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Ethno-Botany and in-situ conservation of the genetic diversity of arracacha (*Arracacia xanthorrhiza* Bancroft), yacon (S*mallanthus sonchifolious H.Robinson),* and wild relatives

Etnobotánica y conservación in-situ de la diversidad genética de la arracacha (*Arracacia xanthorrhiza* Bancroft), yacón (*Smallanthus sonchifolius* H. Robinson), y sus parientes silvestres

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Abstract

The study was conducted in the districts of Huacrachuco and San Pedro de Cholon, province of Marañon and Huanuco region. The aim of the study was to describe the in-situ conservation and ethno-botanical indicators of the phenotypic variability of Arracacha (*Arracacia xanthorrhiza* Bancroft), *Yacon* (*Smallanthus sonchifolius* H. Robinson) and wild relatives. Work was done in the farmers' plots where they preserved from one to three morphotypes of *A. xanthorrhiza* and *S. sonchifolius,* and farmer communities where preserved wild plant relatives. A total of thirteen farmers from three farmer communities in the Huarachuco district, and nine from two farmer communities in the district of San Pedro de Cholon were selected. Six in-situ conservation and three ethno-botanical indicators were described. By using morphological descriptors 23 samples of grown *arracacha* and 34 of grown *yacon*, three samples each of wild *arracacha* and *yacon were* characterized. Based on this characterization, results were as follow: three different morphotypes of grown *arracacha* for 21 descriptors, four different morphotypes of grown *yacon* for 18 descriptors, two ecotypes of wild a*rracacha* (the low field ecotype located in a range of altitude of 2500 to 2750 meters above sea level and the height field ecotype located above 3530 m.a.s.l.) and two ecotypes of wild *yacon* (yellow and red ecotypes).

keywords: arracacia, smallanthus, in situ conservation, ethno-botanical, ecotype, morphotype.

Resumen

El estudio fue realizado en los distritos de Huacrachuco y San Pedro de Cholón, provincia de Marañón, Huánuco. El objetivo fue describir los indicadores de conservación *in situ* y etnobotánicos de la variabilidad fenotípica de arracacha (*Arracacia xanthorrhiza* Bancroft), yacón (*Smallanthus sonchifolius* H. Robinson) y sus parientes silvestres. Se trabajó en parcelas de agricultores donde conservan de uno a tres morfotipos de *A. xanthorrhiza* y *S. sonchifolius,* y en comunidades donde conservan los parientes silvestres. Se seleccionaron un total de 13 agricultores de tres comunidades del primer distrito y nueve de dos comunidades del segundo distrito. Se describieron seis indicadores de conservación *in situ* y tres etnobotánicos. Utilizando descriptores morfológicos se caracterizaron 23 muestras de arracacha cultivada y 34 de yacón cultivado, tres muestras de arracacha silvestre y tres de yacón silvestre. Con base a esta caracterización se encontraron: tres morfotipos diferentes de arracacha cultivada para 21 descriptores, cuatro morfotipos de yacón cultivado para 18 descriptores, dos ecotipos silvestres de arracacha (uno de la zona baja ubicada de 2500 a 2750 m.s.n.m. y otro de la zona alta ubicada a 3530 m.s.n.m.) y dos ecotipos de yacón silvestre (amarrillo y rojo).

Palabras claves: *Arracacia*, *Smallanthus*, conservación *in situ*, etnobotánica, ecotipo, morfotipo.

Introduction

In Peru there are 1 060 species of Pteridophytas, 24 Gymnosperms and 17 119 Angiosperms (Zúñiga 2004). These species would have originated about 80 thousand years ago, since then they are in permanent evolution (Tapia, 2001). This natural and cultivated plant wealth is the "national patrimony", fundamental for the biosphere to continue producing ecological goods and services (food, recreation, genes, education, etc.) for the well-being and survival of man, it is a source for development socioeconomic status of families, communities and nations. As mentioned in Seminar et al. (2003), andean roots and tubers (ARTc) such as the achira, the ahipa, the arracacha, the maca, the mauca, the mashua, the oca, the ulluco and the yacon, are important for the food and culture of the Andean rural people.

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The genetic erosion of local varieties is due to factors, such as population increase, soil degradation, environmental changes, the introduction of modern varieties, migration, deforestation, globalization and ethnic acculturation, oil exploitation (IPGRI, 1999) and the loss of knowledge of the peasants. According to the CBD (2000), around 34,000 species of plants and 5,200 animal species (including one of every eight species of birds in the world) would be in danger of extinction, 45% of natural forests have disappeared, 30% of races of the main domestic animal species are exposed to a high risk of extinction and some species disappear at a rate between 50 to 100 times higher than the natural rate. Peasants are left without resources and the productivity of agroecosystems decreases in time and space, compromising food security and sovereignty in rural and urban areas.

This context, motivated the creation of a Conservation Program of these resources for future generations (Brush, 2003). According to Sevilla and Holle (1995), the best way to conserve biodiversity is to keep the cultivated species and their wild relatives in the place where they have originated, evolved and are currently produced, considering traditional logistical and logistical strategies as indispensable in logistic and rational strategies. This article describes the in situ and ethnobotanical conservation indicators of the phenotypic variability of the arracacha, the yacon and its wild relatives from the province of Huacrachuco, Huánuco.

Materials and Methods

The communities of the district of Huacrachuco are located from 8º24'38 '' to 8º54'29 '' South Latitude and from 77º1'05 '' to 77º44'24 '' West Longitude, with altitudes of 2,500 m.a.s.l. at more than 3,500 m.a.s.l. .; the communities of the district of San Pedro de Cholón from 8º3'47 '' to 8º45'53 '' South Latitude and from 77º20'24 '' to 77º50'52 '' West Longitude, with altitudes of 2 400 m.a.s.l. to more than 2 800 m.a.s.l. Huacrachuco presents two climate stations, warm-temperate from June to September and cold from January to March, an average temperature of 16º C and an annual precipitation of 600 mm. San Pedro de Chonta presents a more homogeneous climate, with an average temperature of 20º C and an annual rainfall that exceeds 900 mm.

The method used in the study was descriptive-explanatory. The methodology consisted of three procedures (adapted from Paz, 1997):

i) Participatory planning, the scope of the study was socialized in each district through workshops with authorities and leading farmers of the conservationist communities (CC); then, in focus groups by communities, preliminary information on in situ, ethnobotanical conservation and wild ecotypes of arracacha and yacon was collected (Madriz, 2000). Based on this information, the scope of work, the road map, communities and conservationist farmers, and farmers with ethnobotanical knowledge were identified. The CC were selected based on the number of farmers who mentioned conserving from one to three arracacha and yacon morphotypes in their plots (according to Seminario et al., 1999, "a morphotype is an intraspecific population that presents the general and typical morphology of the species but presents certain qualitative characteristics that differentiate it from other morphotypes ") and according to the information about the existence of wild ecotypes in the community environment. The conservationist farmers (AgCo) were selected according to the number of morphotypes (from one to three), of the species under study preserved in their plots, corroborated through on-site visits. Farmers with ethnobotanical knowledge were identified according to the information they provided.

ii) Participatory research, through semi-structured surveys with farmers organized in focus groups (Whyte, 1989) and (Geilfus, 1997), the indicators of in situ conservation, ethnobotanical and socioeconomic variables of the communities were described. Then, the indicators and variables that were indicated by 80% or more of the participants were described.

iii) Case study, through semi-structured interviews and open dialogues with 22 AgCo, in situ and ethnobotanical conservation indicators were described (Williams, s. a.); and the geographic and ecological parameters of the habitats of the wild ecotypes were measured in their habitats (Eisenhardt, 1989, Tellis, 1997, Neale et al., 2006). The characterization of *S. sonchifolius* varieties was carried out in farmers' plots, using 20 standardized morphological descriptors proposed by Arbizu et al. (2001) and *A. xanthorrhiza* with 22 descriptors 2003 version of the PRTA-UNC, adapted by Seminario (2006) and Tapia (2007). The wild arracacha and yacón ecotypes were characterized in their natural habitats, by means of characteristics of plants that the farmers use to differentiate the variation, only in the case of the arracacha of puna was it supplemented in plants reproduced in flowerpots. For wild arracachas, habitat, plant size and root conformation were used; and for wild yacon the color of the flower, size of the reserve root, shape of the reserve root and archetype of the plant.La unidad de muestreo para la caracterización de las accesiones cultivadas fue la planta en estado de madurez fisiológica, todas las características fueron evaluadas en cinco muestras, excepto en el caso de las flores y frutos del yacón se muestreó según la disponibilidad del material, y la caracterización de los ecotipos silvestres se realizó con dos o tres plantas, según la abundancia. Se caracterizó 14 muestras de *A. xanthorrhiza* en el distrito de Huacrachuco y nueve en San Pedro de Chonta, 22 de *S. sonchifolius* en el distrito de Huacrachuco y 12 en San Pedro de Chonta, tres muestras de arracacha silvestre y tres de yacón silvestre en el distrito de Huacrachuco.

Statistical analyzes were carried out with the InfoStat / Professional Program, Version 2007p. The indicators were analyzed through descriptive statistics techniques. The phenotypic grouping of the arracacha and yacón variability was performed by means of a hierarchical conglomerate analysis (AC) for qualitative data, using the Ward algorithm

and the Gower distance, with fashion data of the described characteristics (InfoStat, 2004). The phenotypic groups were corroborated with the prediction ellipses technique (95% confidence) of the discriminant analysis (DA), using these groups as classification variables. The most important discriminatory characteristics within the groups were identified through the linear DA method (Hidalgo, 2003). The identification of the wild arracacha and yacón ecotypes was made based on the information collected in the field.

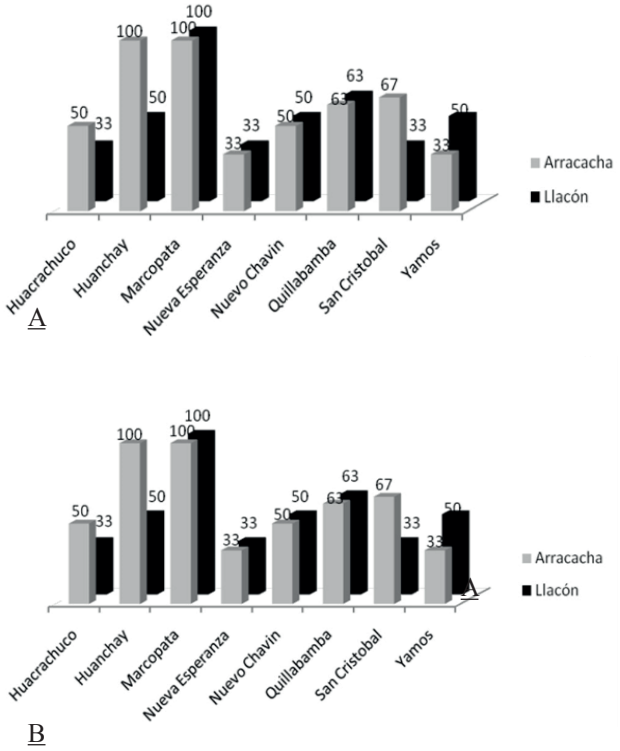

Figure 1. Conservation communities according to the percentage of farmers who conserve between one and three morphs of arracacha (*A. xanthorrhiza*) and yacon (*S. sonchifolius*) in the districts of Huacrachuco (A) and San Pedro de Cholón (B).

Identification of conservationist communities and farmers—A total of 52 people, authorities and producer leaders participated in the planning phase (38 in Huacrachuco and 14 in Cholón). Based on the number of farmers who reported conserving between one to three morphs of yacón and arracacha, three CCs (out of a total of eight) were selected in the district of Huacrachuco: Marcopata, Quillabamba and Nuevo Chavín (Figure 1A) and two (of a total of four) in the district of San Pedro de Cholón: Cholón and Chogopillo (Figure 1B). The community of Huanchay was not considered because only two farmers participated in the planning and communities of Huacrachuco and Yamos because half or more participating farmers indicated not to keep the species under study in their plots. The farmers of Marcopata and Quillabamba asserted the existence of two climatologically differentiated zones where the wild arracacha and yacon ecotypes are developed: 1) Temperate zone or low zone, located from 2,500 to 2,750 m.a.s.l. and 2) zone of puna or high zone, located to more than 3000 m.a.s.l.

In the district of Huacrachuco, 23 farmers reported conserving in their plots one to three arracacha morphotypes, 21 indicated the same number of yacon morphotypes and only one farmer indicated to conserve more than three yacon morphotypes (Figure 2A). In the district of San Pedro de Cholón, nine farmers mentioned maintaining one to three arracacha morphotypes, 12 said that they conserve this same number of yacon morphotypes and only one farmer indicated that he conserves more than three arracacha varieties in his plot (Figure 2B). Farmers' information showed the situation of loss of arracacha and yacón cultivated varieties in family agroecosystems, for example, in Huacrachuco 15 farmers mentioned that they do not sow arracacha morphotypes and 16 do not sow yacon; in San Pedro de Cholón, four farmers said that they do not sow arracacha and two do not sow yacon. For the characterization work of arracacha and yacon morphotypes, 13 AgCo were selected from the three selected communities in Huacrachuco and nine from the two communities of San Pedro de Cholón.

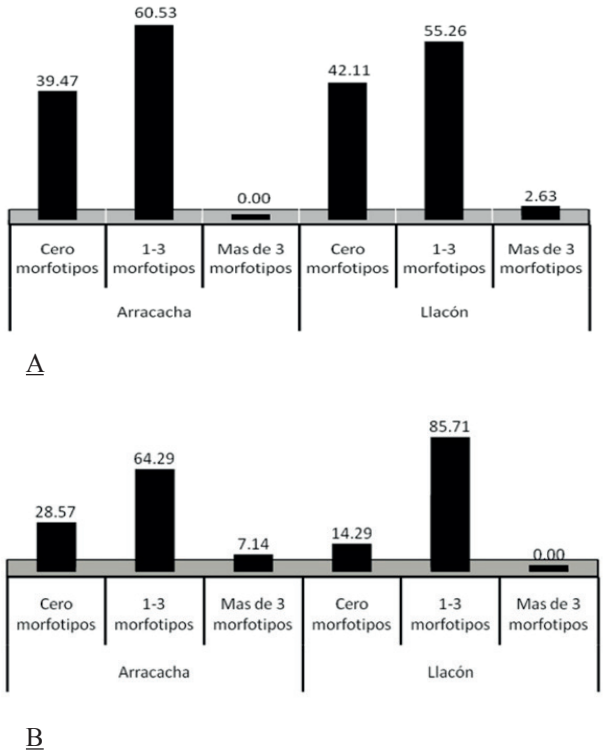

Figure 2. Percentage of farmers surveyed in the districts of Huacrachuco (A) and San Pedro de Cholón (B) according to the number of arracacha (*A. xanthorrhiza)* and yacón (*S. sonchifolius*) morphotypes conserved in their plots.

Sociocultural aspect of conservationist communities—It was found that the communities have active comuneros (when they live in the localities) and passive (people who are registered but live in other localities). Nuevo Chavín, Nueva Esperanza, San Cristóbal, Chogopillo, San Vicente and Ututo have the status of a hamlet; while Huanchay, Marcopata, Quillabamba and Yamos are peasant communities (CC). A hamlet has its own authorities but they fulfill the mandates of the CC to which it belongs, a CC is made up of several villages whose maximum authority is the President, elected by democratic vote for a period of two years. In the district of Huacrachuco, 22 farmers mentioned that they speak Quechua but in Huanchay, Nueva Esperanza, San Cristóbal and Nuevo Chavín they speak Quechua and Spanish; in Quillabamba, Marcopata and Yamos they speak only Spanish. In the district of San Pedro de Cholón, only two growers mentioned that they speak Quechua and are migrants from the Huacrachuco district or from other localities. 20 farmers in Huacrachuco and six in San Pedro de Cholón stated that they only have incomplete primary education, seven in Huacrachuco and three in San Pedro de Cholón studied complete primary education, 11 in Huacrachuco and five in San Pedro de Cholón did not have access to education and No one mentioned that he had access to secondary school. It was observed that the older the producers, the less educated they are. The main source of income for peasant families is agriculture and family upbringing. Monthly monetary income was low (S /. 170.00 in Huacrachuco and S /. 196.25 in San Pedro de Chonta), according to the poverty map prepared by FONCODES (2006) the communities are in the category of poor because said income is lower to the minimum living wage. This situation hinders the conservation of arracacha and yacón germplasm because the heads of households temporarily abandon the plots to work in other paid activities.

The decision on the use and use of resources is made in a general assembly and the person in charge of enforcing them are the presidents in the CC and the lieutenant governor in the hamlets. According to Ruiz and Lapeña (2003), the conservation and sustainable use of agrobiodiversity and its components must be at the community level. The language and level of education are related to the practices and customs of the conservation of agrobiodiversity because its use and use obey a culture of traditional knowledge and linguistics. The loss of the Quechua language and the lack of access by farmers to formal education are threats to the conservation of the arracacha and yacón germplasm, despite the fact that these plant genetic resources are indispensable to ensure the food sovereignty and monetary income of rural societies (Ruiz and Lapeña 2003). For Pia (2005) culture can not survive for long without a basis of sustainable agriculture, an ethic of land use and the adequate use of agrobiodiversity and natural resources existing in the farms. Phenotypic classification of native varieties of the arracacha and yacon

The 23 arracacha samples (*A. xanthorrhiza*) characterized based on 21 qualitative descriptors (Annex 1), were grouped into three different phenotypic groups (GF), with a cofeetic correlation value of 0.67 (Figure 3A). The characteristic color of the edge of the leaflets showed no variability in the samples. The prediction ellipses corroborated the classification of the phenotypic groups identified (Figure 3B).

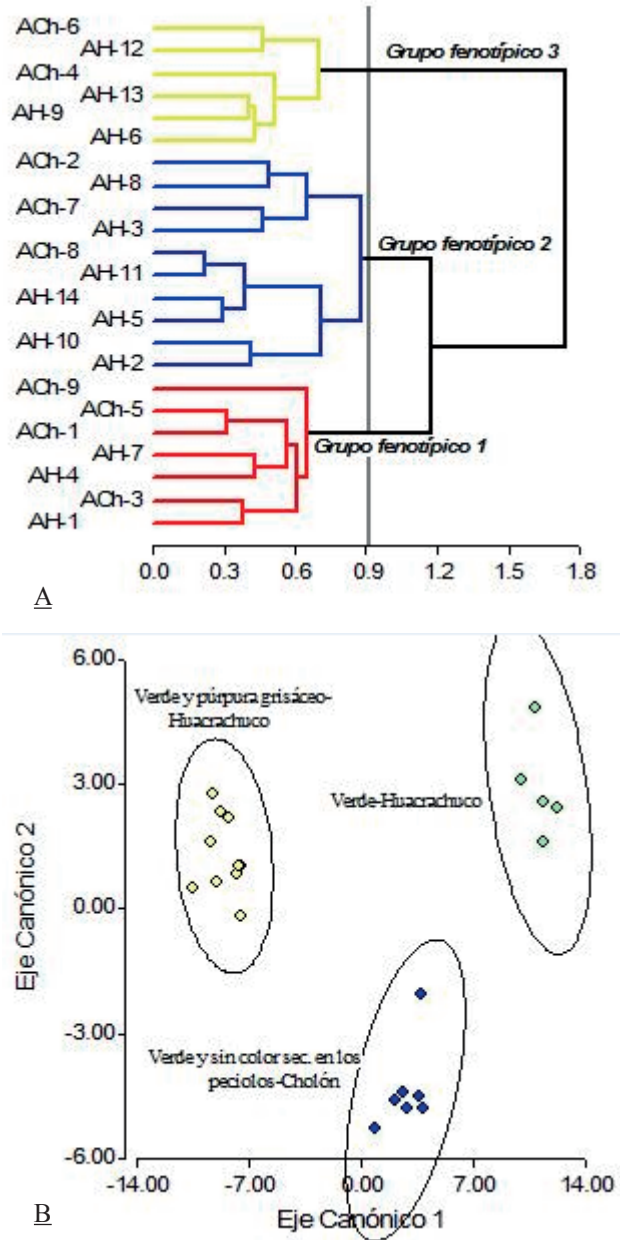

Figure 3. Dendogram (Ward method, Gower distance) (A) and prediction ellipses (B) for the phenotypic classification of 23 arracacha samples (A. *xanthorrhiza*) grown in the province of Marañón.

The GF were nominated based on the most discriminating characteristics within each group of easy

observation in the plants (secondary color of the petiole of the leaves) and the name of the district of origin of the samples: Green and without secondary color in the petioles-Cholón (GF 1), Green and grayish purple-Huacrachuco (GF 2), Green-Huacrachuco (GF 3).

In the AD, the percentage of the eigenvalue associated with the first discriminant function with standardized data explained 88.25% of the variability observed for the 21 characteristics (Table 1) and separated two characteristics of the leaf as the most discriminatory: secondary color of the underside and the secondary color of the petiole; secondarily, it discriminated the predominant color of the petiole, the edge of the leaflets and the secondary color of the surface of the reserve root. The misclassification rate was zero, which indicates that the 23 accessions are classified into three different GFs with high similarity within each group. The importance of these characteristics shows that the producers keep the accessions mainly by the secondary color of the surface of the reserve root. According to the color of the pulp there are four types of arracacha: white, yellow, white with purplish and yellow pigmentation with purplish pigmentation (Tapia and Fries, 2007).

Table 1. Qualitative characteristics that discriminate the three phenotypic groups of 23 arracacha samples (*A. xanthorrhiza*) grown in the province of Marañón.

Qualitative characteristic	Discriminant axis 1
Predominant foliage color	1.26
Predominant color of the underside	-0.97
Secondary color of underside	4.24
Distribution of the secondary color of the underside	-1.74
Predominant color of the petiole	-2.68
Secondary color of the petiole	-4.32
Distribution of the secondary color of the petiole	0.69
Petiole Serosity	-0.29
Leaflets edge	-2.36
Acumen of terminal leaflet	-1.16
Dissection of the terminal leaflet	-1.13
Predominant color of the pulp of the colinos	0.04
Secondary color of the pulp of the colinos	0.46
Distribution of the secondary color of the pulp of the colinos	0.46
Predominant surface color of the reserve root	0.04
Secondary color of the surface of the reserve root	2.93
Distribution of the secondary color of the surface of the reserve root	-1.26
Form of the reserve root	1.56
Predominant color of the reserve root pulp	0.68
Secondary color of the reserve root pulp	0.21
Distribution of the secondary color of the pulp of the reserve root	0.21

The 34 accessions of yacon (*S. shonchifolius*), characterized on the basis of 17 qualitative descriptors (Annex 2), were grouped into four different GFs, with a cofenetic correlation of 0.62 (Figure 4A). The branching of the stems and the leaf apex showed no variability. The prediction ellipses, with a confidence of 90%, clearly corroborate the classification of the phenotypic groups identified (Figure 4B).

The groups were nominated based on the color of the root of the reserve root and the name of the district of origin of the samples: light yellow and orange-gray Huacrachuco (GF 1), whitish yellow-Huacrachuco (GF 2), Yellow whitish-Cholón (GF 3) and Amarillo claro-Huacrachuco (GF 4).

In the AD, the percentage of eigenvalue associated with the first discriminant function with standardized data explained 91.19% of the observed variability (Table 2) and separated a characteristic of the leaf (color from the edge of the sheet of the leaf) and a of the root (color of the pulp of the reserve root) as the most discriminating; secondarily, they discriminated the number of teeth of the flower, the color of the surface of the reserve root and the color of

Table 2: Phenotypic characteristics that discriminate four phenotypic groups of the 34 yacon samples (*S. sonchifolius*) in the province of Marañón

Qualitative characteristics	Dicriminant axis 1
Predominant color of stems	-0.29
Secondary color of stems and their distribution	-0.22
Foliage color	0.38
Beam film color	-0.02
Rib color	-0.17
Overlapping wings	0.00
Plate shape	0.38
Foil base	-0.11
Sheet edge	1.16
Bloom habit	-0.24
Color of ligulate flowers	-0.65
Flower shape	0.17
Number of flower teeth	-0.83
Seed production	0.10
Surface color of the reserve root	0.95
Color of the reserve root pulp	1.17
Slit in the reserve roots	0.07
Color of the propagules	0.78

the propagules. The misclassification rate was zero, which indicates that within the four different GFs there is a high similarity within each one. The GF classification of this species is more related to the classification of the producers, who classify by the color of the reserve roots.

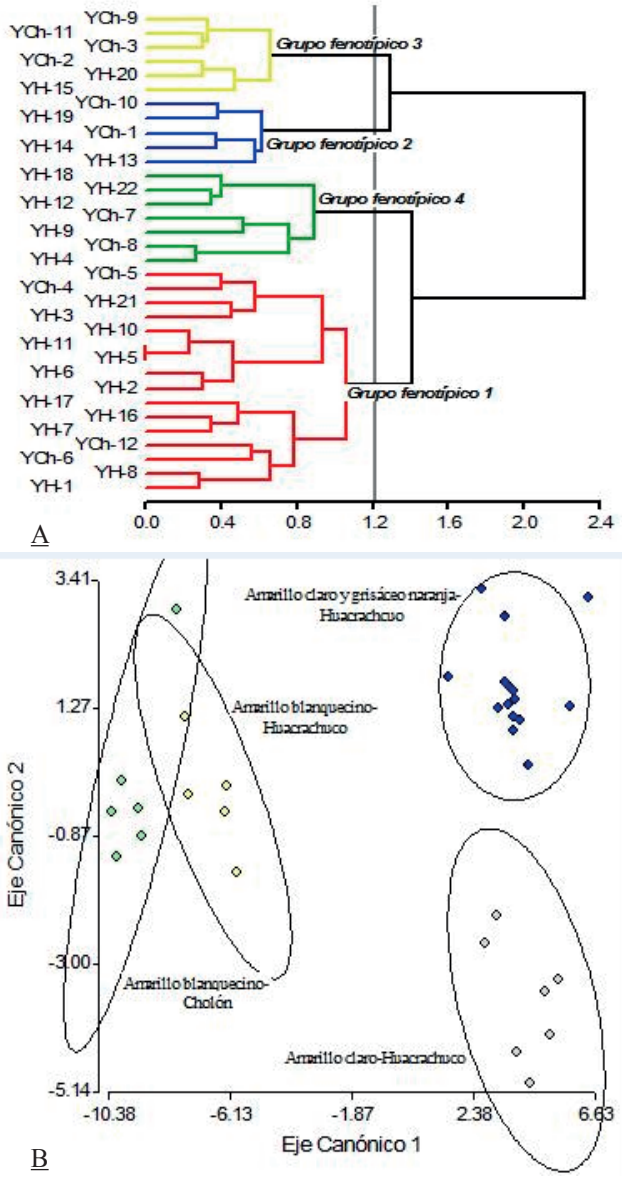

Figure 4. Dendogram (Ward method, Gower distance) and prediction ellipses for the phenotypic classification of 34 yacon samples (***S.*** *sonchifolius***)** grown in the province of Marañón.

Mansilla et al. (2006), based on a molecular study, found greater diversity of yacones in the accessions from the central zone of Peru. Seminar et al. (2003) report, for the northern zone (Cajamarca, Amazonas, Lambayeque, Piura and La Libertad), seven yacon morphotypes, four of them of greater distribution and cultivation: purple (distinguished by the pulp color of the root), yellow and white (distinguished by the pulp color of the root), and purple green (distinguished by the color of the foliage). Tapia and Fries (2007) also report eight morphotypes, cultivated in the north of Peru, whose differential characteristics are the external color of the root, main and secondary color of the pulp, color of the stem, hue in the color of the flower, form of the leaf, shoot color, branch of the stem and vegetative cycle.

The majority of qualitative characteristics showed variation within the samples, which indicates the existence of different morphotypes in the native botanical varieties of *A. xanthorrhiza* and *S. sonchifolius*, because these characteristics are little affected by the environment (Vásquez et al., 2004).

Description of the wild arracacha and yacon ecotypes— The farmers of Huacrachuco distinguish two ecotypes of wild arracacha: tempera and puna. Two tempering samples were described, whose populations develop in the lower part of the communities of Marcopata and Quillabamba, of 2,500 m.a.s.l. at 2750 m.a.s.l., on the right bank of the Rio Grande de Huacrachuco; they inhabit in pircas, grasslands, forests, dry hillsides; the soils are light brown and with abundant stoniness. It has the following morphological characteristics: stems higher than 1.5 m. of height, smaller leaves than of the cultivated varieties, distribution of the branches are similar to these, internodes of the stem more elongated, reserve roots thinner and smaller than of the cultivated ones (Figure 5A); after the physiological maturity all the foliage dries and only the roots and colines are buried for the regeneration of the new plants. According to the habitats described by Blas et al. (2008a, b) for the arracachas in Peru, it would belong to the species A. incisa. Another sample of puna arracacha was described, whose population develops in the Pishtaj ravine (upper part of the community of Marcopata) at 3530 m.a.s.l. it inhabits within an abundant population of pajonales (*Ichu* sp.); the soil presents a high slope, open texture and dark coloration (Figure 5B). The plants reach heights between 0.60 m-0.90 m, the reserve roots are thicker in relation to the tempering ecotype; the branching is more leafy, they have internodes and smaller leaves in relation to the cultivated varieties. According to the habitat described by Blas et al. (2008a, b) and the morphological characteristics that it presents would also be a species of *A. incise*.

According to the producers, the wild yacon accessions evaluated were also classified into two ecotypes: yellow and red. The yellow ecotype (Figure 6B) develops in the forests of the Llapshagaga creek (Nuevo Chavín) and has the following characteristics: plant height between 0.50 m. more than 1 m., inflorescence chapters smaller than the cultivated varieties, they do not present ramifications, the leaves are horned and smaller than the cultivated ones, small mature roots (average of 9 cm long and 3.5 cm. diameter) and excrete white latex; at the end of the vegetative cycle, the entire leaf part is dried and only the reserve roots and the structures of the regeneration strains are buried. This ecotype also develops in the Pishtaj stream

(Marcopata). According to the characteristics described by Grau and Rhea (1997) for wild yacon species, this ecotype would belong to the species *Smallanthus jelksii*. The red ecotype (Figure 6A) develops on the slopes adjacent to the Huacrachuco-Marcopata road; the plants present red flowers, average height of the stem of 35 cm., beam of the pubescent leaves, smaller leaves than of the cultivated varieties, the reserve roots measure 6 cm. of length and 1 cm. in diameter on average.

The arracacha and yacón ecotypes show morphological differences due to the adaptation conditions to different habitats (tempera or low zone and puna or high zone) or speciation differences. In the district of San Pedro de Chonta there were no arracachas or wild yacon; The probable loss of this genetic material can be due to two factors: 1) the degradation of natural habitats due to anthropogenic interventions resulting from agricultural activity and the extraction of wood and firewood from low forests, 2) biophysical barriers that determine the adaptation to particular ecological floors.

Figure 5. Wild arracacha arracacha, grandfather arracacha of tempera in their natural habitat (*A. incisa*) (A) and arracacha of puna grandfather reproduced in pot (*A. incisa*) (B).

Figure 6. Figure 6: Yacon wild ecotypes: sacha yacón rojo (s.i.) (A) and sacha yacon amarillo (*S. jelksii*) (B).

Indicators of in situ conservation of arracacha, yacon and their wild relatives-Six in situ conservation indicators were described for arracacha and yacon: agroclimatic conditions of conservation communities, climatic conditions of wild ecotype habitats, traditional practices of conservation, biotic factors, traditional classification of the phenotypic variability of the arracacha and yacon cultivated, and commercialization of the roots of the arracacha and the yacon.

The communities of the Huacrachuco district are located in the Montano Sub Tropical life zone and the communities of the San Pedro de Cholón district in the Montano Cálido life zone. Altitude, ecological levels, life zones, temperature variation and relative humidity are biophysical variables that influence the morphotype variability of arracacha and yacon. The agro ecosystems of these crops are located from 2500 m.a.s.l. up to more than 3000 m.a.s.l., in ecologic levels Quechua semárida (communities of the district of Huacrachuco) and Quechua semihúmeda (communities of the district of San Pedro de Cholón) (Tapia and Fries, 2007). The wild ecotypes are developed in the Quechua and Suni flats, in natural ecosystems (slopes with thickets, grasslands, pyrrhus, forests, etc.) where the pressures of natural selection are present. In the low zones or tempering of the communities of Marcopata and Quillabamba the wild ecotypes of the arracacha are developed and in the high areas or puna both ecotypes are wild.

Local practices related to the conservation of arracacha and yacon morphotypes are: i) seed management, the arracacha seed colonies are resting for a week under shade or exposed to the sun, then before sowing, women perform a cut in V in the base of the seed to stimulate the rooted, a better development of the plant and the production of roots reservantes of good quality. The producers of Lauricocha (Ayacucho), Pariahuanca (Junín) and Santa Teresa (Cusco) make a round cut at the base of the seed, in addition to four types of cuts: round, triangle, oblique round and cap-shaped (Calua, 2006). In the case of yacon, the parent or daughter strains are rested in shade for one or two weeks before isolating the propágalos, some farmers leave the strains buried or discovered at the harvesting site until planting. The farmers of Lauricocha (Ayacucho) place the selected hives in the shade of the fruit trees or bury them in the farm, in order to avoid dehydration (Calua, 2006); ii) land preparation, are similar for arracacha and yacon; in Huacrachuco they use barretillas for the fallow and pillories for the desterronado (or pestle); in Cholón and Nuevo Chavín, some make the possession, which consists of building pools of 20x20x20 cm. using the barretilla, the same day of the sowing; iii) sowing and management of plantations, sowing is done using peaks and lampas. The arracacha corms or the yacon strains are divided into propagules, before sowing. These crops are usually planted on the edges of fields of corn, potatoes, etc., in some cases in small family gardens, around the house and rarely in monoculture. In the case of the arracacha, this practice would be related to the demands of the crop, which according to Tapia and Fries, (2007) prefers low to medium soils in N and high in P and K; iv) weeding and hilling, the weeding is carried out according to the presence of the weeds in the agros ecosystems and the hilling is carried out once or twice during the campaign; v) harvest, the time that lasts from sowing to harvest varies according to the agroclimatic conditions of the communities. In Huacrachuco, the arracacha and yacon harvest takes place 10-12 months after sowing and in San Pedro de Chonta the arracacha is harvested from six months to 10 months after sowing; Yacon is usually harvested at eight months. The main harvesting practices of the arracacha and the yacón are the removal of the plants with barretilla or the cutting of the foliage prior to harvesting.

The biotic factors that influence the evolution of morphotypes and ecotypes of arracacha and yacon are pests and diseases, although their incidence is low in Huacrachuco and San Pedro de Chonta. The most frequent pests that attack the arracacha are the plant cutters or shiuri (*Agrotis* sp.) And the fly miner (S. I.); in Cajamarca and Piura the main pests of the arracacha are the white worm (s. i.), the chanso (*Bothinus maimon*), the cuso (a white larva-s.i.) and the aphid (*Myzus* sp.); Among the diseases, the leaf spot and the rotting of the reserve roots stand out (Seminario, 2004). The potential pests of yacon are the plant cutters or shiuri (*Agrotis* sp.), The diabrotica (*Diabrotica sp.*) And the slug (*Salix* sp.) That attacks leaves and roots in the district of Hucrachuco. The potential importance of yacon pests may be due to the existence of two defense systems presented by plants (Tapia and Fries, 2007): abundance of hairs on the surface of the leaves that are barriers for insect access and the production of toxic for insects by the glands of the base of the leaves.

The traditional classification of arracacha and yacon variability is based on the color of the flesh, flavor and color of the skin of the reserve roots. In case of yacon, the farmers relate the color of the skin and the pulp of the reserve roots with the archetype of the plant and the coloration of the stems; for example, the varieties whose reserve roots are purple pulp have a higher leaf volume, are more leafy and the leaves are darker in relation to white varieties; in case of the arracacha also relate the coloration of the pulp and the skin of the storage roots with the coloring of the young leaves and the production, for example, the dark green color of the young leaves is related to the purple color of the pulp, the yellow varieties are more productive, the yellow and white varieties are less astringent with respect to the purple ones. Holle (2006) points out that peasant knowledge must be incorporated into conventional descriptors, when the assumption that the characters have a certain heritability is met, for example, a high correspondence between the common name and the morphotypes found for 25 samples of goose evidence relevance of peasant knowledge. To the wild ecotypes of the arracacha and yacon, the farmers of the different communities generally classify by the color of the flower, the use they give it and the habitat where they develop.

The arracacha and yacon reserve roots are generally used for human consumption, 25% of respondents indicated that they give to the neighbor and 30% make barter. In times of harvest, families consume arracacha four to five times a week on average, in different forms: parboiled in place of potatoes or cassava, in soups in the form of slices. For the yacon, only 20% of the producers mentioned selling the reserve roots in the local market and only in times of harvest do families consume up to five times per week.

***Ethnobotanical indicators*—**Three ethnobotanical indicators have been described: linguistics, customs of use and exploitation of the agrobiodiversity of the arracacha and yacon, and the contribution of these resources to the family economy. The common name used by farmers for arracacha cultivated is rich; the wild ecotypes are known as field rich because they consider that they are plants of the grandfather apus or ricahca because they believe that they were domesticated by the Auquillos (pre-Inca settlers); in the north of Peru (Cajamarca and Piura), wild arracachas are known as arracacha "de zorro", "de monte", "de gentile", "de cerro", "de jalca", purunracacha and arracachilla (Seminario, 2004). The cultivated yacon is commonly known as llacón and the wild ecotypes as field llacón because they believe that these plants are owned by the apus, llaconcito or llaconcillo because they give a connotation of an infra-specific group in relation to the cultivated ones, for example, stems and smaller storage

roots.

Most producers know the nutritional benefits of cultivated morphotypes. The nutritional value of the arracacha is given by the quality of its starch and its high content of carotene, calcium, phosphorus, iron and niacin (Jiménez, 2005, Amaya and Julca, 2006), and by the calcium and ascorbic acid content of reserve roots superior to potatoes and iron and niacin superior to cassava (Jiménez, 2005). The healing benefits of the wild ecotypes are known only by farmers called healers who use the foliar part of the mature plants to cure: i) the scare or poor field (charm of the hill or aukillo), in the communities of Marcopata and Quillabamba use grandfather's grandfather combined with other herbs, such as the frame (*Ambrosia* sp.), the chincho (*Tagetes elliptica*), culantro de perro (*Coriandrum sativum*); heat in a pot macerating with kerosene, alcohol or human urine until the branches become flaccid and secrete aqueous substances; then perform the rubbing or "shocpi" the naked patient and finally the remains are thrown to the hill where there is little frequency of passers-by and pay coca and cigar to the aukillos; ii) childbirth and childbirth, with the young leaves of the cultivated and / or wild arracacha an infusion is prepared and then the patient drinks as tea water; the pucha or puchita is also prepared by rubbing the leaves between the fingers until they become flaccid and then a rub is performed to locate the patient on the affected or painful part; iii) cephalalgias, colds and headache, with the leaves of the cultivated or wild arracachas an infusion is prepared for a time of approximately 10 minutes, then they give the patient to drink; the treatment is repeated for three or four days. Tapia and Fries (2007), indicate that the cultivated arracacha is used as an infusion to calm stomach pains, regulate menstrual disorders and facilitate recovery after delivery. Another form of use is rubbing the leaves with your hands until they take a yellowish color and then with them rub the body.

From the cultivated yacon the reserve roots are consumed in the form of fresh, to quench the thirst after the days of work in the farm, as revitalizing in the long walks (12 hours or more) but this practice has been lost in recent years. The roots of the wild yellow ecotype are used as fresh by the shepherd children and for the feeding of pigs by grazing in the open field, the leaves are used to feed guinea pigs; the red ecotype is not used by producers.

The families do not calculate the monetary income obtained by the arracacha or yacón products, nor do they determine the volume of production because these products are for family consumption, exchange, transformation. The yields of these crops depend on the age of the plants, at higher age the reserve roots are larger and thicker, and the genotype. According to the farmers, arracacha amarrilla and yacón crema present higher yields. The yields were estimated based on representative samples of the families. With the data on yields and prices in the local market, the average income per kilogram of arracacha and yacón was estimated at S/. 0.50 and S/. 0.70 respectively for the year 2004-2005. This culture and knowledge of conservationist farmers are important elements for in situ conservation of plant genetic resources and evolutionary processes in family agroecosystems (Chávez, 2006).

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