

Diversity of *Cucurbita moschata* Duchesne (loche and cushé) and *Cucurbita ficifolia* Bouché (chiclayo) in Southern Amazonas, Perú

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Introduction

The National Institute for Agrarian Innovation (INIA) in Perú, among countless projects, maintains the Peruvian National *Cucurbita* spp. germplasm bank representing the remarkable *Cucurbita* spp. diversity in Perú. Prior to this project, the INIA *Cucurbita* collection covered much of the southern Perú *Cucurbita* spp. diversity but was lacking *Cucurbita* spp. samples from northern Perú. Therefore, the Fulbright Program funded this project to investigate and inventory the disappearing diversity of *Cucurbita moschata* and *Cucurbita ficifolia* in the Department of Amazonas, Perú. The collection focused on three landraces that belong to two different species (Table 1). The two *C. moschata* landraces are known in the Amazonas region as loche and cushé, whilst the *C. ficifolia* landrace is commonly known as chiclayo. Loche has a higher economic value and culinary influence, whilst cushé has a greater phenotypic diversity but is farmed on a smaller scale. All three, loche, cushé and chiclayo, show different physical, culinary, cultural, and geographic adaptations. The objectives of this project included: (a) collecting *C. moschata* and *C. ficifolia* samples from different districts in the Department of Amazonas, Perú for seed saving, (b) taking morphological data and photos of each collected sample for analysis, and (c) collecting cultural, historical, and culinary information.

The focused look into the use of the two species over a relatively small amount of terrain allowed for observations worthy of conveying in writing though by no means all-

inclusive of the profound *Cucurbita* information that the landscape of Amazonas holds.

Materials and Methods

Collection trips: The project started with collection of *Cucurbita* fruit samples. Collection trips took place in six of the seven Amazonas provinces: Bongará, Bagua, Chachapoyas, Luya, Rodriguez de Mendoza and Utcubamaba (Figure 1). Most of the collection trips were performed with the guidance of extension employees, of the Research Institute for the Sustainable Development of the Ceja de Selva (INDES-CES) of the Toribio Rodriguez de Mendoza National University (UNTRM), based in each specific collection location, allowing for local knowledge of each province. Collection trips took 2-4 days and were based in a central town, with sample collection conducted within 0–150 km of the base town. Samples were collected based on local knowledge, connections of extension agents, and word of mouth. Most samples were collected via motorcycle directly from producers, excluding the samples collected in Chachapoyas, which were all purchased from the main market.

During the search for samples, locals were asked for any insight on “loche”, “cushé”, or “chiclayo” fruits. These common names are the terms used for *C. moschata* and *C. ficifolia* fruits in Amazonas. Over 50 samples were collected, of which 40 had viable seeds and were mature enough to take meaningful physical data (Table 2). Throughout the collection trips, informal interviews were conducted to investigate cultural

and culinary uses, as producers were asked how the fruit and plant are used in the area. After each collection trip, the samples were brought back to the UNTRM Laboratory of Plant Physiology and Biotechnology for seed saving, fruit photography and collection of morphological data. Culinary and cultural uses of the fruits, along with physical data and seeds of each sample, were consolidated and submitted to the INIA Donoso Agricultural Experiment Station. Collaborators at INDES-CES of the UNTRM were excellent hosts and crucial to successful collection trips and data collection.

Morphological Data Collection: Physical data were collected based, with slight variations, on descriptors published by ECPGR (2008). The data collected included over 30 characteristics ranging from fruit weight and size to soluble solids content and dry matter. Prior to data collection, photos were taken of the whole fruit and a section of it. The fruit was cut, and the seeds were collected, cleaned, and dried at room temperature for two weeks before storage in manila envelopes. All data were collected in the Laboratory of Plant Physiology and Biotechnology at UNTRM, using simple balances, measuring tapes, verniers and some specialized equipment of the laboratory.

Brix measurement was used to measure soluble solids content using an Atago 3810 (PAL-1) Digital Pocket Refractometer. Flesh juice was extracted with a lemon press and three readings per fruit sample were averaged. Dry matter was calculated by drying the fresh fruit flesh. Three pieces of fresh flesh ranging from 3–5 grams were weighed, placed on petri dishes, and dried in an oven for 12 hours at 70 degrees Celsius. The dried flesh was weighed and using the equation, $(\text{Average (dry weight/wet weight)}) * 100$, the dry matter was calculated. pH was taken by averaging five Apera pH60S monitor readings from each sample. Flesh and rind strength was recorded using the average of three digital force gauge readings.

Results and Discussion

Based on conversations with producers, chefs and locals, the use of each researched landrace was shown to hold unique cultural values. Of the three landraces, the loche (Figure 2) was by far the highest in economic value (~\$2-5 USD per kg) and has the most well-known culinary use based on Peruvian *Norteña* (northern) Cuisine, such as *espesado* (thick corn and meat stew), *crema de loche* (creamed loche soup), and *arroz con pato* (rice and duck) (see Figure 3).

Loche is commercially grown and increased through vegetative propagation in the hotter coastal regions of Perú. It is often grown with irrigation and shipped across Perú, making it easy to find in most markets. Although, loche is grown in hotter regions of Amazonas, such as Jaen, most loche

found in Amazonas markets is imported from commercial production in coastal zones as loche produces best in hot climates. The clonal varieties of loche grown in Amazonas are thought to be cold hardy. In general, the loche stands alone with specific, well-documented, traditional uses in books, websites, and other resources (Andres et al., 2006). It is usually seedless and propagated vegetatively for production and maintains high sugar levels (6.5 degrees in this study). For this reason, this project put more resources into studying the less documented, but equally as important, landraces of cushé and chiclayo.

Cushé and chiclayo have many traditional uses, yet are not as well documented, nor as consistently used in current Peruvian cuisine. Many interviews revealed younger generations in Amazonas having to refer to memories with grandparents or older generations to recall the use of cushé and chiclayo. These landraces currently hold a low economic value compared to the loche, but a strong historical and cultural value.

Cushé, also known as cushebamaba (Amazonas) and chuyan (Amazonas sierra), is mostly grown in the lower altitudes, with their warmer climate, in Amazonas. It is seeded early in the rainy season (October – December) and in general produces mature fruit from April – September. Traditionally, cushé was grown alongside corn as a ground protector, allowing for corn and cushé harvest at a similar time. Currently, cushé fruits are still grown in more rural areas, but are rarely grown for market production. The majority of cushé fruits stay on farm for family consumption.

Cushé is the most diverse of the three landraces in all morphological aspects. The fruit varies in size, shape, texture, and color (Figure 4). In this study, cushé showed the highest range of sugar content, from 2.8-9.2 degrees brix as well as the highest brix average of 6.6 degrees. As expressed by Doña Marinita, a Chachapoyan woman who shares traditional Peruvian cuisine on YouTube and Facebook, getting a super-sweet cushé is mostly luck as some cushé will be extremely sweet while others are bland and bitter. Still, the cushé holds unique characteristics, has high nutritional value, and a thick shell that was traditionally used to create serving vessels. The shape of the cushé and loche was often recreated in pottery as seen in museums across Perú, showing its historical value as well (Whitaker and Cutler, 1967).

During this study, bi-colored cushé were found (Figure 5). This finding is consistent with the previous scant reports of the rare bi-colored *C. moschata* occurring in Perú, Ecuador, Colombia, and Brazil (Lietzow et al., 2005–2006). This trait suggests the presence of the *B* gene, which has been used widely to increase carotenoid content in *Cucurbita pepo* (Andres and Paris, 2020). The diversity within the cushé

landrace in Amazonas reveals a pool of genetic diversity that may be useful to plant breeders.

Traditionally, cushé is prepared by chopping into 3–5-inch pieces that are boiled with the skin and served on a plate in the middle of the table to accompany the main dish. One interviewee of the town of Levanto expressed that the plate of cooked cushé should be as full after eating as it was when the meal started, constantly being refilled throughout the meal. Other preparations include *tortillas* (fried cushé patties), *dulces de cushé* (sweetened cushé pudding), *picarones* (cushé donuts), *harina de cushé* (flour) and *locros* or *caldos* with immature fruits (soups with green fruit) (see Figure 6). In an interview, David Ocampo, a local Chachapoyan, expressed the opinion that the cushé holds a relatively high protein content, making it a good option as fodder for the fattening phase of livestock. However, the protein content of cushé has not been documented. Ocampo spent pre pandemic years breeding cushé to grow with a thinner skin to ease the feeding process.

Overall, the cushé is a historically important crop with its high sweetness and hard shell. The shell of the cushé has been an important vessel for serving for many generations, as it maintains its shape when dried. Unfortunately, cushé is currently in decline. As other materials become easily accessible for serving food and limited time does not allow for the time-consuming removal of the shell, the cushé has lost some appeal. Low market value (~\$0.25 – 2.00 USD per fruit), as well as a lack of personnel to harvest the crop, has made it much less popular among farmers and households in Amazonas. Many towns, such as Magdalena or Pedro Ruiz in Amazonas, produced cushé on a regular basis. Currently, few community members are known to still plant and harvest the crop. For this reason, it is important that these cushé landraces are collected, to be conserved in the INIA seed bank, especially with the presence of bi-colored fruits.

Chiclayo, also known as chiuche (Cajamarca), calabaza blanca (Lima), lacayote (Arequipa), and sambumba (Piura), mostly flourishes in the higher altitudes and cooler climates of Amazonas. The plant is extremely vigorous and can be found growing like a weed on the side of the road, climbing over fences, or covering house yards. Most commonly, the plant self-propagates from seeds within old, fallen fruits. There are areas like Pomacochas, Perú where chiclayo is planted and harvested to be sold in city markets. Chiclayo holds a unique cultural history as it is included in many legends and histories of the Chachapoyan culture.

Chiclayo fruits are relatively unvarying in morphological aspects (Figure 7). Externally, the fruit generally resembles a watermelon. Internally, it has white, stringy flesh and white or black seeds; the nutritional value is low and has a low sugar content. In this study, the average sugar content of the

chiclayos sampled was a low 4.3 degrees Brix. One unusual chiclayo morphological feature was some of the fruits having extended necks, revealing potential morphological diversity in the *C. ficifolia* of Amazonas.

The fruit is most known for the classic *dulce de chiclayo* (see Figure 8) consisting of boiled chiclayo pulp, seeds and *chancaca* (solid product of boiling sugar cane). This is often served at traditional events or as street food. The seeds are an important nutritional aspect of the fruit and are toasted and sold with *canchitas* (cooked corn kernels) or milled into a flour used in soups (*Sopa de Pepitas*) or baked goods. The immature fruits are often added to *locros* (corn veggie soups) Since the fruit grows freely, fruits will often be used as filler for animal fodder. Overall, even though the chiclayo has a low economic value (~\$0.50 – 2.00 USD per fruit), it holds an important place in current day Amazonas culture due to its vigor and productivity, and popularity when prepared as *dulce de chiclayo*.

Conclusion

This project allowed for the study of the diversity of *Cucurbita* in the Department of Amazonas, Perú from a social, morphological, historical, and culinary perspective. The finding of bi-colored cushé (*C. moschata*) adds information to the cucurbit community as bi-color has rarely been documented in *C. moschata*. Worth noting as well, chiclayo and cushé landrace use is diminishing, emphasizing the importance of conserving these landraces. All 40 samples were registered in the *Cucurbita* germplasm bank at the Donoso Experiment Station of INIA in Huaral, Perú, to be included in the up-and-coming INIA investigation into Peruvian Cucurbit biodiversity.

Acknowledgments

This investigation would not have been possible without the help and support of affiliations, the Instituto de Investigación para el Desarrollo Sustentable de Ceja de Selva (INDES-CES) of the Universidad Nacional Toribio Rodríguez de Mendoza de Amazonas (UNTRM), the Instituto Nacional de Innovación Agraria (INIA) of Perú, the University of New Hampshire (UNH), as well as the Fulbright Program.

The University Toribio Rodríguez de Mendoza: Danilo Edson Bustamante Mostajo, Damaris Leiva Tafur, Daniel Tineo Flores, Diana Yuvithza Servan Alvarado, Elizabeth Silva Diaz, Fredi Bazan Collantes, Heyton Deivi Garcia Cruz, Jegnes Benjamin Melendez Mori, José Jesús Tejada Alvarado, Juan Carlos Neri Chávez, Luis Alberto Huaman Reyna, Malluri Goñas, Marco Antonio Pasapera Alvitres, Martha Steffany

Calderón Ríos, Percy Lopez Portocarrero, Rosmery Yakelini Ayala Tocto

INIA: Carlos Alberto Amasifuen Guerra, Dina Lida Gutiérrez Reynoso, Mavel Nansi Marcelo Salvador

The University of New Hampshire: Jeanne Sokolowski

Other: Jose Luis, Jose Desiderio Mera Zuloeta, Everardina Zuloeta Penachi, Victor Raul Mera Calderon, Peter Lurche, Doña Marianita, David Ocampo, Etel Hotel Duke

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Table 1. Common and scientific names of landraces studied.

Common name in Amazonas	Scientific name
Chiclayo	<i>Cucurbita ficifolia</i>
Cushé	<i>Cucurbita moschata</i>
Loche	<i>Cucurbita moschata</i>

Table 2. Number of samples collected by species, and by province in the Department of Amazonas, Peru.

Species	
<i>Cucurbita ficifolia</i>	11
<i>Cucurbita moschata</i>	29
Total	40
Province of Amazonas	
Utcumbamba	3
Luya	2
Chachapoyas	19
Bongará	6
Rodriguez de Mendoza	8
Bagua	2
Condorcanqui	0
Total	40

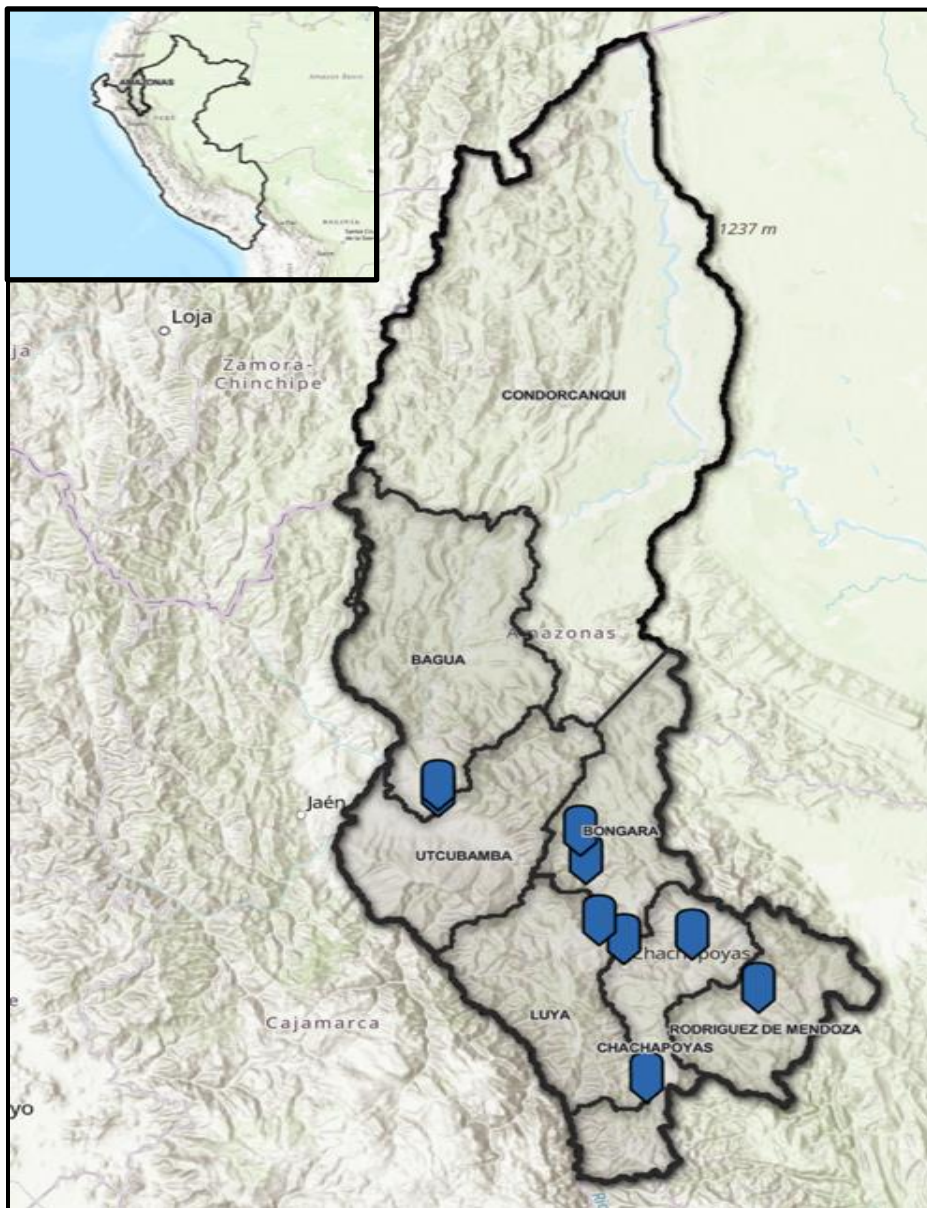


Figure 1. Map of locations in the Department of Amazonas, Perú where collection trips were conducted.



Figure 2: Examples of various fruit forms of loche



Figure 3. (a) harvested loche fruits in the field in Patapo (fruit to scale in red ring), (b) young, vegetatively propagated loche plant, (c) longitudinal section of loche fruit, (d) espesado (thick corn meat stew) made with loche (green) and ceviche, a classic Norteña dish made with fish cooked by lime juice, (e) crema de loche--creamy loche noodle sauce served with grilled meat.



Figure 4. Examples of various fruit forms of cushé.

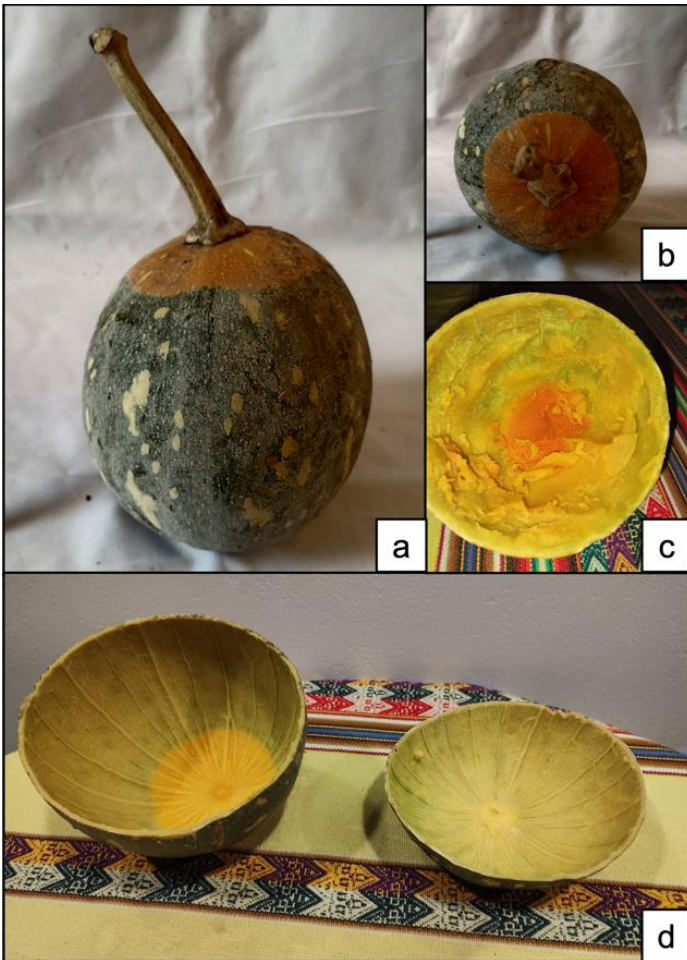


Figure 5. Bicolor cushé, *Cucurbita moschata*: (a) side photo of exterior coloration, (b) top view of exterior coloration, (c) interior pulp color variation viewed in cross-section, (d) interior surface of rind.



Figure 6. (a) serving vessels made from the hard shell of cushé, (b) harvested cushé fruit (in foreground, not to scale) in Mayno with a producer, (c) huaco (sacred vessel) in the form of a duck/cushé dating back to the Incan empire, (d) picarones (cushé donuts) made with the puree of cushé, (e) cushé for sale in the Luya Tuesday market, (f) dulce de cushé boiled with the skin in a sugar syrup, (g) three forms of cushé: bowls made from the thick skin, puree made from boiled flesh, and roasted seeds with salt, (h) longitudinal section of a cushé, (i) snack made from the roasted seeds of cushé or chiclayo mixed with canchitas (cooked corn kernels).

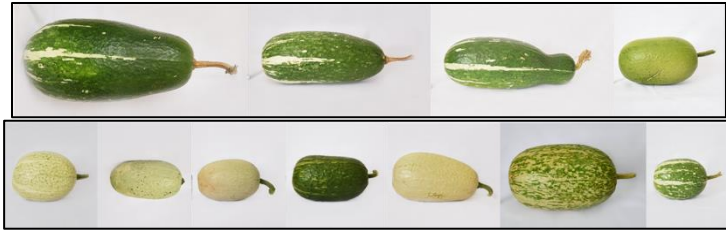


Figure 7. Examples of various fruit forms of chiclayo.



Figure 8. (a) chiclayo fruit with producer in Leimebamba, (b) longitudinal section of fruit with black seeds, (c) dulce de chiclayo (sweetened chiclayo pudding), (d) example of chiclayo plant overtaking a yard in Molinopampa, (e) example of a chiclayo plant growing as a weed on the side of a building, (f) mound of chiclayos in Pomacochas ready for trucking to Lima and larger cities, (g) pepian-soup made from the flour of roasted and milled chiclayo seeds, (h) the chiclayo flower, eaten raw in salads.