



ORIGINAL RESEARCH ARTICLE

OPEN ACCESS

DEVELOPMENT OF FROZEN YOGURT LACTOSE-FREE PLUS *CAMPOMANESIA* SP

¹Gabriela Torres Silva, ²Amariles Diniz Ramires, ²Camila Jordão Candido, ²Jeeser Alves de Almeida, ²Priscila Aiko Hiane, ²Danielle Bogo, ²Valter Aragão do Nascimento, ²Andréia Brochado Antonioli and ^{2,*}Rita de Cássia Avellaneda Guimarães

¹Academic Nutrition, Federal University of Mato Grosso do Sul, 79070-900, Campo Grande, MS, Brazil

²Post-Graduate Program in Health and Development in the Mid-West Region, Federal University of Mato Grosso do Sul, 79070-900, Campo Grande, MS, Brazil

ARTICLE INFO

Article History:

Received 20th November, 2017
Received in revised form
25th December, 2017
Accepted 14th January, 2018
Published online 28th February, 2018

Key Words:

Brazilian Cerrado Fruits
Lactose-Free
Yogurt ice-Creams.

ABSTRACT

Ice creams are globally accepted because of their palatability. However, the number of lactose intolerants is increasing. Therefore, the demand for products in this segment also increases. Guavira is a native fruit from Brazilian Cerrado rich in antioxidants and with potential for inclusion in various food products. Thus, the aim of this study was to elaborate guavira-frozen yogurt lactose-free, expanding products for individuals with lactose intolerance. The product was developed through a factorial design, centesimal composition, and microbiological and sensorial analysis. Data were expressed as g/100g. Thus, 69.25g for moisture, 0.71g fixed mineral residue, 2.48g proteins, 4.27 lipids, 2.19 carbohydrates and 0.9g total dietary fibers. Microbiological analysis was positive and showed potential for the product to be inserted in the food market. In addition, the sensorial analysis reached more than 80% of acceptability. The results demonstrate the possibility of developing products with native-fruits associated lactose-free, benefiting the lactose intolerant subjects and expanding the dairy sector.

Copyright © 2018, Gabriela Torres Silva et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Citation: Gabriela Torres Silva, Amariles Diniz Ramires, Camila Jordão Candido, Jeeseer Alves de Almeida, Priscila Aiko Hiane, Danielle Bogo, Valter Aragão do Nascimento, Andréia Brochado Antonioli and Rita de Cássia Avellaneda Guimarães, 2018. "Development of frozen yogurt lactose-free plus *Campomanesia* sp.", *International Journal of Development Research*, 8, (02), 18935-18939.

INTRODUCTION

Tropical savannas are globally extensive biomes (STEVENS *et al.*, 2016). The Africans have the largest extension with approximately 10 million km² (ACANAKWO, SHEIL e MOE, 2017). In Brazil, the Cerrado is among the richest savannas in the world (MORZELLE *et al.*, 2015). It covers about 22% of the national territory and its biodiversity is considered one of the largest in the world, encompassing about 12.000 species of native plants cataloged, mainly food plants. In this way, these foods are consumed by the local population and/or sold in urban centers, is an important source of income from these natural resources (BRASIL, 2017). *Campomanesia* sp. is a fruitful species of the Brazilian Cerrado, popularly known as guavira, belonging to Myrtaceae family.

***Corresponding author:** Rita de Cássia Avellaneda Guimarães, Post-Graduate Program in Health and Development in the Mid-West Region, Federal University of Mato Grosso do Sul, 79070-900, Campo Grande, MS, Brazil.

The guavira fruit presents succulence, acidity, light sweetness and citrus aroma, pleasant to smell (VALLILO *et al.*, 2006). The centesimal composition presents 77,02% moisture, 15,68% carbohydrates, 1,43% proteins, 1,32% lipids and 4,14% of dietary fiber (MORZELLE *et al.*, 2015). Guavira is considered an important source of vitamin C, presenting about 383.33mg/100g of ascorbic acid, with significant antioxidant activity (MORZELLE *et al.*, 2015). Regarding the minerals, Lima *et al.* (2017) demonstrated that presence of calcium, iron, and zinc; indicate the capacity of maintaining the healthy immune system. Gradually, the population has become aware of the relationship between food and health. Thus, adherents to healthier diets are increasingly seeking lactose-free foods, due to some diseases that cause food restriction and also (ALMEIDA *et al.*, 2016). Ice cream and similar are products with high acceptability, which is an important factor during the product elaboration, mainly in the industrial field, in which innovation and sensory quality important points to be taken into account (SALOMÃO, 2013).

The industry is growing and Brazilian population has increased 46% ice cream consumption (ABIS, 2017). In addition, products such as yogurts, ice creams and similar are most consumed dairy products by North American society. However, about 75% of this population has an insufficient dairy intake (AN e JIANG, 2017). The industry has some factors when choosing the feedstock, the yield is one. Thus, guavira presents high yield, being on average 80% of the edible mass. This makes it a potent fruit for the development of products, including ice cream and derivatives (MORZELLE *et al.*, 2015). The insertion of products based on Brazilian Cerrado fruits in the food sector allows the economic and sustainable development (MORZELLE *et al.*, 2012). Thus, the present study aimed to elaborate a type of lactose-free guavira ice cream. The study allows the valorization of the region fruits and extends the choice of products for lactose intolerant population, through products with good nutritional and sensorial characteristics.

METHODS

Obtaining the material and preparation of the ice cream

The study was conducted at the Federal University of Mato Grosso do Sul (UFMS), at the Food Technology and Public Health Unit, Campo Grande, MS. The ingredients used were: guavira pulp, stabilizer, emulsifier, crystal sugar, semi-skimmed bovine milk UHT, natural skimmed yogurt, heavy cream, bovine powdered milk, all dairy products are lactose-free and were obtained in local commerce, with the exception of fruit pulp, acquired in the frozen form in the region of Jardim, Mato Grosso do Sul, Brazil. Different proportions of ice cream were developed by changing the concentrations of sugar and guavira pulp, according to Table 1. A factorial delineation was performed with three repetitions at the central point, coded in -1, 0 e 1, as the table 2 shows, aiming to investigate the effect of the independent variables (pulp and sugar) on the sensorial properties of ice cream (BOX; DRAPER, 1987). Therefore, five samples were formulated with different compositions. To weigh the ingredients, we used an analytical balance with an accuracy of 0.01 g. During processing the emulsifier was heated, but at a temperature of less than 60°C, so that homogenization followed and then the beating/freezing in semi-continuous ice cream maker, Finamac® Pro 4.

To choose the best formulation, a sensory evaluation with affective test was performed with untrained tasters (n=28), adults, 18 to 50 years, who evaluated the 7 samples, with approximately 10 g of ice cream. The sensorial attributes evaluated were: color, aroma, flavor and texture from a hedonic scale of 9 points (1 = "extremely disagree" to 9 = "liked extremely"). The purchase intent was evaluated with 5-point scales (1 = "certainly would not buy" at 5 = "would certainly buy"). Chemical, microbiological and sensory analyzes were performed based on the ice cream that reached the highest acceptability index.

Chemical composition

The whole sample was used in triplicate according to the analytical norms of the Adolfo Lutz Institute (INSTITUTO ADOLFO LUTZ, 2008). Moisture analysis was obtained by oven drying at 105 °C until constant weight. The analysis of the fixed mineral residue was carried out by incineration in a

muffle at 550 ° C. The total lipid content was determined by extraction with ethyl ether in Soxhlet. The protein value was obtained by the micro Kjeldahl method. The Lane-Eynon method, based on copper reduction, was used to analyze carbohydrates. The total dietary fiber content was performed in accordance with Association of Official Agricultural Chemists (AOAC, 2005).

Microbiological analysis

Microbiological analyzes were performed according to all Brazilian government regulations (ANVISA). Tests were performed to detect *Salmonella* sp., enumeration of coagulase-positive *Staphylococcus* and fecal coliforms. .

Sensory Analysis

For sensorial evaluation of the final formulation, we used affective test with non-trained tasters (n=100), adults, 18 to 50 years, which evaluated a sample of 50g of ice cream. Items such as the overall appearance, color, aroma, taste and texture were evaluated according to a hedonistic 9-points scale (1 = extremely disliked to 9 = liked it extremely). The purchase intention was evaluated in a 5-point scale (1 = certainly would not buy to 5 = certainly buy). The project was approved by the local research ethics committee (n. 51270215.3.0000.0021). All participants signed the informed consent form. The present study has a patent filed of the product and process of guavira ice cream lactose-free in the Agency of Development, Innovation and International Relations (AGINOVA) of UFMS, under process in the National Institute of Industrial Property (INPI), BR 10 2017 000942 4.

Acceptability index

For the calculation of the product acceptability index (AI), the equation $AI (\%) = A \times 100/B$ was used, where A = means core obtained for the product and B = maximum score given to the product. The IA with good repercussion must be equal to or above 70% (DUTCOSKY, 2013).

Overrun rate

The determination of overrun was determined based on the initial weight of the syrup and after freezing with ice cream weight. Using the following equation (HART and FISHER, 1971).

$$\text{Overrun } [\%] = \frac{[\text{Starting weight (mixture)} - \text{Final weight (ice cream)}] \times 100}{\text{Final weight (ice cream)}}$$

RESULTS AND DISCUSSION

The applied processing technique (Figure 1) allowed the obtaining of an ice cream with sensorial characteristics within the required standard in Brazil (BRASIL, 2000). Although low, the overrun rate is similar to other studies (GONÇALVES and EBERLE, 2008). The lactose exemption was not able to affect the overrun rate (SKRYPLONEK *et al.*, 2016) because fat content presented in the ice cream, which reduces values can determine the air incorporation (ARRUDA, OLIVEIRA and OLIVEIRA, 2015). The formulations initially evaluated showed better acceptability. They were the chosen for subsequent analyses. The components in g and % can be seen in table 3.

Table 1. Guavira ice cream formulation

Ingredients	F1	F2	F3	F4	F5	F6	F7
Crystal sugar	248 g	388 g	388 g	448 g	448 g	448 g	518 g
Guavira pulp	600 g	600 g	765 g	900 g	900 g	900 g	980 g
Stabilizer	20 g						
Emulsifier	30 g						
Bovine powdered milk	100 g						
Semi-skimmed bovine milk UHT	1 L	1 L	1 L	1 L	1 L	1 L	1 L
Heavy cream	478 g						
Natural skimmed yogurt	489 g						

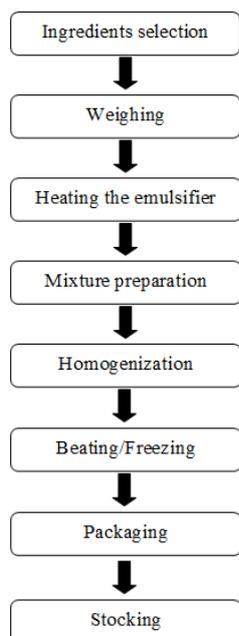
F1: Formulation 1; F2: Formulation 2; F3: Formulation 3; F4: Formulation 4; F5: Formulation 5; F6: Formulation; F7: Formulation 7.

The items used do not allow classifying the ice cream as “frozen yogurt” because it did not reach the minimum of 70% of yogurt in 100g (BRASIL, 2000). Therefore, it is classified as “type-frozen yogurt” due to the presence of a 14.1% of yogurt. Table 4 shows the centesimal composition. The moisture value is similar to that obtained by Morzelle *et al.* (2012) which analyzed four ice cream types composed of Cerrado fruits, varying between 65 to 67% The main factor for this result is the Guavira composition because the pulp presents high moisture content (ALVES *et al.*, 2013).

Table 2. Factorial delineation of formulations of guavira ice cream

Formulations	Encodedvariables	
	X1	X2
1	1	1
2	1	- 1
3	- 1	1
4	-1	- 1
5	0	0
6	0	0
7	0	0

X1 - Guavira pulp; X2 - Sugar
Source: Adapted fromOliveira, 2015.

**Figure 1. Ice cream production flowchart**

In relation to lipids and proteins, Guavirapresents low values, a characteristic common to the Myrtaceae Family, which presents numerous species, among them, Araçá (*Psidium*ssp.), Jabuticabaanã (*Pliniassp.*) and Cagaita (*Eugeniassp.*)

(VASCONCELOS *et al.*, 2017) The existence of dairy products in ice cream composition increases the fat and protein levels and enter in the standard imposed by Brazilian legislation, which indicates that 2.5% in 100g as a minimum (BRASIL, 2000). Among the main characteristics of these products are the high levels of lipids and low fiber contents, which aid in adiposity increases (PAZIANOTTI *et al.*, 2010).An and Jiang (2017) found that more than 34.3% of ice cream consumers were obese when compared with24.3% of yogurt and 26.4% frozen yogurt consumers.

Table 3. Ingredients composition

Ingredients	Amount (g)	Amount (%)
Sugar	448 g	13 %
Guavira pulp	900 g	26 %
Stabilizer	20 g	0.58 %
Emulsifier	30 g	0.86 %
Powdered milk	100 g	2.88 %
Bovine semi-skimmed milk UHT	1 L	28.86 %
Heavy cream	478 g	13.80 %
Natural yogurt	489 g	14.11 %

Table 4. Chemical composition of Guavira ice cream (g/100g)

Components	Results*
Moisture	69.25± 0.01
Mineral residue	0.71± 0.02
Proteins	2.48± 0.01
Lipids	4.27± 0.03
Total carbohydrates	21.9± 0.04
Total fiber	0.9 ± 0.01

*Values are expressed as the mean±SD.

Table 5. Microbiological analysis of Guavira ice cream

Microorganism Result	
Coliformesa 45°	< 3 NMP/g
Salmonellasp.	Negative/25g
Estafilococcu scoagulase positive/g	<1,0x10 UFC/g

Table 6. Mean and acceptability indexof guavira ice cream

Attribute	Evaluation average	Acceptability index
Overall assessment	7.9	87.77%
Appearance	8.5	94.44%
Aroma	8	88.88%
Flavor	7.8	86.66%
Texture	8.6	95.55%
Color	8.2	91.11%
Buy intention	4.19	-

Dairy is the main source of fat in ice cream, but fruit pulp contributes significantly to the formation of total values. Its possible to find concentrations above 50% of monounsaturated and polyunsaturated fatty acids, being omega-6 and omega-9 in greater quantity in guavira pulp (NOZAKI *et al.*, 2012),

which contributes to the nutritional quality of the proposed ice cream. A low total fat value was verified, which can help to reduce empty calories intake while improving the nutrient intake profile (AN e JIANG, 2017). According to Wang *et al.* (2013), the regular yogurt consumption was associated with a better diet quality, with higher nutrient intakes and metabolic profile in adult Americans. Currently, about 65-70% of the adults have lactational intolerance after childhood, which results in an insufficient intake of milk and derivatives (BAYLESS, BROWN e PAIGE, 2017). The US population has lower yogurt consumption when compared to Europeans. Thus, the use of yogurt in products with greater acceptability, such as ice cream, may facilitate the improvement of the calcium and vitamin D profile (WANG *et al.*, 2013). The dairy industry has become one of the largest segments of the food industry. On the other hand, people are increasingly intolerant to lactose. The spread of the importance of milk and other dairy products as a source of essential nutrients is common among health professional and public opinion leaders. Thus, it's important to develop products for the public with lactose restriction (SILANIKOV, LEITNER and MERIN, 2015).

The microbiological analysis demonstrated that the Guavira ice cream is approved for human consumption and are within recommendations of Brazilian government (BRASIL, 2001). Table 6 shows the acceptability values of each attribute evaluated in the sensory analysis. The results indicate an excellent acceptability (> 80% of all scores). The texture was the best-evaluated item (95.5%), which indicates that the absence of lactose and lack of dairy fats did not interfere in overrun rate or even ice cream consistency. According to Skryplonek *et al.* (2016), the lactose break in monosaccharides reduces the yogurt freezing point, which consequently improves the texture and viscosity, avoiding the recrystallization of the ice. Additionally, in the present study, the intent to buy was also satisfactory.

Conclusion

The guavira ice cream type-frozen yogurt achieved excellent results such as high acceptability and nutritional quality. Especially because, a low total fat content and a good dietary fiber ratio, differing from other marketed products. Furthermore, the guavira yogurt is lactose-free, an essential factor in the lactic intolerant diet, which does not reach the daily requirement of calcium in the diet. Therefore, the stimulation of development of new products based on Brazilian Cerrado fruits should be strengthened. Thus, other studies in this area should be carried out in order to add more knowledge about Brazilian regional fruits.

REFERENCES

- Acanakwo EF, Sheil D, Moe, SR 2017. Termites and large herbivores influence seed removal rates in an African savanna [submitted ms]. Ecology. Disponível em: <<http://onlinelibrary.wiley.com/doi/10.1002/ecy.2038/full>>. Acesso em: 25 set. 2017.
- Almeida ABS, Ferreira MAC, Barbosa TA, Siqueira APS, Souza ERB 2016. Elaboração e avaliação sensorial de sorvediet e sem lactose de mangaba endêmica do cerrado. Rev. Agric. Neotrop. 3:38-41.
- Alves AM, Alves MSO, Fernandes TO, Naves RV, Naves MMV 2013. Caracterização física e química, fenólicos totais e atividade antioxidante da polpa e resíduo de gabirola. Rev. Bras. Frutic. 35:837-844.
- An R, Jiang N. 2017. Frozen yogurt and ice cream were less healthy than yogurt, and adding toppings reduced their nutrition value: evidence from 1999-2014 National Health and Nutrition Examination Survey. Nutr. Res. 42:64-70.
- AOAC. Association of Official Agricultural Chemists 2005. Official Methods of Analysis of the Association of Official Agriculture Chemists. 1:1141.
- Arruda EF, Oliveira A, Oliveira AD 2015. Avaliação de sorvete tipo iogurte à base de soja com a adição de microrganismos probióticos. Epist. Transvers. 9:2236-2649.
- Associação brasileira das indústrias e do setor de sorvetes 2017. Estatística: produção e consumo de sorvetes no Brasil. Disponível em: <http://www.abis.com.br/estatistica_producaoconsumodesorvetesnobrasil.html>. Acesso em 17 set. 2017.
- Bayless TM, Brown E, Paige DM 2017. Lactase Non-persistence and Lactose Intolerance. Curr Gastroenterol Rep. 19:2-11.
- Box GEP, Draper NR 1987. Empirical model-building and response surfaces. John Wiley & Sons, pp 669.
- Brasil 2000. Agência Nacional de Vigilância Sanitária. Resolução de nº 28, de 01 de junho de 2000. Regulamento Técnico para Fixação de Identidade e Qualidade de Gelados Comestíveis, Preparados, Pós para o Preparo e Bases para Gelados Comestíveis. Diário Oficial da República Federativa do Brasil, Poder Executivo, Brasília, DF.
- Brasil 2001. Agência Nacional de Vigilância Sanitária. Resolução nº 12, de 2 de janeiro de 2001. Aprova o regulamento técnico sobre padrões microbiológicos para alimentos. Diário Oficial da República Federativa do Brasil, Poder Executivo, Brasília, DF.
- Brasil 2017. Ministério do Meio Ambiente. O bioma Cerrado. Disponível em: <<http://www.mma.gov.br/biomas/cerrado>>. Acesso em: 22 fev. 2017.
- Dutcosky SD 2013. Análise sensorial de alimentos. Champagnat. 4.ed. rev. pp 531.
- Gonçalves AA, Eberle IR (2008). Frozen yogurt com bactérias probióticas. Alim. Nutr. 19:291-297.
- Hart FL, Fisher HJ 1971. Dairy Products (Including Ice Cream, Ice Milk and Sherbets). In: Modern Food Analysis. Springer, pp 108-148.
- Instituto Adolfo Lutz 2008. Métodos físico-químicos para análise de alimentos. Coordenadores Odair Zenebon, Neus Sadocco Pascuet e Paulo Tiglia. 4:1020.
- Lima NV, Arakaki DG, Tschinkel PFS, Melo ESP, Caires ARL, Figueiredo P, Guimarães RCA, Hiane PA, Nascimento VA 2017. Determination of macro and microelements in whole fruit of *Campomanesia adamantium* (cambess.) O. Berg and evaluation of their nutritional potential for children, adolescents and pregnant women. Inter. Jour. Dev. Res. 07:13272-13279.
- Morzelle MC, Bachiega P, Souza EC, Vilas Boas EVB, LAMOUNIER ML, 2015. Caracterização química e física de frutos de curriola, gabirola e murici provenientes do cerrado brasileiro. Rev. Bras. de Frutic. 37:96-103.
- Morzelle MC, Lamounier ML, Souza EC, Salgado JM, Vilas Boas EV 2012. Caracterização físico-química e sensorial de sorvetes à base de frutos do cerrado. Rev. Inst. Latic. "Cândido Tostes". 67:70-78.
- Nozaki VT, Munhoz CL, Guimarães RCA, Hiane PA, Andreu MP, Viana, LH, Macedo MLR 2012. Perfil lipídico da

- polpa e amêndoa da guarirova. Ciênc. Rural. 42:1518-1523.
- Oliveira AC 2015. Desenvolvimento de bebida aromatizada da amêndoa de baru (*Dipteryx alata* vog.). In: Dissertação de mestrado apresentada ao Programa de Pós-graduação em Saúde e Desenvolvimento na Região Centro-oeste da Universidade Federal de Mato Grosso do Sul. Disponível em: [file:///C:/Users/user/Downloads/D ISSERTA%C3%87%C3%83O%20ARIANY%20C%C3%83NDIA%20D' OLIVEIRA.pdf](file:///C:/Users/user/Downloads/D%20ISSERTA%C3%87%C3%83O%20ARIANY%20C%C3%83NDIA%20D'OLIVEIRA.pdf). Acesso em: 17 out. 2017.
- Pazianotti L, Bosso AP, Cardoso S, Costa MR, Sivieri K (2010). Características microbiológicas e físico-químicas de sorvetes artesanais e industriais comercializados na região de Arapongas-PR. Rev. Inst. Latic. "Cândido Tostes". 65:15-20.
- Salomão J, Walter EHM, Cardoso LCD, Barros EBP, Leite SGF 2013. Elaboração de sorvete de morango com características probióticas e prebióticas. In: CONGRESSO BRASILEIRO DE PROCESSAMENTO DE FRUTAS E HORTALIÇAS, 3., 2013, Ilhéus. Anais eletrônicos... Ilhéus, 2013. Disponível em: <http://ainfo.cnptia.embrapa.br/digital/bitstream/item/98260/1/2013-198.pdf>. Acesso em: 22 fev. 2017.
- Santos MS, Petkowicz CLO, Wosiacki G, Nogueira A, Carneiro EBB 2007. Caracterização do suco de araçá-vermelho (*Psidium cattleianum* Sabine) extraído mecanicamente tratado enzimaticamente. Acta Scientiarum. 29:617-621.
- Silanikove N, Leitner G, Merin U 2015. The Interrelationships between Lactose Intolerance and the Modern Dairy Industry: Global Perspectives in Evolutional and Historical Backgrounds. Nutr. 7:7312-7331.
- Skryplonek K, Gomes D, Viegas J, Pereira C, Henriques M 2016. Lactose-free frozen yogurt: production and characteristics. Acta Sci. Pol. Technol. Aliment. 16:171-179.
- Stevens N, Lehmann CER, Murphy BP, Durigan G. 2016. Savanna woody encroachment is widespread across three continents. Global Chang. Bio. 23:235-244.
- Vallilo MI, Lamardo LCA, Gaberlotti ML, Oliveira E, Moreno PRH 2006. Composição química dos frutos de *Campomanesia adamantium* (Cambessédes) O.Berg. Ciênc. Technol. Aliment. 26:805-810.
- Vasconcelos TNC, Proença CEB, Ahmad B, Aguilar DS, Aguilar R, Amorim BS, Campbell K, Costa IR, De-Carvalho OS, Faria JEQ, Giarretta A, Kooij PW, Lima DF, Mazine FF, Peguero B, Prenner G, Santos MF, Soewarto J, Wingler A, Lucas EJ (2017). Myrteae phylogeny, calibration, biogeography and diversification patterns: Increased understanding in the most species rich tribe of Myrtaceae. Mol. Phylogen. Evol. 109:113-137.
- Wang H, Livingston KA, Foxb CS, Meigsc JB, Jacques PF 2013. Yogurt consumption is associated with better diet quality and metabolic profile in American men and women. Nutr. Res. 33:18-26.
