ISSN 0100-2945 DOI: http://dx.doi.org /10.1590/0100-29452018749

Revista Brasileira de Fruticultura

Ripe Ora-pro-nobis (*Pereskia aculeata* miller) fruits express high contents of bioactive compounds and antioxidant capacity

Aline Priscilla Gomes da Silva[1], Poliana Cristina Spricigo[1], Thais Pádua de Freitas[1], Thiago Machado da Silva Acioly[1], Severino Matias de Alencar[2], Angelo Pedro Jacomino[1]

Abstract– *Pereskia aculeata* Miller is a native cactaceae found from the Northeast to the South of Brazil. This plant is recognized by the high nutritional value of their leaves, which are the most used in cooking and folk medicine. However, studies on the chemical characteristics and antioxidant capacity of the ora-pro-nobis fruits are scarce. Therefore, the aim of this study was to determine the best harvest point of the ora-pro-nobis fruits to optimize the content of bioactive compounds and their antioxidant capacity. The fruits were manually harvested, defined by their peel colors in three maturity stages: unripe (green), intermediate (yellowish green), and ripe (yellow) stages. The following attributes were evaluated: soluble solids (SS), titratable acidity (TA), SS/TA ratio, pH, and content of bioactive compounds, such as total chlorophylls, carotenoids, yellow flavonoids, total phenolic compounds, and antioxidant capacity. There was a decrease in the content of chlorophyll followed by an increase in the of total carotenoids and yellow flavonoids, due to the maturity stage. For the total phenolic compounds, it was not observed significant difference between the stages. The antioxidant capacity was quantified by the ORAC method in lyophilized pulp in the unripe (1.95 mmol 100 g^{-1} trolox) and ripe (3.85 mmol 100 g^{-1} trolox) stages. The lowest contents were observed in the intermediate (0.80 mmol 100 g^{-1} trolox in lyophilized pulp) stage. The maturity stage significantly influenced the bioactive compounds of ora-pro-nobis, which presented higher values of total carotenoids, yellow flavonoids, and antioxidant capacity in ripe fruits.

Index terms: *Pereskia aculeata* Miller; Maturity index; Harvest point; Postharvest; Brazilian native fruits.

Frutos de ora-pro-nóbis (*Pereskia aculeata* miller) maduros expressam maiores conteúdos de compostos bioativos e capacidade antioxidante

Resumo – *Pereskia aculeata* Miller é uma cactaceae nativa encontrada do Nordeste ao Sul Brasileiro. A planta é reconhecida pelo alto valor nutritivo das folhas, parte mais utilizada na culinária e na medicina popular. Entretanto, trabalhos sobre as características químicas e a capacidade antioxidante dos frutos de ora-pro-nóbis são escassos. Diante disso, o objetivo deste estudo foi determinar o melhor ponto de colheita em frutos de ora-pro-nóbis, visando a otimizar a presença de compostos bioativos e a capacidade antioxidante. Os frutos foram colhidos manualmente, e os três estádios de maturação foram definidos pela coloração da casca, sendo: estádio verde (coloração verde), intermediário (coloração verde - amarelada) e maduro (coloração amarela). Os atributos avaliados foram os sólidos solúveis (SS), acidez titulável (AT), relação SS/AT, pH, e os compostos bioativos, como as clorofilas totais,carotenoides totais, flavonoides amarelos, compostos fenólicos totais e capacidade antioxidante. Houve diminuição da clorofila e aumento no teor de carotenoides totais e flavonoides amarelos, em função do avanço no estádio de maturação. Para os compostos fenólicos totais, não houve diferença significativa entre os estádios avaliados. A capacidade antioxidante foi quantificada pelo método ORAC, em polpa liofilizada no estádio verde, (1,95 mmol 100 g^{-1} trolox) e maduro (3,85 mmol 100 g^{-1} trolox). Os menores teores foram observados no estádio intermediário (0,80 mmol 100 g^{-1} trolox em polpa liofilizada). O estádio de maturação influenciou de forma significativa sobre os compostos bioativos de ora-pro-nóbis, que apresentaram valores mais elevados de carotenoides totais, flavonoides amarelos e capacidade antioxidante em frutos maduros.

Termos para Indexação: *Pereskia aculeata* Miller; Índice de maturação; Ponto de colheita; Pós-colheita; Frutos nativos brasileiros.

Corresponding author:
jacomino@usp.br

Received: June 02, 2017.
Accepted: October 16, 2017.

Copyright: All the contents of this journal, except where otherwise noted, is licensed under a Creative Commons Attribution License.

(cc) BY

[1]University of São Paulo, "Luiz de Queiroz" College of Agriculture, Crop Science Departament, Postharvest Laboratory of Horticultural Products, Piracicaba, SP, Av. Pádua Dias 11, CEP 13418-900. E-mail: alinepgsilva@gmail.com, polianaspricigo@yahoo.com.br, thaispadua777@gmail.com, tmsacioly@hotmail.com; jacomino@usp.br
[2]University of São Paulo, "Luiz de Queiroz" College of Agriculture, Department of Agri-Food Industry, Food and Nutrition, Piracicaba, SP, Av. Pádua Dias, 11, CEP 13418-900. E-mail smalencar@usp.br

Pereskia aculeata Miller is a creeper plant, which belongs to the Cactaceae family, being native of South and Central America, and tropical America which is naturally distributed from the Northeast to the South of Brazil (SHARIF et al., 2013). It is highlighted as a native plant of excellent potential, being a source of bioactive and nutrient substances (BRASIL, 2004). In Brazil, it is known as ora-pro-nobis, and its leaves are the only part traditionally consumed, being used in culinary and folk medicine (SOUZA et al., 2015). Recent studies have reported the fruits from *Pereskia aculeata* Miller (AGOSTINI-COSTA et al., 2012) and the leaves from *Pereskia grandifolia* Haw (SIM et al., 2010) and *Pereskia bleo* (Kunth) DC. (BAKHARI et al., 2010) are good sources of carotenoids with antioxidant activities.

Although the fruits of ora-pro-nobis have been underused, they are commonly recognized as nutraceutic, or functional and medicinal food, with anti-inflammatory and antinociceptive effects (BARBALHO et al. 2016; SILVA JÚNIOR et al., 2010). The ora-pro-nobis fruits have oval, piriform or rounded shape, yellowish-green, yellow-orange or reddish color (BRASIL, 2010). They are pomaceous, cacti type, with pericarp and seeds dipped in a gelatinous mass (ROSA; SOUZA, 2003). According to AGOSTINI-COSTA et al. (2012), the ora-pro-nobis fruits present protein (1%), fibers (0.7-9.4%), lipids (0.7%), carbohydrates (6.3%); vitamin C (2-125 mg 100 g^{-1}); calcium (174-206 mg 100 g^{-1}), niacin (0.9 mg 100 g^{-1}) and phosphorus (26 mg 100 g^{-1}).

Scarce information on the bioactive compounds and antioxidant capacity of ora-pro-nobis fruits is available; less information about the physicochemical characteristics developed during different maturation stages is also available in the literature. Therefore, this study aimed to determine the best harvesting point in ora-pro-nobis fruits to optimize the presence of bioactive compounds and their antioxidant capacity.

The ora-pro-nobis fruits were collected in June 2014, in a private property, municipality of Campina do Monte Alegre (SP; latitude 23º35'31" S and longitude 48º28'38" W). The fruits were manually harvested in three maturity stages, defined by the peel color. The stages were: unripe (green), intermediate (yellowish green), and ripe (yellow). Then the fruits were transported and selected for no defect to obtain uniform batches.

In the different maturity stages, the fruit pulps were homogenized and submitted to the following analyzes, in triplicates: a) soluble solids (SS) content: quantified in the pulp by direct reading in digital refractometer (Atago PR-101, Palette), and the results were expressed in ºBrix (AOAC, 2012); b) titratable acidity (TA): according to methodology described by AOAC (2012); the results were expressed as citric acid percentages; c) SS/TA ratio: obtained by the ratio between the SS and TA contents; d) pH: measured in liquefied samples using a potentiometer, according to the methodology described by the AOAC (2012); e) content of total chlorophylls and carotenoids: determined by the method described by Lichtenthaler (1987); f) content of yellow flavonoids: determined according to the methodology described by Francis (1982); g) total phenolic compounds (WOISKY; SALATINO, 1998); h) antioxidant capacity by sequestration of the DPPH and ABTS free radicals (RUFINO et al., 2007) and ORAC method (MELO et al., 2015).

The completely randomized experimental design was used, with three replicates (10 fruits each); the data were submitted to analysis of variance and the means were compared using the Tukey's test (5%). The variables were processed using the SAS software, v. 9.3 (2010). Correlations between bioactive compounds (content of total chlorophylls, carotenoids, and total phenolic compounds, yellow flavonoids, and antioxidant capacity by the ORAC method) were calculated using the *Statsoft* (2004) software and coefficients with indices greater than 0.90 were selected.

During fruit ripening, a 91% increase in the SS/TA ratio between the unripe (2.77) and ripe (5.29) stages was observed (Table 1). Thus, the fruits acquired a more attractive taste for consumption along the maturation stages. The increase in the SS/TA ratio occurred due to an intrinsic ripening processes, mainly degradation of organic acids, and maintenance of soluble solids contents (Table 1). The values for the SS/TA ratio observed in ora-pro-nobis fruits were higher than those evaluated in four passion fruit cultivars (3.15-3.99) (CAVALCANTE et al., 2016). For soluble solids, the difference between the unripe and ripe stages reached the value of 0.45 ºBrix. The titratable acidity (TA) of ripe fruits was 1.06% citric acid, which corresponds to a 57% decrease relative to green fruits. Decrease in acidity (about 55%) was also observed in pineapple cv. Vitória fruits when harvested in five different maturity stages (OWAGA et al., 2017).

The pH values measured in ora-pro-nobis fruits were 3.27 in the unripe stage and 3.58 in ripe stage (Table 1). The decrease in the pH value relates to TA and consumption of organic acids during ripening, when these acids act as substrates in the respiratory process (SILVA et al., 2005). However, increase in these values may occur in some fruits along storage, as can be observed in yellow passion fruits (2.74-2.80) (ARAÚJO et al., 2017).

Ripening of the ora-pro-nobis fruits was externally characterized by a marked change in color. With degradation of the green color, result from a decrease in chlorophyll content, predominate the yellow color and the carotenoids pigments. It was observed that the chlorophyll content in the ripe stage of fruits decreased almost three times as compared to the initial value (Table 1). On the other hand, the value of the total carotenoid content in the ripe stage (2.14 mg g^{-1}) contrasted compared to the initial content (1.82 mg g^{-1}) (Table 1). This behavior was validated by the strong negative correlation obtained between the chlorophyll and total carotenoid variables (Table 2). Qin et al. (2015) also observed an increase in total carotenoid contents in two citrus cultivars at the end of fruit ripening.

Carotenoid and flavonoid pigments have antioxidant properties, associated with the reduction in chronic-degenerative diseases (such as cancer and cardiovascular diseases), besides their anti-inflammatory properties (KAULMANN; BOHN, 2014). The ora-pro-nobis fruits showed an increase in the content of yellow flavonoids between the different ripening stages. In ripe fruits, the contents observed in fresh pulp (9.38 mg 100 g^{-1}) (Table 1) were higher than the mean contents (4.70-6.05 mg 100 g^{-1}) described for passion fruit cultivated in the conventional and organic systems (OLIVEIRA et al., 2017). In the unripe stage, the yellow flavonoids content presented a high negative correlation (-0.99) with the total phenolic compounds contents (Table 2).

The total phenolic compounds did not show statistically significant differences between ripening stages (Table 1). The total phenolic compounds content in ora-pro-nobis fruits were higher than those observed in some traditional fruits, such as pineapple (33 mg GAE 100 g^{-1}), papaya (33.4 mg GAE 100 g^{-1}), and mango (41.1 mg GAE 100 g^{-1}) (SEPTEMBRE-MALATERRE et al., 2016). The contents of bioactive compounds in ora-pro-nobis fruits explicit their potential to complement the human diet (BARBALHO et al., 2016). The antioxidant capacity of native cacti fruits in Brazil is of most importance, since the food-health relationship is being explored and highlighted by the scientific community in this scenario (AGOSTINI-COSTA et al., 2012; ARAUJO et al., 2016; BARBALHO et al., 2016; MORZELLE et al., 2015). The antioxidant capacity was determined using the ORAC (peroxyl radical sequestering) and synthetic DPPH and ABTS free-radical sequestration methods. DPPH and ABTS methods were not capable to detect antioxidant capacity at all ripening stages (Table 1). However, the antioxidant capacity was measured (ORAC method) in the unripe (1.95 mmol 100 g^{-1} trolox), intermediate (0.80 mmol 100 g^{-1} trolox), and ripe (3.85 mmol 100 g^{-1}trolox) stages. Ripe tangerine fruits (*Citrus reticulata* Blanco cv. Chachiensis), presented an oxidative capacity of 1.7 mmol 100 g^{-1} trolox (WANG et al., 2016). In kiwi fruits (*Actinidia deliciosa*, cv. Hayward), contents of 0.62 mmol 100 g^{-1} trolox were reported (D'EVOLI et al., 2013). Thus, integrates ora-pro-nobis fruits into the human diet can bring health benefits, since they have a high content of bioactive compounds and a significant antioxidant capacity. In green fruits, a high negative correlation between antioxidant capacity (ORAC) and content of total phenolic compounds was observed, indicating that these components have inverse behaviors at this maturity stage.

Given the results, the progress in the maturity stage positively influences the bioactive and antioxidant compounds of ora-pro-nobis fruits. Harvesting of ripe ora-pro-nobis fruits provide higher content of total carotenoids, yellow flavonoids, and antioxidant capacity.

The authors thank the São Paulo Research Foundation (FAPESP) – grant #2014/13473-7 (scholarship); the Coordination of Improvement of Higher Education Personnel (CAPES) (scholarship); the National Council for Scientific and Technological Development (CNPq) – process #308521/2015-3 (research productivity grant) and 458123/2014-5 (research funding); and the rural producer Helton Muniz, from Campina do Monte Alegre, SP, Brazil, for providing the fruits.

Table 1. Chemical characteristics, bioactive compounds, and antioxidant capacity during the different maturation stages of *Pereskia aculeata* Miller fruits harvested in the municipality of Campina do Monte Alegre, São Paulo (SP), Brazil.

Variables	Maturation stages: Unripe	Intermediate	Ripe	CV (%)
SS (ºBrix)	5.20c	5.35b	5.65a	0.76
TA (% citric acid)	1.87a	1.22b	1.06c	2.30
SS/TA	2.77c	4.38b	5.29a	3.14
pH	3.27b	3.25b	3.58a	3.72
Total chlorophylls (mg g^{-1})	1.63a	1.11b	0.67c	5.99
Total carotenoids (mg g^{-1})	1.82b	1.64b	2.14a	5.69
Yellow flavonoids (mg 100 g^{-1})	5.73b	6.53b	9.38a	7.28
Total phenolic compounds[1] (mg GAE 100 g^{-1})	113.42a	124.03a	120.09a	12.88
ORAC antioxidant capacity (mmol trolox 100 g^{-1} lyophilized pulp)	1.95b	0.80c	3.85a	4.38
DPPH (µM Trolox equivalent g^{-1} FW)	n.d	n.d	n.d	-
ABTS (µM Trolox equivalent g^{-1}FW)	n.d	n.d	n.d	-

In the same line, averages followed by the same letter do not differ significantly from each other (Tukey's test; 5% probability). n.d: not detected.
[1]GAE: gallic acid equivalent.

Table 2. Coefficient values for Pearson's linear correlation between bioactive compounds during different maturation stages of *Pereskia aculeata* Miller fruits harvested in the municipality of Campina do Monte Alegre, São Paulo (SP), Brazil.

Variables	Maturation stages: Unripe					Intermediate					Ripe				
	TC	TCLR	YF	TPC	ORAC	TC	TCLR	YF	TPC	ORAC	TPC	TCLR	YF	TPC	ORAC
TC	1	-1	0,35	-0,50	-0,50	1	0,50	0,86	0,78	-0,5	1	**1**	-0,5	-0,54	0,5
TCLR	**-1**	1	-0,29	0,45	0,45	0,5	1	0,87	0,93	-1	1	1	-0,5	-0,54	0,5
YF	0,35	-0,29	1	-0,99	-0,99	0,86	0,9	1	0,99	-0,9	-0,5	-0,5	1	**1**	0,5
TPC	-0,50	0,45	**-0,99**	1	1	0,78	0,9	0,99	1	-0,9	-0,54	-0,54	1	1	0,46
ORAC	-0,50	0,45	**-0,99**	**1**	1	-0,5	**-1**	**-0,87**	**-0,93**	1	0,5	0,5	0,5	0,46	1

*TC: total carotenoids; TCLR: total chlorophylls; YF: yellow flavonoids; TPC: total phenolic compounds; ORAC:oxygen radical absorbance capacity. Significant correlations at 5% probability level.

References

AGOSTINI-COSTA, T. D. S.; WONDRACECK, D. C.; ROCHA, W. D. S.; SILVA, D. B. D. Carotenoids profile and total polyphenols in fruits of Pereskia aculeata Miller. **Revista Brasileira de Fruticultura**, Jaboticabal, v. 34, n. 1, p. 234-238, 2012

AOAC - Association of Official Analytical Chemists. **Official methods of analysis of AOAC international**. 19th ed. Gaithersburg: AOAC International, 2012. 1015p.

ARAÚJO, L.S.; COSTA, E.M.R.; SOARES, T.L.; SANTOS, I.S.; JESUS, O.N. Effect of time and storage conditions on the physical and physico-chemical characteristics of the pulp of yellow and purple passion fruit. **Food Science and Technology**, Campinas, v. 37, n. 3, p. 500-506, 2017.

ARAUJO, R.D.; LUCENA, E.M.P.; GOMES, J.P.; FIGUEIRÊDO, R.M.F.; SILVA, C.P. Characterization of ripening stages of Myrtle fruit. **Revista Brasileira de Fruticultura**, Jaboticabal, v.38, n.2, 2016.

BAKHARI, N.A.; ABDULLAH, A.R.; OSMAN, H.; NORDIN, N.H. The relationship between phenolic, tannin and flavonoid content with the antioxidant activity of *Pereskia bleo* (Kunth). In: INTERNATIONAL CONFERENCE ON SCIENCE AND SOCIAL RESEARCH, 2010, Malysia. **Abstracts...** Malysia: IEEE, 2010. p. 494-498.

BARBALHO, S.M.; GUIGUER, E.L.; MARINELLI, P.S.; DO SANTOS BUENO, P.C.; PESCININI-SALZEDAS, L.M.; SANTOS, M.C.B.; OSHIIWA, M.; MENDES, C.G.; DE MENEZES, M.L.; NICOLAU, C.C.T.; OTOBONI, A.M.; DE ALVARES, G.R. *Pereskia aculeata* Miller Flour: metabolic effects and composition. **Journal of Medicinal Food**, New York, v.19, n.9, p.890-894, 2016.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. **Manual de hortaliças não-convencionais**. Brasília: MAPA/ACS, 2010. p.62-64.

BRASIL. Ministério da Saúde. **Guia alimentar para a população brasileira**. Brasília, DF, 2004. 210p.

CAVALCANTE, N.R.; KRAUSE, W.; CARVALHO, J.F.; ROCHA, M.K.P.; PALU, E.G.; SILVA, C.A. Productivity, fruit physicochemical quality and distinctiveness of passion fruit populations. **Revista Brasileira de Fruticultura**, Jaboticabal, v.38, n.4, p.e-142, 2016.

D'EVOLI, L.; MOSCATELLO, S.; BALDICCHI, A.; LUCARINI, M.; CRUZ-CASTILLO, J. G.; AGUZZI, A.; GABRIELLI, P.; PROIETTI, S.; BATTISTELLI, A.; FAMIANI, F.; BÖHM, V.; LOMBARDI-BOCCIA, G. Post-harvest quality, phytochemicals and antioxidant activity in organic and conventional kiwifruit (*Actinidia deliciosa*, cv. Hayward). **Italian Journal of Food Science**, Pinerolo, v. 25, n. 3, p. 362-368, 2013.

FRANCIS, F. J. Analysis of anthocyanins. In: MARKAKIS, P. **Anthocyanins as food colors**. New York: Academic Press, 1982. p. 181-207.

KAULMANN, A.; BOHN, T. Carotenoids, inflammation, and oxidative stress—implications of cellular signaling pathways and relation to chronic disease prevention. **Nutrition Research**, New York, v.34, n.11, p.907-929, 2014.

LICHTENTHALER, H. K. Chorophylls and carotenoids: pigments of photosynthetic biomembranes. In: PACKER, L.; DOUCE, R. (Ed.). **Methods in enzymology**. London: Academic Press, 1987. p.350-382.

MELO, P.S.; MASSARIOLI, A.P.; DENNY, C.; SANTOS, L.F.; FRANCHIN, M.; PEREIRA, G.E.; VIEIRA, T.M.F.S.; ROSALEN, P.L.; ALENCAR, S.M. Winery by-products: extraction optimization, phenolic composition and cytotoxic evaluation to act as a new source of scavenging of reactive oxygen species. **Food Chemistry**, Easton, v. 181, p. 160-169, 2015.

MORZELLE, M.C.; BACHIEGA, P.; SOUZA, E.C.; VILAS BOAS, E.V.B.; LAMOUNIER, M.L. Caracterização química e física de frutos de curriola, gabiroba e murici provenientes do cerrado brasileiro. **Revista Brasileira de Fruticultura,** Jaboticabal, v.37, n.1, p.96-103, 2015.

OGAWA, E.M.; COSTA, H.B.; VENTURA, J.A.; CAETANO, L.; PINTO, F.E.; OLIVEIRA, B.G.; BARROSO, M.E.S.; SCHERER, R.; ENDRINGER, D.C.; ROMÃO, W. Chemical profile of pineapple cv. vitória in different maturation stages using electrospray ionization mass spectrometry. **Journal of the Science of Food and Agriculture**, London, v.98, n.3, p.1105-1116, 2017.

OLIVEIRA, A.B.; LOPES, M.M.A.; MOURA, C.F.H., OLIVEIRA, L.S.; SOUZA, K.O.; GOMES FILHO, E.; URBAN, L.; MIRANDA, M.R.A. Effects of organic vs. conventional farming systems on quality and antioxidant metabolism of passion fruit during maturation. **Scientia Horticulturae**, New York. v.222, p.84-89, 2017.

PINTO, N.C.C.; SCIO, E. The biological activities and chemical composition of Pereskia species (Cactaceae) - A review. **Plant foods for human nutrition**, Dordrecht, v.69, n.3, p.189-195, 2014.

QIN, Y.; LI, G.; WANG, L.; TEIXEIRA, J.A.; YE, Z.; FENG, Q.; HU, G.A. comparative study between a late-ripening mutant of citrus and its original line in fruit coloration, sugar and acid metabolism at all fruit maturation stage. **Fruits**, Paris, v.70, n.1, p.5-11, 2015.

ROSA, S.M.; SOUZA, L.A. Morfo-anatomia do fruto (hipanto, pericarpo e semente) em desenvolvimento de *Pereskia aculeata* Miller (Cactaceae). **Acta Scientiarum Biological Sciences**, Maringá, v.25, n.2, p.415-428, 2003.

RUFINO, M.S.M.; ALVES, R.E.; BRITO, E.; MORAIS, S.M.; SAMPAIO, C.G.; PÉREZ-JIMÉNEZ, J.; SAURA-CALIXTO, F.D. Metodologia científica: determinação da atividade antioxidante total em frutas pela captura do radical livre ABTS. Fortaleza**:** Embrapa Agroindústria Tropical, 2007. (Comunicado Técnico).

SAS. **SAS/STAT® 9.3**: user's guide. 2nd ed. Cary: SAS Institute, 2010.

SEPTEMBRE-MALATERRE, A.; STANISLAS, G.; DOURAGUIA, E.; GONTHIER, M. P. Evaluation of nutritional and antioxidant properties of the tropical fruits banana, litchi, mango, papaya, passion fruit and pineapple cultivated in Réunion French Island. **Food Chemistry**, Easton, v.212, p.225-233, 2016.

SHARIF, K.M.; RAHMAN, M.M.; ZAIDUL, I.S.M.; JANNATUL, A.; AKANDA, M.J.H.; MOHAMED, A.; SHAMSUDIN, S.H. Pharmacological relevance of primitive leafy cactuses Pereskia. **Research Journal of Biotechnology**, Karachi, v.8, n.12, p.134-142, 2013.

SILVA, T.V.; RESENDE, E.D.; VIANA, A.P.; ROSA, R.C.C.; PEREIRA, S.M.F.; CARLOS, L.A.; VITORAZI, L. Influência dos estádios de maturação na qualidade do suco do maracujá-amarelo. **Revista Brasileira de Fruticultura**, Jaboticabal, v.27, n.3, p.472-475, 2005.

SILVA JÚNIOR, A.A.; NUNES, D.G.; BERTOLDI, F.C.; PALHANO, M.N.; KOMIEKIEWICZ, N.L.K. Pão de ora-pro-nóbis um novo conceito de alimentação funcional. **Agropecuária Catarinense**, Santa Catarina, v.23, n.1, p.35-37, 2010.

SIM, K.S.; NURESTRI, A.M.S.; NORHANOM, A.W. Phenolic content and antioxidant activity of crude and fractionated extracts of *Pereskia bleo* (Kunth) DC. (Cactaceae). **African Journal of Pharmacy and Pharmacology**, Nairobi, v.4, n.5, p.193-201, 2010.

SOUZA, M.S.S.; BARBALHO, S.M.; GUIGUER, E.L.; ARAÚJO, A.C.; BUENO, P.C.S.; FARINAZZI-MACHADO, F.M.V.; LIMA, L.M.L.; SILVA, B.C.; MENDES, C.G. Effects of *Pereskia aculeata* Miller on the Biochemical Profiles and Body Composition of Wistar Rats. **Journal of Biosciences and Medicines**, Zurich, v.3, n.7, p.82-89, 2015.

STATSOFT. **Statistica**: data analysis software system. Version 7. 2004. Disponível em: <www.statsoft.com>.

WANG, H.; CHEN, G.; GUO, X.; ABBASI, A.M.; LIU, R.H. Influence of the stage of ripeness on the phytochemical profiles, antioxidant and antiproliferative activities in different parts of *Citrus reticulata* Blanco cv.Chachiensis. **LWT-Food Science and Technology**, Zurich, v.69, p.67-75, 2016.

WOISKY, R.G.; SALATINO, A. Analysis of propolis: some parameters and procedure for chemical quality control. **Journal of Apicultural Research**, Cardiff, v.37, n.2, p.99-105, 1998.