

# SHELF LIFE OF FROZEN ARATICUM'S PULP VACUUM-PACKED OR NOT VACCUM-PACKED

*Vida útil de polpa congelada de araticum embalada ou não a vácuo*

*Duración de pulpa de araticum congelado empaquetadas con y sin vacío*



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## ABSTRACT

The objective of this work was to evaluate the role of two types of conditioning process in quality of frozen and stored araticum's pulp at -18°C. The fruits were collected at pre-maturing developmental stage, packed into boxes wrapped with bubble plastic, transported to the laboratory and stored for 7 days at 22°C and 90% RH to complete the maturation. Afterwards, they were pulped and the pulp was stored in: 1) low-density polyethylene packages (LDPE) 60 micro, hermetically packed in a sealing machine or 2) low-density polyethylene packages (LDPE) 60 micro vacuum sealed. Those units were frozen at -18°C for 402 days and were evaluated at processing day and at 30; 90; 150; 210 and 402 days of storage, for soluble solids contents (SS), titratable acidity (TA), SS/TA, ascorbic acid, total extractable polyphenols and total antioxidant activity using the Ferric Reducing Antioxidant Power (FRAP) method. The results were submitted to an analysis of variance and the means were each other compared using Tukey test with Sisvar software. It is concluded that is not necessary the use of vacuum to package the frozen araticum's pulp for 402 days, at -18°C.

**Keywords:** *Annona crassiflora* Mart, freezing, vacuum.

## RESUMO

*O objetivo do trabalho foi verificar a influência de dois tipos de processo de acondicionamento na qualidade da polpa de araticum congelada e armazenada a -18°C. Os frutos foram colhidos no estágio "de vez", acondicionados em caixas protegidas com plástico bolha, transportados para o laboratório e armazenados a 22°C e 90%UR durante 7 dias para completarem o amadurecimento. Posteriormente, foram despulpados em despulpador e a polpa foi acondicionada em: 1) embalagens de polietileno de baixa densidade (PEBD) 60 micra, fechadas hermeticamente com máquina seladora ou 2) embalagem de PEBD 60 micra e selada a vácuo. Estas unidades foram congeladas a -18°C por 402 dias e avaliadas no dia do processamento e aos 30; 90; 150; 210 e 402 dias de armazenamento, quanto: teores de sólidos solúveis, acidez titulável, relação SS/AT, ácido ascórbico, polifenóis extraíveis totais e atividade antioxidante total pelo método de redução do ferro (FRAP). Os resultados foram submetidos à análise de variância e as médias foram comparadas entre si pelo teste de Tukey, utilizando-se o programa Sisvar. Conclui-se que não é necessário a utilização de vácuo para congelamento e armazenamento de polpa de araticum por 402 dias, a -18°C.*

**Palavras-chave:** *Annona crassiflora* Mart, congelamento, vácuo.

## RESUMEN

*El objetivo del trabajo fue comprobar la influencia de dos tipos de procesos de almacenamiento en la calidad de la pulpa de araticum congelado y mantenidos a -18°C. Los frutos fueron cosechados en el estadio de madurez "de vez"*

y empaquetados en cajas protegidas con plástico para su protección, transportados al laboratorio y sometidos a 22°C y 90% UR al largo de siete días de almacenamiento para completar su maduración. En la mayoría de los casos, se utilizaron los siguientes: 1) envases de polietileno de baja densidad (PEBD) 60 micras, cerrados utilizando de una máquina selladora o 2) embalaje de PEBD 60 micras y sellado al vacío. Estas unidades fueron congelados a -18 ° C al largo de 402 días de almacenamiento y fueron evaluadas en los días 30; 90; 150; de acuerdo con lo establecido en la normativa actual en el país de origen. En el caso de que se produzca un cambio en la calidad del producto, los resultados fueron sometidos al análisis estadístico y sus promedios comparadas entre ellas utilizando por el test de Tukey, con el paquete estadístico Sisvar. Se concluye que no es necesario la utilización de vacío para congelación y almacenamiento de pulpa de araticum por 402 días, a -18°C.

**Descriptor:** *Annona crassiflora* Mart, congelación, vacío.

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## INTRODUCTION

The Cerrado biome is considered as Brazilian's second biggest vegetation form, after Amazonia biome, besides of being the richest tropical savanna in biodiversity, combining one-third of the national biodiversity and 5% of the world's flora and fauna (FALEIRO et al., 2008).

Anonaceae's family covers a group of fruit trees with an important role in Brazil's economy. A lot of these plants are natives of Brazil, like araticum (*Annona crassiflora* Mart), a Cerrado Biome's native species (SILVA, 2007).

Araticum's fruits have a great flavor, taste and nutritive quality and it can be consumed *in natura*, besides presenting an average yield of 55% to 65% in pulp, showing a potential to be used as processed frozen pulp, juices, jellies and ice cream (SILVA et al., 2009). However, even though the araticum's fruit have such characteristics, they're still essentially extractive explored, what makes it be consumed only in the regions of spontaneous occurrence. It is a wild species, with cross-pollination and naturally present wide variability for some characteristics in relation to the plant, the production and the fruits (PIMENTA et al., 2014).

Farmers have been searching for benefits of agroindustrial process, aiming to adding value in the commercializations of *in natura* products (MDA, 2006). In the case of fruits, the pulp process allows adding

value, reduce loss and enable the consume of native fruits around the national territory (MORAES, 2006).

The fruit pulp can be defined as a non fermented product, non concentrated or diluted, obtained by smashing fleshy fruits. The Brazilian legislation establish microbiological, identity and minimal physico-chemical characteristics standards for some types of pulp (BRASIL, 1978; BRASIL, 2001).

The market of frozen pulps have been showing substantial increase in the last years and offering great marketing potential, depending on the segment to be accomplished and/or to be substituted, as far as the alimentary habits related to consumption of *in natura* fruits are moved to fruit pulp. The expectancy of this market's increase is directly associated to the consumers's awareness about this consumption alternative, which avoids the difficulty of seasonality in fruit production, in addition to the habit changes caused by various reasons as the adjustment of the urban man to the modern living facilities and the insertion of women in the labour market (OLIVEIRA et al., 1998).

Among the methods to conserve the fruit pulps, we can highlight the frozen process, which can inhibit the development of microorganisms and enzymatic activity and thus extend the shelf life and microbiological safety of these products (ELEZ-MARTÍNEZ, 2006; FELLOWS, 2008). Nonetheless, such technology can change the contents of some

nutrients as vitamins and carotenoids (SILVA et al., 2015).

Thus, it is important to know if the modifications in the quality parameters occur after frozen and processing the pulp. In this way, this work was intended to verify the influence of the two types of packaging process on the quality of the frozen araticum pulp and stored at -18°C.

## MATERIAL AND METHODS

### Plant Material

The araticum's fruits were harvested in the region of Leopoldo de Bulhões (GO), in the early hours of the morning, after their natural fall of the trees, at the pre-maturation stage, which is considered the stage where the peel fruits show small signs of opening.

After the harvest, the fruits were packed in plastic boxes internally covered by bubble wrap and transported to the Horta of the Escola de Agronomia's laboratory, in the Universidade Federal de Goiás, where they were standardized as to the size and absence of defects, besides the elimination of those that were with injuries, in order to homogenize the lot to be processed.

After standardization, the fruits were stored at 22 ° C and 90% relative humidity for seven days until they matured. After this period, the araticums' fruits were depulped in a mechanical pulper and a part of the pulp was stored in 60 micron low density polyethylene (LDPE) packaging sealed with the aid of a sealer. The other part was packed in 60 micron LDPE hermetically sealed under vacuum. Each package was composed of approximately 150 grams of pulp, which were frozen at -18 ° C for up to 402 days.

## Evaluations

The araticum pulp was evaluated on the day of processing (0 day) and at 30; 90; 150; 210 and 402 days, for soluble solids contents (SS), titratable acidity (TA), SS/TA, ascorbic acid content, and total antioxidant activity using the Ferric Reducing Antioxidant Power (FRAP) method. For all evaluations, 3 replicates were used for each type of packaging per day of analysis.

Soluble solids contents (SS) were determined in drops extracted from the araticum pulp using a refractometer, and the results were expressed in °Brix (AOAC, 1997 - method 932.12).

The titratable acidity contents (TA) were quantified by titration with 0.1 N sodium hydroxide solution (NaOH). Weighed 5 grams of araticum pulp, which were diluted in 50 ml of distilled water. The acidity was determined by titration, using phenolphthalein as indicator. The results were expressed in percentage of malic acid (AOAC, 1997- method 942.15).

The SS/AT was calculated by dividing the soluble solids (SS) and the titratable acidity (TA), according to IAL (2008).

The ascorbic acid contents were also quantified by titrimetry, according to the methodology of Strohecker and Henning (1967). 10 grams of pulp were weighed, which were titrated with the Tilmans reagent until the coloration reached color pink. Standard ascorbic acid solution of 50 µg mL<sup>-1</sup> was used and the results were expressed in mg of ascorbic acid 100 g<sup>-1</sup> of pulp.

The total extractable polyphenols contents were determined using the Folin-Ciocalteu method and the results were expressed in milligrams of gallic acid 100 g<sup>-1</sup> of pulp (SINGLETON et al., 1999).

At last, the total antioxidant activity was quantified using Ferric Reducing Antioxidant Power (FRAP) method, according to the methodology

described by Rufino (2008). This method is based on a reduction reaction (in acid medium) of the ferric complex tripyridyltriazine to the ferrous complex, causing its coloration to change to blue in the presence of an antioxidant (BENZIE and STRAIN, 1996, PULIDO et al., 2000). The results were expressed in ferrous sulphate  $\mu\text{M g}^{-1}$  pulp.

The experiment was performed in a completely randomized design and the results were submitted to analysis of variance, using the F test to verify the differences between the types of packaging tested. The significant differences between them were compared using the Tukey test at 5% probability. Whenever significant differences were observed in the interaction between the existing factors, a regression analysis was used.

## RESULTS AND DISCUSSION

Titrateable acidity and soluble solids contents were influenced only by pulp storage time (Figure 1). As for titrateable acidity, a slight decrease was observed up to 90 days, with a subsequent increase at 210 days, and then decreased until the end of pulp storage (Figure 1A). On the other hand, soluble solids showed a tendency to increase during the storage of the araticum's pulp (Figure 1B).

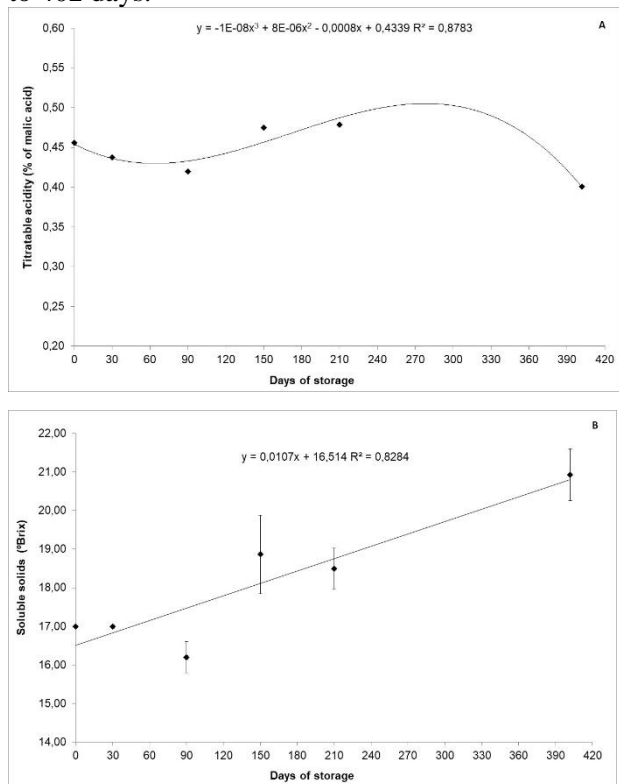
Silva et al. (2009) frozen the araticum's pulp at  $-18^{\circ}\text{C}$  for 60 days and also observed a decrease in titrateable acidity. On the other hand, Silva et al. (2015) observed that there was no change in titrateable acidity levels during storage for 180 days of araticum's pulp submitted to bleaching or pasteurization process and then frozen at  $-5^{\circ}\text{C}$  or  $-18^{\circ}\text{C}$ . Morais et al. (2017) evaluated the in natura and pasteurized araticum's pulp and found titrateable acidity levels of 0,30g of malic acid  $100 \text{ g}^{-1}$  of pulp for both the in natura and the pasteurized pulp, which was lower than that was found in this work during storage.

The increase in soluble solids contents can be explained by the loss of moisture to the environment through the plastic film (BRUNINI et al., 2002). Braga Filho et al. (2014) when evaluating fruits of araticum from different localities found average values of soluble solids of 18,91 °Brix, which was similar to that was found in this work at 150 and 210 days of pulp storage. Silva et al. (2015) concluded that the soluble solids contents remained constant during the 180 days of storage, which was different from the one found in this work. Soluble solid contents similar to this work were found by Silva et al. (2013) when characterizing marolo's fruit (*Annona crassiflora* Mart) from southern of Minas Gerais, Brazil, at the final stage of fruit development.

The soluble solids contents behaviour in fruit pulps is very heterogeneous and can be influenced by the profile of soluble compounds (pectin, reducing sugars, vitamins, among others) of the food matrix (LIMA et al., 2012), which explains the differences between the existing literature.

There is still no Quality and Identity Standard (PIQ) for the araticunzeiro's fruit pulp. On the other hand, for graviola's pulp that is of the same family as araticum, the PIQ established by the legislation determines a minimum value of 9 °Brix (BRASIL, 2000). Thus, because they belong to the same botanical classification for the genus of the species, it can be inferred that these fruits present near levels of SS, which may increase the interest of the food industry in the exploitation of araticum, contributing to the preservation programs of the species (MORAIS et al., 2017).

**Figure 1.** Titratable acidity (% of malic acid) (A) and soluble solids (°Brix) (B) contents of the araticum's pulp packed in low density polyethylene packaging, sealed under vacuum or not and frozen at -18 °C for up to 402 days.



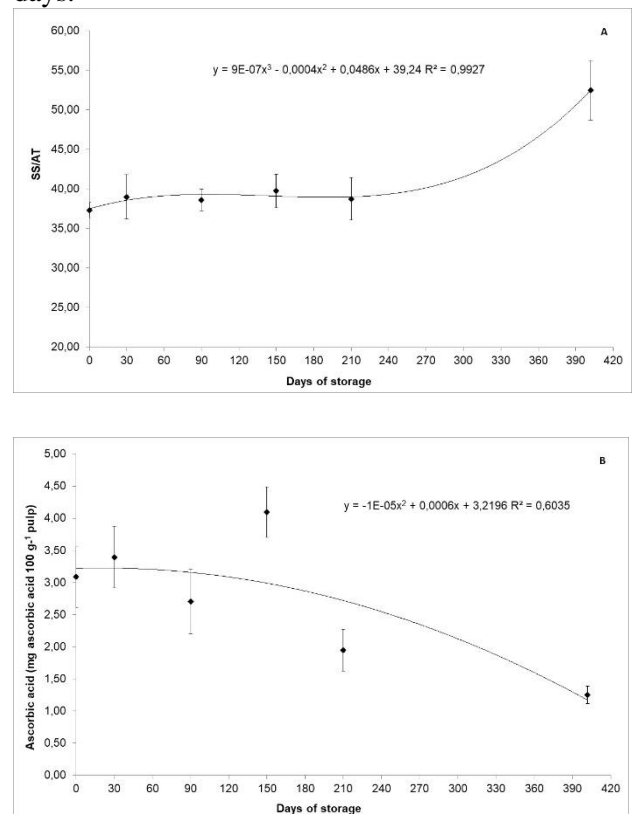
The increase in the soluble solids contents and the decrease in the titratable acidity reflected the SS/TA (Figure 2A), which showed stability tendency until the 210th day of storage, and subsequently the values were increased, which occurred due to the sharp fall in acidity. Lower SS/TA values were found by Morais et al. (2017) when they analyzed the fresh pulp (32,36) and the pasteurized pulp (31,49).

The SS/TA can be used to evaluate the taste of a fruit or pulp in a more precise way, instead of analyzing isolated sugars or acids, and refers to an idea of equilibrium between the two components (CHITARRA and CHITARRA, 2005). When the values found for this ratio are high, they may indicate a high degree of sweetness, suggesting that such pulp can be used in the industries for the production of sweets, ice cream, juices (NASCIMENTO, 2011).

As for the ascorbic acid levels, was observed a decrease during the storage period of the pulp, which

could indicate that there was degradation in the contents due to prolonged storage (Figure 2B). Cheftel et al. (1989) stated that at -18 °C, a considerable portion of water remains in the liquid state, and may migrate into the atmosphere within the package or into the environment, which can result in undesirable changes in appearance and acceleration of oxidative reactions in the product. It is worth remembering that the SS/TA ratio and the ascorbic acid contents were also influenced only by storage time.

**Figure 2.** SS/AT (A) and ascorbic acid (ascorbic acid 100 g<sup>-1</sup> pulp) (B) contents of the araticum's pulp packed in low density polyethylene packaging, sealed under vacuum or not and frozen at -18 °C up to 402 days.

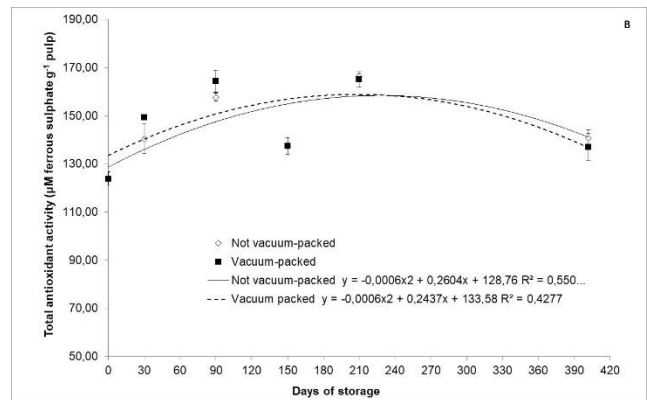
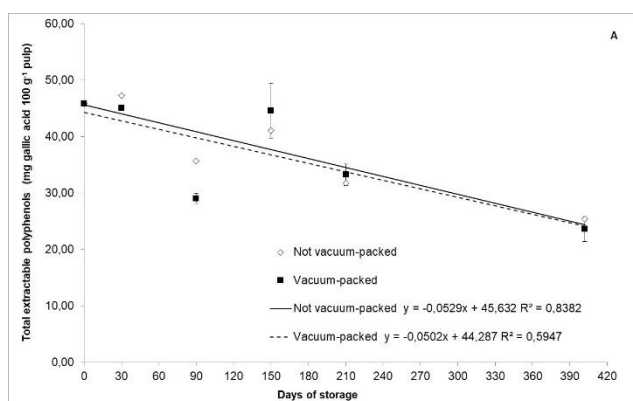


The total of extractable polyphenols contents and the total of antioxidant activity of the araticum's pulp showed a significant interaction between the types of packaging and the period of storage. The polyphenols contents decreased with storage in both packages tested (Figure 3A) and the antioxidant activity tended to increase up to 210 days, and then decreased at the end of storage (Figure 3B). Such

reduction in polyphenol content may have occurred due to oxidative degradation during the processing as a result of the release and action of polyphenoloxidase (MANACH et al., 2004).

The decrease in the antioxidant activity of the pulp may have been influenced by the decrease in the ascorbic acid and polyphenols contents, which contribute with the antioxidant capacity of the araticum's pulp, since some authors found a correlation between the antioxidant activity and the polyphenol content (SANTOS et al., 2008; KUSKOSKI et al., 2005). In addition, the processing of fruits pulp often leads in most of the times, to degradation of sensory and nutritional attributes and to the inevitable partial loss of antioxidant capacity, since it affects the content, activity and bioavailability of the bioactive components of foods (CARVALHO et al., 2000, MAIA et al., 2007, NICOLI et al., 1999).

**Figure 3.** Total extractable polyphenols contents (mg gallic acid 100 g<sup>-1</sup> pulp) (A) and total antioxidant activity determined by Ferric Reducing Antioxidant Power (FRAP) method (µM ferrous sulphate g<sup>-1</sup> pulp) (B) of the araticum's pulp packed in low density polyethylene packaging, sealed under vacuum or not and frozen at -18 °C for up to 402 days.



## CONCLUSION

This work concludes that the use of vacuum for freezing and storage of araticum's pulp is not required for storage up to 402 days at -18 °C.

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## REFERENCES

AOAC. **Official Methods of Analysis of AOAC international**. 19 ed. AOAC 54 International, Gaithersburg, Maryland, USA, 2012.

BENZIE, I.F.F.; STRAIN, J.J. The ferric reducing ability of plasma (FRAP) as a measure of antioxidant power: the FRAP assay. **Analytical Biochemistry**, v.239, p.70-76, 1996.

BRAGA FILHO, R.J.; NAVES, R.V.; CHAVES, L.J.; PIRES, L.L.; MAZON, L.T. Caracterização física e físico-química de frutos de araticum (*Annona crassiflora* Mart.). **Bioscience Journal**, v.30, n.1, p.16-24, 2014.

BRASIL. Resolução Normativa nº 12/78. **Aprova Normas Técnicas Especiais do Estado de São Paulo, relativa a alimentos e bebidas**. Diário Oficial [da] República Federativa do Brasil. Brasília, DF, 1978. 11. 525p.

BRASIL. Ministério da Agricultura do Abastecimento. Instrução Normativa nº 1, de 7 de janeiro de 2000. **Regulamento técnico geral para fixação dos padrões de identidade e qualidade para**

**polpa de fruta.** Diário Oficial da República Federativa do Brasil, Brasília, DF, 10 jan. Seção I, p.54-58, 2000.

BRASIL. Resolução RDC nº 12. **Regulamento Técnico sobre padrões microbiológicos para alimentos.** Diário Oficial [da] República Federativa do Brasil. Brasília, DF, p.45-53, 2001.

BRUNINI, M.A.; DURIGAN, J.F.; OLIVEIRA, A.L. Avaliações das alterações em polpa de manga 'Tommy-Atkins' congeladas. **Revista Brasileira de Fruticultura**, v.24, n.3, p.651-653, 2002.

CARVALHO, R. A.; FERREIRA, C.A.P.; NASCIMENTO JUNIOR, J.D.B.; MENEZES, A.J.E.A.; SUZUKI, E.; SASAKI, G. **Análise econômica da produção de acerola no município de Tomé-Açu, Pará.** Belém: Embrapa Amazônia Oriental, 2000. 21 p. (Documentos, 49).

CHEFTEL, J.C.; CHEFTEL, H.; BESANÇON, P. Metodos de conservacion. In: \_\_\_\_\_. (Ed.) **Introduction a la bioquímica y tecnología de los alimentos.** Zaragoza: Acribia, v.2, cap.7, p.173-299, 1989.

CHITARRA, M.I.F.; CHITARRA, A.B. **Pós-colheita de frutas e hortaliças:** fisiologia e manuseio. 2 ed. Lavras: UFLA, 2005. 785p.

ELEZ-MARTÍNEZ P, MARTÍN-BELLOSO O. Effects of high intensity pulsed electric field processing conditions on vitamin C and antioxidant capacity of orange juice and gazpacho, a cold vegetable soup. **Food Chemistry**, v.102, n.1, p.201-209, 2007.

FALEIRO, F.G.; GAMA, L.C.; FARIAS-NETO, A.L.; SOUSA, E.S. O simpósio nacional sobre o cerrado e o simpósio internacional sobre savanas. In: FALEIRO, F.G.; FARIAS-NETO, A.L. (Ed.). **Savanas:** desafios e estratégias para o equilíbrio entre sociedade, agronegócio e recursos naturais. Planaltina: Embrapa Cerrados, p.32-46, 2008.

FELLOWS, P.J. **Tecnologia do processamento de alimentos: princípios e prática.** Porto Alegre: ARTMED; 2008.

IAL- Instituto Adolfo Lutz. **Métodos físico-químicos para análise de alimentos.** 4 ed. São Paulo: Instituto Adolfo Lutz, 2008, 1020p.

KUSKOSKI, E.M.; ASUERO, G.A.; TRONCOSO, A.M.; MANCINIFILHO, J.; FETT, R. Aplicación de diversos métodos químicos para determinar actividad antioxidante em pulpa de frutos. **Ciência e Tecnologia de Alimentos**, v.25, n.4, p.726-732, 2005.

LIMA, R.M.T.; FIGUEIREDO, R.W.; MAIA, G.A.; SOUSA, P.H.M.; FIGUEIREDO, E.A.T.; RODRIGUES, C.S. Estabilidade química, físico-química e microbiológica de polpas de acerola pasteurizadas e não-pasteurizadas de cultivo orgânico. **Ciência Rural**, v.42, n.2, p.367-375, 2012.

MAIA, G. A.; SOUSA, P.H.M.; SANTOS, G.M.; SILVA, D.S.; FERNANDES, A.G.; PRADO, G.M. Effect of the processing on some components of acerola juice. **Ciência e Tecnologia de Alimentos**, v.27, n.1, p.130-134, 2007.

MANACH, C.; SCALBERT, A.; MORAND, C.; RÉMÉSY, C.; JIMÉNE, L. Polyphenols: food sources and bioavailability. **American Journal of Clinical Nutrition**, v.79, p.727-747, 2004.

MDA - Ministério do Desenvolvimento Agrário (Brasil). **Recomendações básicas para a aplicação das boas práticas agropecuárias e de fabricação na agricultura familiar** - Programa de Agroindustrialização da Agricultura Familiar. Fénelon do Nascimento Neto (organizador). Brasília, DF: MDA, 2006. 243p.

MORAES, I.V.M. **Dossiê Técnico – Produção de polpa de fruta congelada e suco de frutas.** Rede de Tecnologia do Rio de Janeiro – REDETEC. 2006. 26p.

MORAIS, E.C.; PATIAS, S.G.O.; FERREIRA, N.S.S.; PICANÇO, N.F.M.; RODRIGUES, E.C.; NASCIMENTO, E.; FARIA, R.A.P.G. Compostos bioativos e características físico-químicas de polpa de araticum in natura e pasteurizada. **Brazilian Journal of Food Technology**, v.20, e2016142, 2017.

NASCIMENTO, R.S.M.; CARDOSO, J.A.; OLIVEIRA, L.D.dE; OLIVEIRA, J.dA S.; COCOZZA, F.dEL M.; CORTES, J.M. Caracterização físico-química de muricis (*Byrsonima verbascifolia* Rich. ex A. Juss.) produzidos na região Oeste da Bahia. **Magistra**, v.23, p.236-242, 2011.

NICOLI, M.C.; ANESE, M.; PARPINEL, M. Influence of processing on the antioxidant properties of fruit and vegetables. **Trends in Food Science and Technology**, v.10, n.3, p.94-100, 1999.

OLIVEIRA, M.E.B.; FEITOSA, T.; BASTOS, M.S.R.; FREITAS, M.L.; MORAIS, A.S. Qualidade de polpas congeladas de frutas, fabricadas e comercializadas nos estados do Ceará e Rio Grande do Norte. **Boletim CEPPA**, v.16, n.1, p.13-22, 1998.

PIMENTA, A.C.; SILVA, P.S.R.; ZUFFELLATO-RIBAS, K.C.; KOEHLER, H.S. Caracterização de plantas e de frutos de araticunzeiro (*Annona crassiflora* Mart.) nativos no Cerrado Mato-grossense.

**Revista Brasileira de Fruticultura**, v.36, n.4, p.892-899, 2014.

PULIDO, R., BRAVO, L., SAURA-CALIXTO, F. Antioxidant activity of dietary polyphenols as determined by a modified ferric reducing antioxidant power assay. **Journal of Agricultural and Food Chemistry**, v.48, p.3396-3402, 2000.

RUFINO, M.S.M. **Propriedades funcionais de frutas tropicais brasileiras não tradicionais**. 2008. Tese (Doutorado em Agronomia), Mossoró: Universidade Federal Rural do Semi-Árido. 2008.

SANTOS, G.M.; MAIA, G.A.; SOUSA, P.H.M.; COSTA, J.M.C.C.; FIGUEIREDO, R.W.; PRADO, G.M. Correlação entre atividade antioxidante e compostos bioativos de polpas comerciais de açaí (*Euterpe oleracea* Mart). **Archivos Latinoamericanos de Nutricion**, v.58, n.2, p.187-192, 2008.

SILVA, J.A.A. Quem é quem na família das anonáceas. **Pesquisa & Tecnologia**, v.4, n.1, 2007.

SILVA, A.M.L.; GOMES, A.C.G.; MARTINS, B.A. Alterações físico-químicas e estudo enzimático da

polpa de araticum (*Annona crassiflora* Mart). **Estudos**, v.36, n.5/6, p.775-783, 2009.

SILVA, E.P.; VILAS BOAS, E.V.B.; XISTO, A.L.P.R. Characterization and development of marolo (*Annona crassiflora*, Mart.). **Food Science and Technology**, v.33, n.4, p.666-675, 2013.

SILVA, L.L.; CARDOSO, L.M.; PINHEIRO SANT'ANA, H.M. Influência do branqueamento, pasteurização e congelamento nas características físico-químicas, nos carotenoides e no valor de vitamina A de polpa de araticum (*Annona crassiflora* Mart.). **Revista Instituto Adolfo Lutz**, v.74, n.1, p.30-38, 2015.

SINGLETON, V.L., ORTHOFER, R., LAMUELA-RAVENTÓS, R.M. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin–Ciocalteu reagent. **Methods in Enzymology**, New York, v.299, p.152-178, 1999.

STROHECKER, R.; HENINING, H. M. **Análisis de vitaminas: métodos comprobados**, 42p. 1967.