, protein, ash and starch. According to the substitution levels studied, the results show that it is possible to replace up to 20% wheat flour meal by *Pilosocereus pachycladus subsp. pernambucoensis* (Facheiro) for the production of cereal bars. The incorporation of flour *Pilosocereus pachycladus subsp. pernambucoensis* (Facheiro) in the formulation of the cereal bars provides an increase in protein, ash and reduced calorie and carbohydrate content. The microbiological count to coliform, fungi and yeasts remained during processing, showing that the product was suitable for use during the total time studied. The results of this study show that the flour *Pilosocereus pachycladus subsp. pernambucoensis* (Facheiro) may present technological desirable functional properties, representing a viable and cost-effective for use as ingredients in food systems.

Acknowledgements

Vocational Technology Center (VTC) and the Federal University of Campina Grande (FUCG) the subsidies available for this work

References

Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Instrução Normativa n° 62, de 26 de agosto de 2003. Oficializa os Métodos Analíticos Oficiais para Análises Microbiológicas para Controle de Produtos de Origem Animal e Água. **Diário Oficial da República Federativa do Brasil**, Brasília, 18/09/2003. Seção 1, página 14.

Brito IP, Campos JM, Souza TFL, Wakiyama C, Azeredo GA. Elaboração e avaliação global de barra de cereais Caseira. **B.CEBP**. Curitiba, v 22, n 1.p.35 a50.,/ jan/jun 2004.

Freitas DGC, Moretti RH. Caracterização e avaliação sensorial de barra de cereais funcional de alto teor protéico e vitamínico. **Ciência e Tecnologia de Alimentos**, Campinas, n.26 v2. p 318-324, abr.-jun. 2006.

Instituto Adolfo Lutz. **Métodos Físico-Químicos para Análise de Alimentos do Instituto Adolfo Lutz:** Métodos físicos e químicospara análise de alimentos. 4 ed. São Paulo, 2008.

Júnior WEF. Carboidratos: Estrutura, Propriedades e Funções. **ConCeitos CientífiCos em Destaque**, n.29, agosto de 2008.

Kindle EM. **Caatinga e o Nordeste Brasileiro.** Disponível em <<http://emdiv.com.br/pt/brasil/geografia/597-caatinga-e-o-nordeste-brasileiro.html>> acesso em 15 jun. 2012.

Lemos JR. Fitossociologia do componente lenhoso de um trecho de vegetação arbustiva caducifólia espinhosa no Parque Nacional Serra da Capivara, Piauí, Brasil. Dissertação de Mestrado. Recife: **Pós-Graduação em Biologia Vegetal** – Universidade Federal do Pernambuco – Recife (PE), 1999.

Lima EE. Produção e armazenamento da farinha. 2006. (Dissertação Mestrado em Engenharia Agrícola) Universidade Federal de Campina Grande, 2006.

Oliveira LF et al. Aproveitamento alternativo da casca do maracujá-amarelo (Passifora edulis F. Flavicarpa) para produção de doce em calda. **Ciênc. Tecnol. Aliment**. v. 22, n. 3, p. 259-262, 2002.

Oliveira FMN, Alexandre HV, Figueirêdo RMF, Queiroz AJM, Oliveira AR. Características físico-químicas da polpa e casca do fruto do mandacaru. In: CONGRESSO BRASILEIRO DE CIÊNCIA E TECNOLOGIA DE ALIMENTOS, 19., 2004, Recife. **Anais**... Recife: SBCTA, 2004. CD Rom.

Oliveira FMN, Figueirêdo RMF, Queroz AJM, Almeida CA. Caracterização físico-química das polpas dos ramos do mandacaru. **Caatinga,** v.20, n.4, p.89-92, 2007.

Souza VC, Lorenzi H. **Botânica sistemática: guia ilustrado para identificação das famílias de Angiospermas da flora brasileira.** Nova Odessa, SP.: Instituto Plantarum, 2005. 639p.

Souza JML, Negreiros JRS, Álvares VS, Leite FMN, Souza ML, Reis FS, Felisberto FAV. Variabilidade físico-química da farinha de mandioca **Ciênc. Tecnol. Alimentos,** Campinas, v.28 n.4: 907-912, out.-dez. 2008.

Taylor NP, Zappi DC. **Cacti of Eastern Brazil**. Royal Botanic Gardens, Kew. 2004. 499 p.

Yemn EW, Willis AJ. The estimation of carbohydrate in plant extracts by antrone. Biochemical Journal, Cambridge, v.57, n.2, p.504-514, 1954.