CHAPTER 136

Camu-camu: Historical rescue as a basis for its valorization in the Amazon

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ABSTRACT
The camu-camu is a fruit native to the Amazon, rich in ascorbic acid and antioxidant substances. Aiming to contribute to the knowledge of the food potential of the Amazon and to the rescue of the work of pioneering researchers, this work aimed to raise information about the camu-camu for its appreciation in the Amazon, considering until the early 1990s. This work discussed the botanical description and taxonomic position, synonymy and common names, geographical distribution and dispersal, habitat and edapho-climatic conditions, phenology and genetic variability, production and commercialization, and also the uses and technological aspects. The information promotes a historical rescue that can serve as a basis for its appreciation in the Amazon.

Keywords: Natural populations, Cultivation, Nutritional value, Food use.

1 INTRODUCTION

The Amazon covers 58.5% of the Brazilian territory, being composed of regions subject to periodic flooding, which, its exploitation, requires the adoption of short-cycle and/or flood-resistant crops during much of the year, and by the terra firma, which is characterized by the presence of jungle that requires untouchability in some areas and specific management conditions in others, so that the balance is preserved.

The large demographic voids and isolated population centers are interconnected with the main centers of production and consumption by river, whose excellence, subject to great distances and absence of infrastructure for the movement of perishable products, is not reached.

The lack of agro-industrial tradition in the Amazon stems from the peculiarities of the ecosystem, irregularity and extractivism of the raw material, difficulties in the disposal of goods produced and/or benefited. The potential of its renewable natural resources comes from the great diversity of species, used extractively or in subsistence agriculture.

According to Samanez-Mercado (1990), the challenge of the Amazon is a task full of difficulties. The enormity of its geographical dimension, the multinational political structure, the biological diversity, the persistence of generalizations and myths, the threats to ecology, the need to rationally take advantage of the region, the superficial exuberance and the underlying poverty, as well as many other factors, come together forming a complex summation. However, knowing and conserving is the fundamental aspect for its development.

Currently, there are antagonistic situations: ecological thinking that alerts to the untouchability and fragility of the ecosystem; On the other hand, there is a need for development self-sustaining, the settlement of migrants, the installation of new agricultural frontiers, the exodus of the native population without conditions of survival, and the unsustainability of extractivism.

Because it is a unique region, agro-industry in the Amazon is only viable with its own dimensions and characteristics.ias. The inverse of developed regions, where the food industry conditions agricultural production to certain geographical areas and the work is directed to the adaptation of raw materials to the processes and the final objective, in the Amazon the most convenient strategy in the short term, is to adapt conventional technology to the characteristics of the great diversity of exotic tropical species, not excluding the difficulty of connecting with external economies and peculiarities of ecological, economic and social factors (Andrade, 1991).

The plant diversity of the tropics and in particular of the Amazon, is raised by researchers, and disseminated in various segments. This evaluation of a minimal portion of native tropical fruits shows its importance as a source of one or several fractions essential to human nutrition (Clement et al., 1982).

Among the wild fruits, of occurrence mainly in the Central and Western Amazon, is the camu-camu *Myrciaria dubia* (H.B.K.) Mc Vaugh. Data on composition, nutritional value, production and phenology in the wild habitat come from the Peruvian Amazon, where consumption is current in various segments of the population.

In recent decades, the National Institute of Amazonian Research – INPA, conducts research on adaptation, management, phenology and production of camu-camu on dry land, as well as the dissemination of its nutritional value and potential for commercialization and industrialization.

A fact that deserves to be emphasized, is the similarity of the ecosystem and the means of survival of the Amazonian in Brazil and Peru. However, camu-camu is an exception, as its large consumption in the Peruvian jungle is not observed in Brazil. The question of eating habits is not explained: why is camu-camu, a fruit of pleasant taste, very attractive appearance, large production and wide occurrence, providing excellent juice (if the pulp properly obtained) not consumed by the population of the Brazilian Amazon, which has access to it? In Brazil, the non-acceptance of the camu-camu flavor results from the lack of previous heat treatment of the fruit, which avoids the bitter/undesirable taste of the pulp.

The scientific knowledge of the sensory, nutritional, functional and technological properties of camu-camu, so that it is recommended to the organs of diffusion of technologies, extension, and the population in general, justifies the development of research in the areas of agricultural management, physiology and biochemistry of the fruit, post-harvest technology and processing at the artisanal and/or industrial level. It would be the way to obtain knowledge and technologies appropriate to the region, consolidate existing experiences and cultures, take advantage of the conditions of raw material and environment available, contribute to the improvement of eating habits and agro-industrial development of medium and small enterprises.

Aiming to contribute to the knowledge of the food potential of the Amazon and to the rescue of the work of pioneering researchers, this work aimed to raise information about the camu-camu for its appreciation in the Amazon.

2 CAMU-CAMU

2.1 BOTANICAL DESCRIPTION AND TAXONOMIC POSITION

According to Mc Vaugh (1969), Gutierrez Ruiz (1969) and Rodrigues, A. W. 1990, researcher at INPA, personal communication), the camu-camu is a shrub up to 8 m, rarely up to 13 m tall, glabrous or subglabra as an adult, diminutive and sometimes very sparsely hispidulous on the branches and ventral surface of the petioles, with sharp, clear trichomes about 0.2 mm long. Leaves opposite, simple, petiolate. Lanceolate or elliptical leaf blades, often subnechilateral 3.0 to 10 cm, rarely up to 12 cm long, 1.0 to 4.5 cm wide, glabrous, glandular, acute or gradually acuminate at the apex, rounded or subcuneated at the base; broad, flat or convex midrib on the upper page, somewhat elevated on the lower page; primary ribs numbering 16 to 30, very thin and obscure on the adult leaves or lightly printed on both pages and joined by a submarginal rib 3 to 7 cm long. Short petioles 3 to 9 mm long and about 1 mm thick.

Axillary or supra-axillary inflorescences, up to 1 mm above the base of the petiole; peduncles 1.0 to 1.5 mm long, with ciliated edges about 1.5 cm long and wide; pedicels up to 1.5 mm long and about 1 mm thick; persistent bracteoles, broadly oval and rounded at the apex, joined at their basal margins in a cupuliform casing 0.5 mm high in the centerline, 2.0 to 3.5 mm long and 1.5 to 2.0 mm wide; sessile, largely obconic hypnots, 2.5 to 3.0 mm long; globose calyx, or glabrous subglobose, with glandular points; 4 oval lobes, tomentose on the upper surface and obtuse at the apex; corolla with 4 glandular petals, white, alternating with the sepals, umguiculate, oval-rhomboid, abruptly acuminate and obtuse at the apex, provided with ribs branched from the base, hairy on both sides; stamens up to 125, from 7 to 10 mm long; anthers 0.5 to 0.7 mm long; styluses 10 to 11 mm long.

Globose fruits, 10 to 32 mm in diameter, pink to dark red and even purple-black with glandular points on the surface, apex crowned by the scar of the calyx, which is protruding and circular in shape;

acidic pulp; 2 to 3 seeds per fruit, reniform, ellipsoid, 6 to 15 mm long, 5.5 to 11.0 mm wide sharply flattened, covered by a mesh of fibrils.

The camu-camu has the following taxonomic position according to Takhtajan (1980):

Division: Magnoliophyta (Angiospermae)

Class: Magnoliopsida (Dicotyledones)

Subclass: Rosidae

Superorder: Myrtanae

Order: Myrtales

Family: Myrtaceae

Gender: Myrtaciaria

Species: dubia (H. B. K.) Mc Vaugh

2.2 SYNONYMY AND COMMON NAMES

Myrciaria dubia (Humboldt, Bonpland & Kunth) Mc Vaugh, presents the following synonymy, according to Mc Vaugh (1969):

- *Psidium dubium* K.B.K., Nov. Gen. & 6:152. 1823
- *Eugenia divaricata* Benth., Day. Bot. Hook. 2:319. 1840
- *Myrciaria phillyracoides* Berg, Linnaea 27:334. 1856
- *Myrciaria divariacata* (Benth.) Berg, Linnaea 27:334. 1986
- *Myrciaria* Berg, Mart., Fl. Bras. 14(1):364. 1857
- *Myrciaria riedeliana* Berg, Mart., Fl. Bras. 14(1):1959
- *Myrciaria caurensis* Steyern., Fieldiana. Bot. 28:1020. 1957.

For its dispersal, along rivers and lakes of the Amazon, an extensive region, and which covers distinct countries, the camu-camu is known by a number of names; The most common are:

- Araçá d'água: in the rivers Maçangana in Ariquemes and Urupá in Ji-Paraná in Brazil (Ferreira, 1986).
- Araçá de igapó: Rio Negro, Madeira, Tocantins and Javarí in Brazil (Suarez Mera, 1987).
- Caçari: region of the Brazilian Central Amazon (Cavalcante, 1988).
- Camocamo: in Peru (Gutierrez-Ruiz, 1969).

Camu-camu: Western Brazilian Amazon region of Manaus in the Central Amazon (Keel & Prance, 1979; Falcão et al., 1990) and the upper Solimões region (personal information of inhabitants of the region); South Florida U.S.A. (Whitman, 1974 and the entire low-jungle region of the Peruvian Amazon (Alvarado Vertiz, 1969; Suarez Mera, 1987).

- Guayabito and/or guyabato: Orinoco basin in Venezuela (Clément, 1986; Suarez Mera, 1987).

- Guayabo: Orinoco River in Colombia (Clement, 1986; Suarez Mera, 1987).

2.3 GEOGRAPHICAL DISTRIBUTION AND DISPERSION

The distribution area of camu-camu extends from the central region of the State of Pará in the rivers Trombetas, Cachorro and Mapuera. On the Javarí River and tributaries, Maçangana in Ariquemes and Urupá in Ji-Paraná, State of Rondônia. Passing through the middle and upper Amazon and the upper Solimões, it reaches the entire low jungle of the Peruvian Amazon, mainly in the tributaries of the Amazon, and the high and middle Orinoco Basin in Venezuela and also Colombia (Alvarado Vertiz, 1969; Mc Vaugh, 1969; Kell & Prance, 1979, Suarez Mera, 1987). Native to the Amazon Basin, it was introduced to and is grown on dry land in South Florida (Whitman, 1974).

Because it constitutes a food for the Ichthyoflora distributed in the igapós and banks of large rivers and tributaries, this is responsible for the dispersal of seeds over great distances, establishing population communities when in favorable conditions. The species of the ichthyofauna of greater importance in the dispersion are the tambaqui, pacu, matrinxã and curimatá. It is also possible to disperse, at great distances, by wild ducks, herons, grebes, etc. that, from the evolutionary point of view, present efficient mechanisms and strategies of dispersal (Suarez Mera, 1987).

2.4 HABITAT AND SOIL AND CLIMATIC CONDITIONS

Of native occurrence in the Amazon, it is typical of periodically flooded regions, such as floodplains and banks of rivers and lakes, more often in light waters than in dark ones, with pH variations between 4.0 and 7.5. Populations are scarcer in areas of rapids and waterfalls; however, on rocky substrates they resist the currents of rivers, such as Trombetas, Cachorro, Mapuera –PA and Javarí and tributaries – RO (Clement et al., 1982; Clement, 1986; Suarez Mera, 1987).

In the wild habitat, it develops in alluvial substrates, of silty, clayey, silt-clay, slime-sandy texture, and in poorly drained soils (Calzada Benza, 1980; Suarez Mera, 1987).

In the native state, the camu-camu vegetates on the banks of rivers and lakes with part of its trunk submerged to a height of 30 to 40% of its total height (Calzada Benza, 1980). According to Peters & Vasquez (1986/87), the camu-camu is extremely tolerant to flooding and can remain submerged in water for 4 or 5 months.

Studies of the vegetation of a black earth igapó in the Central Amazon, about 1 km from Manaus, a forest under severe environmental stress, poor soil and seasonal flooding, revealed the dominance of the species *Myrciaria dubia*. The species were distributed differently along the moisture gradient. Although some species showed a zonal distribution trend, the boundaries of the zones were not abrupt (Keel & Prance, 1979). The authors suggest that the distribution of species is the result of physiological differences for flood tolerance and emphasize the need for research on the various adaptive strategies to seasonal flooding and drought and the reproductive potential of the forest.

The camu-camu was introduced in Florida (U.S.A.) in 1964 (Whitman, 1974). The plants were grown in acidic sandy soil and submitted to irrigation three times a week. The only problem observed was the burning of the ends of the leaves during the dry winter months. The first fruiting took place in September 1982 in sufficient quantity to bend many branches to the ground.

Calzada Benza (1980), reports that work carried out in the Sub-Agricultural Station of San Roque (Iquitos) has shown that it is possible to develop camu-camu in the highlands of the Amazon, provided that it maintains high soil moisture all year round.

In 1980, the National Institute of Amazonian Research (INPA) introduced camu-camu in its list of priorities, aiming at the introduction and adaptation of the camu-camu to the edafo-climatic conditions of terra firme. Using germplasm from Iquitos-Peru and Yellow Red Podzolic soil, clayey texture, with smooth wavy relief, and original vegetation of humid tropical forest surrounding the experimental area, in a climate classified as "Afi" (Köppen system) with annual averages of 2,478 mm of rainfall and 25.5 °C of temperature, the performance of camu-camu is evaluated through spacing studies, fertilization, phenological and ecological aspects, types of pruning, selection of matrices, and chemical and technological analysis of fruits (Chavez Flores 1988; Falcao et al., 1990).

Second Chavez Flores (1988), the camu-camu has shown reasonable adaptation to terra firma, being able to develop in poor and acidic soils with pH between 4.0 and 4.5. It does not accept shading and prefers maximum temperatures between 28 to 35 °C, minimum of 17 to 22 °C and an average annual rainfall of 2800 mm. Falcão et al. (1990), state that the camu-camu can adapt to the edapho-climatic conditions of the terra firme of the Central Amazon; however, its flowering and fruiting are influenced by the rainfall regime.

2.5 PHENOLOGY AND GENETIC VARIABILITY

The time of Foliage of the camu-camu is a function of the hydrological flow. As the waters descend, the first leaf buds appear, and after the end of fruiting (time of new floods of the rivers) the plants are submerged, completely losing their leaves (Suarez Mera, 1987). In terra forme leaf change occurs throughout the year, although there is greater senescence and leaf fall at the end of the harvest and marked appearance of new leaves at the beginning of flowering (Falcão et al., 1990).

In floodable regions, flowering goes from September to November, that is, 2 to 3 months afterThe descent of the waters, depending on the hydrological regime of the region (Suarez Mera, 1987). Falcão et al., (1990), state that on dry land flowering occurs almost all year round with peaks during the dry season until the beginning of the rainy season. However, Suarez Mera (1987) states that there are two phases of flowering: the main one called "strong flowering", which occurs from September to November (coincides with that of floodable regions), and the secondary, known as "weak flowering", in the months of April-May.

In flooded regions, plants begin to bloom when the basal diameter reaches 2 cm. Flowering is not synchronized, occurring in stages within the same plant. Flower buds are first produced in the distal part of the higher branches, and after their opening and pollination, other buds come out in a nearby place, on the same branches. Flowering follows in this way from the upper to the lower branches. Thus, the plant can present at the same time, floral buds, flowers and fruits at various stages of development. Up to 12 flowers can come out in each node, and there is also the formation of flowers on the trunk and thick branches of adult plants. Anthesis occurs early in the morning and the flowers remain receptive to pollination for a period of 4 to 5 hours. After pollination, the stamens wither and the entire corolla dries up, falling the next day (Peters & Vasquez, 1986/87).

During anthesis, the stylus comes out first and the stamens several hoas after, demonstrating an evident protogyne. Results of pollination experiments indicate that this mechanism is very effective in avoiding autogamy. At the time of pollen release by the stamens, the stygma is no longer receptive to pollination. The dichogamy of camu-camu, however, does not rule out the possibility of self-fertilization by "geitonogamy" due to the lack of floral synchrony. Pollen from other flowers of the same plant can effect pollination. Experiments have shown that 91% of flowers pollinated with pollen from other flowers of the same plant formed fruits, and it can be concluded that camu-camu presents facultative allogamy, but not mandatory, and has no mechanism of genetic incompatibility (Peters & Vasquez, 1986/87).

In addition to the wind, bees are the most effective pollinators for this species, attracted by nectaries that exude sweet and pleasant fragrance. *Melipona fuscopilaria* and *Trigona portica* are the most common pollinators observed by Peters & Vasquez (1986/87). In addition to a number of insects of the order hymenoptera, these two species were also the most frequent observed by Falcão et al. (1990), when the camu-camu flowers were opened on dry land.

In general terms, according to Peters & Vasquez (1986/87), the camu-camu in the natural habitat presents 46% of pollination, and that 15% of the immature fruits abort before reaching maturity. In camu-camu on dry land, Falcão et al. (1990) obtained an average percentage of catching (average of 3 years) of 32% and 29% in unfertilized and fertilized plants, respectively; In one of the years of less severe drought, the averages were 38% in the unfertilized and 36% in the fertilized.

According to Falcão et al. (1990), in terra firmes, fruiting occurs in more pronounced periods coinciding with the end of the dry season and the beginning of the rains, being approximately 100 days the period between the opening of the flower and the ripening of the fruit. Chavez Flores (1988), states that January and February are the months of greatest production. Suarez Mera (1987), observes that on dry land, the main harvest goes from December to March, with a secondary one occurring in the month of July, and that, in the floodable wild habitat, there is only one harvest period, which extends from December to March.

According to Suarez Mera (1987), germination and propagation assays demonstrated the great variability of seedlings obtained from fruit seeds harvested in various regions of the Amazon Basin. The variability resulting from the origin was also evident in the size of the fruits, number of seeds, color of the peel and pulp and in the acidity of the fruit.

Falcão et al. (1990), studying the flowering and fruiting, detected (regardless of fertilization) variability in the precocity and adaptation of plants on dry land. Research in terra firme forest suggests genetic plasticity in flowering and fruiting (intermediate crop), possible of manipulation to obtain two crops/year, translating into more profitable economic activity (Suarez Mera, 1987). Variation in plants in Florida suggests vegetative propagation of selected strains as to plant vigor and fruit quality (Whitman, 1974). Second Chavez Flores (1988), the selection of camu-camu matrices is one of the priority studies of the Coordination of Agronomic Sciences of INPA.

2.6 PRODUCTION AND MARKETING

The production on dry land starts from 3 to 4 years after definitive planting, and varies between 10 to 15 t/ha/year if correctly managed (Chavez Florez, 1988).

Working with 50 randomly selected plants in a wild population near Iquitos-Peru, for a period of only 44 days, and not for the whole season, totaling 4 harvests, Alvarado Vertiz (1969) obtained an average production of 12,086 kg/plant with a maximum of 19,650 and minimum of 4,090 kg/plant. It was also observed that the number of fruits/kg ranged from 102 to 140. With an average of 119. Estimating the yield per hectare in a spacing of 4x4 (625 plants), with an average yield of 12.086 kg/plant, the author suggests an average production for terra firme of 7.6 t/ha.

Following for two years a wild population of camu-camu in a river lake on the Ucayali River-Peru, Peters & Vasquez (1986/87), detected a density of 1,231 plants/ha, and if we consider the regrowth of the profuse basal branching, the total population density reaches more than 1500/ha. They obtained a high correlation between production and plant size, as they verified that large plants have higher production per tree; however, the vast majority of total production comes from the small diametric categories due to their marked abundance. They concluded that wild populations are extremely productive, with values equivalent to 9.5 and 12.7 t/ha in 1984 and 1985, respectively. Considering that the lake holds more than 60 ha of camu-camu, its total productive capacity is between 600 and 700 t/year.

The camu-camu is widely consumed in the Peruvian Amazon, being marketed in the cities, mainly Iquitos, whose growing market is supplied by fruits from natural populations located up to 150 km from Iquitos (Peters & Vasquez, 1986/87). In Lima, the capital of the country, it is considered exotic and rare (Alvarado Vertiz, 1969).

The natural populations of camu-camu are visited once a week by people from the region, usually between 5 and 6 a.m., so that there is time to move the fruits to the market on the same day. The fruits are placed in canoes without care to avoid exposure to the sun's rays and contact with other fruits damaged by handling and thus transported to the city. In Iquitos the packages are wooden boxes with a capacity of about 4 kg, which serve to take them to the market and pass them to the merchants in charge of selling them to the public. Much of it is marketed "in natura", and for sales are made measured in containers of enameled iron, which contains around 20 to 30 fruits (varies with the size of the fruit) and average weight of 160 g. They are also marketed in the form of soft drinks, juices and ice cream by restaurants and ice cream parlors (Alvarado Vertiz, 1969; Suarez Mera, 1987).

Alvarado Vertiz (1969), reports that the transport in the canoes is done without hygiene and care measures in order to avoid exposure to the sun's rays and contact with fruits damaged by improper handling. Such factors, such as lack of education, lack of knowledge of the market and the principles of food conservation and handling, environmental conditions, habits, etc., are factors that influence the marketing system in Iquitos. It recommends precautions, such as: using open baskets for transport in the canoes; cool the fruits during transport in the river by spraying water; increase the post-harvest period by refrigeration (5 to 10 °C); observe the stage of maturation by picking fruits that have a slightly pinkish appearance and not dark purple coloration that denotes "extreme ripening"; Commercialize product of uniform quality by classification by size, stage of maturation, coloration, sanities, etc.

2.7 USES AND TECHNOLOGICAL ASPECTS

In the Amazon the camu-camu is used by the Indians and caboclos as bait for fishing and indicator of localized abundance of fish at the time of fruit fall. In the Peruvian Amazon since remote times, Indians and native population consumed it "in natura" or as components of beverages; however, in the Brazilian part its food use is unknown (Suarez Mera, 1987; caboclos and fishermen, personal communication).

Its consumption in the Peruvian Amazon is made in the form of ice cream, popsicle, juice, soft drink, jelly, sweet, coktail (with vodka, gin and other alcoholic beverages), wine, liquor, or to give flavor to pies and desserts. Due to its high acidity its consumption "in natura" is restricted (Ferreyra, 1959; Alvarado Vertiz, 1969; Calzada Benza, 1980, Ferreira, 1986; Clement, 1986).

From the fruit the pulp (endocarp) and the peel (mesocarp + epicarp) are consumed. In the preparation process, care must be taken to avoid damaging the seed, because this occurs, pulp of bitter taste is obtained (Calzada Benza, 1980). Camu-camu processing operations are rudimentary, at home level, with characteristics that reflect regional habits and availability.

Calzada Benza (1980) reports that, to facilitate the pulping operation, about 20% of water is added to the fruits, and after slight heating (to remove the bitterness), the separation of the seed is done manually. Pulp residues still adhering to the seeds are removed through a second operation. Separated from the seed, the pulp is crushed with bark forming a homogeneous paste of intense red coloration. In the preparation of nectar this pulp is mixed with water (1:4 or 1:5) and sugar to taste. From 1 kg of camu-camu one obtains 4 to 5 liters of juice.

According to Andrade (1991) the extraction of pulp by the caboclo interiorano (without boiling) is also done by crushing the fruit, maceration in water for 1 or 3 days, manual pressing in sieve for the removal of the seed and residues of bark (epicarp). As the color of the fruit is present only in the mesocarp, this process releases the pigments to the endocarp, making it red and with a more accentuated flavor; increases the pulp yield, because the mesocarp is dissolved, easily releasing itself from the epicarp (film that constitutes the residue); and decreases the bitterness and astringency (nutmeg-like) most evident in the mesocarp. To this pulp are added water and sugar, obtaining a juice of pleasant flavor (Garcia Torres & Sotero Solis, professors of La Universidad Nacional de La Amazonía Peruana, Iquitos, Peru, personal communication).

Mechanical pulping using Dixie® pulper, mod Indiana-181215, with mesh of 0.027 inches and processing of camu-camu juice with or without the use of potassium sorbate, as well as the evaluation of its quality through chemical and sensory analysis, were part of a research commissioned by the Agricultural Development Bank of Peru. The good results of this research are reported by Alvarado Vertiz (1969), who believes that a new perspective is emerging in the exploration of this Myrtaceae.

In the United States camu-camu imported from South America is processed in the form of tablets, and marketed in specific food stores as natural vitamin C under the brand name of "camu plus" (Whitman, 1974). However, according to Chavez Flores (1988), production is currently suspended due to lack of raw material.

Post-harvest technology is recommended by Calzada Benza (1980), when he states that the thin shell requires care in transport and storage; that, for the same reason, storage should not be too prolonged (3 to 5 days). Adequate postharvest management to minimize vitamin C loss is advised by Naksone & Bolton (1984), when they state that research in Hawaii has shown a decrease in vitamin C after acerola harvest, and noted that similar biochemical activities are likely to occur in camu-camu.

2.8 CHEMICAL COMPOSITION

Second Calzada Benza (1980), among the many fruits of the Peruvian Amazon, the camu-camu stands out as one of the most important for the high content of ascorbic acid and excellent flavor. He reports that "it went unnoticed in the jungle until, in 1957, the Instituto de Nutrición del Ministerio de Salud del Perú found high levels of ascorbic acid, about 2700 mg/100 g of pulp and even higher values in the peel. Years later, the Native Fruit Program of the Universidad Nacional Agraria, La Molina, confirmed this richness through several publications."

Despite the importance and consumption of the fruit by the native population of the Peruvian jungle (Blasco Lamenca et al., n.d.), data on the composition of the fruit "in natura" and its processed products are scarce; however, since past decades, there have been several studies, however, to rescue the history of camu-camu, the oldest data found in the literature are presented in Tables 1 and 2.

In the tropics, camu-camu resembles acerola, both with about 2.5% vitamin C (Zapata & Dufour, 1993; Andrade et al., 1991; Andrade et al., 1995). According to Clement (1986), the high content of vitamin C makes camu-camu a potential, in the form of a product exportable to the market of natural products of the northern hemisphere. It could be a great option for growing on small farms and/or along the large hydrographic systems of the tropics.

Table 1. Chemical composition of camu-camu *Myrciaria dubia* Mc Vaugh

Constituents	Authors	
	1	2
Calories (kcal)	16,0	17,0
Humidity (%)	93,2	94,4
Proteins (%)	0,5	0,5
Carbohydrates (%)	4,0	4,7
Fiber (%)	0,5	0,6
Ash (mg%)	0,2	0,2
Calcium (mg%)	28,0	27,0
Phosphorus (mg%)	15,0	17,0
Iron (mg%)	0,5	0,5
Thiamine (mg%)	0,01	0,01
Riboflavin (mg%)	0,04	0,04
Niacin (mg%)	0,61	0,62
Reduced ascorbic acid (mg%)	2089,0	2880,0
Total ascorbic acid (mg%)	-	2994,0

Source: 1 = Collazzos et L. (1957), cited by Alvarado Vertiz (1969); 2 = Roca (1965), cited by Gutierrez Ruiz (1969)

Table 2. Ascorbic acid content in the fruit and products obtained from the camu-camu *Myrciaria dubia* Mc Vaugh

Goods	Ascorbic acid (mg/100 g)	
	Reduced	Total
Original pulp I	2032	2415
Sweetened juice I	334	1050
Sweetened juice II	579	1041
Pectin free jelly	917	1680
Jelly with pectin I	250	912
Jelly with pectin II	290	1041
Marmalade	250	706
Marmalade	214	639
Ice cream	102	-

Source: Roca (1965) cited by Alvarado Vertiz (1969) and Gutierrez Ruiz (1969)

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