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# Utilization of Inajá (*Attalea maripa* (Aubl.) Mart.) in Communities of Abaetetuba, Pará, Brazil

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**HIGHLIGHTS**

- Inajá is a reference as a full-use plant with wide forms of use.
- Consensus of use varied by the two Amazonian communities.
- Important for maintaining the reproduction of the social life of the two communities.
- Used as a source of food, utensil, protection and shelter.

**Abstract:** Palm trees are striking elements of tropical forests and provide many jobs for Amazonian populations. The research's objective was to identify the palm trees present in the local way of life, the one with the highest consensus value for use in two riverside communities in Abaetetuba, Pará, and evaluate traditional knowledge and implications for residents' way of life. The study was carried out in Rio Urubueua de Fátima (R.U.F) and Nossa Senhora dos Anjos (N.S.A). The interviewees' selection was made by non-probabilistic sampling. The data were obtained through participant observation, semi-structured interview, non-specific induction, annotation in a field diary, and audiovisual record. Of the total palm trees cited, the Ethno-species Inajá was chosen due to its consensus use-value with values of 0.438 for R.U.F. (with 36 citations) and 0.484 N.S.A. (27). Three categories of use were identified: food, construction, and utensils. The high consensus of service is justified by the wide use from its various parts, being a reference as a plant of full use for making it possible to obtain food, protection, shelter, and utensils. Its use is related to the vast repertoires of the interlocutors received from their ancestors. This implies the importance of a species for maintaining people's social lives in two Amazonian riverside communities that depend on nature for their livelihood and quality of life.

**Keywords:** Amazon; Ethnobotany; Palm Trees.

## INTRODUCTION

Palm trees are among the most important botanical families for humans [1]. In the Amazon, there is a great diversity of species occurring in different ecosystems. This group of plants has a wide distribution, abundance, productivity, and variety of uses with social, cultural, and economic importance for local populations [2]. Its species have been supplying the needs of man for centuries, being used in food (fruits, the heart of palm, soft drink, and edible oil), fibers for making handicrafts, wood for building and covering houses and shelters; in the oil by-products industry, among other applications [3].

Despite their use and economic potential, most species are still poorly known for generating income and strengthening economically for local populations. The production chain of these species, whether for the manufacture of processed pulp (refreshment) or for obtaining oil, is still made by hand and supplied by traditional extraction. However, given the diversity of palm trees found in the Amazon, they can become an economical alternative for the region and grown in agroforestry systems [4].

Among the palm trees of great relevance, *Attalea maripa* (Aubl.) Mart. It stands out, a rustic species with a wide occurrence and natural abundance in silvopastoral systems and secondary forests [5]. Morphological characteristics show that the species has an erect and cylindrical stalk (stem) without tillers, solitary, reaching 13m in height and 57cm in diameter (D.A.P.) at chest height [6]. Flowering and fruiting are long-term events that undergo annual fluctuations [7]. The fruit is of the ovoid drupe type with base protected by the perianth and the apex by the stigma, fibrous epicarp of yellow to brown color, fibrous mesocarp of yellow-orange color, and thick, hard endocarp and brown color, presents from one to four seeds [8].

*Attalea maripa* (Aubl.) Mart. it is popularly known as inajá [9]. It is native to Brazil [10;11) and is present in the Amazon phytogeographic domain with distribution in the North (Acre, Amazonas, Pará, Rondônia), Northeast (Maranhão) and Midwest regions of the country (Mato Grosso do Sul, Mato Grosso) [12].

The palm tree can be found in anthropogenic vegetation environments such as grasslands and pastures due to its easy regeneration and adaptation to high temperatures, presenting great potential for the recovery of degraded areas [7], since there is regrowth easily and breaking of seed dormancy after contact with fire [9]. It is also recurrent in the campinarana, non-flooded forest, and lowland forest environments [10]. According to [13], palm trees are considered human presence indicators due to the varied agricultural and management practices in a given area. Although it allows a diverse application resource, this species' natural populations are the target of constant burning during agricultural areas and cleaning of pasture in silvopastoral systems in northeastern Pará [6].

Several traditional uses are related to inajá: the preparation of "vegetable soap" from the pulp of ripe fruits, which in many locations has ceased to be produced due to the substitution by industrial soap, which has become easier to acquire; straw was used to cover houses temporarily and, depending on the size, each home could require between 120 and 250 straws; the tala, which is the outermost part of the leaf petiole (the “arm”), used to make cacuri (fish trap); the coaratá, the spathe of the inajá bunch, which was used as a container because it is very resistant and can last up to 3 months. With this object, water and animal feed were stored and is a type of toy for children. From the inflorescence stalk, which is the stem that connects the bunch to the tree, dusters were created, and the fruits were used as food for people, domestic animals, and game; in rubber plantations, they were also burned to smoke rubber [4].

Studies on the use, knowledge, rescue, and systematization of useful species with traditional populations remain vital since they can also direct new jobs to species already known [14]. Therefore, it is essential to understand which strategies are used by human populations of this plant species and thus move towards sustainable management. The research's objective was to identify the palm trees present in the local way of life, the one with the highest consensus value for use in two riverside communities in Abaetetuba, Pará, and evaluate traditional knowledge and implications for residents' way of life.

## MATERIAL AND METHODS

### Study area

The research was carried out in two riverside communities belonging to the municipality of Abaetetuba (01º43'24” S and 48º52’54” W), state of Pará, Brazil. The community of Rio Urubueua de Fátima (01º38'22 ”S and 48º56'53” W), belonging to the island Rio da Prata, and the community of Nossa Senhora dos Anjos (01º30'30.1 ”S and 48º57'55.7” W) located on the island Sapucajuba (Figure 1).

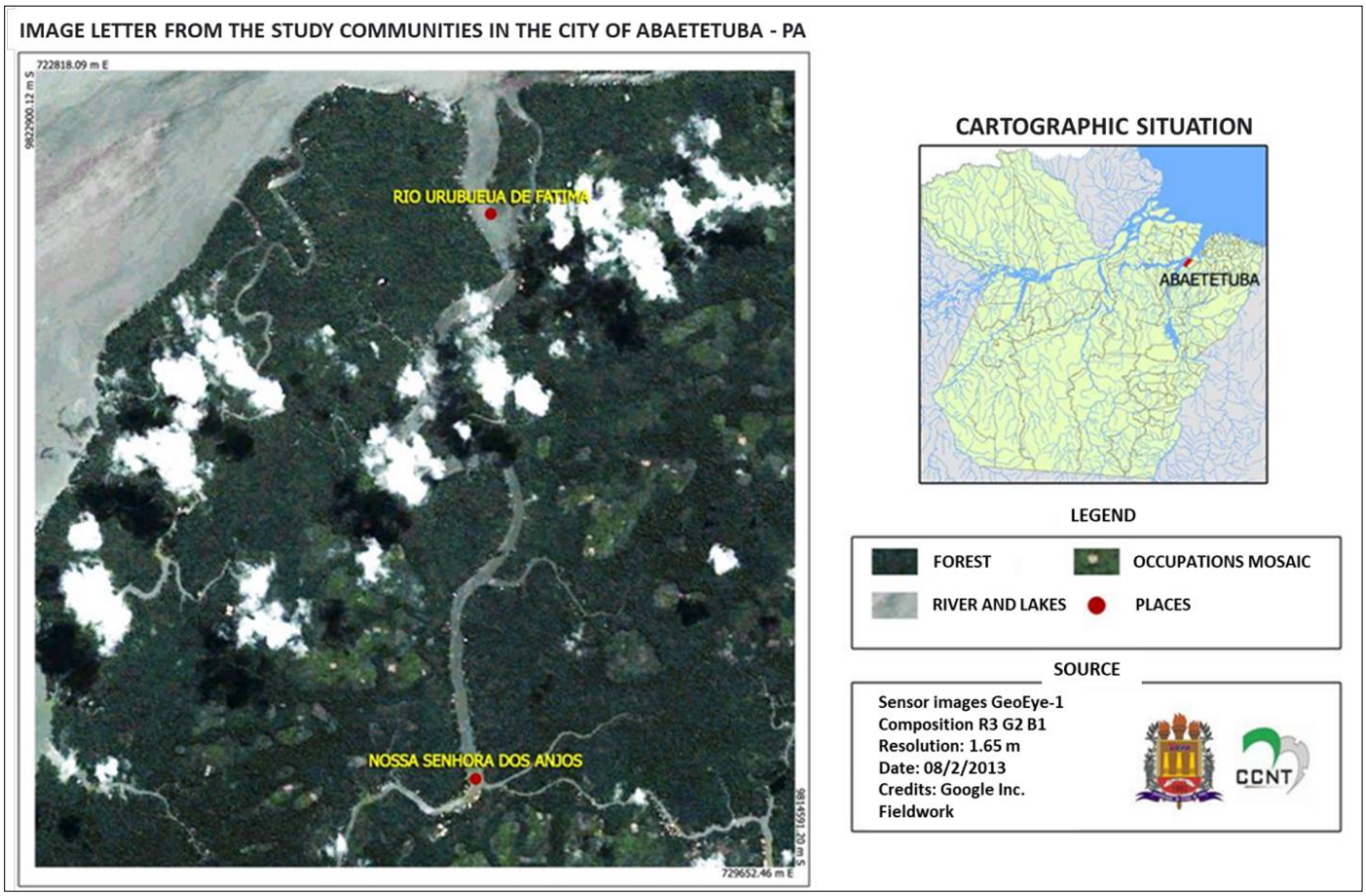


**Figure 1.** Map of the location of the study area.

The city of Abaetetuba is part of the mesoregion, northeastern Pará, and microregion of Cametá. It has an estimated population of 153,380 people, being in an accelerated commercial, economic growth and being recognized as the sixth-largest city in the state [15]. There are 72 islands located at the Tocantins River's confluence with the Pará River, in the Amazon River estuary, where the floodplain is covered by alluvial sediments from the Holocene period [16]. The climate is characterized by super humid conditions, high temperatures, and constant rainfall [17].

The predominant ecosystems are floodplain forests, regionally known as várzea forest, igapó forest, and broadleaf ombrophilous forest. The floodplains cover about 300 km2, approximately 2/3 of the Amazon's wetlands, influencing the local and regional climate [18]. In the area, more conserved and other secondary forest environments are observed, with phytophysiognomy dominated by species such as açaí (*Euterpe oleracea* Mart.), Miriti (*Mauritia flexuosa* L. f.), Red mangrove (*Rhizophora racemosa* G.Mey.), Rubber tree (*Hevea brasiliensis* (Willd. Ex Juss.) Müll.Arg.), Aninga (*Montrichardia linifera* (Arruda) Schott) and munguba (*Pachira aquatica* Aubl.).

## Selection of informants

In the first stage, an observation was carried out in the communities of Abaetetuba. Of these, two were selected because they showed an abundance of the group of palm trees as well as the insertion of these plants in the local way of life, with wide use, in addition, the residents accepted to participate and gave support in the logistics. The objectives and aspects of the research were presented to residents during a meeting with each community's leaders. After reading the project, the Consent Term was signed, agreeing with its execution. The research carried out in the communities followed the mandatory methodological protocols to obtain consent from the informants and were registered with SISGEN (National System for the Management of the Genetic Heritage and Associated Traditional Knowledge) under the number A476196.

Through non-probabilistic sampling, it was possible to compose the sample universe of interlocutors, which was complemented with the "snowball" technique, which seeks to reach a larger number of participants [19], in which one interviewee indicates another, aiming to reach the residents who were known in the communities for having valuable information about the palm trees. There was also the assistance of the main

informant or key informant [19], who indicated possible interviewees based on the resident's criterion who holds the knowledge.

In the participant observation technique, direct contact was established with the residents to understand the communities' reality better. In this stage, the acquired data are qualitative and help to describe the interviewees' daily lives. The interviews were divided into two parts: 1) socioeconomic and 2) identification of the known palm species, their uses, and applications.

### Data collection, botanical material, and species selection

Data collection took place over five months, with monthly visits lasting one week. In addition to the techniques mentioned above, socioeconomic and ethnobotanical data were obtained through semi-structured interview techniques, non-specific induction, through notes in a field diary and audiovisual records [19].

The botanical material collected was identified by comparing herbarium specimens and national and international platforms (species link, Tropicos, and The New York Botanical Garden) and then incorporated into the collection of Herbarium (M.G.) Museu Paraense Emílio Goeldi, Belém-PA. Other samples of the inajá were also included in the collection of the Herbary (M.F.S.) Prof. Dr. Marlene Freitas da Silva of the University of the State of Pará with Voucher number MFS001250. The preparation of the material followed the Collection Guide Palm Trees [20]. The scientific names were updated in the Flora do Brasil 2020 database.

The selection of the palm species that would be part of the present research took place from the initial data collection, which carried out the available inventory of the palm trees and, subsequently, the agreement was made among the informants for the highest consensus value of using a species. For this, was used the formula of Consensus value of use (U.C.s) U.C.s = 2ns / n-1, where ns = number of people who use the species [21]. This index ranges from -1 to +1 measures the degree of agreement between informants regarding whether a species is useful or not.

## RESULTS

Thirty-two residents were interviewed in Rio Urubueua de Fátima, 21 men and six women aged between 24 and 76 years old, and in Nossa Senhora dos Anjos 31 residents, of these 12 were men and 14 women aged between 22 and 76 years old. In the two communities, the primary source of income was fishing, with large commercialization of fish, and vegetable extraction, with açaí being the most commercialized palm. There are other types of income sources, which include government benefits such as retirement and scholarships.

The palm inventory totaled 21 species that covered eight categories of use, with 131 uses reported in RUF and 147 in N.S.A. (Table 1). The values of Consensus of Use (UCs) had expressive positive results for six species: the inajá (0.438 RUF / 0.444 NSA), açaí (1,000 / 1,000), white açaí (-0.25 / 0.742), haystack (0.625 / 0.806), the miriti (0.875 / 1,000) and the jupati (0.75 / 0.742), confirming the agreement among the informants regarding their usefulness. The other palm trees reported obtained low (negative) values for this index, varying between -0.938 and -0.161, which meant no significant agreement regarding their uses among these species. According to [21] and [22], negative values indicate that many species are used by few people or are not used and that most informants use a small number of species.

**Table 1.** Species cited by community informants.

| Species | Etnoespecies | Usage category | | Usage quotes | | Voucher |
|---|---|---|---|---|---|---|
| | | R.U.F. | N.S.A. | R.U.F. | N.S.A. | |
| *Acrocomia aculeata* (Jacq.) Lodd. Ex Mart. | Mucajá | a | a | 4 | 4 | MG 204272 |
| *Astrocaryum murumuru* Mart. | Murumuru | a | co | 5 | 1 | MG 204266 |
| *Astrocaryum vulgare* Mart. | Tucumã | a | a; art; co | 17 | 31 | MG 204265 |
| *Attalea maripa* (Aubl.) Mart. | Inajá | a; c; u | a; c; co; u | 36 | 27 | MG 204262 |
| *Attalea phalerata* Mart. ex Spreng. | Urucuri | a | -- | 1 | -- | MG 204267 |
| *Bactris gasipaes* Kunth | Pupunha | a; co | a; co | 16 | 9 | MG 204273 |
| *Bactris major* Jacq. | Marajá | a | a; co | 2 | 6 | MG 204277 |
| *Cocos nucifera* L. | Coqueiro | f; tr; m | f; tr; m | 32 | 33 | MG 204269 |
| *Copernicia alba* Morong ex Morong & Britton | Carnaúba | cr; m | -- | 4 | -- | MG 204271 |
| *Desmoncus orthacanthos* Mart. | Jacitara | tr; u | u | 16 | 7 | MG 204261 |
| *Elaeis guianensis* Jacq. | Dendê | F | f | 6 | 1 | MG 204275 |
| *Euterpe oleracea* Mart. | Açaí | f; fe; c; tr; m; u | f; fe; c; tr; m | 187 | 179 | MG 204258 |
| -- | *Açaí branco | f; tr; m | f; c; tr; m | 25 | 59 | MG 204278 |
| *Geonoma baculifera* (Poit.) Kunth | Ubim | c; u | c | 4 | 2 | MG 204270 |
| *Manicaria saccifera* Gaertn. | Palheira; Palha do Bussu | c; tr; m; u | f; c; tr; m; u | 59 | 79 | MG 204264 |
| *Mauritia flexuosa* L.f. | Miriti | f; cr; c; tr; u | f; cr; c; tr; u | 165 | 215 | MG 204263 |
| *Mauritiella armata* (Mart.) Burret | Caranã | f; c; u | f; c; u | 3 | 25 | MG 204274 |
| *Oenocarpus bacaba* Mart. | Bacaba | f; tr | f; tr | 22 | 28 | MG 204259 |
| *Oenocarpus bataua* Mart. | Patauá | f; tr | f; c; tr | 3 | 52 | MG 204276 |
| *Oenocarpus minor* Mart. | Bacabí | f | -- | 1 | -- | MG 204671 |
| *Raphia taedigera* (Mart.) Mart. | Jupati | f; cr; c; tr; u | f; c; tr;u | 68 | 73 | MG 204268 |
| *Socratea exorrhiza* (Mart.) H.Wendl. | Paxiúba | c; m; u; mu | c | 20 | 7 | MG 204260 |

f: feeding; fe: fertilizer; cr: crafts; c: construction; t: trade; m: medicinal; u: utensil; mu: mystical use. R.U.F: Rio Urubueua de Fátima; N.S.A: Nossa Senhora dos Anjos.
*Ethnovariety of *Euterpe* sp.

The use consensus for 0.438 inajá in RUF was indicated by 23 informants and 0.484 in N.S.A. 23 and classified in three categories of use: food, construction, utensil, and instrument. In addition to inajá, açaí (*Euterpe oleracea* Mart.) With a consensus usage value of 1.00 for the two communities also stood out 32 citations (RUF) and 31 in N.S.A., and miriti (*Mauritia flexuosa* Lf), 30 citations RUF, and 31 N.S.A.

## DISCUSSION

### Inajá in food

In the food category, the fruits of inajá (Figures 2A, 2B) were consumed by residents of both communities naturally as "flour porridge" and in the form of wine and porridge. This porridge is served to all members of the family, including children. According [23], the fruits are usually "gnawed" almost always in the natural state, accompanied by cassava flour or prepared as porridge due to the pulp's sweet flavor. The total sugar content in the inajá pulp was around 9.17 ° Brix in the study by [24]. The authors also observed a high content of soluble solids (S.S.) and a low acidity (AT) in this fruit, which justified the high SS / AT ratio obtained. This relationship reflects the characteristic sweetness of the fruits. [25] Found that amounts of total sugars concerning the soluble solids of the inajá correspond to approximately 57%, which corroborates what was mentioned by [23] when referring to the sweet taste.

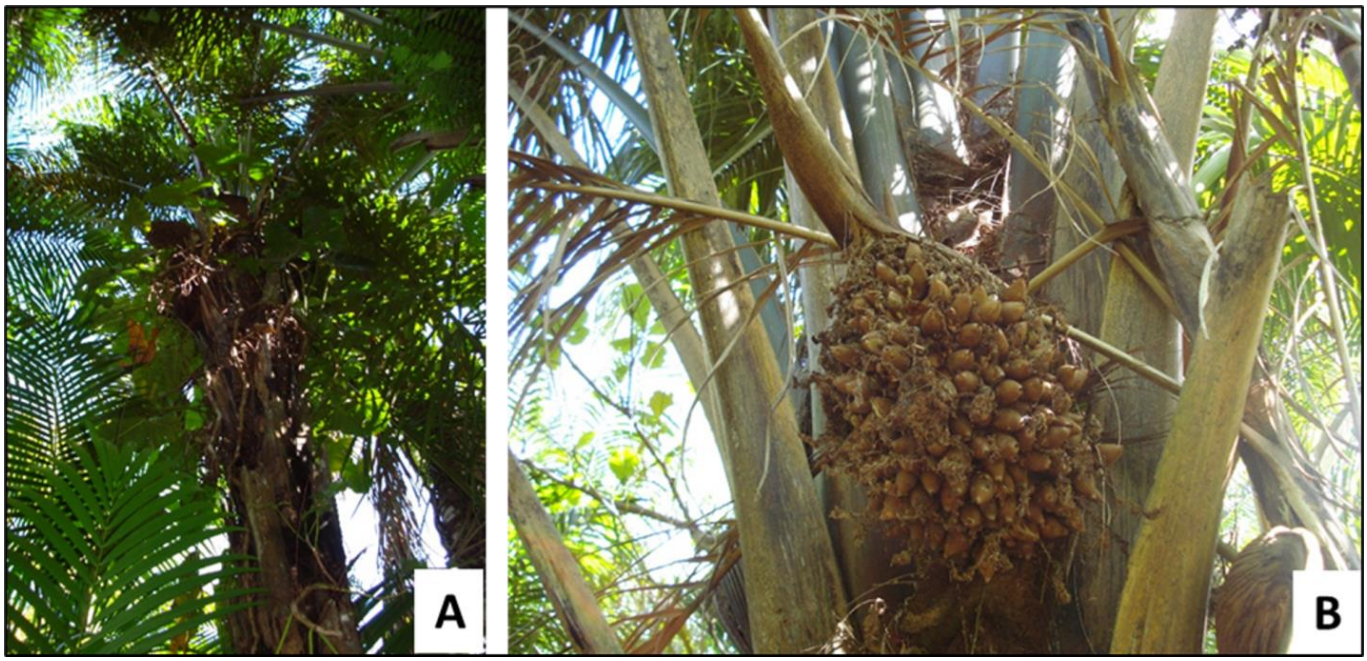


**Figure 2.** Fruits of *Attalea maripa* (Aubl.) Mart. (A) the general aspect of the inajá and (B) curl.

The fruits and the bunch are also useful in feeding pigs and as a trap, locally called "comidilha," to attract game like cutia (*Dasyprocta* spp.), Paca (*Agouti paca*), catitu (*Tayassu tajacu*), veado (*Mazama* spp.), tatu (*Dasypus* spp.), quati (*Sciurus* spp.) and macacos (*Cebu*s spp.) [4]. According [26], the fauna that feeds in parallel plays the ecological role of seed dispersers, and in this process, there is the representation of a very diverse fauna, with agouti, tapir, cateto, white-tailed deer and bush, catinguelê, monkey- nail, blue macaw among others. Thus, both human use and that used by other animals reflect a relationship of proto-cooperation by allowing the perpetuation of individuals of the inajá palm through food.

In the family farming community of Palmares II belonging to the municipality of Parauapebas, in the southeastern state of Pará, the use of natural fruits for human consumption and by-products such as olive oils and oils has also been reported [25]. The use of mesocarp as food in the localities is associated with the organoleptic characteristics of the pulp, such as juiciness, aroma, the availability and abundance of fruits throughout the eastern Amazon from January to March, a period which each inajá produces 5 to 6 bunches and each bunch comprises 800 to 1,000 fruits [4].

The use in human and animal food of the fruits comes from the protein and caloric content. Its high concentration of proteins in the pulp can vary from 3.14% to 7.06%, and this value represents about 8.49% to 18.91% of an adult man's need for daily protein intake. The presence of minerals such as phosphorus, potassium, calcium, sodium, magnesium, and essential fatty acids confer nutritional relevance to the fruit [27]. [28] analyzed the fatty acid profile of inajá pulp oil and identified high levels of unsaturated fatty acids such as linolenic acid, linoleic acid, oleic acid; and saturated as myristic, lauric, and palmitic acid. According to the authors, some acids cannot be synthesized in the mammalian organism, so it is necessary to obtain

them through food. Such fatty acids produce benefits for human health since in balanced amounts in the diet; they can prevent neurodegenerative diseases such as Parkinson's and Alzheimer's disease [28,29].

In the fruit, the fatty acids that are found in abundance [8] give the oil a composition similar to that of other oils of commercial value such as soybean, sunflower, corn, and cotton, with the advantage of having a higher oil yield [30]. Vegetable oils are necessary for many human body functions, such as enzymatic reactions, the transmission of nerve impulses, memory storage, and hormone synthesis. Besides, technological functions are attributed to it, such as emulsifiers, polymeric materials, lubricants, coatings, structural adhesives, texturizers, flavorings, humectants, food frying, Biodiesel production, and others [31]. Its use would be profitable for the inhabitants of the communities of Abaetetuba since the long period of flowering and fruiting would guarantee the supply of raw material, in the case of industrialization for oil extraction, and the sustainable management of its natural population [7].

In addition to the fruits, the seeds in the woody endocarp (stone) may be economically relevant because they present oil with excellent physical and chemical characteristics. Such characteristics are conditioned to the composition of fatty acids, degree of unsaturation, their position in the glycerol molecule, and the carbon chain's size making them more stable, which guarantees more remarkable preservation and less possibility oxidative degradation [32]. The inherent physicochemical characteristics of vegetable oils are directly related to the quality of the biofuel. [33] demonstrated that the inajá oil could use as a raw material in an enzymatic hydroesterification reaction to synthesize biodiesel. According [8], seeds can supply 72.45% of lipids. Although the almonds are large and with good quality oil, there are difficulties in preparation since the woody skin and the epicarp together represent 65% of the fruit's total weight, impairs the almond's separation of the oily mass [34]. However, for this author, an alternative process would be to grind the fruit, after being dried and reduced to mass, by powerful mills, which would yield a percentage of 13% oil.

The heart of palm is another part of this palm tree that, when sweet, had a great appreciation in the food of the residents of the community of Rio Urubueua de Fátima. According [23], the inaja tree enables an excellent quality heart of palm, but its removal requires considerable physical effort due to the thickness of the stipe. However, its quality prevails, making it a potential economic resource. [35] demonstrated that the stipe of inajá could be indicated for energy uses. The heart of palm is also used to feed animals such as cattle, as it helps in weight gain, the so-called "fattening," increasing milk production [4].

The species has similar uses in other locations in the Amazon region, where humans consume palm hearts in the Colombian rainforest [36], making it an essential nutritional alternative for Amazonian populations. According [37], although it is of low nutritional value, the heart of palm is a food rich in minerals containing sodium, potassium, manganese, calcium, iron, fluorine, copper, boron, and silicon.

## Construction

In the construction, the leaves have already been used to cover houses and animal shelters. This practice is advantageous for residents, as the inajá has a great capacity to adapt to edaphoclimatic factors prevalent in the northeast of Pará, which implies the constant emission of new leaves [7]. This straw is always available to be used frequently by both communities. According [38], straw-covered most of the houses in Zona Bragantina, since they rotted more slowly and were less susceptible to insects' action. These characteristics led to a greater demand for the "straw" of the inajá to replace that of buriti, the latter that was widely used [39]. The scarcity of buriti "straw" has led ethnic groups that inhabit the Macuxi-Wapixana complex, in the state of Roraima, to look for that of the inajá to cover malocas [40]. Informants from the communities in Abaetetuba also mentioned that they previously used the leaves of the inajá as a natural bleach for clothing. White clothes after washing were spread over the leaves in order to acquire a lighter appearance.

## Utensils and instruments

As a tool, the residents reported using the inajá splint (leaf petiole) for making *matapi* (Figures 3A and 3B), an essential and widely disseminated instrument throughout Brazilian Amazon shrimp fishing. This object consists of a cylinder with small openings at both ends, in the shape of a funnel facing inwards, where baits are placed. This species is also used for making ropes (Figure 4). In the region of Baixo Tocantins, municipalities of Baião, Mocajuba, Cametá and Limoeiro do Ajuru, matapi is made from the inajá splint in combination with that of the jupati palm (*Raphia taedigera* (Mart.) Mart.), Allowing it to float with ease. In this region, in addition to the *matapi* there are other accessories for fishing, made from inajá and jupati: the *pari* has rectangular panels made with the splints of palm trees that act as a barrier where the fish is trapped with the flow of the tide, and the paneiro which are baskets used by the fisherman to catch the shrimp during the harvest period when it is found in abundance [41].

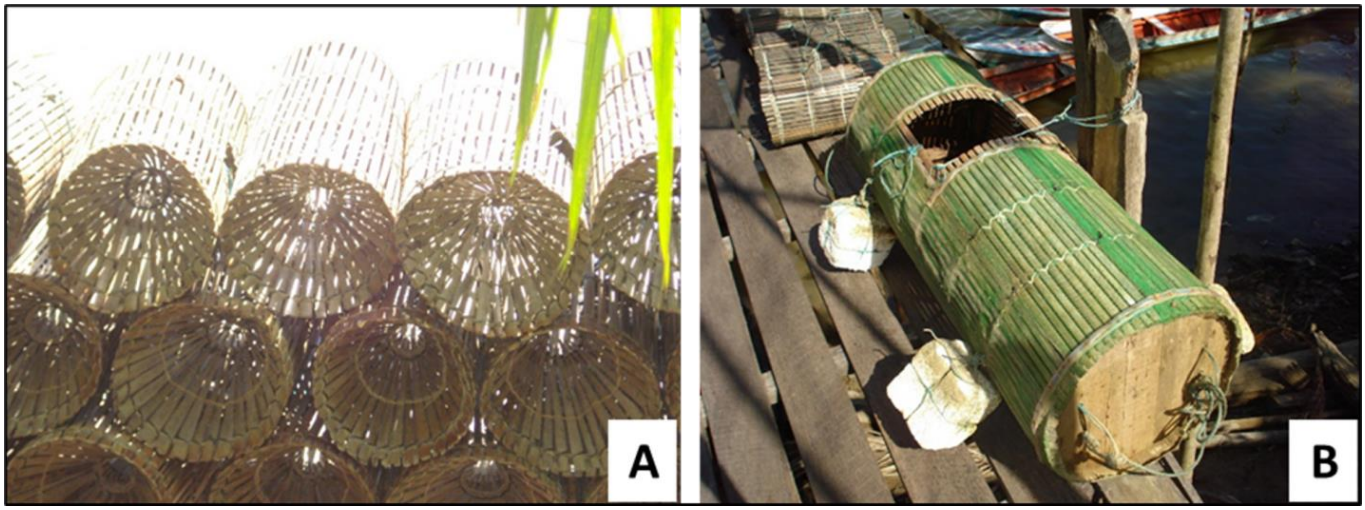


**Figure 3.** An instrument used for fishing for shrimp (A) matapi stored and (B) matapi in use.

**Figure 4.** Rope making.

In the Colombian Amazon, the Huaorani who inhabit the Yasuní National Park area and the Huaorani Ethnic Reserve work with the petiole and the inajá leaves' branches to make mats for resting in the middle of the forest. Petioles are also used to prepare torches, and the pines, which are leaves, to light them. The rachis (a structure that is on a central axis supporting the palm leaves) and the petioles are sculpted to compose darts [42].

## Bioprospecting of inajá

Inajá is a plant resource with significant potential for research and technological development, helping local populations' productivity due to its full use, and being the object of analysis by industry and commerce to prospect compounds and products from biodiversity. Currently, there are two patented technologies on the market involving the improvement in obtaining esters from the species' vegetable oil [43]. The Brazilian Agricultural Research Corporation (EMBRAPA) has investigated the potential of inajá, as well as other palm trees native to the Amazon, murumuru (*Astrocaryum ulei* Burret), and miriti as a source of biofuels [14]. [43] compared the investigations carried out in prospecting with the inajá and bacaba (*Oenocarpus bacaba* Mart.), And observed that the inaja tree has a total of four patents involving the chemical and food industries so that the holders of technologies are mostly companies and institutes.

## CONCLUSION

In the communities studied, the Inajá is a reference as a plant for full use because it represents a wide variety of forms of use related to the rich repertoires brought by these local interlocutors, who received information from their ancestors. The broad knowledge reported demonstrates the importance of this species in people's daily lives, which establish the continuity of their lives from the resources of nature, both for

organic and physiological sustenance and for the generation of income and quality improvement of family life.

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