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## Andiroba OIL'S (*carapa guianensis* Aubl.) mechanical extraction in a Cooperative in the city of Abaetetuba, Pará, Brazil

### Extração mecânica do óleo de andiroba (*Carapa guianensis* Aubl.) em uma Cooperativa na cidade de Abaetetuba, Pará, Brasil

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### ABSTRACT

The Fruticultores de Abaetetuba's cooperative (COFRUTA) was founded in the 90s and with a history of 21 years of activity has been building protocols to the extraction of vegetable oils in the tocantina Amazon. Therefore, this research's goal was to follow the process of the mechanical extraction of andiroba oil at COFRUTA. The cooperative extracts oils from andiroba seeds by mechanical pressing, obtained from 24 partner communities and respects the production cycle of andirobeiras, making the activity sustainable. The andiroba oil extracted in this cooperative had an acidity of 51.78 mgKOHg<sup>-1</sup> and peroxides 0.99 meqkg<sup>-1</sup>. The final destination of all the cooperative's production is the cosmetics market.

**Keywords:** Extraction of vegetable oils; Mechanical pressing; Andirobeira.

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## RESUMO

A Cooperativa dos Fruticultores de Abaetetuba (COFRUTA) foi fundada na década de 90 e com uma história de 21 anos de atividade tem construído protocolos para extração de óleos vegetais na Amazônia Tocantina. Sendo assim, o objetivo dessa pesquisa foi acompanhar a o processo de extração mecânica do óleo de andiroba na COFRUTA. A cooperativa extrai óleos das sementes de andiroba por prensagem mecânica, obtidas de 24 comunidades parceiras e respeita o ciclo de produção das andirobeiras, tornando a atividade sustentável. O óleo de andiroba extraído, nessa cooperativa, apresentou acidez de 51,78 mgKOHg<sup>-1</sup> e peróxidos 0,99 meqkg<sup>-1</sup>. Toda a produção da cooperativa tem como destino final o mercado de cosméticos.

**Palavras-chave:** : Extração de óleos vegetais; Prensagem mecânica; Andirobeira.

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## INTRODUÇÃO

Andirobeira (*Carapa guianensis* Aubl.; Meliaceae) is a large tree, abundant in the “Baixo Tocantins” region, in the northeast of the state of Pará. It occurs predominantly in floodplain areas and in floodable environments through the “igapós” (SAMPAIO, 2000). The fruit is a hedgehog and, when falling to the ground, it separates into four valves, releasing almonds in the brown color, from which the oil is extracted, that in the Brazilian Amazon is known as andiroba oil or andiroba olive oil (PENNINGTON e TAYLOR, 1981; LORENZI, 1992; FERRAZ et al 2002).

Rich in fatty acids (oleic, palmitic, stearic and linoleic), bitter taste, yellow or green color, solidifies at temperatures below 25° C and is widely used in folk medicine (NOVELLO et al, 2015; SOUSA et al, 2019a; SOUSA et al, 2019b; SOUSA et al, 2021). These are some of the physical and chemical characteristics already established for the oil extracted from the seeds of *C. guianensis*. As regards to extraction, it can be done in two ways: by cooking followed by removing the pulp and heating in the sun to release the oil, or by pressing the seeds using presses (MENDONÇA e FERRAZ, 2007; MENDONÇA et al, 2020).

The traditional method of obtaining andiroba oil, according to Mendonça and Ferraz (2007), can be divided into three stages: collecting and selecting the seeds, preparing the mass/pulp and extracting the oil. Based on ethnobotanical surveys carried out in six rural communities in the “Baixo Tocantins” region, the first three stages change according to the culture and knowledge of each community (LEAL et al, 2019; SANTOS et al, 2019; MESQUITA et al, 2021).

The press used to extract the oil from the andiroba almonds can be hydraulic or screw thread (MENDONÇA et al, 2020). A study carried out at the Experimental Field

of Mazagão (00°06'54" S and 51°17'20" W), of Embrapa (Amapá), compared the yield of oil extracted by electric (worm screw thread) and hydraulic press (platform). The results showed a yield of 17% in the electric press and 18% in the hydraulic press of the extracted oil in regard to the weight of the pressed seeds (SOUZA et al, 2015). Furthermore, in a research developed by Mendonça *et al.* (2020), the oil extraction yield was better when the seeds were dried at 40° and with a humidity of 10%, when the andiroba oil was extracted by cold hydraulic press, controlling the humidity and drying temperature of the seeds almonds.

In terms of quality, the cold-pressed extraction method produces andiroba oil with high amounts of phenolic compounds and a good antioxidant capacity (FERREIRA et al, 2011). Therefore, this research's goal is follow the process of mechanical extraction of andiroba oil at the Fruticultores de Abaetetuba's cooperative (Pará), as well as to relate the quality of the product obtained with the conditions of treatment of the seeds before arriving and after being received in the cooperative.

## METHODOLOGY

Fruticultores de Abaetetuba's cooperative (COFRUTA)

In 2002, the Association of Development of Mini and Small Farmers of Abaetetuba (ADEMPA), with the support of the Union of Rural Workers of Abaetetuba (STR) of Abaetetuba, encouraged the creation of the Fruticultores de Abaetetuba's cooperative (COFRUTA) so that it could act in the segment of improvement production, industrialization and commercialization of fruits.

Founded on March 2, 2002, based on the principles of cooperativism, to develop actions with the aiming of raising the productives, organizational and commercial potential of products from family farming and solidarity economy, COFRUTA started to promote the generation of work and income for the city of Abaetetuba. The Cooperative currently has a membership of 103 cooperative members, 57 men, 27 women and 19 young people, bringing together farmers from a family economic base with the purpose of developing actions to increase the productive, organizational and commercial potential.

COFRUTA members also manage an açaí and other fruit processing plant, which sells frozen pulps and jams to various locations throughout the country. His next challenge is to expand the factory to improve all the products from family farming, which can be sold as school meal to public schools in the region, enriching the diet of children and adolescents and generating even more income for the cooperative members.

## Andiroba oil extraction at COFRUTA

Seed's obtainment from partner communities

COFRUTA collects seeds from the following locations: Abaetetuba (12 communities), Ponta de Pedras (2 communities), Cachoeira do Arari (3 communities), Muaná (3 communities), Barcarena (2 communities), Santo Antônio do Tauá (1 cooperative ) and Mosqueiro (1 association). The cooperative contacts the leaders of these communities and stipulates the quantity, the date of receipt and transports the seeds until its headquarters in Abaetetuba.

When the seeds arrive at COFRUTA, they are weighed and it's checked the producer's code. Then, they pass through the rotary dryer to remove the excess of moisture, because they usually arrive wet. In this process, the seeds enter with 50% humidity and leave with 9% humidity, with a drying time of 72 hours. In the next step, the weighing will be done, with the goal of verifying yield or breakage. After these steps, the almonds are stored in the storage house until the oil is extracted.

### Andiroba oil extraction process

COFRUTA, over 21 years of activity, has been building protocols for the extraction of vegetable oils in the Tocantina Amazon. The extraction of oil from the seeds of andirobeiras by press is already an activity with all the steps defined, according to the table 1.

Table 1: Time for extraction of andiroba oil in COFRUTA, taking into account one ton (1000kg).

Stages	Runtime
Weight, code, humidity and supply	8 hours
Drying in rotary dryer	72 hours
Shortage	8 hours
Weigh and grind	1 hour and 40 minutes
Cooking: 20 to 30 minutes at 60°C (300 kg capacity of the cooker)	2 hours
Press	12 hours
Decant	12 hours
Lung tank 1	30 minutes
Filter press and lung tank supply 2	8 hours
Bag filter and homogenizer supply	20 minutes
Pack weight (each container 15 kg) and seal	60 minutes

Considering all the steps described in table 1, the work methodology adopted at COFRUTA, the oil's extract time from one (01) ton of seeds is approximately six (06) days.

## RESULTS AND DISCUSSION

The way in which COFRUTA acquires the almonds is important because it does not cause environmental damage and respects the andirobeiras production cycle, making the activity sustainable. In addition, the residents of these communities who know the local dynamics are the ones who collect the seeds, while the cooperative just does the preparation and transport. This almonds' transport from the places of origin to COFRUTA was done by covered boat and this dynamic depends on the tide tables.

Proper care for the seeds will directly affect the yield, that is, the relationship between the amount of oil obtained per kg of seeds. In COFRUTA, to obtain 35% oil, 1 kg of dry seeds are needed and for every 1 kg of dry seeds, 2 kg of wet seeds are needed. This yield is higher than that obtained by Souza et al. (2015) who, under experimental conditions, obtained a yield of 17% in the electric press and 18% in the hydraulic press, of the oil extracted in relation to the weight of the pressed seeds.

Under experimental conditions, Mendonça et al. (2020) obtained the highest oil release when the seeds were dried at 40 °C and 10% of humidity. Under these conditions, 3 kg of seeds were needed to obtain one liter of oil. Unlike these results, at COFRUTA the drying temperature was 150 °C, humidity of 9% and from 4 kg of seeds, one liter of final product was extracted.

Andiroba oil extractors from the communities Ilha das Onças (Barcarena), Mamangal (Igarapé-Miri) and Santa Terezinha do Menino Jesus (Abaetetuba) do not usually weigh the seeds and relate them to the quantity of product obtained. However, based on data provided by residents of these communities, around 10 kg of seeds are needed to obtain one liter of oil (Sousa et al, 2019b). This value is very close to that described by Mendonça and Ferraz (2007), which was 11 kg of seeds for one liter (1 L) of extracted oil. Based on these results, it can be inferred that the methodology adopted at COFRUTA obtains better results, as from 4 kg of seeds one liter of oil is extracted.

The artisanal andiroba oil extractors may not have all the technology implemented in the cooperative that are being studied, but the development of a press accessible to these riverside would be an alternative, aiming to reduce the extraction time and to improve the yield in the relation between seed quantity and amount of extracted oil. One

possibility would be to seek partnership with the engineering courses of the University itself.

The yield can be affected by factors such as grinding, increasing the contact surface area of the particles and the cooking, because the right amount facilitates the softening of the seeds and also facilitates pressing. However, humidity above 9% and heating above 60° C during cooking compromises the quality of the extracted oil. Another important phase, with a rise in temperature, occurred during pumping, after passing through the press, the oil must be heated to 80° C for a maximum of 20 minutes, in order to facilitate its passage through the filter.

Regarding the extraction time, in the cooperative it was reduced to six days, while using the traditional method it lasts approximately 30 days. This discrepancy can be attributed to the reduced time of each phase at COFRUTA, as can be seen in Table 1. However, the pressing time used at COFRUTA is longer when compared to the 3-hour pressing time adopted in a study carried out by Vasconcelos et al. (2009).

The extraction by press of andiroba oil carried out in the cooperative generates income and contributes to the preservation of the species, as this methodology presents a good cost-benefit ratio, does not use any type of chemical compound, and does not produce toxic waste to the environment. (LIRA et al, 2021).

The artisanal extraction method can be considered as of low efficiency in relation to the amount of oil that still remains in the mass basis during dripping, even when exposing the mass to the sun or using "tipiti". However, according to Singh and Bergale (2000), mechanical screw presses are relatively inefficient, leaving over 10% of the available oil in the cake. In this context, the income of the cooperative in question can be considered satisfactory, since it obtains 35% oil from dried seeds and that a ton of almonds can be processed in six days.

Andiroba oil does not cause environmental damage, as it has complete biodegradability in a short time interval and toxicity is low when in contact with water (CAVALCANTE et al, 2016). Regarding the chemical composition, the main components found were oleic (47.19%), palmitic (27.3%), stearic (12.52%) and linoleic (9.29%) acids (SOUSA et al, 2021). Therefore, handling or spilling this vegetable oil, whether intentionally or accidentally, does not pose risks to human health, flora or local fauna.

At COFRUTA, the extracted andiroba oil had an acidity of 51.78 mgKOHg<sup>-1</sup> and peroxides 0.99 meqkg<sup>-1</sup>. A possible explanation for the high acidity value of this oil,

according to the cooperative, can be attributed to the conditions of the seed's collecting, transporting and drying. Furthermore, this oil is not produced for human consumption. Andiroba oil extracted under experimental conditions showed acidity indexes of 1.84 in an electric press and 1.53 in a hydraulic press (SOUZA et al, 2016), fermented from 10.665 (VASCONCELOS et al, 2009) and in hydraulic press ranged from 4.48 to 12.52 (MENDONÇA et al, 2020). Based on these results, it is possible to infer that depending on the experimental conditions, almost all oils had acidity indexes within the values established by RDC 270, for crude and cold-pressed oils. However, Cavalcante et al. (2016) when comparing the acidity index of andiroba oil with other oils such as sunflower, rice, castor and tucamã, considered it high, with a value of 7.20 (mg KOH.g<sup>-1</sup>).

COFRUTA, although it has provided training to the almond suppliers, has little control of the collection and storage conditions. And, after being received, the seeds go through a rotary dryer at 150° C for 72 hours. According to Mendonça et al. (2020), humidity, temperature and storage conditions are essential to obtain good yield and quality of the oil obtained. Although under experimental conditions, with seeds of two species of andiroba (*C. surinamensis* and *C. guianensis*), three temperature conditions and three moisture contents, almonds of *C. surinamensis* released a higher amount of oil after pressing, regardless of humidity and temperature. The acidity index of *C. surinamensis* (3.37 to 12.52 mg KOH g<sup>-1</sup>) was higher compared to *C. guianensis* (2,14 a 4,74 mg KOH g<sup>-1</sup>).

At COFRUTA, the seeds were crushed with the bark and submitted to cooking at 60°C. In the experiments of Mendonça et al. (2020) the bark and oils extracted from the seeds of *C. guianensis* were removed, regardless of the temperature's drying, they had acid and peroxide indexes in accordance with the indexes for cold-pressed crude oils. Unlike the oil obtained from COFRUTA, only the peroxide levels were in accordance with the standards established by the regulatory body, ANVISA.

## CONCLUSION

The oil extracted from the andiroba seeds at COFRUTA by mechanical pressing is obtained in an ecologically sustainable way. All steps of andiroba oil extraction, for one ton of seeds, took place in six days. This product had an acid index of 51.78 mgKOHg<sup>-1</sup>

<sup>1</sup> and of peroxide 0.99 meqkg<sup>-1</sup>. Results that are possibly due to the conditions for collecting, transporting and drying the seeds. The cooperative allocates all of its production to the cosmetics industry.

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