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Cubiu mesocarp picles processing for full use of the fruit and diversification in food use

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ABSTRACT

Cubiu is native to the Amazon and research has shown its agronomic and nutritional potential due to its high fruit production, rusticity and high pectin content. This work aimed to evaluate the use of mesocarp for the production of pickles, as a way to diversify the use of cubiu in food, testing types of cut, heat treatment and brine formulation. Initially, the mesocarp was cut into slices and cubes. However, for uniformity it was decided to use only the slices. The slices were placed in glass jars, added with brine and subjected to heat treatment (15 min in boiling water). For brine, four formulations prepared with water (83, 85, 87 and 90%), vinegar (10, 13, 15 and 17%), sucrose (2.5, 2.5, 2.5 and 3%), NaCl (2%) and condiments (0.5%) were used. The pickles were subjected to microbiological and sensory analysis. Slicing was the best for uniformity and yield. All treatments showed an intense and attractive yellow color. The slices remained intact, and had a soft texture. The results of the microbiological analyzes were within the standards of good quality. As for flavor, less acidic pickles were more preferred. Thus, it served as a basis for the use of mesocarp for the production of pickles.

Keywords: Solanaceae, *Solanum Sessiliflorum*, Brine Formulation, Sensory Analysis, Microbiological Analysis.

INTRODUCTION

Cubiu cultivation in Amazonas is not intense and the supply of fruits on the Manaus market is small. However, research shows its agronomic and nutritional potential due to high fruit production, rusticity (SILVA FILHO *et al.*, 2005; SILVA FILHO, 2012), high levels of citric acid and pectin (PIRES *et al.*, 2006; ANDRADE JÚNIOR & ANDRADE, 2015). Silva Filho (2002) reports the use of cubiu for homemade medicines, and for foods based on meat and fish. Studies were carried out with cubiu, such as, nectar and conventional jelly (RIBEIRO & DURIGAN, 2018), diet jelly (YUYAMA *et al.* 2008), spicy sauce and compote (FIGUEIREDO, 2015), obtaining and preserving the pulp (OLIVEIRA, 2002), chemical peeling (GOMEZ-CACERES *et al.*, 2012), ternary solutions to produce dehydrated cubiu (GOMEZ-CACERES, 2010) and dry cubiu in combined methods (FREITAS, 2011; ANDRADE *et al.*, 2013). Cubiu has low energy density and high dietary fiber content, especially pectin, being classified as a functional food (YUYAMA *et al.* 2007; ANDRADE JÚNIOR & ANDRADE, 2014).

Cubiu is originally from the Upper Orinoco region of the Amazon basin. It is a shrub (1 to 2 m high) with large leaves (up to 58 cm). Flowering occurs between four to five months after germination. The fruit is a berry, with variables shape and weight from 20 to 490 g. The seeds are numerous, yellow, and 3.2 to 4 mm long. The plant is rustic, easy to grow and very productive. It is an annual plant and well adapted to the lowland soils of the Amazon, making it possible to produce fruits with little or no fertilizer and to sell at affordable prices (SILVA FILHO, 2002; SILVA FILHO, 2012).

The food industry, attentive to consumer care, has developed products with low calorie and fat content, and the use of raw materials with bioactive compounds (ANDRADE, JR, 2019). Pickles are fruits and vegetables, preserved in brine, with or without fermentation, with a pH below 4.5 and low calories. The brine contains water, salt, sugar, vinegar (acetic acid) and spices (LIMA *et al.*, 2006; YULIANA & SARI, 2020; ALJAHANI, 2020). In Brazil, the pickles production follows the regulations of the Agência Nacional de Vigilância Sanitária – ANVISA (National Health Surveillance Agency) (BRASIL, 2005). As a fruit from the Amazon and consumed by the local population, cubiu is still little known in other regions of Brazil. By using a fruit from the region and proposing alternatives for its processing and consumption, it contributes to a new market and increased demand from farmers and consumers in the Amazon.

OBJECTIVE

This work aimed to evaluate the use of mesocarp for the production of pickles, as a way to diversify the use of cubiu in food, testing types of cut, heat treatment and brine formulation.

MATERIAL AND METHODS

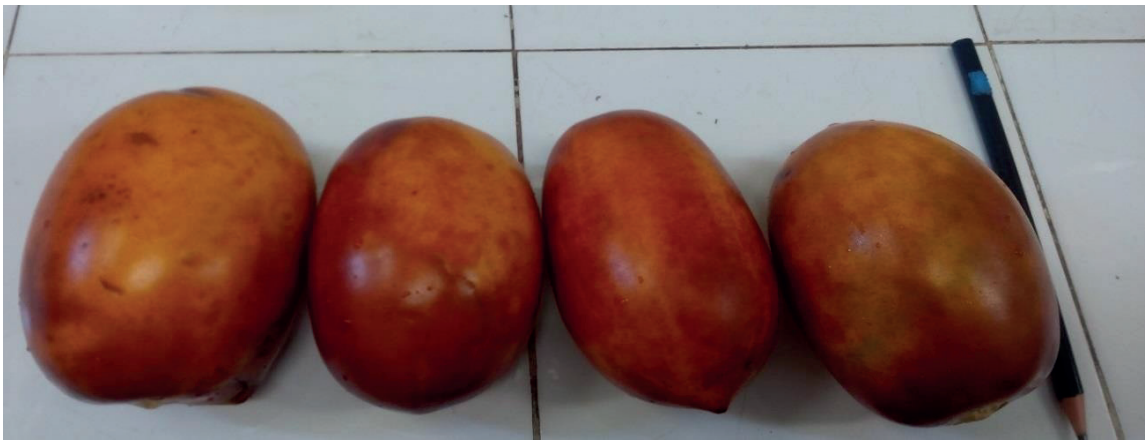
A priori, the research project was submitted to the Research Ethics Committee-National Research Ethics Commission (CEP-CONEP/INPA), received the number 042906/2016 and was approved with the number 1.562.566 and CAAE 56059816.4.000.0006.

In this research, four treatments (brine formulation) were evaluated, varying the amounts of water, vinegar and sucrose. Initially, several experiments were carried out, varying the quantities of the brine ingredients, the type of cut (halves, slices and cubes) of the fruit and the time of heat treatment. After selecting the type of cut (slices) and the time (15 minutes) for heat treatment, four formulations of brines were the treatments chosen to be evaluated in this experiment. The pickles were processed, and subsequently subjected to microbiological and sensory analysis.

Obtaining fruits and sliced mesocarp

The ripe cubiu fruits (Figure 1) were harvested from plants grown (Figure 2) in the Ariaú experimental station. This experimental station belongs to the Instituto Nacional de Pesquisas da Amazônia – INPA (National Institute for Research in the Amazon), has an area of about 100 hectares, is located in a periodically flooded region (typical lowland of the Amazon) in the state of Amazonas, Brazil. The fruits were transported to INPA's Food Technology Department where they remained (one night) at room temperature and were processed the next day.

Figure 1. Cubiu fruits (*Solanum sessiliflorum*) used in the production of mesocarp pickles (CRUZ, 2016).



The fruits were selected (immature and very ripe fruits were discarded), washed with tap water, sanitized by immersion for 30 minutes in sodium hypochlorite solution (200 $mg.L^{-1}$) and rinsed under running water.

Manually and with a stainless steel knife, the fruit was peeled, cut into halves (longitudinal direction of the fruit), the endocarp (placenta) was removed and the mesocarp was sliced

(± 1 cm). All of these operations were performed quickly (to avoid enzymatic browning) and the cubiu mesocarp slices immediately went on to the subsequent steps.

Figure 2. Cubiu plants (*Solanum sessiliflorum*) at the Experimental Station of the Ariaú, INPA, located in Amazonas, Brazil (CRUZ, 2016).

Brine preparation

The ingredients used for the formulation of brine (covering liquid) were purchased in markets in the city of Manaus. The following ingredients were used in the treatments: alcohol vinegar with 4% acetic acid (indicated by the manufacturer on the packaging label); sucrose (white crystal sugar); refined salt (iodized) and dehydrated condiments (oregano and fine herbs). The coding of the treatments, the ingredients and their respective quantities are shown in Table 1.

The brine was prepared at the time of use (concomitantly with obtaining the sliced mesocarp) using a stainless steel container and industrial stove heated with gas. First, the water was heated and, when boiling started, sodium chloride, sucrose and condiments were added. After a few minutes of boiling, vinegar was added and the boiling was maintained for another two minutes. As the brine was prepared at the time of use, its transfer to the pickle containers was carried out with its temperature still high (± 90ºC).

Table 1. Coding of treatments, ingredients and their respective quantities used in the brine formulations of the cubiu (*Solanum sessiliflorum* Dunal) mesocarp pickles.

Brine ingredients	Treantments and quantities			
	T1	T2	T3	T4
Water	83	85	87	90
Vinegar ([1])	17	15	13	10
Sucrose	3.0	2.5	2.5	2.5
Sodium chloride	2.0	2.0	2.0	2.0
Condiments ([2])	0.5	0.5	0.5	0.5

([1])Vinegar with 4% acetic acid (quantity stated on package label)
([2])Condiments (oregano and fine herbs)

Pickles processing and analysis

To obtain the pickles, the slices (± 100 g for each container) were packed (placed manually) in a glass jars (wide opening, previously washed and sterilized by immersion in boiling water), and then the free space was filled with the hot brine, leaving about 1 cm for the empty space.

To remove the internal air (exhaust), the glass jars (with the lids kept on the top, however, still without the airtight closure) were kept immersed (until just below the top edge) for 5 minutes in almost boiling water (≥ 85^{0}C). Then, the lids were completely closed, and the already tightly closed glass jars remained fully immersed for 10 minutes in the boiling water.

After heat treatment, the glass jars were cooled (under running water), coded and stored in the refrigerator (± 4 ^{o}C). About 15 days after processing, microbiological analysis were performed as described by Cruz (2016). The staff of the laboratory responsible for this research performed sensory analysis, and the appearance, color, aroma, texture and flavor were observed.

RESULTS AND DISCUSSION

Tissue part of the fruit

The cubiu fruit is a berry, consisting of the exocarp (peel), mesocarp (pulp) and endocarp (locular tissue). The exocarp and endocarp do not have desirable characteristics for the production of pickles. The peel is thin and firm, and after heat treatment or cooking it detaches from the mesocarp, acquires strength and elasticity, making it impossible to be manually broken or fragmented. The endocarp is uneven, with different tissue parts, soft, juicy, interspersed with small seeds and very acid. In the endocarp, the citric acid content is higher than in the mesocarp. The taste of the endocarp is similar to that of lemon, a sensory characteristic that makes it difficult its consume *in natura*. The enzymatic browning of the

endocarp is restricted by high acidity and low pH. In the preparation of juices, the heating of the endocarp is done only to improve the taste. Due to its high juiciness and acidity, the endocarp is suitable for the processing of jellies, nectars, spicy sauces and chutney.

The mesocarp has a firm texture and is suitable for processing pickles. This firmness resists excessive softening caused by heat treatment. The texture is soft, without fragmentation and without losing its shape. The acid content of the mesocarp is less than that of the endocarp. Mesocarp can be consumed in its natural form, as it has a slightly acidic taste, similar to that of green apples. Due to its firm texture, the mesocarp is suitable for processing compote (FIGUEIREDO, 2015), dried fruits (osmo-convective dehydration) (FREITAS *et al.*, 2017) and pickles (CRUZ, 2016).

Cutting type

In pickle processing, the type of cut and the size of the vegetable portion depends on the raw material used. Some small raw materials do not require the cutting operation. The purpose of the cut is to reduce and standardize the portion size. Thus, it facilitates the packaging inside the packaging, standardizes the heat transfer during the heat treatment, and the translocation of the brine solutes, and consequently, harmonizes the desirable characteristics related to the texture and taste.

In the cubiu it was necessary to cut the mesocarp. Initially, cut into longitudinal slices, and then, each slice was cut in the transverse direction to obtain the cubes. Uniform cubes were only obtained from the central region of the slices. The ends of the slices provided small irregular pieces. Thus, the best procedures were to remove the peel, cut in half, remove the endocarp and slice the mesocarp and using only the slices. With the adoption of the slices, there were no leftovers of the small and irregular pieces coming from the ends. The slices were manually packed, always with the inside part arranged for the center of the package.

Heat treatment

Heat treatment is used in food processing, both home-made and industrial. Depending on the purpose (enzymatic inactivation or sterilization), this treatment varies in time and temperature. In the processing of plant foods, the short treatment time (bleaching) is used for enzymatic inactivation. Thereafter, heat treatment (sterilization) is used to eliminate microorganisms, and also to promote cooking and obtain a safe and palatable food.

In the home-made conditions used, after the initial step to remove oxygen, the time of 15 minutes was chosen, based on the desired texture evaluated by tasting. The heat treatment time used and the storage in the refrigerator proved to be ideal, according to the results of the sensory (CRUZ, 2016) and microbiological analyzes (Table 2), which showed

a safe pickle with desired organoleptic characteristics. The microbiological analysis showed absence of total coliforms, fecal coliforms and *Salmonela sp*, and values <10 CFU (Colony Forming Units) for *Bacillus cereus*, molds and yeasts.

Table 2. Results of microbiological analysis of cubiu mesocarp pickles (*Solanum sessiliflorum* Dunal) Microorganisms.

Microorganisms	Treatments			
	T1	T2	T3	T4
Total coliforms	Absent	Absent	Absent	Absent
Fecal coliforms	Absent	Absent	Absent	Absent
Bacillus cereus (CFU)	<10	<10	<10	<10
Molds and Yeasts (CFU)	<10	<10	<10	<10
Salmonella sp	Absent	Absent	Absent	Absent

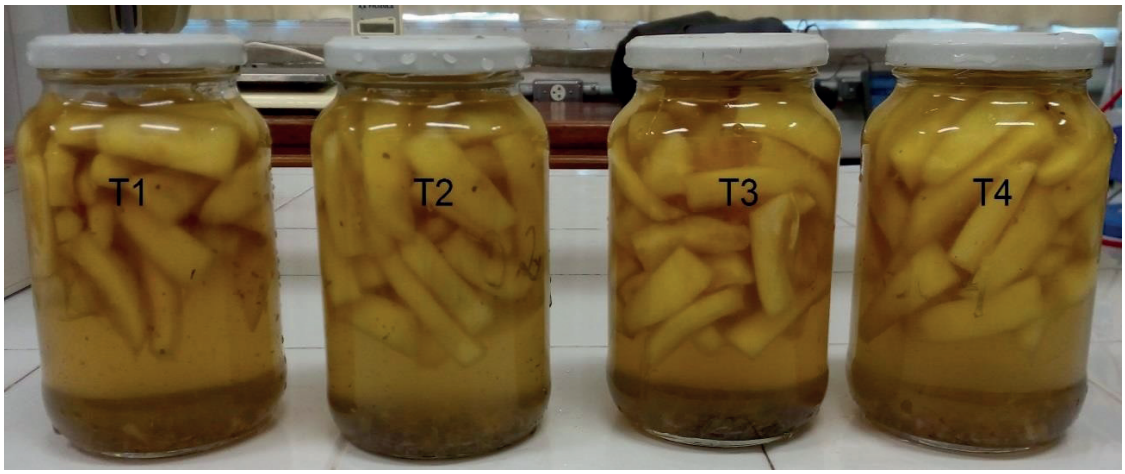
Brine formulation

Canned vegetables, when in the containers, the free space is filled by the covering liquid. In salty foods, brine is used (acidified or not) and in sweet foods syrup is used. The main functions of the covering liquid are to fill the empty spaces, expel oxygen, facilitate the transmission of heat and contribute to the flavor. For the production of unfermented pickles, acidified brine with vinegar is generally used, which provides acetic acid and decreases the pH. The brine is prepared with a combination of water, vinegar, salt, sugar and spices to promote dilution and improve the taste and aroma. The lowest concentrations of vinegar in the brine (T3 and T4) were preferred (CRUZ, 2016)

Characteristics of pickles

The appearance of the cubiu mesocarp pickles is shown in Figure 3.The pickles showed an attractive yellow color. When still in nature, the mesocarp has a whitish yellow color. With the heat promoted by the heat treatment, the color was intensified, becoming intense yellow. Even without using the preliminary bleaching operation, the speed of the processes, the acidity and hot temperature of the brine, and the immediate heat treatment contributed to the non-visualization of the enzymatic browning. The time and temperature of the heat treatment caused the texture to soften. The pickles had a soft texture, without excessive softening. The shape of the slices and the edges of the cuts remained intact.

Figure 3. Effect of brine formulation on the appearance of pickles obtained from cubiu mesocarp (*Solanum sessiliflorum* Dunal).



The microbiological analysis of a processed food shows the quality of the product and the conditions of hygiene in the production process and the possible risks that the product may cause to health. The results obtained in this study (Table 2), are in accordance with the current legislation for microbiological standards in the food class, established by Resolution RDC nº 12 of January 1, 2001 from ANVISA (BRASIL, 2001). Cubiu contains a high content of pectin, both in the mesocarp and in the endocarp (ANDRADE JÚNIOR *et al.*, 2016; ANDRADE, JR, 2019). The acidified and hot medium is commonly used for pectin extraction. The heat and the acidic medium used promoted the release of the pectin, immediately visualized after processing. This release was detected visually, due to the presence of turbidity in the form of “clouds” in the brine, located just in the vicinity of the slices (Figure 3).

CONCLUSION

The processing of pickles from a tissue part (mesocarp) of the cubiu fruit, can contribute to its diversification of consumption, and thus, be an incentive for its expansion in the local productive arrangements and for its cultivation in urban agriculture. Sliced mesocarp and less acidic pickles are promising for processing. The intense yellow color, the integrity and softness of the slices and the slightly acid flavor were the main attributes of sensory quality.

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