Optimization of camu-camu pulp concentration added in gummy candies

Otimização da concentração de polpa de camu-camu adicionada embalas de goma

DOI: 10.34117/bjdv6n4-373

ABSTRACT

The camu-camu (Myrciaria dubia McVaugh), a superfruit from Amazon region, is considered the richest source of vitamin C, being also rich in bioactive compounds such as polyphenols and carotenoids. Several studies have been published on health properties of camu-camu and derived products. This work aimed to optimize the concentration of camu-camu pulp added in the formulation of gummy candies elaborated using both gelling agent pectin and gelatin to replace flavouring and colouring and to enrich the candies with the Amazonian superfruit biocompounds. The ingredients used for pectin candy elaboration were pectin (GENU 121 Slow Set), sugar, glucose syrup, camu-camu pulp and water and for gelatin candy elaboration were gelatin 240 bloom, xylitol, maltitol syrup, camu-camu pulp, water, citric acid and capol. To optimize the concentration of the different ingredients used in the formulations of both pectin and gelatin candies, a Rotational Central Composite Design (RCCD) was used with the performance of a complete factorial $2^3$, including 6 centered points and three repetitions at the central point, totaling 17 tests. Considering the experimental conditions employed in carrying out this work, it can be said that the objective initially proposed was successfully achieved and it was possible to optimize the concentration of ingredients in the formulation of both pectin and gelatin candies, with addition of 20.5% and 15% of camu-camu pulp in the candies formulations, respectively. The candies developed can be considered innovative products, free of artificial flavorings and dyes due to the use of camu-camu pulp in its formulation.
Keywords: Myrciaria dúbia, camu-camu, gummy candy, pectin, gelatin, poliols

RESUMO
O camu-camu (Myrciaria dúbia McVaugh), uma superfruta nativa da Amazônia, é considerada a fonte mais rica em vitamina C, sendo também rica em compostos bioativos como os polifenóis e carotenóides. Vários estudos foram publicados sobre as propriedades benéficas do camu-camu e produtos derivados. Este trabalho teve como objetivo otimizar a concentração da polpa de camu-camu adicionada em balas de goma elaboradas tanto com pectina como gelatina para substituir a utilização de flavorizante e corante e enriquecer as balas com os biocompostos presentes na superfruta Amazônica. Os ingredientes utilizados para a elaboração das balas de pectina foram pectina (GENU 121 Slow Set), açúcar, xarope de glicose, polpa de camu-camu e água e para elaboração de balas de gelatina foram gelatina 240 bloom, xilitol, xarope de maltitol, polpa de camu-camu, água, ácido cítrico e capol. Para otimizar a concentração dos ingredientes utilizados nas formulações das balas de pectina e gelatina foi utilizado um Delineamento Composto Cenral Rotacional (DCCR) com a realização de um fatorial completo $2^3$, incluindo 6 pontos centrados e três repetições no ponto central, totalizando 17 testes. Considerando as condições experimentais empregadas na realização deste trabalho, pode-se dizer que o objetivo inicialmente proposto foi alcançado com sucesso e foi possível otimizar a concentração dos ingredientes na formulação de balas de pectina e gelatina, com adição de 20,5% e 15 % de polpa de camu-camu nas formulações de balas, respectivamente. As balas desenvolvidas podem ser consideradas produtos inovadores, livres de aromas e corantes artificiais, devido a utilização de polpa de camu-camu em sua formulação.

Palavras-chave: Myrciaria dúbia, camu-camu, bala de goma, pectina, gelatina, poliós

1. INTRODUCTION

The camu-camu (Myrciaria dubius McVaugh), species belonging to the Myrtaceae family, is a native fruit of the Amazon and known by the high content of vitamin C. With natural habitat in flooded lands, but with good adaptability to the mainland, it is one of the most promising fruitful activities, given its economic, social, nutritional and functional importance (YUYAMA et al., 2002; YUYAMAn et al., 2003).

The camu-camu fruit is rich in polyphenols including the flavanols, flavonoids and flavanones such as catechin, rutin, quercetin, kaempferol and anthocyanins cyanidin-3-glucoside, delphinidin – 3-glucoside. The total phenolic content is higher in its seeds and peel (MORAIS & PINHEIRO 2018; VILLANUEVAn et al., 2010; ZANATTA et al. 2005). This fruit is considered the richest source of Vitamin C in Brazil, with content 20 times higher than acerola and about 60 times greater than citrinus lemon and orange (VIDIGAL et al. 2011, ZAMÚDIO 2007). In addition, the camu-camu has carotenoids including lutein, β-carotene, lycopene and zeaxanthine (ZANATTA & MERCADANTE 2007; RIBEIRO et al. 2016).

Several studies have been published on health properties of camu-camu and derived products. BARROS et al. (2018) reviewed the biological activity of camu-camu and reported in vitro experiments that indicated inhibition of α-glucosidase activity and pathogenic microbial
growth, animal studies indicating anti-obesity, hypolipidemic, hepatoprotective, anti-inflammatory, neuroprotective, cellular regeneration and spermatogenic effects with some of these effects also demonstrated by human trials, demonstrating that camu-camu could be used for nutraceutical purposes.

The industry in general, as in the confectionery sector, has been paying attention to macrotrends in global food consumption and the advent of functional foods, as their products can change from villainous position to a select group within a market that grows every year, in the world (ROBERFROID, 2000). In this context, the ingredients used in the preparation of food products are of great importance (PIMENTEL et al, 2005; ROBERFROID 2000; ROBERFROID 2007). As an example, using camu-camu pulp as an ingredient to impart flavour, colour and bioactive compounds to candies would probably make them functional products.

Among the food segments in which the Brazilian industry stands out, the Confectionery sector can be mentioned, which includes candies, chewing gums and other products elaborated by a sugar base. Brazil occupies the third position in the ranking of the largest producers worldwide in terms of confectionery volume, behind only of the United States and Germany (MONTENEGRO & LUCCAS, 2014).

Gummy candies are a great class of confectionery with low cooking and high moisture content (about 20% or more) whose texture is provided by the gelling agent used, which can be gum arabic, agar, gelatin, pectin and special starches (QUEIROZ, 1999). Both gelatin and pectin are hydrocolloids used in the manufacture of candies, but there are important differences between these two gelling agents. As they are obtained from very different sources, they present different nutrients and health benefits, as well as confer different sensory characteristics in the final product, especially in the texture of the candies.

Foods that contain gelatin offer an additional health benefit, since gelatin is a protein and an excellent source of the amino acids glycine and proline present in high concentration and, therefore, have a beneficial effect on bones and joints, connective tissue, gives shine to the hair and firmness of the nails, improves the water balance of the skin and helps to reduce, notably, the depth of wrinkles (FIB 2011).

The pectin is probably the most complex natural macromolecule. It is a heteropolysaccharide containing predominantly galacturonic acid residues. This polymer, from the group of dietary fibers, is widely used as a gelling agent and stabilizer in the food industry. Regarding the pharmacological effects of pectin, it can be mention the reduction of total cholesterol, the binding with degradation products in the colon, the increase in the excretion of bile acids; the decrease in fractions popularly known as bad cholesterol (LDL) and, although it does not
alter good cholesterol (HDL), it can also be protective against atherosclerosis by improving the HDL / LDL ratio; increasing the viscosity of the liquor of digestion and the thickness of the layer of the internal intestinal wall, reducing the absorption of glucose; reducing body weight by immobilizing nutrients in the intestines, increasing the feeling of satiety and decreasing the activity of certain enzymes, which leads to less digestion and absorption; and binding to heavy metals and toxic microorganisms in the colon, preventing the reabsorption of toxins produced by them (SHRAMA et al. 2006).

The pectin, unlike gelatin, due to its exclusive vegetable origin, follows the principles of veganism and vegetarianism, a group that has been showing an increase in the world population. Nowadays, vegan consumption is becoming more and more recurrent. There has been a "substantial growth seen in recent years" in the number of people adopting vegan diets in many areas of the world, including in the Americas, Europe and in different regions of Asia (RADNITZ et al. 2015; BFT 2020).

The polyols, also called polyhydric alcohols or alcohols sugar, constitute a special class of carbohydrates, which can be monosaccharides (sorbitol, mannitol, xylitol, erythritol) and disaccharides (maltitol, lactitol, isomalt). Monosaccharide polyols are found naturally in fruits and vegetables and as an intermediate product in carbohydrate metabolism in animals, including man (FIB 2008). The polyol with the greatest sweetness is xylitol, which is generally considered to be the same as sucrose. Xylitol is the only sweetener available, which allows substitution of sucrose 1:1 in food formulations (FIB 2012). The polyols have properties non-cariogenic (non-caries-causing), cariostatic (inhibits the formation of new caries) and anti-carcinogenic (promotes reversal of caries formation) (FIB 2010). Metabolically, they behave like carbohydrates, but are absorbed independently of insulin by passive absorption and without elevated blood glucose, and can be consumed by diabetics. The human intestine has limited ability to use polyols, with less than 50% to 75% of the ingested dose being bioavailable. When ingested in excess, due to the low rate and slow speed of absorption by the small intestine (several times less than that of sucrose), they can promote, when reaching the colon, an osmotic effect, causing diarrhea. Tolerance to the intake of polyols varies from individual to individual, being higher for people used to ingesting them. Sugars in general contribute 4 kcal / g, while polyols give an average of 1 to 2.5 kcal / g, significantly reducing the caloric amount of the products in which they are used (ZUMBE et al., 2001). The main applications of polyols in food are in sugar-free confectionery, such as candies, chewing gum and chocolate, as well as in biscuits, breads, soft drinks, ice cream, jams and dairy products (FIB 2008).

This work aimed to optimize the concentration of the ingredients in the formulation for the preparation of gummy candies with the addition of camu-camu pulp to provide flavour and colour.
of fruit to the candies, as well as to provide functional properties to the product, using both gelling agent pectin and gelatin. In addition, in the gelatin candies, xylitol and maltitol syrup were used as ingredients in the formulation to replace the sugars addition.

2. METODOLOGIA

All experimental work was carried out in the Food Technology laboratory at CMC / IFAM. The results obtained in this work were presented at the XXVI Brazilian Congress of Food Science and Technology (SARMENTO & BOEIRA 2018; RAMOS et al., 2018).

The camu-camu was purchased at open markets in Manaus and the pulp was obtained in the laboratory. The fruits were washed, sanitized with sodium hypochlorite, washed again and processed in a blender. The pulp obtained was packed in plastic packages covered with aluminum foil and kept frozen until use.

2.1. ELABORATION OF PECTIN CANDIES

Pectin, sugar, glucose syrup, camu-camu pulp and water were used as ingredients for elaboration of the candies. The pectin (GENU 121 Slow Set) was supplied by CPKelco. The sugar and the glucose syrup were purchased from local stores. The starch (Faramil OL) for molding was supplied by Ingredion. The basic steps of the process used to prepare pectin candies can be summarized in hydration of pectin, mixing with glucose and sugar syrup, cooking at atmospheric pressure, molding in the form of starch, drying, demoulding and finishing (BUREY et al., 2009).

The pectin was hydrated in hot water (80 to 90 °C) using vigorous stirring. A premixing of the sugar, glucose syrup and hydrated pectin was performed, the mixture was subjected to heating until it reached 95°C, the camu-camu pulp was added and mixed continuously until the mass reaches a TSS content between 72 °Brix and 74 °Brix. The mass was dosed in previously formatted starch molds. The starch used was previously dried in an oven at 60°C for 24 hours to reach a moisture content between 6 to 8%. The molds were kept at 35 °C for 48 h, after demoulding was performed with the help of a brush to remove the excess of the starch from the surface of the candies. The finishing was made with sugar to cover the surface of the candies (Figure 1).
To optimize the concentrations of the ingredients in the formulation, it was used an experimental design based on statistical principles (RODRIGUES & IEMMA 2014) using the Protimiza Experimental Design software. The independent variables were the percentages of pectin, sugar and camu-camu pulp used in the formulation for the preparation of the candies (Table 1).

**Table 1.** Variations in the concentrations of ingredients used in the optimization of the candy formulation.

| Independent variables | Unity | -1 | 0   | 1   |
|-----------------------|-------|----|-----|-----|
| Pectin (X₁)           | %     | 1,20 | 1,80 | 2.4 |
| Sugar (X₂)            | %     | 20  | 31  | 42  |
| Camu-camu pulp (X₃)   | %     | 12  | 18  | 24  |

The experimental design was obtained through a Rotational Central Composite Design (RCCD) with the performance of a complete factorial 2³, including 6 centered points and 3 repetitions at the central point, totalizing 17 tests (Table 2).
Table 2. Coded values (v.c.) and real values (v.r.) of the experimental design obtained with the aid of the Protimiza Experimental Design software.

| Test | Pectin (X1, %) | Sugar (X2, %) | Camu-camu Pulp (X3, %) |
|------|---------------|---------------|------------------------|
|      | v.c. v.r.     | v.c. v.r.     | v.c. v.r.              |
| 1    | -1 1,2        | -1 20         | -1 12                  |
| 2    | 1 2,4         | -1 20         | -1 12                  |
| 3    | -1 1,2        | 1 42          | -1 12                  |
| 4    | 1 2,4         | 1 42          | -1 12                  |
| 5    | -1 1,2        | -1 20         | 1 24                   |
| 6    | 1 2,4         | -1 20         | 1 24                   |
| 7    | -1 1,2        | 1 42          | 1 24                   |
| 8    | 1 2,4         | 1 42          | 1 24                   |
| 9    | -1,68 0,8     | 0 31          | 0 18                   |
| 10   | 1,68 2,8      | 0 31          | 0 18                   |
| 11   | 0 1,8         | -1,68 12,5    | 0 18                   |
| 12   | 0 1,8         | 1,68 49,5     | 0 18                   |
| 13   | 0 1,8         | 0 31          | -1,68 7,9              |
| 14   | 0 1,8         | 0 31          | 1,68 28,1              |
| 15   | 0 1,8         | 0 31          | 0 18                   |
| 16   | 0 1,8         | 0 31          | 0 18                   |
| 17   | 0 1,8         | 0 31          | 0 18                   |

The concentrations of water and glucose syrup were calculated in relation to the concentrations of pectin (multiplied by 16) and sugar (divided by 1.7), respectively. After adding all the ingredients (X1 + X2 + X3 + Water + Glucose syrup), the value obtained was calculated for each of the ingredients for a total value of 100% in each test. Thus, for the performance of each of the 17 tests, the sum of the concentrations of the ingredients was always equal to 100%. Therefore, variations in the concentrations of ingredients were 1% to 2.8% for pectin, 18% to 42% sugar, 9% to 32% camu-camu pulp, 16% to 45% of water and 11% to 25% glucose syrup. After carrying out the seventeen tests, the candies were submitted to sensorial analysis.
2.2. ELABORATION OF GELATIN CANDIES

The ingredients used were gelatin, xylitol, maltitol syrup, camu-camu pulp, water, citric acid and capol. Gelatin 240 Bloom (Gelita®) was purchased from NP Comércio de Produtos Alimentícios Ltda, xylitol and maltitol syrup were purchased from Nutramax. Capol® was supplied by Tovani Benzaquen Ingredientes.

The basic steps in the processing of gelatin candies can be summarized in cooking, depositing or molding, removing molds, cleaning, finishing and packaging. The gelatin was dissolved in water at 85 ºC and remained in a water bath at 70 ºC for 30 min. During this period, a film was formed on the gelatin surface and it was removed before the gelatin was added to the syrup, prepared with xylitol, maltitol syrup and camu-camu pulp. The ingredients were mixed and heated until reach a TSS content of 87 ºBrix. Gelatin was added to the syrup (90 ºC to 100 ºC) and citric acid solution was added. The mass was mixed and remained in a water bath at 70 ºC for 10 minutes to remove bubbles. After the mass was added in the silicone form and remained at a temperature between 5 ºC and 10 ºC for a maximum of 3 hours. The candies were unmolded, polished with Capol, gloss and sealant based on vegetable oil and natural wax, and packed in laminated film bags with low water vapor permeability.

To optimize the concentration of the different ingredients used in the formulation of gelatin candies, a Rotational Central Composite Design (RCCD) was used with the performance of a complete factorial $2^3$, including 6 centered points and three repetitions at the central point, totalizing 17 tests. The variations in the concentrations of gelatin, xylitol and camu-camu pulp used are shown in Table 3 and the coded values of the experimental design obtained with the aid of the Protimiza Experimental Design software are shown in Table 4.

| Table 3. Variations in gelatin, xylitol and camu-camu pulp concentrations used in RCCD |
|------------------------------------------|---|---|---|---|
| **Independent variable**                | **Unity** | **-1** | **0** | **1** |
| gelatin ($X_1$)                          | %          | 8      | 9    | 10   |
| camu-camu pulp ($X_2$)                   | %          | 10     | 15   | 20   |
| xylitol ($X_3$)                          | %          | 15     | 20   | 25   |

The proportions of each ingredient were expressed as percentages in the formulations and, for each of the 17 tests, the percentage of water was always twice that of gelatin, the acid was 1% and that of maltitol syrup was necessary for the sum of the ingredients to be equal to 100%. Thus, the addition of water varied from 16% to 21.4% and maltitol syrup from 32% to 40%.
Table 4. Coded values of the experimental design for the 17 gelatin candies formulations.

| Test | Gelatin(X1, %) | Pulp (X2, %) | Xylitol(X3, %) |
|------|----------------|--------------|----------------|
| 1    | -1             | -1           | -1             |
| 2    | 1              | -1           | -1             |
| 3    | -1             | 1            | -1             |
| 4    | 1              | 1            | -1             |
| 5    | -1             | -1           | 1              |
| 6    | 1              | -1           | 1              |
| 7    | -1             | 1            | 1              |
| 8    | 1              | 1            | 1              |
| 9    | -1.68          | 0            | 0              |
| 10   | 1.68           | 0            | 0              |
| 11   | 0              | -1.68        | 0              |
| 12   | 0              | 1.68         | 0              |
| 13   | 0              | 0            | -1.68          |
| 14   | 0              | 0            | 1.68           |
| 15   | 0              | 0            | 0              |
| 16   | 0              | 0            | 0              |
| 17   | 0              | 0            | 0              |

2.3. PROCESS CONTROL PARAMETERS

The time and temperature of both steps cooking and drying in the preparation of the candies were controlled. The TSS content (°Brix) was determined with a portable refractometer (Atago). The determination of water activity was performed with the use of a portable water activity meter (Rotronic) and the pH with a bench pH meter (Hanna Instruments) with the use of a spear tip-type electrode inserted directly into the candy.

2.4. SENSORIAL ANALYSIS

The candies elaborated with the seventeen formulations were submitted to sensorial analysis by a team of five tasters (pectin candies) and seven tasters (gelatin candies) to evaluate acceptability through the flavor and texture attributes (pectin candies) and appearance, colour, texture and flavor attributes (gelatin candies) using a hedonic scale balanced with nine points: (9) liked extremely and
(1) disliked extremely. To evaluate the purchase intention, a balanced hedonic scale with five points was used: (5) certainly would buy and (1) certainly would not buy (MEILGAARD et al. 2005). Based on the data from the sensorial analyzes, the Acceptance Index (A.I.) for each evaluated attribute was determined, according to TEIXEIRA et al. (1987). The I.A. % was calculated by multiplying the average score obtained in the attribute by 100 and dividing it by the highest score in the attribute.

3. RESULTS AND DISCUSSION
3.1. ELABORATION OF PECTIN CANDIES

The pectin candies elaborated are shown in Figure 2 and the results obtained in the sensory analyzes of the candies elaborated with the formulations established in the seventeen tests through the experimental design are shown in Table 5.

![Figure 2. Pectin candies with camu-camu pulp prepared with the seventeen established formulations.](image)

| Test | Sabor | Textura | I.C. |
|------|-------|---------|------|
|      | Média | I.A. (%) | Média | I.A. (%) | Média | I.A. (%) |
| 1    | 7,0   | 78      | 6,0  | 67      | 3,2  | 64      |
| 2    | 4,3   | 48      | 1,7  | 19      | 1,7  | 33      |
| 3    | 7,0   | 78      | 5,8  | 64      | 3,3  | 65      |
| 4    | 4,4   | 49      | 6,2  | 69      | 2,6  | 52      |

*Table 5. Results obtained in the acceptability test for pectin candies using the attributes flavor and texture and purchase intention test followed by the acceptance index (A.I%).*
Through the results obtained in the sensorial analyzes of the seventeen formulations and analyzing the regression coefficients for each of the tested attributes, it was observed that the variation in the sugar concentration ($X_2$) in the candy formulations significantly influenced the responses to the texture and purchase intention assessed by the tasters. The correlation coefficients ($R^2$) for flavour, texture and purchase intention responses were 75.60%, 87.59% and 85.36%, respectively. For the last two attributes, the percentage of variation explained was sufficient for the elaboration of response surfaces and contour curves. The contour curve obtained for the purchase intention response is shown in Figure 3.

![Figure 3](image-url)
In the Figure 3, it can be clearly seen that the highest concentrations of sugar and camu-camu pulp used in the formulations of pectin candies obtained a higher value in the responses of the tasters to the purchase intention. In order to obtain a value equal to 4 or greater in the purchase intention response, the concentrations of sugar and camu-camu pulp in the candy formulations must be at least 32% and 21.8%, respectively. According to the model constructed and observed in Figure 3, to obtain a score of 5 in the purchase intention response, the candy formulation must contain 1.8% pectin, 49% sugar and 28% pulp. Thus, the amount of water (pectin * 16) and glucose syrup (sugar / 1.7), must be 28.8% and 28.8%, respectively. After adding all the ingredients in the formulation and calculating to 100%, the formulation corresponded to 1.3% pectin, 35.9% sugar, 20.5% pulp, 21.1% water and 21.1% glucose syrup. The new formulation, predicted by the model and optimized, was validated through the preparation of the candy following the same methodology used for the preparation of the others seventeen candies and it was subjected to sensorial analysis by the same group of tasters. The score obtained for the response to the purchase intention by all tasters was 5, corresponding to the answer “certainly would buy”.

Others published works have also demonstrated the potential of using fruits as a functional ingredient in the manufacture of candies. NORZIAH et al. (2015) studied the preparation of candies with pectin and gelatin and red pitaya puree and concluded that the incorporation of pitaya provided a desirable texture, increased antioxidant activity and provided a natural vibrant red color to the products. MAMATHA & PRAKASH (2016), demonstrated that the pectin candy with tamarind could be a great vehicle for iron fortification due to the high acceptability of the candies and the high iron contente bioavailable.

3.2. ELABORATION OF CANDIES WITH GELATINA AND POLIOLS

For the optimization of the concentrations of the different ingredients in the formulation of the gelatin candy with camu-camu pulp and without sugar, the experimental strategy was based on multivariate statistics through the use of a RCCD. The results obtained in the acceptability test for the seventeen formulations are shown in Table 6.
Table 6. Results obtained in the acceptability test for the appearance, colour, texture and flavour attributes of gelatin candies

| Test | Aparência mean | s.d.* | Cor mean | s.d.* | Textura mean | s.d.* | Sabor mean | s.d.* |
|------|---------------|-------|----------|-------|--------------|-------|------------|-------|
| 1    | 6,9           | 1,864 | 6,7      | 1,704 | 6,7          | 1,704 | 6,7        | 1,704 |
| 2    | 6,9           | 1,951 | 6,4      | 1,618 | 6,4          | 1,718 | 6,4        | 1,718 |
| 3    | 7,7           | 0,487 | 7,7      | 0,487 | 6,7          | 1,799 | 7,3        | 1,112 |
| 4    | 6,1           | 2,267 | 7,4      | 1,812 | 6,9          | 2,035 | 7,3        | 1,253 |
| 5    | 5,0           | 2,708 | 5,9      | 2,267 | 6,1          | 2,115 | 6,3        | 1,603 |
| 6    | 6,3           | 1,704 | 6,4      | 1,718 | 6,6          | 1,618 | 7,1        | 0,690 |
| 7    | 5,6           | 2,370 | 7,0      | 1,154 | 6,6          | 1,618 | 7,0        | 1,154 |
| 8    | 6,4           | 2,070 | 7,0      | 1,000 | 6,3          | 1,253 | 6,3        | 1,603 |
| 9    | -             | -     | -        | -     | -            | -     | -          | -     |
| 10   | 7,3           | 0,487 | 7,7      | 0,755 | 6,7          | 2,360 | 6,0        | 1,914 |
| 11   | 6,3           | 1,889 | 6,0      | 1,527 | 5,7          | 1,889 | 5,4        | 1,902 |
| 12   | 6,3           | 2,286 | 6,6      | 1,902 | 5,9          | 2,035 | 5,7        | 1,603 |
| 13   | 5,7           | 2,058 | 7,4      | 1,397 | 5,9          | 1,772 | 5,7        | 1,380 |
| 14   | 5,9           | 2,267 | 6,3      | 1,889 | 7,1          | 0,899 | 7,4        | 0,786 |
| 15   | 7,6           | 1,133 | 7,7      | 1,112 | 8,1          | 0,690 | 7,7        | 0,951 |
| 16   | 7,4           | 0,975 | 7,6      | 0,975 | 7,0          | 1,000 | 7,3        | 1,112 |
| 17   | 5,9           | 2,193 | 6,6      | 1,902 | 6,3          | 2,058 | 5,6        | 2,225 |

s.d. (standard deviation)

As seen in Table 6, the minimum and maximum mean values obtained for the appearance attribute of gelatin candies were 5.0 and 7.7; for colour 5.9 and 7.7; for texture 5.7 and 8.1 and for flavour 5.4 and 7.7; respectively. The highest mean value obtained for appearance attribute was in test 3. For the attributes colour, texture and flavour, the test 15 presented the highest mean values.

The candies prepared in the test 9 were not subjected to sensorial analyzes because it was not possible to remove them from the silicone form. In this case, the concentration of gelatin used was the lowest when compared to all other tests performed and it was the only one that did not gel, demonstrating that a concentration below 8% of gelatine cannot be used in the preparation of the candies with camu-camu pulp. The lack of results in the test 9, a high experimental error and
perhaps the lack of training of tasters caused an insufficient percentage of variation explained for the elaboration of response surfaces and contour curves.

The gelatina candies elaborated showed water activity between 0.6 and 0.7 and pH between 3.2 and 3.6. The gelatin candies with camu-camu pulp elaborated with the seventeen formulations are demonstrated in the Figure 3 and the results obtained in the purchase intention test are showed in the Figure 4.

**Figure 3.** Gelatin candies with camu-camu pulp and poliols elaborated in the tests performed.

**Figure 4.** Results obtained for the purchase intention test for the gelatina candies elaborated.
As can be seen in Figure 4, the highest value for purchase intention (4.7) was obtained in the test 15, followed by tests 3 and 16 (4.3).

Table 7 shows the acceptance index (%) for each of the seventeen tests performed considering the attributes flavour, texture, colour and appearance. According to TEIXEIRA et al. (1987), a product is considered accepted if it has an average score equivalent to 70% calculated through the acceptance index. Through of the results presented in Table 7, it can be seen that the tests 4, 5, 7, 10, 11, 12, 13, 14 and 17 were not accepted by the tasters who participated in the sensorial analyzes. For all other tests, considering all the attributes used, the values were above 70%.

Table 7. Acceptance indexes (%) for each of the seventeen tests performed considering the acceptability test for the attributes flavour, texture, colour and appearance.

|       |  1 |  2 |  3 |  4 |  5 |  6 |  7 |  8 |  10 |  11 |  12 |  13 |  14 |  15 |  16 |  17 |
|-------|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| **Appearance** | 76 | 76 | 86 | 68 | 56 | 70 | 62 | 71 | 81 | 70 | 70 | 63 | 65 | 84 | 83 | 63 |
| **Flavour**     | 75 | 74 | 86 | 83 | 65 | 71 | 78 | 78 | 86 | 86 | 73 | 83 | 80 | 84 | 73 |
| **Texture**     | 75 | 71 | 75 | 76 | 68 | 73 | 73 | 70 | 75 | 63 | 65 | 65 | 79 | 90 | 78 | 70 |
| **Colour**      | 75 | 71 | 81 | 81 | 70 | 79 | 78 | 70 | 67 | 60 | 63 | 63 | 83 | 85 | 81 | 62 |

Several works have already been carried out for the elaboration of candies and confectionery with functional appeal. GARCIA & PENTEADO (2005) investigated the stability of vitamins A, C and E in the fortification of gelatin candies, providing 30% of the IDR of these vitamins in 100 g of product. The authors demonstrated that vitamins A and C dictated the shelf life of gelatin candies over a period of 6 months stored at 20°C. LAZZAROTTO et al. (2008) studied the development of a gelatin candy containing polydextrose as a dietary fiber. FONTOURA et al. (2013), developed gelatin candies enriched with iron, calcium, beta-carotene, lycopene and vitamin C and demonstrated the stability of these substances and great nutritional and sensory viability.

4. CONCLUSIONS

Considering the experimental conditions employed in carrying out this work, it can be said that the objective initially proposed was successfully achieved and it was possible to optimize the concentration of ingredients in the formulation of both pectin and gelatin candies, with addition of 20.5% and 15% of camu-camu pulp addition in the candies formulations, respectively. The candies developed can be considered innovative products, free of artificial flavorings and dyes due to the use of camu-camu in its formulation. Future work will be carried out to study the stability of
sensorial attributes and vitamin C to estimate the shelf life of both pectin and gelatin candies with addition of camu-camu pulp.

ACKNOWLEDGMENTS

To the Programa de Apoio ao Desenvolvimento de Pesquisa Científica Aplicada À Inovação Tecnológica (PADCIT) do IFAM and to CNPQ for the scientific initiation scholarship. To CPKelco for supplying the pectin and Ingredion for supplying the starch Faramil OL.

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