

**Preparation of gourmet jam made of red fruits with ginger, physical-chemical, microbiological and sensorial characterization****Preparação de atolamento gourmet de frutas vermelhas com caracterização genética, química-química, microbiológica e sensorial**

DOI:10.34117/bjdv6n6-067

Recebimento dos originais: 01/05/2020

Aceitação para publicação: 03/06/2020

**Eliana Moreira**

Técnico em agroindústria

Instituição: Instituto Federal de Santa Catarina.

Endereço: Rua Fermino Pedro Vanzin, 51 D - Universitário

Chapecó -SC, Brasil

E-mail : moreira\_eliana@hotmail.com

**Andréia Paula Dal Castel**

Tecnóloga em Alimentos

Instituição: Faculdade SENAI Chapecó. Serviço - Nacional de Aprendizagem Industrial de Santa Catarina, Graduação Tecnológica em Alimentos .

Endereço: Rua Frei Bruno, 201 E - Jardim América, Chapecó - SC, Brasil.

E-mail: andreia.pdc2304@gmail.com

**Andressa Barella de Freitas**

Especialista em tecnologia e inovação

Instituição: Faculdade SENAI Chapecó. Serviço - Nacional de Aprendizagem Industrial de Santa Catarina, Graduação Tecnológica em Alimentos .

Endereço: Rua Frei Bruno, 201 E - Jardim América, Chapecó - SC, Brasil.

E-mail: andressa.freitas@sc.senai.br

**Elisa Sonza**

Mestre em Ciência e Tecnologia de Alimentos

Instituição: Faculdade SENAI Chapecó. Serviço - Nacional de Aprendizagem Industrial de Santa Catarina, Graduação Tecnológica em Alimentos.

Endereço: Rua Frei Bruno, 201 E - Jardim América, Chapecó - SC, Brasil.

E-mail: elisasonza@edu.sc.senai.br

**Josiane Kilian**

Doutora em Engenharia de Alimentos;

Instituição: Conformità Engenharia

Endereço: Rua Antônio Siqueira 2589E- Parque das Palmeiras, Chapecó- SC, Brasil.

E-mail: josi\_kilian@yahoo.com.br

**Josiane Betat da Silva**

Mestre em Engenharia de Alimentos

Instituição: Faculdade SENAI Chapecó. Serviço - Nacional de Aprendizagem Industrial de Santa Catarina, Graduação Tecnológica em Alimentos.

Endereço: Rua Frei Bruno, 201 E - Jardim América, Chapecó - SC, Brasil.

E-mail: josi@sc.senai.br

**Crivian Pelisser**

Mestre em Ciências Ambientais

Instituição: Faculdade SENAI Chapecó. Serviço - Nacional de Aprendizagem Industrial de Santa Catarina, Graduação Tecnológica em Alimentos.

Endereço: Rua Frei Bruno, 201 E - Jardim América, Chapecó - SC, Brasil.

E-mail: crivian.pelisser@edu.sc.senai.br

**Creciana Maria Endres**

Mestre em Ciência e Tecnologia de Alimentos

Instituição: Faculdade SENAI Chapecó. Serviço - Nacional de Aprendizagem Industrial de Santa Catarina, Graduação Tecnológica em Alimentos.

Endereço: Rua Frei Bruno, 201 E - Jardim América, Chapecó - SC, Brasil.

E-mail: creciana.maria@gmail.com

**ABSTRACT**

Extra gourmet jams serve a demanding public in terms of quality aspects, as this type of jam does not have preservatives, stabilizers and gums in its formulation. The aim of this work is to develop the physical-chemical, microbiological and sensory characterization of a strawberry and raspberry jam with ginger. The strawberry, and red and black raspberry pulps, are source of nutrients and vitamins, and grated ginger root, which is famous for anti-inflammatory properties, were used for the preparation of gourmet jam, in addition to vanilla extract, pectin and sucrose. Regarding the physical-chemical characterization, the content of total soluble solids, pH, moisture and ash were determined, all in duplicate, following the methodology proposed by the Adolfo Lutz Institute. The microbiological analysis of molds and yeasts was performed according to the methodology proposed by Normative Instruction N.º 62 (December 29, 2011). For the sensory acceptance, a 9-point hedonic scale and a 5-point hedonic scale were used for purchase intention. The microbiological results were in line with that recommended by RDC N.º 12 (January 2, 2001) and the sensory evaluation showed that the product has a good acceptance and a high percentage of purchase intention. The content of soluble solids was 50%, the legislation recommends a content from 62% to 65%, consequently, the moisture content was higher than the recommended, and this is attributed to the low percentage of sucrose used in the formulation in order to avoid the crystallization of the final product. *Clean label* foods are a trend in the consumer market due to their healthy appeal, the proposal of red fruit jam with ginger brings this concept as a priority, but further studies are suggested the replacement of sucrose by another sweetener constituent, with the aim of increase the content of soluble solids and decrease the moisture content of the final product.

**Keywords:** quality, *clean label*, healthy.

**RESUMO**

As geleias gourmet extras atendem a um público exigente em termos de qualidade, pois esse tipo de geleia não possui conservantes, estabilizadores e gengivas em sua formulação. O objetivo deste trabalho é desenvolver a caracterização físico-química, microbiológica e sensorial de uma geleia de morango e framboesa com gengibre. O morango e as polpas de framboesa vermelha e preta são fontes de nutrientes e vitaminas, e a raiz de gengibre ralada, famosa pelas propriedades anti-inflamatórias, foi utilizada na preparação de geleia gourmet, além de extrato de baunilha, pectina e sacarose. Quanto à caracterização físico-química, foram determinados o conteúdo de sólidos solúveis totais, pH, umidade e cinzas, todos em duplicata, seguindo a metodologia proposta pelo Instituto Adolfo Lutz. A análise microbiológica de fungos e leveduras foi realizada de acordo com a metodologia proposta

pela Instrução Normativa nº 62 (29 de dezembro de 2011). Para a aceitação sensorial, uma escala hedônica de 9 pontos e uma escala hedônica de 5 pontos foram usadas para a intenção de compra. Os resultados microbiológicos foram condizentes com os recomendados pela RDC Nº 12 (2 de janeiro de 2001) e a avaliação sensorial mostrou que o produto possui boa aceitação e alto percentual de intenção de compra. O teor de sólidos solúveis foi de 50%, a legislação recomenda um teor de 62% a 65%, consequentemente, o teor de umidade foi superior ao recomendado, e isso é atribuído à baixa porcentagem de sacarose utilizada na formulação, a fim de evitar a cristalização do produto final. Alimentos com rótulo limpo são uma tendência no mercado consumidor, devido ao seu apelo saudável, a proposta de geleia de frutas vermelhas com gengibre prioriza esse conceito, mas estudos adicionais sugerem a substituição da sacarose por outro componente adoçante, com o objetivo de aumentar o teor de sólidos solúveis e diminuir o teor de umidade do produto final.

**Palavras chave:** qualidade, etiqueta limpa, saudável.

## 1 INTRODUCTION

In the current scenario, characterized by the growing demand for practical and convenient foods, mainly healthier and tastier, is an opportunity for innovation with benefit for the food industry. Today's consumers are increasingly interested to know and understand what types of foods they are bringing to their table, what ingredients and what implications these ingredients will have on their health. Many additives, which play an important role when it comes to making industrialized food on a large scale are being rejected by this consumer profile.

*Clean label* foods enter the scene to serve this new consumer. A food trend that emerged about ten years ago, in Europe and the United States, driven by the increasing desire of consumers to acquire a healthier lifestyle (BLUM et al., 2012).

These foods are formulated with special care, having in their composition only natural ingredients, i.e. free from artificial additives and a label of simple and easy to understand ingredients. An important effort is required in the selection of the appropriate raw material and manufacturing technology to obtain quality food, a safe food, free from chemical, physical and microbiological contamination, and with good sensory characteristics.

The Brazilian Food Law defines fruit jam as "a product obtained by cooking whole or in pieces, fruit pulps or juices, with sugar and water, and concentrated to a gelatinous consistency". The classification adopted by the legislation determines that a jam can be common or extra. Jams considered extra are prepared in a proportion of fifty parts of fresh fruit or its equivalent to fifty parts of sugar.

This type of red fruit jam fits into the extra classification, with the differential - gourmet jam - for being a product of limited production, proportion of 68% fruit and 32% sugar, high quality raw material, with unique characteristics, with a "Premium" positioning, and product with added value.

Fruit jam is a product with good sensory acceptance and with a high added value (gourmet), with a market that has been growing in search of processed products with excellent nutritional quality.

Berries are a great source of nutrients, vitamins and minerals. A balanced diet characterized by the consumption of red fruits, combined with physical activities, protects the body from many diseases. This habit of consuming red fruits can prevent many types of diseases, such as cardiovascular, stroke, cancerous, stomach, cystitis, prevents premature skin aging, and anti-inflammatory properties. Their consumption improve the immune system, making the body more resistant to these diseases. The redder the fruits are, the richer in phenolic and mineral compounds. Also a source of calcium, phosphorus, potassium, fiber, vitamins A and C, and sources of ascorbic acid.

The term *berry fruits* refers to fruits such as strawberries, raspberries, blueberries and blackberries. They have antioxidant power, conferred by the phenolic compounds present in them, in amounts that vary from species to species.

The main characteristic, the color, varies from red to blue, due to the presence of natural pigments known as anthocyanins, which are soluble in water and are distributed in plant tissues (GIUSTI; JING, 2007).

The strawberry tree is a perennial, creeping plant, belonging to the Rosacea family and of the genus *Fragaria* (Gomes 2007). Its fruits are considered a pseudo-fruit, non-climacteric, of bright red color, due to the presence of anthocyanins; the slightly acidified flavor corresponds to citric and malic acids (Silva, 2006). Strawberries are rich in vitamin C, a very important vitamin for the human organism, as it plays a fundamental role in the development and regeneration of muscles, skin, teeth and bones, formation of collagen, regulation of body temperature, production of hormones, metabolism in general (Andrade et al., 2002).

The active substances present in the fruits act in the prevention and / or cure of many diseases, and mainly: its diuretic effect and its anti-inflammatory activity in rheumatism and gout, antioxidant action (by phenolic compounds), and the ability to reduce susceptibility to infections (LIMA, 2014).

The raspberry belongs to the family Rosaceae, genus *Rubus*. Raspberry is among the main foods with functional properties that have already been experimentally related to beneficial effects on cardiovascular diseases, atherosclerosis, and certain types of cancer, obesity, aging and neurodegenerative diseases (Santos et al., 2011).

Phenolic compounds, and anthocyanins, present in raspberries, vary according to their color, the darker the more phenolic compounds; these contribute to the protection against degenerative diseases. The antioxidant activity is responsible for combating free radicals, which are produced in abundance by physiological processes, and resulting from external factors (MARCHI, 2015).

Ginger, whose scientific name is *Zingiber Officinale Roscoe*, is an herbaceous plant, with Asian origin, which reaches 1.50 meters in height. Traditional and contemporary medicine uses ginger, it is

a spice whose rhizome is widely marketed due to its industrial and food use, especially as a raw material for the manufacture of drinks, perfumes and confectionery products, such as breads, cakes, cookies and jams (ELPO, 2004).

Ginger has in its chemical composition volatile (terpenes), non-volatile (phenolic compounds and alkaloids), extractable oleoresins, fats, waxes, carbohydrates, vitamins and minerals. Rhizomes contain a potent proteolytic enzyme called zingibain (SILVA NETO, 2012). It has several active components, 115 described, within these, the phenolic compounds, gingerol and shogaol have been widely studied with different properties, such as antipyretic, analgesic, angiogenesis inhibitor and immunomodulatory activities.

Several studies indicate that the compounds found in ginger are highly effective in relieving the symptoms of various diseases. Ginger has been used for centuries due to its anti-inflammatory properties.

The health benefits of ginger, preferably fresh, are mainly due to the presence of phenolic compounds, responsible for the pungent flavor. These are the gingerols (BENZIEL; WACHTEL - GALOR, 2011).

Given the above, the objective of this work was to develop a formulation of gourmet jam made of red fruits and ginger, characterize it in terms of microbiological, physical-chemical and sensory parameters, assessing its potential in the Brazilian consumer market, in order to provide the consumer more and more *Clean Label* food alternatives.

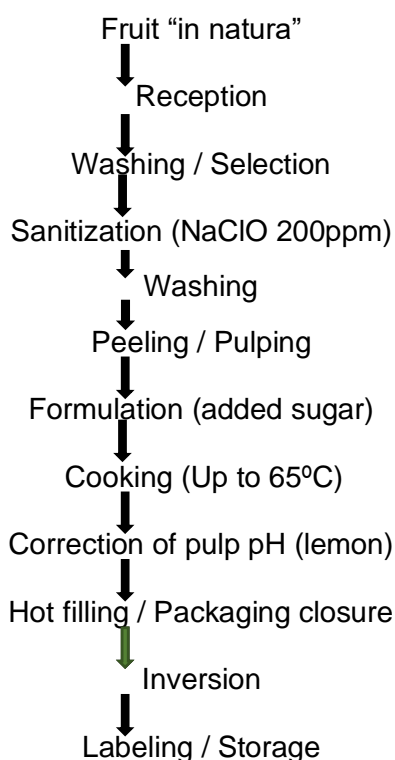
In this way, a gourmet red fruit jam was developed to serve this new market niche, which is concerned with offering products with clean labels, paying special attention to current consumer requirements.

## **2 MATERIAL AND METHODS**

The jam was made at the company Sweet Stuff - gourmet jams- located in the city of Xanxerê – SC (Brazil), and the physical-chemical, microbiological and sensory analyzes in the didactic laboratories of the Faculty of Food Technology of SENAI - Chapecó – SC (Brazil). Fruit, the raw material used in the preparation of red fruit jam, was acquired in the organic garden owned by the company.

Important steps in the processing of red fruit jam with ginger were followed as shown in Figure 1.

Figure 1. Flowchart of the elaboration of gourmet red fruit jam with ginger.



Source: Author

The jam was made in the proportion of 68% / 32% (pulp / sucrose). The sugar used was demerara, as it has greater sweetening power, offering more health benefits from the nutrients that are present in it. For this, it was cooked in a stainless steel pan, with continuous manual stirring until the concentration of soluble solids of 50° Brix, measured in a refractometer. The jams were filled in glass containers with a capacity of 320 grams.

Table 1 shows the formulation of red fruit jam with ginger.

Table 1. Formulation of red fruit jam with ginger.

Ingredients	Amount
Strawberry (g)	500 grams
Raspberries (red and black) (g)	250
Demerara sugar (g)	350
Vanilla extract (mL)	15
Lemon (mL)	30
Ginger (mL)	5

Source: Leteller, Laetitia (2014)

The jam pH was analyzed by using the potentiometric method, previously calibrated (standard solutions 4 and 7), moisture due to the loss of mass of the sample in an oven at  $105 \pm 2$  whose water and volatile substances were removed, total soluble solids ( $^{\circ}\text{Brix}$ ) measured in portable refractometer 58~92%  $^{\circ}\text{Brix}$ ,  $A_w$  in Aqualab 4TEV apparatus, ash by muffle incineration at a temperature of  $500^{\circ}\text{C}$  -  $600^{\circ}\text{C}$ . All analyzes were performed in duplicate according to the methods recommended by Adolfo Lutz Institute (2008). The standards for microbiological analysis were based on RDC No. 12 (January 2, 2001), for molds and yeasts. For the sensory acceptance, the 9-point hedonic scale method was used (“1” = dislike extremely, “5” = “neither like nor dislike”, “9” = “like extremely”), with the purchase intention on the five-point scale. The sensory evaluation was tested with 50 people of both sexes, aged between 16 and 50 years, among professors and students of the institution Senai – SC (Brazil). The jam sample was served in a disposable cup, coded with random three-digit numbers. These were served with accompaniment of a toast, and a 100 mL glass of water to clean the palate in the sample evaluation.

### 3 RESULTS AND DISCUSSION

#### 3.1 PHYSICOCHEMICAL ANALYSIS

The results of the physical-chemical analysis of the red fruit jam are shown in table 2.

Table 2. Characterization of gourmet red fruit jam with ginger.

Parameters	Results
% Soluble Solids ( $^{\circ}\text{BRIX}$ )	50 <sup>o</sup>
Humidity	40,60%
pH	3,39
Ashes	0,24%
$A_w$	0,89

All determinations were made in duplicates. Results were expressed as mean  $\pm$  uncertainty (IC).

The minimum total soluble solids content, recommended by law, for extra jam (% w/w) must be 62% and 65%. In the formulation of gourmet jam it was 50 $^{\circ}$  Brix. Close value found by Jorge, et al., which was 49.90% for chili jam with pepper, destined for the “gourmet” market.

In the manufacture of red fruit jam, sucrose (in the proportion of 35%) was used, which in an acidic environment, by the addition of lemon, undergoes a hydrolysis process, being partially broken down into glucose and fructose (inversion), this helps to avoid the crystallization that can occur during storage (TORREZAN, 1998). However, when a final concentration above 65% of total soluble solids



is made, it is necessary to replace part of the sucrose to avoid crystallization, using corn glucose or inverted sugar. In order for there to be an increase in soluble solids, it will be necessary to increase the proportion of sucrose, without raising the sweetness attribute too much, which de-characterizes the product.

The pH value was 3.39, which means regular acidity for the gelation to occur; adequate consistency of the jam, without the addition of acidulantes. In order to obtain a better gelation, the final pH must be between 3.0 to 3.2, with the optimum acidity value. For most fruits, this pH is not reached in the fruit, pectin and sugar system, requiring acidification, preferably using organic acids, natural constituents of fruits, such as citrus. However, the pH slightly above the recommended did not affect the final quality of the product. This formulation obtained good sensory acceptance.

Other authors have also found pH values different from this optimal value. Caetano et al. They obtained pH ranging from 3.42 to 3.48 in acerola cherry jam and Lago et al. They found a pH of 3.41 in java plum jam.

In the preparation of the jam, the legislation establishes a maximum humidity of 38% (w/w). According to the result of the physical-chemical evaluation (table 2), this higher value is observed. The presence of sugar increases the osmotic pressure of the medium and, consequently, decreases the water activity of the food, also removing the water layer that protects the pectin molecules, enabling the formation of gel. By increasing the content of soluble solids, water activity would decrease, thus obtaining greater stability (TORREZAN, 1998).

### 3.2 MICROBIOLOGICAL ANALYSIS

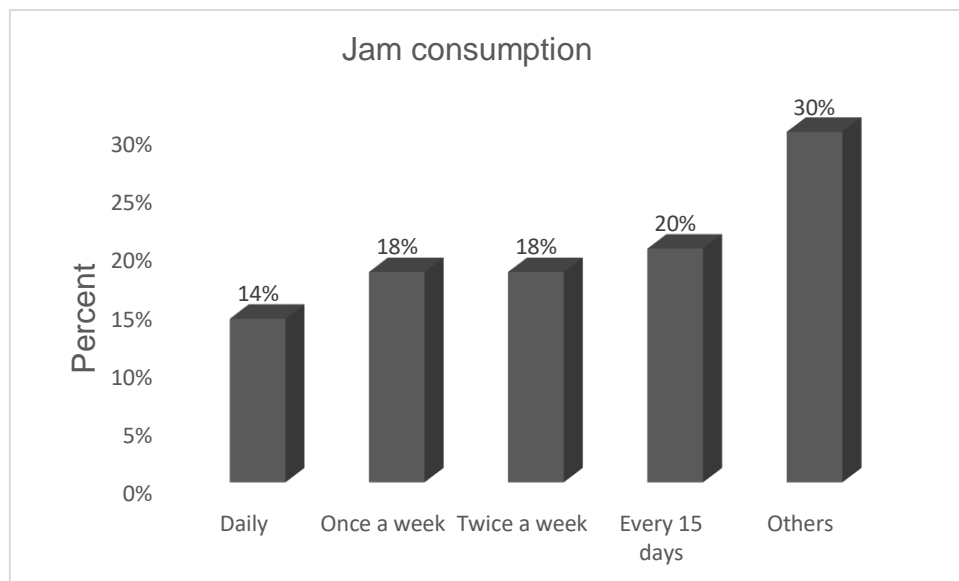
The results of the microbiological analysis for molds and yeasts (Incubation at  $25 \pm 1^\circ\text{C}$  for 5 days), meeting the standards of RDC N. ° 12 (January 2, 2001) the sample was within the standards established by current legislation.

### 3.3 SENSORY ANALYSIS

In the acceptability test, 50 people were interviewed, 36% men and 64% women. The frequency with which participants include jam in their diet is shown in Figure 1, which shows regular consumption. The most consumed flavors are, preferably, grape with 42%, followed by strawberry 30%.



Figure 1. Frequency of jam consumption.

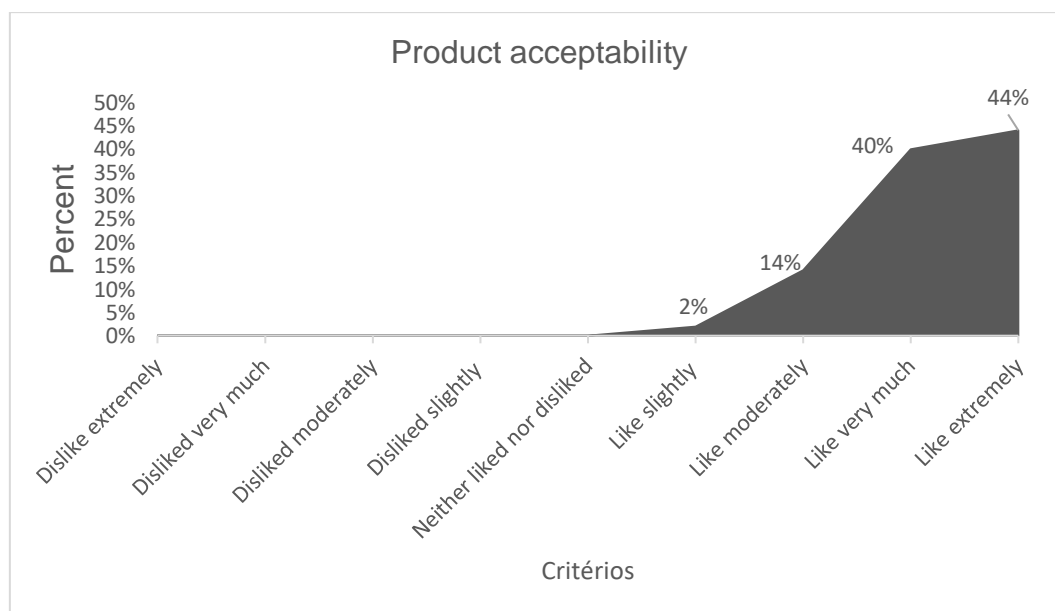


Source: Authors, 2019.

The acceptability index (AI) of red fruit jam with ginger was over 70% (Figure 2). According to Dutcosk (2011) for a product, it has good acceptability it is necessary that the AI is equal to or greater than 70%. Thus, it is observed that the formulation of the jam elaborated in the present work presents values higher than the

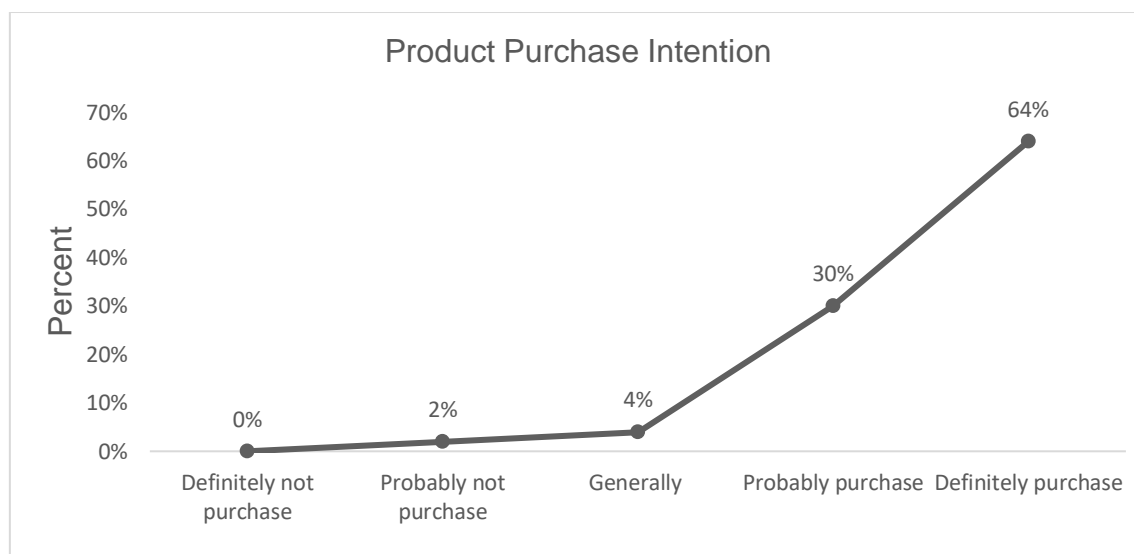
The purchase intention (Figure 3), presented an average between “possibly buy” and “certainly buy”, showing that the product was well accepted by consumers and that it is an alternative to a new product in the Brazilian market.

Figure 2. Result of the acceptability test in the formulation of red fruit jam.



Source: Authors, 2019.

Figure 3. Percentage of purchase intention, showing the good acceptance of the jam formulation by the consumer.



Source: Authors, 2019.

The results indicate high acceptability of the product, a positive point, showing that it can be produced on an industrial scale.

#### 4 CONCLUSION

The good results, following the objective of the work, with the obtainment of a jam with differentiated sensory characteristics, aimed the gourmet market and the fact that the product was well-accepted, demonstrated great market potential.

For the physicochemical requirements of pH, soluble solids and humidity, which presented higher values in accordance with the established standards, factors that should be reviewed, perhaps with the elaboration of new formulations, trying not to mischaracterize the jam as a gourmet product, with different characteristics.

The sample met the microbiological standards established by current legislation. The product under study can be produced on an industrial scale, making it an alternative in the *clean label* product line.

#### BIBLIOGRAPHIC REFERENCES

ANDRADE, R. S. G. de; DINIZ, M. C. T.; NEVES, E. A.; NÓBREGA, J.A. **Determinação e distribuição de ácido ascórbico em três frutos tropicais.** Eclética Química, São Paulo, v.27, n. especial, 2002.

BENZIE, I. F. F.; WACHTEL-GALOR, S. The Amazing and Mighty Ginger. Herbal Medicine: Biomolecular and Clinical Aspects. 2. ed. Boca Raton (FL): CRC Press, cap.7, 2011.

BLUM, Rodrigo W., SOUZA, Daiana. **Clean Label** – Inovação e Tecnologia. Jornal da Unisinos, 30/11/2012, available at:  
<http://www.juonline.com.br/index.php/inovacao-e-tecnologia/30.11.2012/clean-label/2cc9>

BRASIL. Ministério da Saúde. Agência Nacional de Vigilância Sanitária. RDC nº 12, January 2, 2001. Aprova o regulamento técnico sobre padrões microbiológicos para alimentos. Diário Oficial da União, Brasília/DF, 10 jan. 2001.

BRASIL, ANVISA (RDC nº 272, September 22, 2005.).

COUTO, Andriara Freitas. **Elaboração e aplicação de pré-mix de framboesa (*Rubus idaeus* L.) estabilizado por xantana e ácido tartárico**. Pelotas, 2012. 111f. il. - Dissertation (Master's) - Graduate Program in Science and Technology Agroindustrial. Faculty of Agronomy Eliseu Maciel. Federal University of Pelotas. Pelotas, 2012.

CAETANO P. K. C, DAIUTO, E. R., VIETES R. L. **Caracterização físico-tipos de tachos com polpa e suco de acerola**. Rev Energ Agric. 2011; 26(2): 103-18.

DUTCOSKY, S. D. **Análise sensorial de alimentos**. 3ª ed. Curitiba: Editora Champagnat, 2011.

ELPO, E. R. S. et al. *Zingiber officinale roscoe*: **ASPECTOS BOTÂNICOS E ECOLÓGICOS**. Visão Acadêmica, Curitiba, v. 5, n. 1, p. 27-32, 2004.

GIUSTI, M. M.; JING, P. Natural pigments of berries: functionality and application In: **Berry fruit: value-added products for health promotion**. New York: CRC Press, 2007, p. 105-146.

GOMES, P. **Fruticultura brasileira**. 13.ed. São Paulo: Nobel, 2007. p.342-348.

GOMES, Sophia L. S. **Desenvolvimento e caracterização de geleia mista de maracujá e acerola**. Trabalho de conclusão de curso (graduação – Tecnologia de Alimentos) – CTDR/UFPB; 48 p., 2014. Instituto Adolfo Lutz. **Normas Analíticas do Instituto Adolfo Lutz**. 2 ed. São Paulo, 1985, 371 p.

JORGE, L.; CIPOLLI, Kátia M. V. A. B.; SILVA, Marta G.; BAGGIO, Sueli R.; TAVARES, Paulo E. R.”. **Desenvolvimento de geleia de pimentão com pimenta, visando à elaboração de produtos destinados ao mercado “gourmet”**. Instituto de Tecnologia de Alimentos - ITAL, Fruthotec; CCQA; Faculdade de Engenharia de Alimentos – Unicamp; VII Congresso Interinstitucional de Iniciação Científica – CIIC 2013, 13 a 15 de agosto de 2013 – Campinas, São Paulo.

LAGO, E. S, GOMES, E., SILVA, R. **Produção de geleia de jambolão (*Syzygium cumini* lamarck): processamento, parâmetros físico-químicos e avaliação sensorial**. Rev. Ciência e Tecnologia de Alimentos, 2006; 26(4): 847-52.

LIMA, Alessandro, et al. **GENGIBRE (*ZINGIBER OFFICINALE ROSCOE*), PROPRIEDADES BIOATIVAS E SEU POSSÍVEL EFEITO NO DIABETES TIPO 2: ESTUDO DE REVISÃO**. Rev. Saúde em Foco, Teresina, v. 1, n. 2, art. 1, p. 15-25, ago/dez. 2014; [www4.fsanet.com.br/revista/](http://www4.fsanet.com.br/revista/)

MARCHI, Priscila Monalisa. **Propagação, aspectos agronômicos e qualidade de frutas de cultivares de framboeseira**. 2015. 123f. Dissertation (Master in Agronomy) - Graduate Program in Agronomy, Federal University of Pelotas, Pelotas, RS.

ROCHA, Denise Alvarenga, et al. **Análise comparativa de nutrientes funcionais em morangos de diferentes cultivares da região de Lavras – MG**. Rev. Bras. Frutic., Jaboticabal - SP, v. 30, n. 4, p. 1124-1128, dezembro 2008.

SANTOS, C. N., et al. **Poder antioxidante dos pequenos frutos e seus efeitos benéficos para a saúde humana**. In: III Colóquio Nacional da Produção de Pequenas Frutas, 3, 2008, Sever do Vouga. Actas Portuguesas de Horticultura, n.18, p.97104, 2011,

SANTOS, P. R. G, CARDOSO, L. M., BEDETTI, S. F., HAMACECK, F. R., MOREIRA, A. V. B., MARTINO, H. S. D., et al. **Geleia de cagaita (*Eugenia dysenterica* DC.): desenvolvimento, caracterização microbiológica, sensorial, química e estudo da estabilidade**. Rev. Inst. Adolfo Lutz. São Paulo, 2012; 71(2):281-90.

SILVA, P.A. **Qualidade de morangos cultivados na região de Lavras-MG, armazenados em temperatura ambiente**. 2006. 71 f. Dissertation (Master in Agrochemistry) - Federal University of Lavras, Lavras, 2006.

SILVA NETO, A. G. **Estudo dos efeitos vasculares e Renais causado pelo 6-glicerol isolado do gengibre**. 2012. 103f. Dissertação (Mestrado) - Departamento de Fisiologia e Farmacologia, Universidade Federal do Ceará, Fortaleza, 2012. Folder 12, Porto Velho, 2001.

VIEIRA, N. A. et al. **Efeito anti-inflamatório do gengibre e possível via de sinalização**. Semina: Ciências Biológicas e da Saúde, Londrina, v. 35, n. 1, p. 149-162, jan/jun. 2014.

TORREZAN, R. **Manual para a produção de geleias de frutas em escala industrial**. Rio de Janeiro: EMBRAPA - CTAA, 1998. 27 p. (EMBRAPA-CTAA. Documentos, 29).