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Original Paper

# Traditional botanical knowledge: food plants from the *Huni Kuĩ* indigenous people, Acre, western Brazilian Amazon

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**Abstract**

The *Kaxinawá* indigenous people (auto-identified as the *Huni Kuĩ*) are native to the western Amazon, on the Brazilian border with Peru, and have an extensive biodiversity-related knowledge, which is parti of a coherent social-ecological system. Our study investigated native knowledge of edible forest plants, in three communities within the *Kaxinawá* Indigenous Land on the Lower Rio Jordão, Acre state, Brazil. The principal methods used were participant observation, open and semi-structured interviews and walk-in-the-woods. The study recorded 89 native food species. Some 60% are managed in food-production areas, with 56% of the recorded species have received little or no scientific study of their food potential. The role which natural systems play in *Huni Kuĩ* society is indicated by the management and use of a high diversity of native species, which contributes to food security and nutritional sovereignty. However, there is a progressive under-utilization and substitution of forest species, due to the introduction of cultivated exotic species and the increase in consumption of industrialized products. An enhancement of the value given to native food-plants is needed to encourage continuing autonomy of production, and diet diversification, as well as the conservation of sociobiodiversity of traditional peoples in the Amazon through sustainable management practices of the current social-ecological system.

**Key words**: Amazon, ethnobotany, food plants, indigenous knowledge, management and use, sociobiodiversity conservation, transdisciplinarity.

**Resumo**

O povo indígena *Kaxinawá* (auto-denominado *Huni Kuĩ*) é nativo da Amazônia ocidental, na fronteira brasileira com o Peru, e possuem um vasto conhecimento sobre a biodiversidade, formando um sistema sócio-ecológico consistente. O presente estudo investigou conhecimentos nativos de plantas florestais alimentícias, em três comunidades da Terra Indígena *Kaxinawá* no Baixo Rio Jordão, estado do Acre, Brasil. As principais metodologias utilizadas foram: observação participante, entrevistas abertas e semiestruturadas e trilhas-guiadas na floresta e nos agroecossistemas. O estudo registou 89 espécies alimentícias nativas. Dessas, cerca de 60% são manejadas igualmente em áreas de produção alimentar. Ao mesmo tempo, aproximadamente 56% das espécies possuem pouco ou nenhum estudo científico sobre o seu potencial alimentar. O papel que os sistemas naturais desempenham na sociedade *Huni Kuĩ* é indicado pelo uso e manejo de uma grande diversidade de espécies nativas, o que contribui para a segurança e a soberania alimentar e nutricional. Contudo, há uma progressiva subutilização e substituição de espécies florestais, devido à introdução de espécies exóticas cultivadas e ao aumento do consumo de produtos industrializados. Nesse sentido, é importante valorizar as plantas alimentares nativas a fim de promover a contínua autonomia de produção e diversificação alimentar, bem como a conservação da sociobiodiversidade dos povos tradicionais na Amazônia, por meio de práticas de manejo sustentável do atual sistema socioecológico.

**Palavras-chave**: Amazônia, etnobotânica, plantas alimentícias, conhecimento indígena, uso e manejo, conservação da sociobiodiversidade, transdisciplinaridade.

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## Introduction

One of the consequences of globalization is cultural homogenization, which is also reflected in a standardization of food (Canesqui & Garcia 2005), largely due to the globalization of markets, industrial agriculture, and the increased use of industrialized products (Muller *et al.* 2010). It is worth noting that the potential global food biodiversity is estimated at around 30,000 plants, but only 15 to 200 species are generally used by humans (Jacob & Albuquerque 2020). In Brazil more than 50% of the species consumed are exotic, originating largely from Eurasia, perhaps indicating a form of gastronomic-food "imperialism" (Kinupp & Lorenzi 2014).

Machado (2020) states that there are at least 2,200 species of native food plants in Brazilian Amazon alone. This estimate is based on a combination of information from Kinupp (2007), that at least 21% of the plants of natural habitats in the tropical regions can be used as food by humans, and Cardoso *et al*. (2017), that at least 10,000 species of angiosperms occur in the Brazilian Amazon. Despite this vast food biodiversity, research in tropical regions commonly reveals that most of these species are unstudied by modern Western science (Kinupp & Lorenzi 2014; Paz *et al.* 2018; Teixeira *et al.* 2019). Additionally, it is important to highlight that, of those native and traditional species that are known, most have great potential as sources of energy, nutrients and bioactive compounds (Mendes 2015).

Knowledge of the biodiversity accessible from local food systems forms a key element when structuring biodiversity-related information concerning food plants and, therefore, for the formulation and implementation of public policies on food and nutrition security, towards healthier, more diversified and sustainable diets (Jacob & Albuquerque 2020). Indigenous peoples play a central role in achieving this objective. They contribute to the evaluation and monitoring of forests, wildlife or agroecosystems, and furnish critical knowledge concerning biodiversity in poorly-studied regions (Reyes-García & Benyei 2019), which can be considered a crucial element in effective food plant conservation.

Through customary rules, values and norms, as well as spiritual beliefs and perceptions of ecosystem functions (Joa *et al.* 2018) that guide and restrict the use of natural resources, indigenous communities have been managing the environment that surrounds them for thousands of years, thus ensuring the long-term continuation of their livelihoods (FPP *et al.* 2016). In the Amazon region, interdisciplinary research indicates that, far from being pristine, the current rainforest landscape is, instead, a cultural or anthropogenic forest (Levis *et al.* 2017). That is, it is a product of a co-evolution between human and nature, one whose composition has been formed in accordance with the material and spiritual needs of the local indigenous groups (Balée 2008; Linhares 2009). Levis *et al*. (2017) emphasized the positive features of such modifications, which result in an increase in the local biodiversity of useful plants, including those used for food. As a result, there is an interdependent relationship between the permanence of the indigenous livelihood and the diversity of plants used for food in such anthropogenic forests (Preiser *et al*. 2018).

From this perspective, knowledge co-produced between scientists and indigenous peoples can contribute to advances in the use, management and conservation of food plants (Reyes-García & Benyei 2019). Ethnobotany, as an interdisciplinary science that seeks to understand the multiple ecological, evolutionary and cultural interactions of past and present human societies with plants biodiversity (Alexiades 1996), can collaborate with this transdisciplinary method of research. In addition to the formerly pervasive tendency to focus on producing inventories of food plant species, ethnobotanical research nowadays has the highly conservation-relevant role of analyzing the contribution of these plants to food and nutritional security, the local economy and to biodiversity conservation (Jacob & Albuquerque 2020).

However, the understanding of indigenous knowledge through the lens of modern scientific analysis is still scarce compared to other study fields (Cámara-Leret & Dennehy 2019). Given the importance of accumulating a more comprehensive knowledge regarding food plant biodiversity, for both biocultural conservation and the promotion of more sustainable diets, the current study sought to understand material and symbolic aspects of the knowledge and use of native food plants linked to the social-ecological system of the *Huni Kuĩ* indigenous people in three villages in the *Kaxinawá do Baixo Rio Jordão* Indigenous Land, in Acre state, western Amazon, Brazil.

*Huni Kuĩ* indigenous people (whose self-given name means "real people") belong to the

Pano ethnolinguistic family (Erikson 1992), and are known to other indigenous and non-indigenous people as the *Kaxinawá* ("bat people") (Aquino & Iglesias 1994). Most of their territories are located in what is now Acre state, western Amazon, Brazil. Among the main economic activities, those related to food are central to *Huni Kuĩ* culture - that is the most important aspect of the social life of the family nucleus (Aquino & Iglesias 1994). It is imperative to eat well for the health of the body (*yuda*) and the spirit (*yuxĩ*). Those who do so are good *xinanya*, that is, endowed with good thoughts or, as translated by Keinfenheim (2002), "good conscience".

It is worth noting that the present research was guided by the cultural values surrounding food plant biodiversity of the *Huni Kuĩ* people, including both utilitarian and symbolic/intangible elements. We adopt an emic approach, in which the agents of the research are the subjects and/or interlocutors/collaborators of the study (Posey 1987). We intend to answer some aspects about the following questions: what are the native food plants used by the *Huni Kuĩ* people and what is the relative traditional knowledge? Using interdisciplinary methods, characterization of native food plants was carried out in terms of traditional botanical knowledge, diversity, management landscape forms, life forms and parts eaten, and modes of consumption.

In addition, a systematic review of the identified species was conducted to provide baseline information for further scientific investigations into food plant biodiversity. This resulted in a literature review whose major outcome was to ascertain: which of the surveyed species, based on published ethnobotanical and bromatological data, were already known to western Science? And which of the remainder had little or no published scientifical studies, but possessed sufficient food potential that they should be investigated in future research?

Finally, the current study seeks to contribute to ethnobotanical science in the sense of corroborating the theory of cultural forests and expanding the scientific knowledge of the diversity of Amazonian food plants, as well as adding to the elaboration and implementation of public policies that value this diversity and the indigenous culture through, for example, national and/or regional programs of sociobiodiversity conservation, territorial and environmental management, and food and nutritional security and sovereignty.

## Material and Methods

### Study area

The study was conducted in the 9,000 ha *Kaxinawá do Baixo Rio Jordão* Indigenous Land (hereafter I.L), gazetted in 2001, in the Alto Juruá region of Acre state, western Brazilian Amazonia. The I.L. is part of a complex of three Indigenous Lands (Fig. 1), viz.: *Kaxinawá do Rio Jordão*, *Kaxinawá do Baixo Jordão* and *Kaxinawá do Seringal Independência* (this last accessed via the upper Tarauacá river). Close by lie the Alto Juruá Extractive Reserve, Alto Tarauacá Extractive Reserve, *Kaxinawá/Ashaninka do Rio Breu* I.L., *Kuntanawa* I.L, *Alto Tarauacá* I.L. (reserved for indigenous people in a voluntary state of isolation) and an urban area in the municipality of Jordão. It is a broad mosaic of protected areas, with enormous potential for socio-biodiversity conservation.

The three villages involved in the study were: a) *Nova Empresa*; b) *Nova Cachoeira*; and c) *São Joaquim* "*Centro de Memória*" (memory center). All lie along the main channel of the Jordão River and are separated, on average, by a thirty to forty minutes boat-ride, depending on the vessel and pluviometric conditions. All communities are situated close to streams, which form reference points for territorial delimitation.

The combined population of the three villages totals approximately 260 inhabitants, of which about 60% are female, and around 40% are male (Tab. 1). There are also more women than men in each of the villages separately. The population is demographically extremely young. At the time of the study, more than 60% of the population in the three villages were under the age of 18. Young people and adults (between 18 and 60 years) make up about a third of the residents, while the elderly (those over 60 years old) represent less than 5% of the total (Tab. 2).

### The *Huni Kuĩ* indigenous people

This is the most populous indigenous group in the Acre state, and the one with the largest number of demarcated lands which are distributed in areas between the Purus, Juruá, Envira, Muru, Humaitá, Tarauacá, Jordão and Breu rivers. Their lands occupy some 650,000 ha of territory, with a population of about 14,000, according to the Federation of the *Huni Kuĩ* people of Acre (CPI/AC 2021).

Overall, 67% of the *Huni Kuĩ* live within the Tarauacá River valley, on a right bank

tributary of the Juruá River. There are also a considerable number of families currently living in the municipalities of Santa Rosa do Purus, Tarauacá, Jordão, Feijó, Cruzeiro do Sul and in the state capital, Rio Branco. There are also just over 2,100 *Huni Kuĩ* living in Peru, distributed among eleven officially recognized native communities, along the Curanja and upper Purus rivers (Iglesias 2014).

All these communities speak *hãtxa-kuĩ* ("the true language"). One of the characteristics that distinguish them from other Pano groups is their form of social organization and transmission of proper names via alternation of generations (McCallum 1989). Social organization involves the division into two exogamous groups (*Duabakebu* and *Inubakebu*). These are descended from common ancestors and do not marry within the group. Those belonging to the *duabakebu* group - where the men are termed *Dua* and the women are *Banu* - are considered the "children of brightness", symbolized by the snake (*yube*) and the moon (*ushe*) (Lagrou 1991). Usually, they have the functions of shaman (*mukaya*) and medicinal plant experts (*dauya*). The other group is the *Inubakebu*, in which men are *Inu* and women are *Inani*, who are associated with the mythical figure of "Inká God", who is considered the son of the inhabitants of heaven. This group is symbolized by the jaguar, so that its members usually assume political leadership roles, in addition to being warriors and hunters. As a result of this kinship system, relatives from the same group are consanguineous, while those in opposing groups are related.

This model of social organization has achieved considerable success in terms of preserving both native culture (including food habits), and the vernacular language (including chants and prayers). Currently, *Huni Kuĩ* members of society aim to strengthen and improve ancestral practices, such as rituals, traditions and certain management and productive activities (Iglesias 2014).

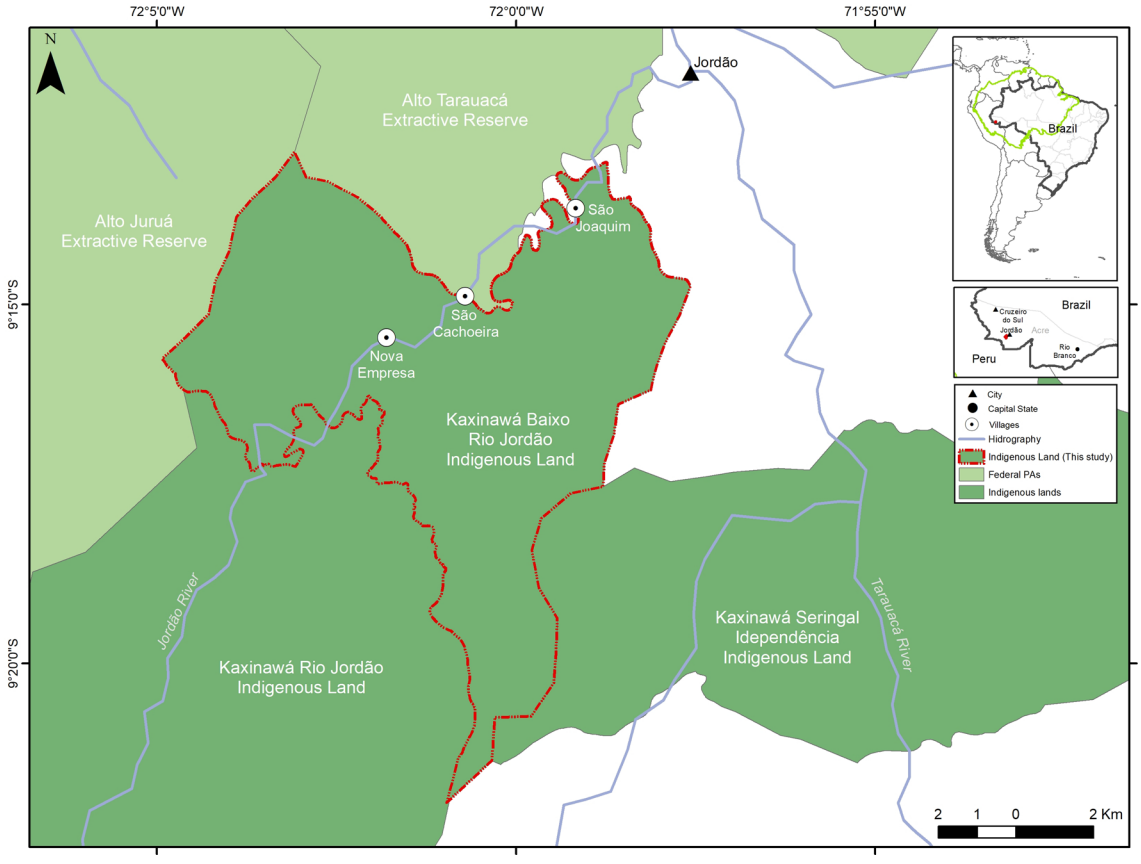


**Figure 1** – Map of T.I. *Kaxinawá* do Baixo Rio Jordão, showing the location of the three participating communities: Nova Empresa, Nova Cachoeira and São Joaquim, 2018.

**Table 1** – Population by gender of the three villages of the *Kaxinawá do Baixo Rio Jordão* Indigenous Land participating in the research: Nova Empresa, Nova Cachoeira and São Joaquim.

| Village | Nova Empresa | Nova Cachoeira | São Joaquim | Total |
|---|---|---|---|---|
| Female population | 33 (65%) | 54 (56%) | 63 (58%) | 150 (58%) |
| Male population | 18 (35%) | 42 (44%) | 46 (42%) | 106 (41%) |
| Total population per village | 51 | 96 | 109 | 256 |

## Field activities and ethical aspects

Four visits to the villages were made, in different seasons, between January 2018 and January 2019 - a total of 116 days of fieldwork. All activities were monitored by indigenous agroforestry agents from the respective communities. Ethical procedures followed research protocols of the International Society for Ethnobiology (ISE) and the Brazilian National Commission for Ethics in Research (CONEP), under the ethical review registration number 82076018.5.0000.0006, on "Plataforma Brasil" (a national and unified base for the registration of research involving human beings for the entire CONEP system).

## Data collection and analysis

To characterize the native food species known to the collaborators, interviews were conducted in a free-list format. Out of respect for the indigenous social organization, the first interlocutors were selected from indications made by village leaders. A snowball sampling technique was used, in which the researcher asked the participant for an indication of another person from the community, who possessed specific knowledge about known and used native food plants that might contribute to the topic and, so, successively, until saturation of the sampling frame, that is, the point at which no new names were offered (Vinuto 2014).

Interviews were conducted with 60 residents over 18 years old from the three villages: 22 from *São Joaquim*, 23 from *Nova Cachoeira* and 15 from *Nova Empresa*. Of the participants, 36 were female, and 24 male. The mean age, across both sexes, was 42 years. Following Martin (1995), the free lists used were recorded in table format. Content covered the following aspects of known and used native food plants: plant names in Portuguese (if known); indigenous nomenclature; growth form; place of occurrence (managed landscape forms); and forms of consumption. The distribution of food plant-related knowledge between women and men was also analyzed. Additionally, the overall frequency with which each species was mentioned in the interviews was tallied, with species classified into three groups (see final column of Table S1, available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>): 1 (species mentioned in 40 to 60 interviews), 2 (species mentioned in 20 to 39 interviews), and 3 (species mentioned in 1 to 19 interviews).

Further relevant information regarding traditional botanical knowledge, such as the cosmovision of plants, food uses and restrictions, ethnotaxonomy, songs and prayers, etc., were recorded throughout. These notes were made through participant observation (Angrosino 2009) and/or acquired from open interviews and

**Table 2** – Age range of the population of the three villages of the the *Kaxinawá do Baixo Rio Jordão* Indigenous Land, Acre, participanting in the research: Nova Empresa, Nova Cachoeira and São Joaquim.

| Age Group | Nova Empresa | Nova Cachoeira | São Joaquim | Total per age group |
|---|---|---|---|---|
| Children and adolescents | 36 (70,5%) | 59 (61%) | 63 (58%) | 115 (60%) |
| Youth and adults | 14 (27,5%) | 35 (36%) | 41 (38%) | 89 (34%) |
| Elderly people | 1 (2%) | 2 (3%) | 5 (4%) | 8 (3%) |
| **Total** | **51** | **96** | **109** | **260** |

informal conversations. The collected data were continuously analyzed during field activities, with the interlocutors involved via checks and corrections to the way in which the information was interpreted. Systematization was performed via tables and graphic models to improve the qualitative understanding of the data.

## Collection, specimen preparation and identification of native species

Once free lists completed, a "walk-in-the-woods" methodology was used to encounter the mentioned species, to obtain botanical collections and photographic records, and to recognize the managed landscape forms mentioned in interviews. Accompanied by agroforestry agents (local guides), visits were made to *terra firme* and low-lying forests (riverside and stream banks) habitats, as well as to backyards and agroforestry systems. Plant voucher specimens were dried and stored and later deposited in the Herbaria of the National Institute for Amazonian Research (INPA) and the Federal Institute of Education, Science and Technology of Amazonas (EAFM/IFAM). Subsequently, the material was identified with the help of both general taxonomists and specialists in each botanical family to the lowest possible taxonomic group.

Finally, a systematic review with a focus on ethnobotany (food use), as well as bromatological aspects (chemical and nutritional composition) of the native food species encountered was conducted. This followed the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) checklist (Moher *et al.* 2010). How the review process operated is shown below:

Literature search strategy: specialized bibliographic publications up to the year 2021 were consulted using the following four databases[1]: a) google scholar; b) sciencedirect; c) scielo; and d) pub med. The search was conducted in three languages: English, Portuguese and Spanish. Following PRISMA recommendations, a search strategy was prepared using two areas (ethnobotany and bromatology). The keywords used in the search process were the scientific names of the species derived from the free-lists and "walk-in-the-woods" methodologies, followed by the search key words:

"Chemical composition" or "nutritional composition" (bromatological area) followed by the terms "edible" or "eaten" and the eaten part of the plant (*e.g.*, "*Trichostigma octandrum*" + "chemical composition" + "edible" + "leaves"; "*Pouteria pariry*" + "nutritional composition" + "fruit").

"Ethnobotany" or "traditional botanical knowledge" followed by the terms "food use" or "edible" or "eaten" and the eaten part of the plant (*e.g.*, "*Talisia cerasina*" + "ethnobotany" + "food use" + "fruit"; "*Caryodendron amazonicum*" + "traditional botanical knowledge" + "edible" + "seed").

A number of the identified studies were discarded due to duplication (Fig. 2). Studies in which the full text could not be extracted or which did not have public access were also discarded. Finally, following the eligibility criteria described below, a total of 1,135 studies were selected for data extraction.

Inclusion and exclusion criteria: Information obtained from the database and other sources were scrutinized based on the following conditions: Articles, scientific books, bachelor's, master's and doctoral theses reporting food uses and/or chemical and nutritional composition were included. Research related to: (i) taxonomy; (ii) morphology; (iii) anatomy; (iv) phenology; (v) genetics; (iv) medicinal uses of the species not related to the part used as food; (vi) use as animal food; (vii) or any other themes other than those search keys mentioned above were excluded from the review.

Data extraction: For each of the included studies, the following informations were extracted for each plant species: their food uses, the geographical region where the species are used, local names (ethnobotanical studies); and information related to their chemical and nutritional composition (bromatological studies).

Data analysis: The search was not considered exhaustive, but provided an overview of existing scientific knowledge on the food species known to the indigenous collaborators. A total of 1,135 studies were screened as mentioned and a quantitative analysis was performed to determine which species have studies produced, according to the literature search strategy. For this, the species were grouped into four categories: A = species with more than 100 studies; B = species with 50 to 99 studies; C = species with 10 to 49 studies; and D = species with less than 10 studies. Finally, of these total studies: 90 are represented in table 5 (the most recent studies and/or the studies that

[1] The databases were selected due to their recognised importance in Brazil as sources of indexed scientific studies.

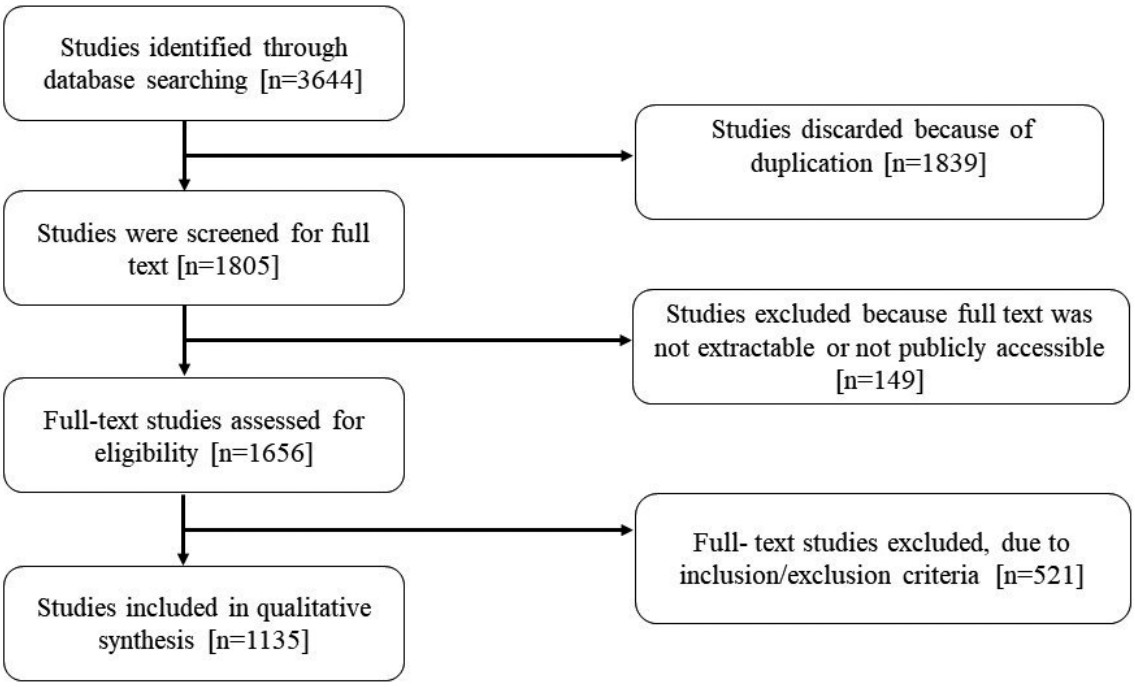


**Figure 2** – Flow of the information retrieving strategy during identification, screening, and scrutinizing the eligibility of the studies for the systematic review, according to PRISMA method.

have the most complete specifical information); and 30 in the discussion of this article (considering the species that have studies and that are from botanical families with at least three species surveyed).

Outcomes of interest: The major outcomes of interest of this systematic review were: (1) the collation and summarizing of information on the plant species culturally known to, and used by, *Huni Kuĩ* communities; (2) the provision of information for the research community to conduct further scientific investigations on the theme of Amazonian edible phytodiversity.

## Results

### Cultural aspects of traditional botanical knowledge

The *Huni Kuĩ* were found to group plants via sensory, morphological and physiological characteristics, such as aroma, flavor, color, texture, size, among others. In addition, they classified them by: i) species physiognomy; ii) inter-specific ecological relationships (animal-plant); iii) morphological analogies with other living beings (mainly animals and humans); and iv) the presence of cultural (uses), symbolic (meanings) and spiritual (healing) attributes.

It is inferred that this occurs due to the cohesive interaction that these indigenous people have with natural systems. Through observation, management and use of natural resources carried out over thousands of years, they built, and continue to build, an extensive knowledge that integrates a complex social-ecological system and which is transmitted orally from generation to generation. It should be noted that the *Huni Kuĩ* also group plant species according to their various growth forms: *hi yuapa* (large trees); *ni yuapa* (medium-sized trees); *maxu* (shrubs); *nixipurũ* (woody lianas); *bãxãya* (herbaceous lianas); and *dau* (terrestrial herbs).

According to collaborators Lucas Sales Kaxinawá/*Bane Duabake Huni Kuĩ* (36 years old), Francisco das Chagas Maia Kaxinawá/*Nixiwaka Inubake Huni Kuĩ* (33 years old) and Osvaldo Manduca Mateus Kaxinawá/*Isaka Inubake Huni Kuĩ* (40 years old), in *Huni Kuĩ* traditional botanical knowledge systems, food plants are classified into families (as in modern Western botany). However, a key determinating criterion is their flavor: *batapabu* (sweet), *bũncaxpabu* (sour), *mukapabu* (bitter), *paismapabu* (neutral), *hãtzupabu* (astringent) and *xiapabu* (spicy) - where *pabu* is the suffix used to

indicate plurality. Likewise, they differ due to the presence/absence of latex, with those that have it being called *xukuyapabu* (lactiferous).

Exogamous sections that are part of the *Huni Kuĩ* social organization (*Banu*, *Inu*, *Dua*, *Inani*) are also used to refer to plant beings. According to one of the interviewed shamans,

*All living beings have their families and after dying the spirit can transform into another being. For example,* Huni Kuĩ *when they die, can become plants. For this reason, all living things in the forest are* Huni Kuĩ. *A traditional story tells it in this way:* Hutxi Kuxpa *[the first God] said* Shukui, shukui, kãyui, kãyui, *which means, renew and recycle yourselves. (Francisco das Chagas Sereno Maia Kaxinawá/*Nixiwaka Inubake Huni Kuĩ, Nova Cachoeira *village)*.

*Huni Kuĩ* cosmology narrates that many plants appeared to cure the diseases (*nissũ*) that affected the ancestors (*xenipabu*). These diseases were caused, generally, by the ingestion of the meat of particular animals. The various plant species originated, according to the cosmology, from the collective deaths of different families of shamans, each of which were then reborn in the form of a plant.

The women belonging to the *Banu* societal sector come from *Batani*, which gave rise to the plant *bata pei rutupa* (*Caamembeca spectabilis* (DC.) J.F.B.Pastore), a sweet herb with medicinal properties. From this "first woman-plant", others emerged, such as *tũku dau bata* (*Leonia crassa* LBSm & Á.Fernández) and *xipĩ tũ iti bata* (*Casearia pitumba* Sleumer), as well as other species that have fruits with a sweet taste, including *ixtibĩ* (*Matisia cordata* Kunth), *txashu reshã* (*Theobroma cacao* L.) and *shane kaxa* (*Talisia cerasina* (Benth.) Radlk.), among others.

Plants with a bitter (*muka*) and neutral (*paisma*) flavor, as well as large species (*hi huapa*) - those that reach the canopy in the forests - emerged from the *Inu* social division. The common ancestor for this group is *awa punu nena utzi* (*Fridericia* sp.), a bitter medicinal plant. Examples of *Inu* species are the *xebũ* (*Attalea phalerata* Mart. *ex* Spreng.), *isã* (*Oenocarpus bataua* Mart.), *peri isã* (*O. bacaba* Mart.) and *pana isã* (*Euterpe precatoria* Mart.), as well as those emergent trees whose seeds are edible: *kumã* (*Dipteryx ferrea* (Ducke) Ducke), *nai xapu* (*Ceiba lupuna* P.E. Gibs & Semir) and *nibĩ* (*Posoqueria* sp.).

The first shaman of the *Dua* section became *matsi pei tarunua* (*Piper crassistilum* Yunck.), a medicinal plant considered "cold", and used to treat various inflammations. Then came the species without smell and others that have sour fruits (*bũkax*), such as *xekex* (*Garcinia* spp.), *xexũ* (*Spondias mombin* L.), and *manã yukã* (*Psidium acidum* Mart. *ex* O.Berg).

Aromatic flowering plants pertain to the *Inani* social division. They were generated from the first woman of this lineage, who became the *ininipabu* ethnospecies (*Annona* spp.) - some of which, due to the pleasant aroma they present, are currently used by one of the collaborators (Osvaldo Manduca Mateus Kaxinawá/*Isaka Inubake Huni Kuĩ*, *São Joaquim* village, son of a great shaman of this indigenous people) for the extraction of essential oils within his village.

The other classifications such as *hãtzupabu* (astringent), *xiapabu* (spicy) and *shukuyapabu* (presence of latex) do not pertain to any social division. According to the shaman of *Nova Cachoeira* community, this is because they did not arise from the transformation of people into plants; in other words, in this native conception, they are beings that have existed from a period preceding the appearance of people, and so belong to the Great Spirit (*Yuxibu*), represented by the "great snake".

## Food phytodiversity

A total of 89 native species from the western Amazon were recorded as foods, all having been mentioned by at least one of the collaborators from the three participating villages (Tab. S1, available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>). Of these, 84 were identified: 73 to species and 11 to genus level. The species belong to 53 genera, representing 34 botanical families. Five ethnospecies mentioned were not identified because they did not occur in these communities, which made the botanical collection impossible viable.

The families with most species (Fig. 3) were: Fabaceae (13); Arecaceae (12); Malvaceae and Sapotaceae (both with 6); Passifloraceae and Rubiaceae (both with 5); Moraceae (4); Clusiaceae (3); Annonaceae, Loganiaceae, Meliaceae and Poaceae (both with 2). The remaining 22 families were each represented by a single species (Tab. S1, available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>).

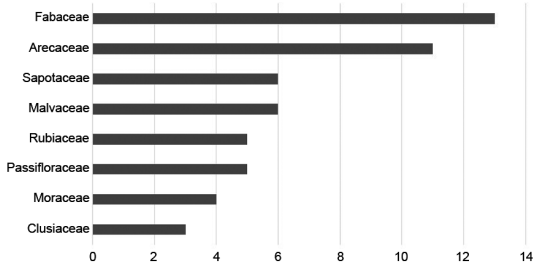


**Figure 3** – Researching the botanical families most common in the interviews.

## Distribution by gender of food plant-based knowledge

The free-listing of food species by male and female interlocutors was similar in quantity and diversity of plants. Men mentioned 80 species, while women cited 75. Of these, 14 were exclusively recorded in interviews with men, while nine species were mentioned only by women (Tab. 3).

The food species mentioned only by men occur exclusively in *terra firme* and flooded forest environments. Possibly men remember such species because they travel more often through the forest (hunting activities) than do women. Thus, they have more frequent contact with the diversity of plants that occur many kilometers away from the villages. The species mentioned only by women were: *Guadua* sp. and *Gynerium sagittatum*, both of which are used in culinary preparations, which may explain the fact that they are remembered by the female collaborators[1]; *Pleonotoma* sp., a liana, the tuberous organs of which are consumed only by women, with the cultural purpose of producing male children, which would explain the citation of the species only by the women; *Ceiba lupuna*, which is the only species mentioned exclusively by women to occur in a *terra firme* forest environment. It is inferred that *C. lupuna* is remembered because, besides the use of the seeds for food, the women make clothes and toys for their children out of its cotton; the other species (*Tilesia baccata*, *Cordia nodosa*, *Lantana trifolia*, *Muntingia calabura* and *Passiflora foetida*) usually occur in the anthropized areas around dwellings, areas frequently accessed by the women. In addition, they have small fruits commonly consumed by children while they walk in groups or accompanied by their mothers/aunts/ grandmothers through the landscape units of the villages.

## Managed landscape forms

Native food species can occur exclusively in forest environments, namely: a) in *terra firme* (*manã kaya*), that is areas of higher relief within the forest; and b) in low-lying forests (*napãpa*), such as riversides and stream banks. They can also be managed in different anthropized areas, such as: i) backyards (*hatiu bai*); ii) agroforestry systems (AFS); iii) swiddens (*bai kuĩ*), which represent the traditional agricultural system; and iv) *capoeiras* (*nawã*). It is interesting to note that the widely spread and popularly used regional term "capoeira" comes from the Tupi indigenous language - in which *ka'a* means forest and *uera* means "from the past". For *Huni Kuĩ* these are areas that have already been converted to agriculture and, after loss of fertility, have been put in fallow and are in the process of natural regeneration.

More than half (approx. 60%) of the recorded plants not only occurred in the interior of the forest but were also commonly managed in different production units and in *capoeiras*, especially if they grew spontaneously in such locations. On the other hand, around 40% occurred only in forest environments (Fig. 4). These were characterized by being both large trees and mentioned mainly by male interlocutors. This can be explained culturally, since men are more likely to move around in the woods, especially while conducting their hunting, gathering and fishing activities - unlike women, adolescents, children and elders, who are more likely to be active in areas closer-to-home, such as backyards, swidden and *capoeira*s.

Some edible fruits and seeds are found only in *terra firme* environments. This is the case for those derived from 20 to 25 m tall, canopy tree species. Species within this category included: *kumã* (*Dipteryx ferrea*), *nai xapu* (*Ceiba lupuna*), *baxawa* (*Brosimum lactescens (*S.Moore) C.C.Berg), *nibĩ* (*Posoqueria* sp.), and two indeterminate species which could not be collected as individuals were not encountered.

Low-lying forests (floodplain environments) contained five food species cited as occurring exclusively in these regions. Among these are two species from riparian forests, where they are often consumed *in situ* (*Inga ruiziana* G.Don and *I. umbellifera* (Vahl) DC.), while *tawa* (*Gynerium*

[1] Both of which are used in culinary preparations, which may explain the fact that they are remembered by the female collaborators. See more in Pilnik *et al*. (2021).

**Table 3** – Discrimination of species mentioned exclusively by men and women in the participating indigenous communities. *The species with an asterisk have only the indigenous name, not being possible to determine the scientific name.

| N° | Men | Women |
|---|---|---|
| 1 | *Alibertia curviflora* | *Guadua* sp. |
| 2 | *Brosimum lactescens* | *Gynerium sagittatum* |
| 3 | *Costus scaber* | *Pleonotoma* sp. |
| 4 | *Duguetia* sp. | *Tilesia baccata* |
| 5 | **Kunub* | *Ceiba lupuna* |
| 6 | *Matisia ochrocalyx* | *Cordia nodosa* |
| 7 | *Passiflora* sp. | *Lantana trifolia* |
| 8 | *Pourouma cecropiifolia* | *Muntingia calabura* |
| 9 | *Pouteria* sp. | *Passiflora foetida* |
| 10 | *Protium unifoliolatum* | |
| 11 | *Pseudolmedia laevis* | |
| 12 | *Uncaria tomentosa* | |
| 13 | **Xaka pei* | |
| 14 | **Xana* | |

*sagittatum* Aubl.), *xapuã* (*Muntingia calabura* L.), and species of *paka* (*Guadua* spp.) also occur here. *Nawãti* (*Trichostigma octandrum* L.) is also native to flooded areas; however, due to its frequent use in cooking, this is the only recorded floodplain native species that is also grown in backyards.

*Capoeiras* are predominantly occupied by pioneer species. Some of these are used to provide snacks on the trails to the fields or on paths between houses. This is the case of *matxã* (*Lantana trifolia* L.), *paxĩ* (*Tilesia baccata* (L.f.) Pruski), and two species of passion-fruit vine (*Passiflora* cf. *ceratocarpa* F.Silveira and *Passiflora* sp.).

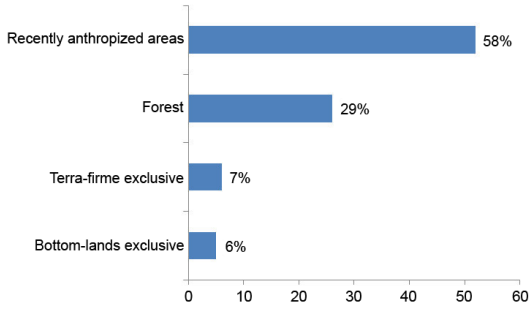


**Figure 4** – Landscape units in which study species were found (productive units, backyards, *capoeira* [forest in early stages of regeneration], seasonally-flooded forest and *terra-firme* rainforest).

Some of the native species surveyed, have been planted incipiently in backyards and agroforestry systems - as a result, according to interlocutors, of their being highly appreciated by most of the population. Usually, the seeds are collected in the forest then raised using local techniques for seedlings propagation in nurseries near houses. This occurs, for example for *burũte* (*Passiflora nitida* Kunth), *txashu reshã* (*Theobroma cacao*), *nisse pau bĩ* (*Herrania mariae* (Mart.) Deckne. *ex* Goudot), *manã yukã* (*Psidium acidum*), *yae* (*Pouteria pariry* Ducke Baehni), *isã* (*Oenocarpus bataua*) and *puya stuku xekex* (*Garcinia brasiliensis* Mart.). There are also species, such as *pesa* (*Chrysophyllum bombycinum* T.D.Penn) and *nia kũta* (*Attalea tessmannii* Burret), that occur at low densities in the surrounding forest and are therefore cultivated to facilitate access.

More common are those species that are self-sown but tended. These are individuals which, following human consumption of fresh fruits along the trails, develop spontaneously in different anthropized areas or are even sown - whether intentionally or not. Examples include: *xekex* (*Garcinia* spp.), *isã* (*Oenocarpus* spp. and *Euterpe* spp.), *xebũ* (*Attalea phalerata*), *burũte* (*Passiflora nitida*), *Theobroma* spp., *Inga* spp., *manã yukã* (*Psidium acidum*), *ixtibĩ* (*Matisia cordata*), *nibĩ Pouteria* sp., *xexũ* (*Spondias*

*mombin*), *nutxũtu* (*Strychnos* spp.), *maspe* (*Clavija lancifolia* Desf.) (Tab. S1, available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>).

## Life forms and parts eaten

Of the 89 inventoried native species, 56 (63%) were trees (*hi huapa*) or small trees (*ni huapa*), 12 (14%) were lianas (*nixipurũ*), 12% were palms, 7% were shrubs (*maxu*), and 3% were herbs (*dau*). For most of the species used for food, the fruit was the main part consumed (67%) (Fig. 5). There was a considerable number used for their seeds (Fig. 6a-b) where the aril, endosperm and/or cotyledon were eaten. This is true both for plants grown in backyards (such as *pani*, *Astrocaryum murumuru* Mart.; *Hepe*, *Phytelephas macrocarpa* Ruiz & Pav; *Nia kũta*, *Attalea tessmannii*; *Nena*, *Aiphanes aculeata* Willd.), and those collected in the forest (*e.g.*, different types of inga, *Inga* spp.; *Kumã*, *Dipteryx ferrea*; *Nibĩ*, *Posoqueria* sp.; and *yawa hubu*, *Caryodendron amazonicum* Ducke) (Tab. S1, available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>).

Palm species were recorded in this study as being exploited for their edible hearts (apical buds and stem interiors) were *tau* (*Iriartea deltoidea* Ruiz & Pav.), *nisti* (*Socratea exorrhiza* (Mart.) H. Wendl.) and *pani* (*Astrocaryum murumuru*). As a rule, these are consumed raw on walks in the forest, mainly in the middle of hunting activities or when travelling on foot to other villages during the dry season.

Buds seem to be used rarely, with records appearing to be restricted to only one traditional

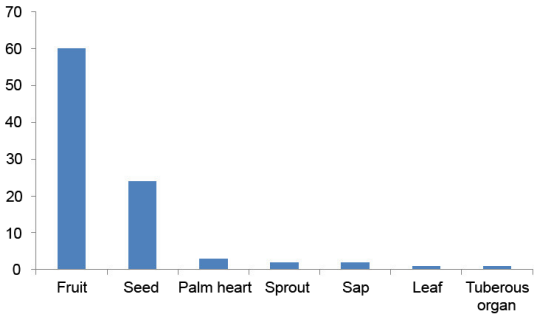


**Figure 5** – Number of species for each type of eaten organ (fruit, seeds, palm heart, bud, trunk-water, leaf and tubers).

culinary preparation (called *yuxi*). This is a creamy dish made with buds from *paka* (*Guadua* sp.) or *tawa* (*Gynerium sagittatum*) (Fig. 7a), leaves from *nawãti* (*Trichostigma octandrum*) and grains (*Zea mays* L. and *Arachys hipogaea* L.).

Use of sap involves the "water" of two vines: *mamuxa* (*Uncaria tomentosa*) (Fig. 7b) and *nai nixi* (*Gurania* cf. *macrophylla* Barb. Rodr.) as an alternative hydration source during forest activities that last for extended periods (two days to a week), such as hunting, rituals and crossings between villages/indigenous lands, when activities take those involved away from other water sources.

Compared to other indigenous peoples in the Amazon region[1], the *Huni Kuĩ* have a high diversity of leaves in their traditional diet - with the great majority coming from cultivated plants. For

[1] For more informations about this theme see Katz et al. (2012).


**Figure 6** – a. Mature seeds of *Posoqueria* sp. b. Immature seeds of *Phytelephas macrocarpa*.


**Figure 7** – a. Woman collecting *Gynerium sagittatum* shoots in Nova Empresa village. b. Extracting trunk-water from *Uncaria tomentosa* in the woods when thirsty. c. Food preparation made with the leaves of *Trichostigma octanrum*.

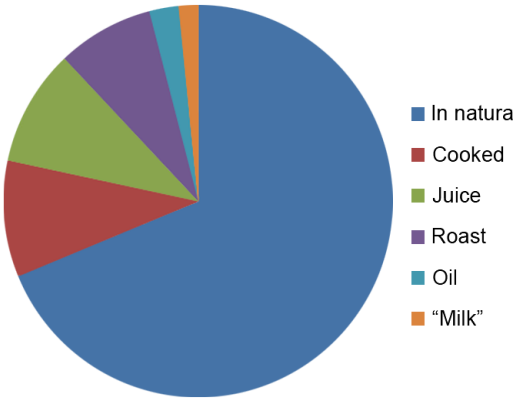


**Figure 8** – Ways in which wild-based food plants were consumed in the three villages participating in the research.

native species, *nawãti* (*Trichostigma octandrum*) (Fig. 7c), a tree-sized liana, with dark green leaves, is naturally common on the banks of rivers and streams. It is used in a variety of food preparations (always boiled), and is of great importance in the nutritional security of local populations.

As a representative of a native tuberous organ, only one species of liana was mentioned. Called *puxku pusi*, it belongs to the genus *Pleonotoma* (Bignoniaceae), and occurs mainly in clearings or trails in *terra firme* environments. It is considered a medicinal food, as it is consumed only by pregnant women who wish to give birth to male children.

## Modes of consumption

Six different forms of consumption were recorded for native species: fresh, boiled, roasted, juice, oil and "milk" (Fig. 8). Most are consumed fresh. It is mainly seeds that are boiled or roasted. Juices come largely from species of palm trees, as well as for those species with minimally juicy fruits (see Tab. S1, available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>). In general, these are processed by hand or with manual blenders, since the communities lack electricity.

Oils are extracted from particular palm trees, such as *nena* (*Aiphanes aculeata*), *pani* (*Astrocaryum murumuru*), *xebũ* (*Attalea phalerata*), *nia kũta* (*A. tessmanni*) and *peri isã* (*Oenocarpus bataua*). Vegetable milk is removed only from the two species of *Attalea* mentioned above. Both practices were frequent from the pre-contact period with non-indigenous people until about the end of the 20th century. Now, the use of these foods is in decline in the three villages; only elderly women know how to prepare them.

## Systematic review

Of the 89 species surveyed in the study, 73 went through the literature review process. Those that were either identified only to the genus level (11), or were not determined (5). Quantitatively, 75% of the studies reviewed involved ethnobotanical research with a food focus, and 25% had information about the bromatological composition (chemical and/or nutritional). Of all the species reviewed (73), 41 (56%) have only ethnobotanical studies, and of these, 12 (30%) were only mentioned as food species only in the current study (Tab. S2, available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>).

As can be seen on the two graphs in Figure 9a-b, the number of species and the number of

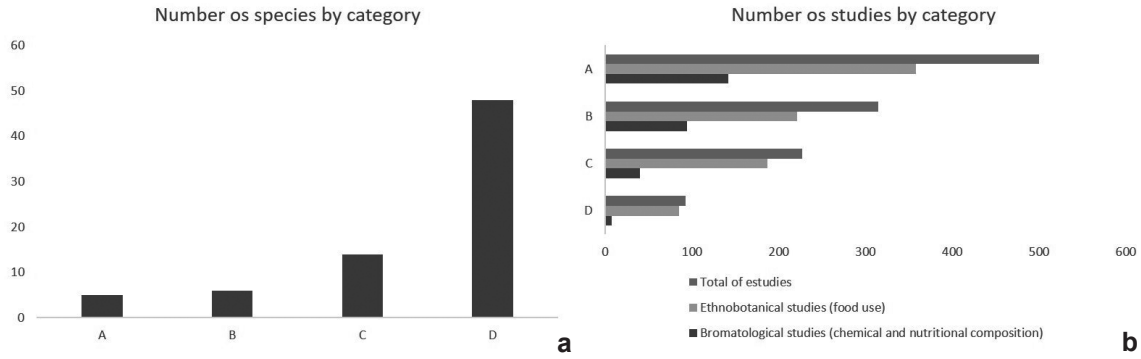


**Figure 9** – a. Number of species by category (A = more than 100 studies; B = between 50 and 90 studies; C = between 10 and 40 studies; D = less than 10 studies). b. Number of studies (both total and separated by subject: bromatological and ethnobotanical) by species category.

studies was inversely proportional, *i.e.*, a smaller number of species (category A: more than 100 studies) has a greater number of scientific studies found (both ethnobotanical and bromatological). In contrast, the greater the number of species surveyed (category B: 50–99 studies; category C: 10–49 studies; and category D: 1–10 studies), the lower the number of studies recorded, including some species with no recorded bromatological studies (Tab. S2, available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>).

In descending order of number of studies, species in category A were: *Theobroma cacao*, *Spondias mombin*, *Euterpe precatoria*, *Oenocarpus bataua* and *Inga edulis*. The ones in category B were: *Oenocarpus bacaba*, *Matisia cordata*, *Muntingia calabura*, *Passiflora foetida*, *Genipa americana* and *Pourouma cecropiifolia*. In addition, 14 species were surveyed in category C, among them: *Aiphanes aculeata*, *Socratea exorrhiza*, *Garcinia brasiliensis*, *Clarisia racemosa*, *Pseudolmedia laevis* and *Lantana trifolia*. Finally, 48 species were recorded in category D. Due to the high number of species, only a few examples are cited: *Trichostigma octandrum*), *Inga* sp., *Jacaratia digitata*, *Caryodendron amazonicum*, *Pseudolmedia macrocarpa*, *Talisia cerasina*, *Garcinia acuminata* and *Clarisia racemosa*. The other species from categories C and D are listed in Table S2 (available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>).

Some of the species that were mentioned quite frequently are placed in category D, such as: *Inga* spp., *Passiflora* spp., *Pouteria pariry*, *Pouteria torta*, *Trichostigma octandrum*, *Clavija lancifolia*, *Garcinia acuminata* are placed in category D. This reinforces the need to develop in-depth studies on the species little known by modern science, but appreciated by indigenous peoples, as results indicate that these species have food and production potential. The food uses of some species included in category D have only been reported in the current study. Some examples are: *Alibertia curviflora*, *Agonandra peruviana*, *Anomospermum grandifolium*, *Costus scaber*, *Dipteryx ferreaI*, *Strichnos brasiliensis* (see Tab. S2, available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>). Some of these species are considered in the discussion section.

## Discussion

### Biodiverse food plants

Studies carried out with both indigenous peoples and riverside communities, and in a wide variety of locations in Amazonia, have also recorded consumption of a high diversity of native food species (*e.g.*, Bustamante 2009: 81 species; Fernandes 2012: 45 species; Gonçalves 2017: 163 species; Machado 2020: 220 species). For the *Huni Kuĩ* biodiverse food plants, detailed analysis of traditional botanical knowledge was made for botanical families with at least three species reported during the survey.

The large number of Fabaceae consumed is mainly due to the genus *Inga*, from which the sarcotesta of 12 species is frequently eaten, and especially appreciated by children. *Inga* is one of the plant genera most widely used by Amazonian indigenous peoples. Bustamante (2009) highlights the use of *Inga* species in the agroecosystems of the Sateré-Mawé people (in central Amazonia), while Gonçalves (2017) found seven species from the genus being used as food by indigenous peoples of the upper Negro River; of these, *Inga edulis* Mart. was the only one also reported in the current study.

Another Fabaceae, *Dipteryx ferrea*, was also mentioned frequently in interviews, a consequence of its multiple uses. Known as *kumã*, which means "strong" or "great", it is considered sacred - a "strong spirit" (*ni yuxĩ*) - a designation which may be directly related to the characteristics of its extremely heavy wood (one English common name is "ironwood"). Shamans (*mukaya*) and apprentices prepare snuff (*dume*) from *D. ferrea* ashes, and a traditional pestle (*runeti*) (Fig. 10a-b) is made from the wood of its buttress roots - with which women prepare much of the daily food. Handicrafts and charcoal (biofuel) are produced from the seeds, which are also consumed roasted (their flavor resembles peanuts). Finally, medicinal baths are prepared from the leaves to strengthen the body (*yuda*), and the spirit (*yuxĩ*).

The second most commonly-mentioned family was Arecaceae. The large number of palm tree species used by the *Huni Kuĩ* for food supports results of other ethnobotanical studies which, due to their multiple utilitarian uses, generally find this family to be one of the vegetal resources most valued by Amazonian populations, including the Ashaninka people in western Amazonia, Karipuna in Upper Madeira river and the Waimiri-Atroari north of Manaus, among others (Sosnowska *et al.*

2010; Smith 2014). According to the *Huni Kuĩ*, some Arecaceae species bear fruit all year round and are thus key, reliable nutrient and energy sources, especially since they provide a rich source of calories (starch and oil), proteins and vitamins (Clement *et al.* 2005). They are also notable for a number of edible food items they provide (heart of palm, fruits and seeds -, consumed *in natura*, boiled and/or roasted (Fig. 11a-c). Their seeds can also be used for crafts; the stipe for constructing foundations and floors of houses, and leaves for basketry, weaving and roofing.

The interlocutors reported that during extended trips into the forest interior, it is common for the only sustenance to be *Attalea* spp. fruits - sometimes mixed with manioc flour. This shows the importance of this plant to general food security, as it is a key emergency food. Araújo *et al*. (2016) reported a similar role for *Attalea speciosa* Mart. for riverside and indigenous populations, such as the Mebêngôkre-Kayapó in eastern Amazon, who consume the fruit and extract oil from the seeds for food. Additionally, such palms have an ecological function of attracting animals (mainly rodents interested in the seeds, such as *Agouti paca* and *Dasyprocta azarae*) to the ground beneath them, so contributing to success when hunting these desirable prey animals.

For the family Sapotaceae, two genera were reported as being used. *Pouteria* had five species, of which two could be fully identified: *yae* (*P. pariry* (Ducke) Baehni) and *txu txu bã pũ* (*P. torta* Radlk. subsp. *glabra* (Mart.) T.D.Penn). It was not possible to determine the other *Pouteria* taxa to species level due to the lack of fertile material during the botanical collection activity period. The second genus contained one species, *pesa* (*Chrysophyllum bombycinum*), which is commonly planted close to houses and in agroforestry systems, because it is rare in the forest surrounding the communities. *Pesa* fruits are highly appreciated by the general population, so much so that, when fruiting trees are


**Figure 10** – a. Buttress roots of *Dipterix ferrea*. Raw material for the production of the *Huni Kuĩ* traditional pestle. b. Woman preparing food using a traditional pestle.


**Figure 11** – a-c. Diversity of food items derived from palm trees – a. Palm heart of *Iriartea deltoideia*; b. seeds of *Astrocaryum murumuru*; c. fruits of *Attalea phalerata*.

found - usually on walks in the forest -, fruits are collected and taken back to the village, to please family members.

However, all Sapotaceae species are excluded from the diet of pregnant women, due to the high concentration of latex in the fruits. According to interlocutors, this is because this can affect the physiological development of the fetus. This food restriction can be considered a temporary taboo, which represents an orally transmitted social rule, whose purpose is to regulate human behavior (Colding & Folke 1997). These commonly accompany important periods of the life cycles such as puberty, menstruation, pregnancy and puerperium (Silva 2007).

Of the six species of Malvaceae identified in this research, two were from the genus *Theobroma*. For *txashu reshã* (*T. cacao*), in addition to consuming the fruits' mesocarp, *Huni Kuĩ* also use the epicarp when preparing teas to help women during child birth. The seeds can also be roasted, crushed and used as a shampoo to stimulate hair growth. The use of the species in parturation is also known to riverside and extractivist communities in the region. *Theobroma microcarpum* Mart. is known as *nubĩ* in *hãtxa kuĩ*, which is directly related to the expression *hao nubia* ("time of high fruit production"). Interlocutors explained that the species has this name because, in season, the trunk is covered with fruits (it is cauliflorous), and so is considered a reference to the high fecundity of the entire forest. In addition to the species of the genus *Theobroma*, use of three other Malvaceous genera were recorded: *Ceiba* (*C. lupuna*), *Herrania* (*H. mariae*) and *Matisia* (*M. cordata* and *M. ochrocalyx*).

Five species of Rubiaceae were recorded providing fruits and seeds for food. Fruits were consumed from three, seeds from one, and the last is used to quench thirst while travelling in the forest, due to the large amount of watery sap it produces. For *nanĩti* (*Alibertia curviflora* var. *loretana* Delprete & C.H.Perss), there are contradictions among interlocutors report as to whether the species is used for human food. Some reported that the fruit is eaten only by animals, while others mentioned the preparation of a juice, commenting that "the taste is similar to that of genipap [*Genipa americana* L.]". This plant may be considered an "unconventional food plant" - *sensu* Kinupp & Lorenzi (2014) - among the *Huni Kuĩ* themselves.

The arils of the innumerable seeds of *nanewã* (*Pentagonia amazonica* (Ducke) L.Andersson & Rova) are commonly consumed by everyone, especially in the summer, during collective fishing activities. The leaves of the species are used in the preparation of medicinal baths to revitalize sick children. Its wide distribution in the villages happens both because it occurs naturally in several different environments (*terra firme*, low-lying forests, *capoeiras*) and because it is actively cultivated in agroforestry backyards.

The inclusion of *mamuxa* (*Uncaria tomentosa* Willd. *ex* Roem. & Schult. DC) in the list of food species is because the "water" (sap) of this vine is occasionally consumed during forest trips where participants lack access to other sources of water for several days. To extract the liquid, they cut the stem of the plant and raise it high above the mouth (like a tube) and so drain the sap. This tasteless liquid is like pure water. It is, therefore, an important species because it allows human hydration in times of general need or even during *in extremis* survival situations.

The use of five species of Passifloraceae were recorded during the survey. The indigenous populations of the Lower Jordão River consume the fruits of all of them, with four identified to species level, and one only to genus. *Passiflora foetida* L. was notable, as it occurs in the new *capoeiras* (between one and four years old) located inside the villages. It is locally known as *burũtã itsa*, in which the first name is proper to the fruit and the second refers to its specific quality, namely, its strong aroma. Thus, in this respect there is a parallel between the scientific and Huni Kuĩ nomenclatures. Meanwhile, *P. vespertilio* L. is appreciated by the indigenous people for its sweet taste. At the same time, it is considered to "clear the throat of the *txana* [spiritual singers] or those who talk a lot". In this sense, it is known in *hãtxa-kuĩ* as *xati tempu*, where *xati* means knife and, *tempu* throat. Its consumption is also advised for future parents who wish to "have beautiful children (*bakixta hãdua*)".

The *Passiflora* sp., which remained unidentified to species, is known locally as *yuxĩ ni bãstã*, whose literal translation would approximate to "cutting evil spirit". In addition to edible fruits, it is considered to be a spiritual plant with medicinal powers, since an eye bath is prepared from the leaves and a smoke-based cure also uses it to remove/"cut" evil spirits from the forest.

The botanical family Moraceae had four food species recorded: *baxawa* (*Brosimum lactescens* (S.Moore) C.C. Berg); *piu (Clarisia racemosa* Ruiz & Pav.); *kuru pama* (*Pseudolmedia laevis* (Ruiz &

Pav.) J.F.Macbr.); and *pama kaya* (*P. macrophylla* Trécul). *B. lactescens* occurs exclusively in *terra firme* environments and has, in addition to fruits, edible seeds (information which was reported in none of the scientific literature reviewed by the authors).

*Clarisia racemosa* is called *piu* by the *Huni Kuĩ*. This is, in fact, a generic name for everything edible. Its meaning comes close to a synonym for "food". Such a finding reveals the appreciation the people have for *C. racemosa* fruits, which have a farinaceous sweetly-flavored mesocarp that could have potential to prepare cakes, pies and jellies. We suggest its use to substitute or reduce the consumption of wheat flour and refined sugars acquired from the surrounding society; accordingly, relevant studies of its nutritional potential are required. Demonstrating the accuracy of traditional ecological knowledge (animal-plant interaction), interlocutors reported that the *piu* (*C. racemosa*) fruiting period coincides with the hatching time for trumpeter birds (*Psophia* spp.) - "when we walk in the forest and see there is *piu* fruit, we know it's time for new trumpeters".

One aspect of the *Huni Kuĩ* botanical knowledge nomenclatural System is that: when a plant has an affinity with another or resembles it, the term *kuru* is used, which corresponds to *affinis* or *similis* in Western botany (Rodrigues 1905). In this context, there is also terminology that refers to the original or true plant (*kaya*). So, for example, the species *Pseudolmedia laevis* is called *kuru pama* (false *pama*), because it looks like *Pseudolmedia macrophylla*, which is considered to be the true plant, or *pama kaya*.

Finally, three native species of Clusiaceae, all of the genus *Garcinia*, were recorded: *matxa xekex* (*G. acuminata* Planch. & Triana), *matsirau xekex* (*G. brasiliensis* Mart.) and *puya stuku xekex* (*G. madruno* (Kunth) Hammel). The *Huni Kuĩ* greatly appreciate them, especially the latter two. Besides occurring in the forest interior, they occur in a managed state in backyards, agroforestry systems and, eventually, in swiddens. *Garcinia acuminata* (Fig. 12a) owes its indigenous name (*matxa xekex*) to special morphological characters of the fruit, where *matxa* means "tooth" or "pointed", and *xekex* is the name for this type of plant (as with a Linnean genus). It is notable that this name is similar to that used by Linnean nomenclature, where epithet also refers to the sharp terminal point that the epicarp of the fruit possesses.

## Managed landscape forms

A significant number of species surveyed in this study (almost 60%) occur in areas that have undergone some level of anthropic transformation. This is most likely because indigenous people build their houses in *terra firme* environments, places that normally and naturally hold food species. New habitations may be selected in areas where there was plant cultivation by, indigenous or non-indigenous[1] in the past. Subsequently, such plants that survived from past cultivation, might be used again by the families present today.

Archaeological studies have shown that territorial re-occupation has been a frequent feature of many locations in the Amazon across thousands of years. A good example is provided by the *Caverna da Pedra Pintada* (Painted Stone Cave), in the municipality of Monte Alegre, in the eastern Brazilian Amazon state of Pará. Here, archaeological evidence shows that, since the first occupation some 12,000 years ago, humans have returned repeatedly to occupy this site and that, when doing so, they likely benefitted from the landscape changes that had resulted from previous occupations. In such cases, changes caused by occupation of certain sites are likely to be positive and cumulative, making such places attractive to new human groups -including the enrichment of local floristic resources (Py-Daniel & Moraes 2019).

Clement (1999) considers some species recorded in the current study to be wild species in various stages of domestication, including *xexũ* (*Spondias mombin*), *xã kũ* (*Pourouma cecropiifolia* Mart.), *txashu reshã* (*Theobroma cacao*), *pani* (*Astrocaryum murumuru*) and *peri isã* (*Oenocarpus bacaba*), since they have been historically managed and selected by native Amazonian peoples for food purposes. This theory proposes that the Amazon Forest landscape has been transformed by indigenous people since time immemorial, and that these sequential influences across centuries have resulted in the increase in abundance and distribution of useful species, resulting in what are known as cultural or anthropogenic forests (Levis *et al.* 2017). This is a view corroborated by the present study with the *Huni Kuĩ* people.

The *Huni Kuĩ* cosmovision appears to resemble the categorization of Clement (1999).

[1] Individuals such as the rubber tappers, migrants from northeastern Brazil who, in the early 20th century, arrived in the region to work on the extraction of latex from *Hevea brasiliensis* L. for rubber production (Aquino & Iglesias 1994).

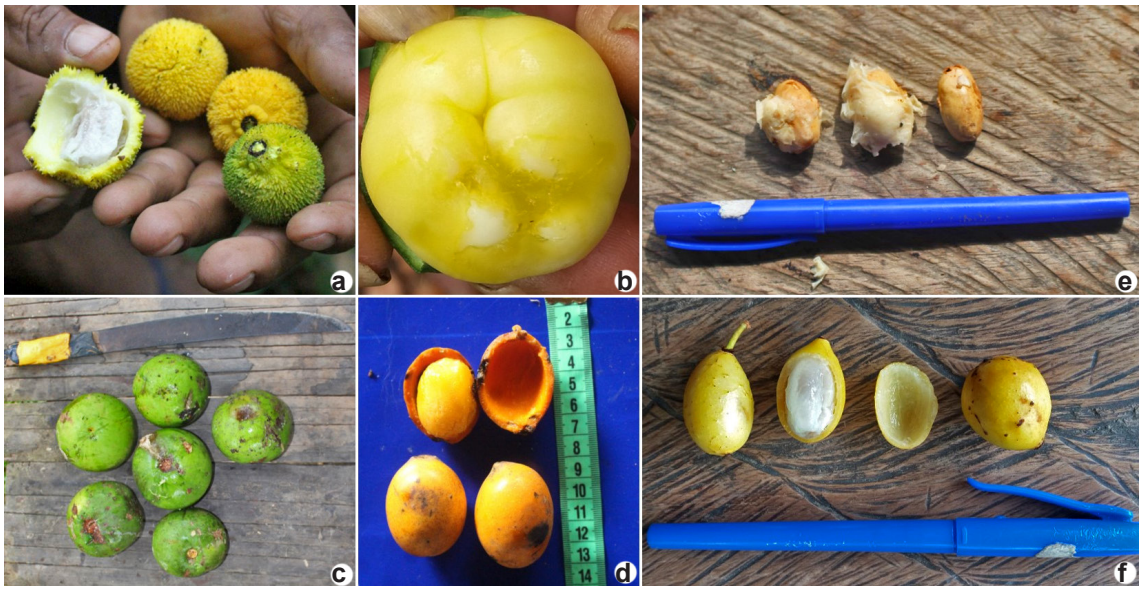


**Figure 12** – a. Fruits of *Garcinia acuminata* collected during visits to the *terra firme* forest surrounding Nova Empresa village. b. Mesocarp of *Clavija lancifolia* in the Nova Cachoeira village. c. Fruits of *Pouteria pariry* in São Joaquim village. d. *Agonandra peruviana* oval epicarp and mesocarp with a whitish cream color in Nova Empresa village. e. Fruits of *Anomospermum grandifolium* in Nova Cachoeira village. f. Fruits of *Talisia cerasina* in São Joaquim village.

They see forest plants and their spirits (*yuxĩ*) as grandmothers of cultivated plants, a position indicative of their common ancestry. Lagrou (1991) comments that *Huni Kuĩ* men are considered parents of the plants they cultivate, just as wild species are the parents of animals, which, in turn, are nourished by their fruits. In support, Lagrou points out that there are ways to meet plant spirits, in other words, your "genetic ancestry" - notably large trees which are known for hosting the most powerful spirits (*yuxĩ*), such as *Ceiba pentandra* (L.) Gaertn.

Linked to this are the historiographic notes of Sombra (1913), which provide supportive information from the beginning of the 20th century, concerning the ancestral relationships between *Huni Kuĩ* productive activities and palm tree species. These records can be regarded as evidence of deliberate planting of forest fruit-providing trees (in different stages of domestication) by the Amazonian indigenous peoples, since pre-conquest times:

*In the past, around the* copichauas *[indigenous dwellings] they cultivated a lot of* pupunha *[*Bactris *spp.]. Very tasty and eaten boiled, but nowadays they do not plant it anymore, because they are not sure of being there to harvest the fruits, due to the fear in which they live of be expelled from their lands at any time. These* pupunhais *[*Bactris *spp. groves] were destroyed shortly after the* correrias *[or "rush", the expression popularly used by indigenous peoples of the Alto Juruá and Purus basins, in Acre state, to characterize the period of invasion of traditional territories by non-indigenous society, with the consequent expulsion of native populations], because the rubber tappers generally just cut these and other palms down to harvest their fruits. (Sombra 1913).*

Although the historical record points to the habit of planting native species, the present study found that most currently cultivated species are exotic. Consequently, nowadays only a small portion of the diet is characterized by native species planted intentionally in backyards and agroforestry systems. This shows that some aspects of the current relationship between *Huni Kuĩ* society and natural systems, which may indicate a contemporary process of progressive underutilization of autochthonous plants. However, this relationship can be quite complex: when considering the limiting factors of seasonality - especially of fruit trees in the region -, and the cultivation of exotic species meets some key food demands. Thus, having species that

produce in different seasons, and well-adapted to local conditions, contributes to the increase in indigenous agrobiodiversity and allows a greater volume and variety of food to be available at different times of the year (Gonçalves 2017). On one hand, exotic species are important for the food system, but on the other, it is understood that they should not replace native species or, in a more extreme situation, alter traditional food systems. After all, native plants are not only essential for food security and sovereignty, but are also a source of identity, especially for *Huni Kuĩ*, for whom food is a central cultural element.

One way to maintain and intensify the consumption of edible native plants, and to diversify the diet, improve production and strengthen local food culture, would be to encourage the systematic planting in agroecosystems of the most appreciated native species. According to Baldermann *et al.* (2016), native plants do not require special care, as they are adapted to local animal-plant interactions, and are better able to withstand regional conditions of environmental stress than are exotic species. In addition, they are highly resilient and can contribute to low-cost production systems, producing seedlings and propagules *in situ*. All this favors food autonomy, when compared to propagative material sourced from the seed industry and the acquisition of foreign individuals (Kinupp & Lorenzi 2014).

The implementation of public policies[1] and the execution of projects managed by indigenous organizations could contribute to this scenario of enhanced food sovereignty through management, stewardship, and sustainable activities from social-ecological systems (for example, investing in equipment for collecting seeds, building nurseries and contracting technical assistance and rural and agroecological extension).

## Modes of consumption

Most of the surveyed species are consumed when in season and with little processing (being mainly eaten raw). This links to the importance of investing in policies that improve traditional and low-cost techniques for forest food processing and storage, especially to reduce wastage during fruiting seasons. One of these techniques, which was also mentioned by one of the research interlocutors, would be a solar drier for fruits and seeds: "*when trees have fruit, they have loads! We just can't get them all and most rot. I once saw this thing for drying fruits, and that would let us eat them at other times of year, because they wouldn't go off. I'd like to make one here*" (Maria Laísa Sales Kaxinawá/*Pãteani Inanibake Huni Kuĩ*, 47 years old, *Nova Empresa* village).

Local food culture could be enhanced and maintained by integrating it with new (*i.e.*, allochthonous), but low-cost and low-maintenance technologies. It could also provide an opportunity for income generation for indigenous people, since it would allow commercialization of dehydrated products from several sites and seasons, which could be done within the scope of such existing public policies as the National School Food Program (PNAE) and Food Acquisition Program (PAA). Although the practice of extracting vegetable oils and milks is in decline, with few people still possessing the requisite technical knowledge, the extraction methods were obtained by talking to some elderly women:

*My mother got lots of oil from* patoá *[*Oenocarpus bataua*],* pupunha-brava *[*Aiphanes aculeata*],* cocão *[*Attalea tessmannii*],* ouri-curi *[*A. phalerata*] and* mundubim *[*Arachys hipogaea*]. But I only watched, I never did it. She used to make a porridge with a little water and leave it to stand overnight. The next day there was a load of oil on top and you could take it off with a spoon. For peanuts, you pounded them raw and the oil came out, it was ready right away. It was the cocão [*A. tessmannii*] that gave milk. You took the husk off the seed, pounded it and there was the milk. (Olga Sereno Kaxinawá/*Ibãtsai Banubake Huni Kuĩ*, 78 years old,* Nova Cachoeira *village).*

Prior to contact with non-indigenous people, and even during the period when the *Huni Kuĩ* were overwhelmed by rubber tapping enterprises, oils were used both as food and in topical medicines - especially in the treatment of cuts and bruises. The following excerpt from Sombra's reports (1913) clearly shows the uses, at the time, of vegetable oils in cosmetics and repellents:

*The head is covered by a vast living head-dress of hard, thick, shiny black hair, qualities*

[1] Such as: National Policy for Territorial and Environmental Management of Indigenous Lands (PNGATI); National Program for Strengthening Family Agriculture (PRONAF); National Policy for Technical Assistance and Rural Extension (PNATER); National Plan for the Promotion of Sociobiodiversity Product Chains; National Policy on Agroecology and Organic Production (PNAPO); among others.

*it has acquired from the repeated application of coconut oil from the* patauá *palm [*O. bataua*] (...). These indigenous people, although clean and much given to bathing, nevertheless give off an unpleasant odor from their body as a result of the peanut oil with which they anoint themselves, not only to protect themselves from colds and catarrhs to which they are subject as a result of living naked, but also to avoid the caustic and painful stings of irritating sandflies, biting flies and terrible mosquitoes which are the most ferocious of the many animals that swarm in the countless rivers, lakes and igapós of the vast Amazonian vastness (Sombra 1913).*

At present there is a significant change in the *Huni Kuĩ* way of life because some forest-based foods are beginning to lose acceptability, since they are seen as "things of the ancients (*xeni pabu*)". Although habits in this native society are transmitted orally, a process can be seen where forest-derived foods are losing prestige compared to industrialized products - which are supposedly considered to be of better quality (Kinupp 2007; Katz 2009; Cruz *et al*. 2013).

Such a process can be detected in the progressive disuse of certain practices mentioned by the collaborating elders. It is an issue that impacts the three communities and, in different proportions, the entire Kaxinawá Indigenous Land of the Lower Jordão River. According to interlocutor Olga Sereno Kaxinawá/*Ibatsãi Banu Huni Kuĩ*, 78 year-old, from *Nova Cachoeira* village, this happened with oil preparations, for example, because the population started to use industrialized cooking oil; and, with the medicinal attributes that vegetable oils provided (among them, anti-inflammatory), as they were replaced by ointments acquired in the nearest cities.

In this scenario of transformation in the *Huni Kuĩ* food system, there is a demand for modern Western science to compliment traditional indigenous knowledge. Among the promising perspectives for the engagement of the natural sciences in this complex social-ecological context, the field of ethnobotanical (food use) and bromatological (chemical and nutritional composition) studies of native species to improve and strengthen traditional food habits stand out. Furthermore, ethnoculinary studies, as a prominent interdisciplinary field, should be encouraged to enable the edible parts and their associated processing techniques to be recorded.

## Systematic review

### *Scientific knowledge of food species culturally known and used by the Huni Kuĩ people*

This section, addresses aspects of the scientific knowledge concerning the species known and used culturally by the *Huni Kuĩ* people, and also encountered while conducting the systematic review. The plant species concerned were classified into four categories, from those with the most studies (A), to those with an intermediate number of studies (B and C), to those with few or no studies (D) (see Tab. S2, available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>).

Species in category A, those with the greatest number of studies, might be widely researched because: a) they have a wide geographic distribution; b) broad knowledge exists in the surrounding society concerning their use; c) there has already been commercialization in regional and/or national markets; d) there is a diversity of preparation forms (juices, fermented drinks, oils, dyes, etc.); and e) the existing use of the fruits and seeds for cosmetic purposes.

Arecaceae is one of the botanical families with a very high number of studies, with 40% of category A species (including *Euterpe precatoria* and *Oenocarpus bataua*). According to Cámara-Leret *et al*. (2014), palms - compared to other families - are very frequently mentioned in ethnobotanical research (which is clearly true here for the *Huni Kuĩ*). At the same time, their bromatological aspects have been well studied due to the regional, national, and even international importance of the multiple uses of their fruits, palm hearts, and vegetable oils (Oliveira & Rios 2014). As shown in Table S2 (available on supplementary material <https://doi.org/10.6084/m9.figshare.22246198.v2>), their well-known chemical and nutritional importance is mainly due to the presence of unsaturated oils, in addition to bioactive compounds with high antioxidant and anti-inflammatory activity, such as flavonoids and carotenoids (Santos *et al*. 2015).

For species in category B species, *ixtibĩ* (*Matisia cordata*) and *xãkũ* (*Pourouma cecropiifolia*) are widely distributed in the Amazon basin, and also sold in urban centers (Vela 2011). According to Smith *et al*. (2007), a single tree of *M. cordata* can produce in one season up to a thousand fruits, and is thus considered one of the most productive species in the region. The

mesocarp bright orange of various tones, and is dense, juicy, not very fibrous, and has a sweet flavor. The coloring is due to a high carotene content, and it is considered an excellent source of vitamin A. The fruits are rich in minerals such as calcium (Leterme *et al.* 2006), and contain antioxidant polyphenolic compounds (Cerón *et al*. 2014). In addition to the fruits being greatly appreciated by the *Huni Kuĩ*, pregnant women are recommended to ingest juice from the leaves if they wish to have male children.

*Xãkũ* (*Pourouma cecropiifolia*) is a small to medium-sized tree, often confused with the more common species of the genus *Cecropia*, due to the appearance of its leaves. It is widely used by indigenous people of the Amazon, mainly in Colombia, Peru and Brazil. The fruit can be eaten fresh or fermented, the latter providing a wine-like flavour which is extremely similar to common grapes. Research into their chemical composition indicates that these fruits have the medicinal potential to combat cancer cell proliferation, due to the high concentration of phenolic compounds, including anthocyanins (Lopes-Lutz *et al.* 2010).

Among the species included in category C, *burũte* (*Passiflora nitida*) and *kuru pama* (*Pseudolmedia laevis*) should be highlighted. The first because it has the highest number of bromatological studies, while the second is widely appreciated by the *Huni Kuĩ*. *Passiflora nitida* is distributed throughout the Amazon. It belongs to the group of sweet passion fruits and shows great potential as a functional food, mainly because of its hypoglycemic effects, helping to control type II diabetes (Lima *et al.* 2012). Although some small-scale planting is practiced in the participating communities, most fruits of this species are collected from the forest. Also, they grow spontaneously in agroecosystems, so that some indigenous people do not cut them in cultivated areas. Besides its use as food, *P. nitida* is very important to the *Huni Kuĩ* for its medicinal value: the leaves are used in baths for children to strengthen their bodies, and a tea is prepared to combat diarrhea.

*Kuru pama* (*Pseudolmedia laevis*) is mentioned for its food use in ethnobotanical studies of indigenous and riverine communities throughout the Amazon (Céron *et al*. 2006; Machado 2018; Arrascue 2018). However, the literature review found only one study of its chemical and nutritional potential, and this concerned its role in the diet of primates (Felton *et al*. 2009). According to this author, the fruits are highly appreciated by primates and are a source of protein, carbohydrates, fiber, and lipids. The *Huni Kuĩ* narrate a story about the relationship between the emergence of the peccary pig (*Tayassu pecari*) and this plant. Briefly, one of the interlocutors relates it as follows:

*Once two* Huni Kuĩ *were in the woods and saw a tree with reddish fruits. They were curious and ate the little fruits. Soon after they ate, they became* yawa *[peccary pig]. This is how our wild pig was created. (Jaime Maia Kaxinawá/*Mãtu Inu Bake Huni Kuĩ*, 51 years old,* Nova Cachoeira *village).*

Of those species in category D, we mention here *maspe* (*Clavija lancifolia*) and *yae* (*Pouteria pariry*) due to their great food potential, appreciation by the indigenous population and, in contrast, the low number of studies devoted to them. Paz *et al*. (2018) related that, on the Purus River, in the southern region of the state of Amazonas, *C. lancifolia* has the vernacular name *remela-de-cachorro*[1]. Their analysis of the fruit found that the mesocarp (Fig. 12b) has low cytotoxicity, with 11 different antioxidant compounds and 27 volatile organic compounds. Despite this, the authors comment that one of the few ethnobotanical observations for the species is J.M. Cruxent's, made in the 1950s during his expedition to the headwaters of the Orinoco River, in Venezuela, when he recorded the use of the species for food and medicine. Due to its qualities, Paz *et al*. (2018) encourage consumption of these fruits and consider the species to have definite economic potential, as it is a natural food from the Amazon, and little known by non-indigenous society. In *Huni Kuĩ* culture, its consumption is recommended for pregnant women who want to give birth to female children.

*Yae* (*Pouteria pariry* (Ducke) Baehni) is a tall tree, reaching up to 40 m (Cavalcante 2010), which occurs naturally in *terra firme* and low-lying habitats. It is also planted and managed in backyards and *capoeiras*. A study by Maia *et al.* (2003) identified a series of volatile compounds from the fruit pulp (Fig. 12c), with methyl 2-methylbutanoate and methyl 2-methyl thiopropanoate having the highest concentrations, and being responsible for the fruit's pleasant aroma.

[1] "*Remela*" is the crust of dried ocular fluid that is found collected at the tear duct upon waking - sometimes called "sleep" in English; "cachorro" means dog.

In addition to fruit consumption, *Huni Kuĩ* children regularly use seeds to make a toy whose name translates as "accordion", made of two perforated seeds articulated by cotton fibers (*Gossypium* spp.).

From this brief characterization of the chemical and nutritional potential of species widely and minimally known to Western science, yet forming an integral part of Huni Kuĩ ethnobotanical knowledge, it is clear that the use and knowledge of the *Huni Kuĩ* of the Lower Jordão River of native food plants is both extensive and of great nutritional importance. Together they supply macronutrients, minerals, vitamins, fibers, energy and bioactive compounds to their diet, ensuring food and nutritional security, through extractive and agroforestry activities. This importance is enhanced when we consider how the phenology of the plants involved guarantee food resources during those periods of the year when access to urban centers is restricted (due to the flood pulses of the rivers), and the frequent scarcity of the financial resources required for the acquisition of exogenous foods. Together, these aspects mean that native plants provide the communities with relative food autonomy, which can be considered one of their most robust benefits.

### *Traditional Huni Kuĩ knowledge of food species poorly known by modern Western science*

Of the species inventoried in the study, 56% are poorly represented in the scientific literature. Although there is some mention in ethnobotanical studies of how these plants are used in the diet of indigenous and riverside communities in the Peruvian, Bolivian, Ecuadorian, Colombian and Brazilian Amazon (according to systematically reviewed studies), there has been, to our knowledge, no in-depth research on these species in terms of their bromatological characterization, among other aspects. Yet, some of these species were widely cited by the indigenous interlocutors during the current study.

Nutritional composition data play a key role in planning recommendations, food processing programs and other food security and nutrition policies (Jacob & Albuquerque 2020). However, such data are still scarce in the scientific literature for many of the food plants in the diet of indigenous peoples (Kennedy *et al*. 2017). According to Kinupp (2007), one of the reasons for the lack of publications on the subject is because of "food xenophilia", that is, the exaggerated placing of value on exotic species to the detriment of native ones, even when the native species may have fruits and or characteristics similar and even superior to exotics. The development of bromatological studies is crucial for a more informed and rational interpretation of the nutritional contribution of the food consumed by indigenous communities.

Despite this, for the autochthonous plants, the *Huni Kuĩ* have retained multiple aspects for both material (related to the potential of these species for, among other properties, food, medicine, construction and handicrafts) and immaterial knowledge (relating to diets and food taboos, songs and prayers associated with the collection/harvest and myths about the origin of particular plant species). Given what was reported by most of the interlocutors and what became apparent during the literature review, we highlight three species that remained unexplored by Western science, but which have an enormous food potential due to their palatability, productivity and versatility. They represent a specific sector of the knowledge pertaining to *Huni Kuĩ* social-ecological system.

*Biũch* (*Agonandra peruviana* Hiepko) is a tall tree that occurs naturally in *terra firme* habitats in Western Amazonia. It was only described in the year 2000 and is popularly known as "*pracuúba-branca*". Indigenous people consume the fruits, which have an oval epicarp, a whitish cream mesocarp, and contain only one seed (Fig. 12d). Tasted in October, when it was ripe, it had an oily texture and a sweet flavor which resembles the flavor of the "milk" of *Cocos nucifera* L. It probably has great food and economic potential because it may be rich in unsaturated oils. However, studies of nutritional and chemical composition of the species are required, since the only mentions of it are in terms of forest floristic composition in Peruvian territory (García-Villacorta 2009). In addition to the fruits, the leaves are used in medicinal baths to "remove the *nissũ*", that is, to cure diseases resulting from an energy imbalance, most times acquired by the improper consumption of certain game meats. Such information implies a strong medicinal potential.

In *Huni Kuĩ* culture, there are certain species about which it is necessary to ask permission from its spirit (*yuxĩ*) so that it may be collected. This can be done through chants and prayers (*pakari inka/he inka*), which form connecting vehicles between people and plant spirits. The transcription of one of these traditional intonations is recorded in *hãtxa kuĩ* for the species *Agonandra peruviana*:

*Dãi dãi dãi dãi,*
*dãi dãi dãi dãi*
*Ê mia biushumi*
*E mia sheay ê a muka*
*terasuyama shawe*
*Enabuabubeta ê mia betxikubaiti*
*Mĩ pepa Mĩ yani bimi.*

According to one of the participating shamans (Manoel Vandique Kaxinawá/*Dua Buse Duabake Huni Kuĩ*, 76 years old), the above prayer/song has the following meaning "*that these plants allow the collection of fruits and that they are succulent and sweet and will feed the collector and his whole family, thus bringing strength, health, longevity and happiness to all*".

*Isũ bã tũti* (*Anomospermum grandifolium* Eichler) is a woody liana which occurs in *terra firme* and low-lying forests. The fruits are small, oblong, with an orange epicarp and mesocarp, and have between one and two seeds (Fig. 12e). They are used as fresh food, mainly by hunters, on expeditions into the forest. According to the indigenous people, monkeys and deer also consume them. Some women report that they cannot consume them, otherwise, they function as a sexual attractant and, according to some collaborators, men can then "come after you". A study is suggested regarding its chemical and nutritional composition, considering that the fruits were consumed in the present study and have a pleasant bittersweet flavor, with potential for the preparation of juices, jams, sweets and fermented products.

The consumption of *shane kaxa* (*Talisia cerasina* (Benth.) Radlk.) fruits have been identified in previous ethnobotanical studies in Brazilian and Peruvian Amazonia (Vasquez & Gentry 1989; Guarim Neto *et al.* 2000; Santos-Fonseca *et al*. 2019; Teixeira *et al*. 2019), as well as appearing in lists of useful plants (Kunkel 1984; Martínez 1997; Revilla 2002; Torre *et al*. 2008). The fruits are drupaceous and yellow when ripe, ellipsoid in shape with a sweet white mesocarp (Fig. 12f). There are references to the medicinal use of leaves as an antivenereal treatment (Revilla 2002). However, no published studies were found concerning its chemical and nutritional composition.

In the *hãtxa-kuĩ* language, *T. cerasina* is called *shane kaxa*, in which *shane* is a local bird and *kaxa* means "crying". Interlocutors reported that, if pregnant women consume the fruits excessively, the new-born children "will cry a great deal" (*kaxaya*). On the other hand, the leaves of the species are recommended for medicinal baths, which, according to interviewees, have the effect of "quieting children's crying". It is curious to observe the antagonism, in which the same plant that causes crying also assists in its control. This recalls the "similar cures similar" principles of homeopathy. That the fruits are used in one way and the leaves in another, could indicate different properties for these organs so that they would not be biochemically or therapeutically similar. There is a need for more in-depth studies of the species.

From this brief juxtaposition of modern Western science and traditional indigenous knowledge, it can be seen that a rich potential exists for transdisciplinary studies - especially in research that focus on cultural forests and social-ecological systems. We consider it essential that public policies and social projects be implemented in partnership with the third sector and the private sector, to design appropriate strategies for the conservation and valorization of both traditional food habits in indigenous communities and their activities of management, stewardship, and sustainable use of biodiversity, integrating the ecological, social and political spheres.

Considering the significance of indigenous botanical knowledge for the food security and nutritional sovereignty of the indigenous populations, as well as its contribution to the conservation of socio-biodiversity and natural resources, we suggest that a variety of participatory and inclusive actions be implemented. These could include: fairs for exchanging seeds, seedlings and knowledge; promoting workshops on the relationship between traditional food and health; the organization of activities for the exchange of agroecological techniques combined with landscape management; among other innovative initiatives within the foundations of the traditional social-ecological system.

A variety of species of native food plants were recorded and characterized in the three studied villages of the Kaxinawá Indigenous Land of the Lower Jordão River/AC, of which more than half were also managed in productive units. This data provides a supportive contribution to the theory of cultural forests, that is, the indigenous livelihood has, for thousands of years, been powerfully integrated with the diversification of the Amazon forest. Native plants were found to be of high importance for the indigenous food

system, which underscores the fundamental role that natural ecosystems play in their way of life, and their culture in the preserving the integrity of the life-supporting ecosystems. It is, therefore, not unreasonable to assume that the cultural uses of plant species can facilitate, through sustainable management, the enrichment of biodiversity of social-ecological systems.

Many species known to the *Huni Kuĩ* people are excellent sources of nutrients, minerals and bioactive compounds, and that their cultural dietary consumption can strengthen their food and nutritional security and sovereignty. On the other hand, more than half of the species recorded have received little or no scientific study. In addition, the use of some of these species is declining. These circumstances may lead to a scenario of loss of knowledge about food plants, which highlights the need for future research on Amazonian food biodiversity. This illustrates the need for social-ecological systems analysis and ethnobotanical studies with a transdisciplinary approach, conducted in a dialogical and participatory manner with key social groups, to value and give visibility to the associated indigenous knowledge, as well as to substantiate socio-biodiversity conservation agendas.

Our research contributes both to future studies on native food biodiversity, to the formulation and implementation of Brazilian public policies related to food and nutritional security and sovereignty and to territorial and environmental management, for example, the National School Food Program (PNAE), the Food Acquisition Program (PAA) and the National Policy for Territorial and Environmental Management of Indigenous Lands (PNGATI).

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