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Characterization of *Capsicum* germplasm collected in Northwestern Argentina based on morphological and quality traits

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SUMMARY

Paprika production is concentrated in Northwestern Argentina, where around 1500 ha are annually grown. Farmers mainly from Andean valleys, maintain their local landraces or "criollas" under different environmental conditions, using their farming traditions and selection criteria. These traditional varieties represent valuable genetic resources for conservation and selection of agronomical and quality traits. Between 2005 and 2007 eight collecting trips were made to Northwestern Argentina in order to recover local germplasm. As a result, five hundred new vegetable seed samples have been incorporated into the Germplasm Bank. Among these accessions 32 belong to *Capsicum,* the majority for paprika production, that were evaluated in field conditions using a randomized block design with three repetitions of eight plants per accession; 54 morphological and agronomical traits were measured during two production cycles. Multivariate analyses determine three groups, where fruit characters were the most efficient for accession differentiation. Accessions suitable for paprika production were further examined, and variability for fruit pungency and color was found. Promising accessions were selected for *ex situ* conservation and breeding purposes.

Key words: *Capsicum annuum*, *C. baccatum*, germplasm, characterization, pungency, pre-breeding

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RESUMEN

La producción de pimiento para pimentón se concentra en el noroeste de la Argentina, donde anualmente se cultivan unas 1500 hectáreas. En los valles andinos los agricultores mantienen sus variedades locales o "criollas" en diferentes condiciones ambientales y siguiendo sus tradiciones agrícolas y criterios de selección. Estas variedades son recursos genéticos valiosos para la conservación y selección de caracteres agronómicos y de calidad. Entre 2005 y 2007 se realizaron ocho viajes a dicha zona, con el fin de recuperar el germoplasma local. Como resultado 500 nuevas muestras de semillas de

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hortalizas se han incorporado en el Banco de Germoplasma. Entre ellas 32 entradas de *Capsicum*, la mayoría utilizadas para la producción de pimentón, que se evaluaron a campo mediante un diseño de bloques al azar con tres repeticiones de ocho plantas por entrada, y se midieron 54 caracteres morfológicos y agronómicos durante dos ciclos de producción. El análisis multivariado determinó tres grupos, donde los caracteres del fruto fueron más eficientes para la diferenciación de las entradas. Se estudiaron en particular las entradas para la producción de pimentón, encontrándose variabilidad en el picor y en el color del fruto. Las entradas promisorias fueron seleccionadas para su conservación *ex situ* y mejoramiento.

Palabras clave: *Capsicum annuum*., *C. baccatum*, germoplasma, caracterización, picor, mejoramiento

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INTRODUCTION

Andean civilizations in America domesticated several species for different purposes; peppers are found among these species, (Popenoe *et al.*, 1990). An area comprising Bolivia, Northern Argentina, Paraguay and middle and Southern Brazil has been considered the center of origin of *Capsicum* species (Pickersgill 1969, 1997). In Northwest Argentina, farmers have grown pepper crops following their traditional practices maintaining local populations under different environments over many years, resulting today in genetically different populations (Asprelli *et al.,* 2011). These types of populations are named “criollas”, “local” or landraces (Zeven, 1998). Nevertheless, there have not been systematic efforts in Argentina to recover these valuable resources, which are important for breeding programs (Thul *et al.*, 2006; Rêgo *et al.*, 2011b).

Genetic diversity among and within species of the genus *Capsicum* has been extensively investigated (Souza & Maluf, 2003); the level of variation within the domesticated species is lower than in their wild relatives, and variation in peppers with elongated and sweet fruit is limited compared to the diversity found among pungent peppers (Lefebvre *et al.*, 1993; Portis *et al.*, 2006, Marame *et al.,* 2009). Morphological and agronomical characters have been useful to evaluate local pepper collections in many countries like United States (Smith *et al.*, 1987), Yugoslavia (Zewdie & Zeven, 1997), Colombia (Medina *et al.*, 2006; Pardey *et al.*, 2006), Italy (Portis *et al.*, 2006), Turkey (Bozokalfa *et al.,* 2009), Peru (Ortiz *et al.*, 2010), Brazil (Rêgo *et al.,* 2009; 2011a,b; Rodrigues Monteiro *et al.*, 2010). In Argentina, genetic resources of vegetable crops are preserved *ex situ* at the Germplasm Bank of the Agricultural Experimental Station La Consulta INTA (Mendoza). Pepper genetic diversity maintained there was considered limited and local landraces were poorly represented in the germplasm collection until the year 2004. This concern brought the need for the recovery and evaluation of local populations.

Our work was specially directed towards the characterization of *Capsicum* germplasm suitable for paprika production. In Argentina around 13,000 ha of pepper are cultivated annually among them 1,500 ha are for paprika production, which is concentrated in Northwestern Argentina, in the provinces of Salta, Tucumán and Catamarca (Galmarini, 2000). Two paprika populations of *Capsicum annuum* L. are mainly cultivated, one with elongated fruits, locally called “Trompa de elefante” (elephant trunk), and another with round fruits known as “Bolita Salteño” or “Ñora” (Galmarini, 1993). Traditionally, Argentine market demands sweet paprika with intense color for dehydrated products. However, a common practice done by farmers in Northwest Argentina is to cultivate spicy peppers in family orchards in the vicinity of sweet paprika crops (Occhiuto *et al.,* 2006; Occhiuto 2009). As a consequence, contamination with pollen coming from plants with pungent fruits is quite common, since natural crosses may occur depending on varieties, environment conditions and the type and frequency of pollinators (Portis *et al.*, 2004; Thul *et al.*, 2006).

The main objective of this work was to evaluate local germplasm using morphological and agronomical traits. This characterization contributes to assess the variability of the accessions, to classify them for *ex situ* preservation in the Germplasm Bank, and also to determine promising materials suitable for breeding programs.

MATERIALS AND METHODS

Germplasm

Eight collecting trips were performed to Northwestern Argentina between 2005 and 2007. The itinerary included small villages, some of them isolated in high mountain valleys, in the provinces of Catamarca, Tucumán, Salta and Jujuy. In these rural communities, 103 growers were interviewed through informal surveys requiring information about traditional cultivation practices, consumption habits, criteria for selection of the fruits and seed maintenance methods (Peralta *et al.*, 2008). A total of 511 vegetable crop samples, representing 33 of different genus were recovered, among them 32 *Capsicum* accessions. These pepper samples were mainly collected in Andean valleys where paprika production is concentrated (Table 1, Figure 1). Seed samples were incorporated into the Germplasm Bank of the Agricultural Experimental Station La Consulta INTA.

Table 1 Pepper accessions, species, local names and characteristics of collection sites. (A P: Ají Picante, P M: Pimiento Morrón, P R: Pimiento Redondo,T E. Trompa de Elefante, U D: UCODULCE INTA).

Nº	Accession	Species	Local name	Elevation (m.o.s.l.)	Latitude (S)	Longitude(W)	Locality	Province
1	LC493	*C. baccatum*	A P	885	28º09,409'	65º39,415'	Paclín, La Merced	Catamarca
2	LC495	*C. baccatum*	A P	1208	27º56,493'	65º41,887'	La Higuera, Balcosna	Catamarca
3	LC496	*C. baccatum*	A P	1208	27º56,493'	65º41,887'	La Higuera, Balcosna	Catamarca
4	LC516	*C. annuum*	P M	2432	25º22,507'	66º26,134'	Refugios, Luracatao	Salta
5	LC517	*C. annuum*	P R	2400	25º22,195'	66º25,994'	Refugios, Luracatao	Salta
6	LC518	*C. annuum*	P R	2400	25º22,195'	66º25,994'	Refugios, Luracatao	Salta
7	LC521	*C. annuum*	P R	2651	25º17,608'	66º28,414'	Cabrerías, Luracatao	Salta
8	LC523	*C. annuum*	P R	2636	25º17,684'	66º28,285'	Cabrerías, Luracatao	Salta
9	LC506	*C. annuum*	T E	2083	27º09,279'	66º42,368'	Hualfín, Los Nacimientos	Catamarca
10	LC711	*C. annuum*	T E	2083	27º09,279'	66º42,368'	Hualfín, Los Nacimientos	Catamarca
11	LC507	*C. annuum*	T E	2083	27º09,516'	66º43,121'	Hualfín, Los Nacimientos	Catamarca
12	LC509	*C. annuum*	T E	1189	27°41,130'	66°59,644'	La Puntilla	Catamarca
13	LC510	*C. annuum*	T E	1246	27º39,160'	67º1,358'	Artasa, Belén	Catamarca
14	LC512	*C. annuum*	T E	1263	27º37,895'	67º1,580'	Belén	Catamarca
15	LC513	*C. annuum*	T E	1835	27º13,332'	66º49,621'	Hualfín, Los Nacimientos	Catamarca
16	LC514	*C. annuum*	T E	1951	25º59,672'	66º1,686'	San Antonio, Cafayate	Salta
17	LC522	*C. annuum*	T E	2651	25º17,608'	66º28,414'	Cabrerías, Luracatao	Salta
19	LC525	*C. annuum*	T E	1886	26º41,698'	66º3,015'	Las Mojarras, Santa María	Salta
20	LC526	*C. annuum*	T E	1932	26º43,590'	66º4,596'	Chañar Punco, Santa María	Catamarca
21	LC527	*C. annuum*	T E	1932	26º43,590'	66º4,596'	Chañar Punco, Santa María	Catamarca
22	LC528	*C. annuum*	T E	1904	26º41,300'	66º3,836'	El Cerrito, Santa María	Catamarca
23	LC529	*C. annuum*	T E	1957	26º46,894'	66º3,777'	San José, Santa María	Catamarca
24	LC531	*C. annuum*	T E	1934	26º46,899'	66º3,782'	San José, Santa María	Catamarca
25	LC532	*C. annuum*	T E	1873	26º40,002'	66º2,513'	El Puesto, Santa María	Catamarca
26	LC497	*C. annuum*	T E	1940	26º46,695'	66º3,595'	Santa María	Catamarca
27	LC498	*C. annuum*	T E	1926	26º43,370'	66º2,794'	San Antonio del Cajón	Catamarca
28	LC499	*C. annuum*	T E	1926	26º43,370'	66º2,794'	San Antonio del Cajón	Catamarca
29	LC501	*C. annuum*	T E	1943	26º46,142'	66º4,946'	Fama Tanka, Santa María	Catamarca
30	LC502	*C. annuum*	T E	1926	26º43,370'	66º2,794'	San Antonio del Cajón	Catamarca
31	LC503	*C. annuum*	T E	1926	26º43,370'	66º2,794'	San Antonio del Cajón	Catamarca
32	LC504	*C. annuum*	T E	1926	26º43,370'	66º2,794'	San Antonio del Cajón	Catamarca
33	Control	*C. annuum*	U D				Commercial cultivar	

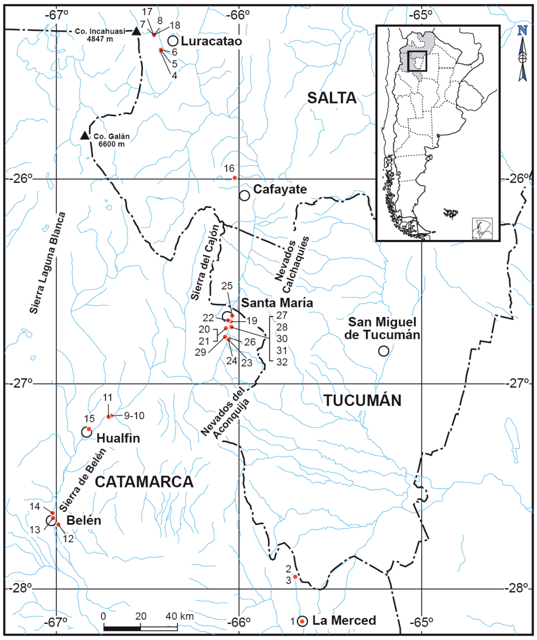

Figure 1 Collection sites in Northwestern Argentina. Number indicates pepper samples corresponding to the accessions evaluated (Table 1)

Experimental field and design

The trial was carried out on the experimental field of the Institute of Horticulture (33° 00,268'S, 68° 52,254' W, 912 m.a.s.l.) at the Faculty of Agricultural Sciences, Chacras de Coria, Luján de Cuyo, Mendoza, Argentina. Thirty two pepper accessions collected in Andean valleys of Northwestern Argentina, and a commercial pepper UCODULCE INTA selected for paprika production (Galmarini & Fuligna, 2003) were evaluated in two consecutive seasons (September 2005 - April 2006 and September 2006- April 2007). A randomized block design with three repetitions of eight plants per accession was used. The plants were placed at 0,45 m within row and 0,8 m between rows, cultivation was carried out under anti-hail mesh and drip irrigation.

Characterization

Characterization of the accessions was based on international descriptors for *Capsicum* (IPGRI,AVRDC and CATIE, 1995). Thirty five qualitative and 19 quantitative traits belonging to morphological, phenological, agronomical and fruit quality characters were evaluated (Table 2). Morphological, phenological and agronomical variables were calculated as averages of eight

Table 2. Morphological and agronomical traits measured in *Capsicum ssp* accessions

	Qualitative trait	Quantitative trait
Seedling	Hypocotyl color	Cotyledon leaf length (mm)
	Hypocotyl pubescence	Cotyledon leaf width (mm)
	Cotyledon leaf shape	
	Cotyledon leaf color	
Plant	Stem color	Plant height (cm)
	Stem pubescence	Plant canopy width (cm)
	Nodal anthocyanin	
	Plant growth habit	
	Branching habit	
Leaf	Leaf color	Mature leaf length (cm)
	Leaf shape	Mature leaf width (cm)
	Leaf pubescence	
	Lamina margin	
Flower	Number of flowers per axil	Days to flowering
	Flower position	
	Corolla color	
	Corolla shape	
	Corolla spot color	
	Anther color	
	Filament color	
	Stigma exertion	
	Male sterility	
	Calyx pigmentation	
	Calyx margin	
Fruit	Anthocyanin spots or stripes	Days to fruiting
	Fruit color at intermediate stage Fruit color at mature stage	Fruit width (cm) Fruit weight (g)
	Fruit shape	Fruit peduncle length (cm)
	Fruit shape at peduncle attachment	Fruit wall thickness (cm)
	Fruit shape at blossom end	Placenta length (cm)
	Fruit appendage end	Fruit yield/ plant
	Fruit cross-sectional corrugation	Soluble solids
	Fruit surface	Pungency
	Number of locules	pH of pericarp
Seed	Seed color	

plants per repetition. External color, pungency, pH and soluble solids were measured on 10 ripe fruits from each replicate.

Fruit pungency was assessed using a sensorial method (Barbosa *et al.,* 2002), the percentage of pungent fruits per accession was established, and the angular transformation of the average value was calculated. The external fruit color was measured with a Konica Minolta CR-400 colorimeter. The Hunter scale parameters (L, a, b), where "L" measured the brightness of the sample; "a" measured the tone of red to green colors; and "b" the tone of yellow to blue colors. With these parameters the hue angle was calculated (hue= arc tan b/a) and purity of color (chroma= √(a2 + b2); the value of "L" brightness was obtained as a direct measure of the colorimeter (Moreno-Pérez *et al.*, 2006). A multiple correspondence analysis was applied to the qualitative variables using the programme Statistica 6.0 (Statsoft, 2004). The significance of the quantitative variables was tested through the analysis of variance, for a $p \leq 0,05$.

A grouping analysis of the 33 accessions was performed using significant quantitative variables. Only significant continuous variables were included in the analysis, and the algorithm of Ward was used. A detailed analysis for pepper accessions suitable for paprika production was performed. The explanatory variables were as well identified (Matus *et al.*, 1996).

RESULTS

Qualitative Characters

Among the 35 qualitative variables evaluated, 24 were not polymorphic, so 11 qualitative characters were included (Table 3). Pepper accessions were arranged in three defined groups (Figure 2).

Table 3. Summary of differential qualitative characters present in different accessions groups

Group	Accession	Differential qualitative characters
I	4, 5, 6, 7, 8	green hypocotyls, erect plant growth habit, ovate leaf shape, dark green leaf color, purple anther, triangular fruit, fruit with 3 locules, cordate peduncle attachment
II	9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29,30, 31, 32, 33	green hypocotyls, erect plant growth habit, ovate leaf shape, dark green leaf color, purple anther elongate fruit, fruit with 2 locules, obtuse peduncle attachment
III	1, 2, 3	purple hypocotyls, intermediate plant growth habit, deltate leaf shape, light green leaf color, corolla with greenish spots inside, yellow anther, elongate o blocky fruit, fruit with 2 o 4 locules, obtuse peduncle attachment

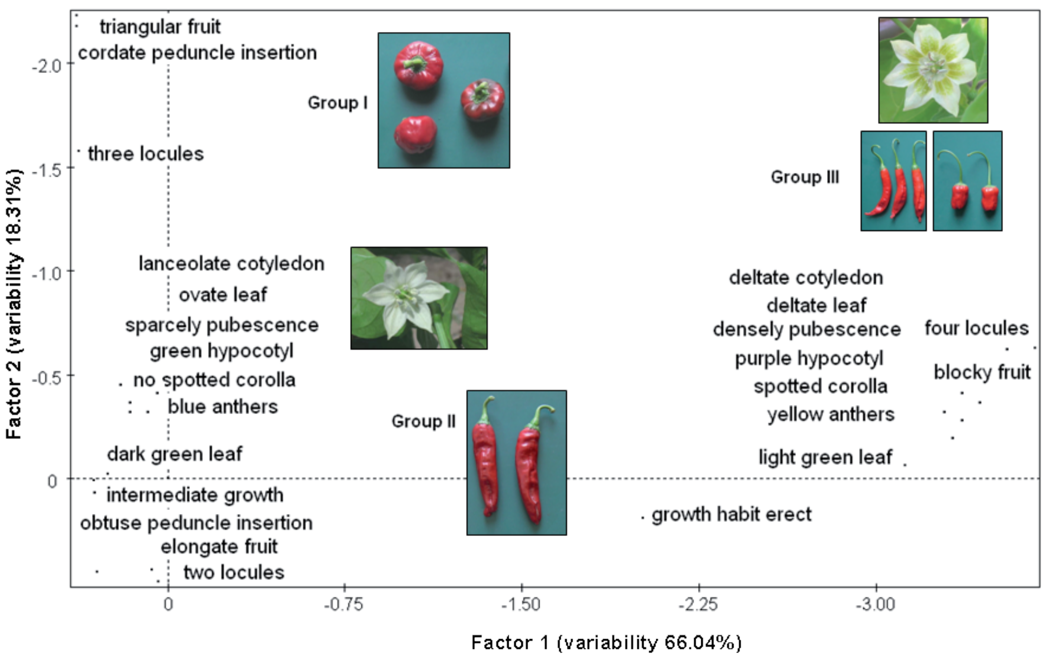

Figure 2. Multiple correspondence analyses, showing three groups based on 11 qualitative characters of 33 pepper accessions

Groups I and II correspond to entries that belong to *Capsicum annuum*. These two groups share the following common characteristics: green lanceolated hypocotyls, spare pubescence, erect plant growth habit, ovate leaf shape, dark green, non spotted corolla, blue anthers, and wide or elongated triangular fruits, with 2 or 3 locules, Group I, included 5 entries, differentiated by their triangular fruits with cordate insertion of the peduncle and three locules. In Group II, 25 entries had elongated fruits, with obtuse fruit shape at peduncle attachment and 2 locules, Group III included 3 accessions of spicy peppers, which correspond to *C. baccatum* L., characterized by purple hypocotyls, intermediate plant growth habit, deltate leaf shape, light green, narrow elongated or blocky fruit, with 2 or 4 locules, spotted corolla, and yellow anthers. In one of the accessions the fruit shape was typically square and narrow.

Quantitative Characters

There were no significant effects for blocks and years (data not shown), so the average was calculated using the data of two seasons. Among the 19 quantitative traits, four (plant width, leaf length and width, and days from transplant to fruiting), did not show significant differences for a level of $p \leq 0,05$, all the others were polymorphic (Table 4).

Cluster Analysis

The groups obtained were similar to those found using multiple correspondence analyses. Fruit characters were the most influential variables in clustering results (Figure 3, Table 5).

Accessions corresponding to groups I and II belonged to the species *C. annuum*. Group I included 5 entries, with triangular fruits of greater pulp thickness (0,36 cm), wider (6,21) and smaller length.

Group II, included 25 entries with elongated fruits. This group subdivided two subgroups: "a" including fruits of greater length and lower flesh acidity, and "b" grouping less pungent and reduced pulp thickness fruits.

Group III included 3 accessions of spicy peppers, corresponding to *C. baccatum*, characterized by the largest number of fruits per plant (113,53), less fruit weight (6,94 g) and size, and pungent fruits; the subgroup "c" was highlighted by its elongated fruits. A subgroup "d" was separated by its square fruit shape.

Table 4. Analysis of variance of 33 *Capsicum* accessions for 21 quantitative traits

S.V.	Accessions[b]	Error
df[a]	32	163
CLL	0.00056*	0
CLW	0.00011*	0
PH	460.53*	265.29
PW	415.55	523.91
LL	8.12	9.95
LW	1.16	0.98
DFL	80.1*	51.04
DFR	67.62	60.18
DFL	80.1*	51.04
DFR	67.62	60.18
FL	97.88*	0.94
FWI	8.49*	0.1
FW	1039.26*	48.98
PL	1.72*	0.09
PLL	6.74*	0.62
PT	0.03*	0.0022
L	13.95*	4.34
H	0.0015*	0.0009
C	14.54*	5.82
NFP	5157.21*	58.38
P	1.16*	0.13
pH	0.1*	0.02
SS	8.8*	1.78

[a] df: degree of freedom; [b] Mean Square values; * Significant at $p \leq 0.05$; CLL: Cotyledon leaf length; CLW: Cotyledon leaf width; PH: Plant height; PW: Plant canopy width; LL: Mature leaf length; LW: Mature leaf width; DFL: Days to flowering; DFR: Days to fruiting; FL: Fruit length; FWI: Fruit width; FW: Fruit weight; PL: Fruit peduncle length; PLL: Placenta length; PT: Fruit wall thickness; L: lightness; H: hue; C: chroma; NFP: Number of fruits per plant; P: pungency; PP: pH of pericarp; SS: Soluble solids.

Evaluation of pepper accessions suitable for paprika production

Principal Component Analysis (PCA): PCA was performed among 25 accessions of group II that were suitable for paprika production. Three components explained 60,4% of the variability (Figure 4). The first principal component (33,4%) included the variables: leaf length and width, fruit weight and width, and components of the external fruit color (brightness, tone and purity), length of peduncle, pulp thickness and fruit pungency. The second principal component explained 14% of the variation, and the variables were number of days to flowering and fruiting, and number of fruits per plant. Finally, on the third component (13%) the variables that contributed to explain variation were placenta and fruit length.

Accessions 29, 30, 31 and 32 have the best

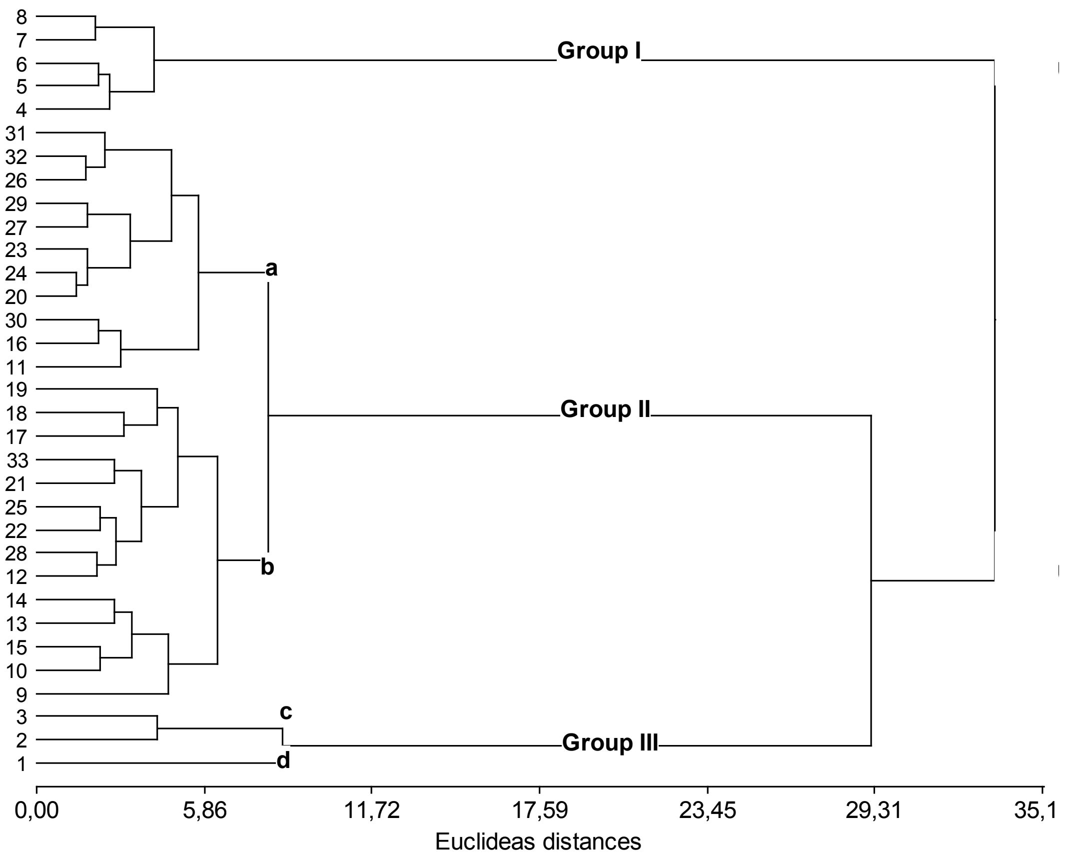

Figure 3 Dendrogram of 33 pepper accessions (numbers are indicated in Table 1)

Table 5 Means, standard deviations, and ranges of significant quantitative characters of the accession groups

Trait	Group I	Group II	Group III
CLL	1.02 ± 0.09 (0.9-1.1)	1.09 ± 0.08 (0.92-1.25)	0.92 ± 0.03 (0.89-0.94)
CLW	0.2 ± 0.03 (0.15- 0.24)	0.23 ± 0.03 (0.17-0.29)	0.24 ± 0.11 (0.16-0.37)
PH	69.64 ± 6.44 (60.12-78.18)	73.68 ± 7.3 (61.14-86.48)	88.5 ± 3.77 (85.97-92.83)
DFL	113.73 ± 2.63 (110.5-116.83)	110.52± 2.89 (105.67-119.67)	116.89 ± 5.6 (113.17-123.33)
FL	4.34 ± 0.25 (4.1-4.69)	13.95 ± 1.2 (11.71-17.25)	6.91 ± 3.32 (3.47-10.09)
FWI	6.21 ± 0.29 (5.89-6.58)	3.64 ± 0.28 (3.18-4.23)	1.71 ± 0.5 (1.38-2.28)
FW	53.7 ± 4.84 (49.04-60.79)	42.37 ± 6.82 (30.99-54.39)	6.94 ± 0.93 (5.87-7.54)
PL	3.25 ± 0.15 (3.1-3.48)	3.72 ± 0.26 (3.28-4.13)	5.18 ± 0.11 (5.11-5.31)
PLL	1.46 ± 0.09 (1.36-1.55)	3.7 ± 0.52 (2.75-4.85)	4.12 ± 1.86 (2.23-5.95)
PT	0.36 ± 0.03 (0.31-0.39)	0.19 ± 0.01 (0.17-0.22	0.09 ± 0.02 (0.07-0.11)
L	24.01 ± 0.47 (23.47-24.65)	26.17 ± 0.61 (25.05-27.38)	29.83 ± 0.72 (29.09-30.52)
H	0.3 ± 0.01 (0.29-0.3)	0.32 ± 0.01 (0.31-0.34)	0.34 ± 0.004 (0.34-0.35)
C	25.27 ± 0.33 (24.91-25.72)	27.45 ± 0.61 (25.97-28.24)	32.04 ± 0.91 (30.99-32.57)
NFP	15.57± 1.28 (13.33-16.33)	12.88 ± 1.39 (9.33-15)	113.53 ± 4.47 (109.25-118.17)
P	0.13 ± 0.14 (0.03-0.38)	0.48 ± 0.29 (0-1.05)	1.57 ± 0
pH	5.32 ± 0.05 (5.25-5.38)	5.2 ± 0.13 (5.02-5.47)	5.27 ± 0.19 (5.07-5.45)
SS	11.67 ± 0.41 (11.07-12.2)	13.85 ± 0.66 (12.62-15.27)	13.88 ± 2.81 (10.73-16.13)

CLL: Cotyledon leaf length; CLW: Cotyledon leaf width; PH: Plant height; PW: Plant canopy width; LL: Mature leaf length; LW: Mature leaf width; DFL: Days to flowering; DFR: Days to fruiting; FL: Fruit length; FWI: Fruit width; FW: Fruit weight; PL: Fruit peduncle length; PLL: Placenta length; PT: Fruit wall thickness; L: lightness; H: hue; C: chroma; NFP: Number of fruits per plant; P: pungency; PP: pH of pericarp; SS: Soluble solids.

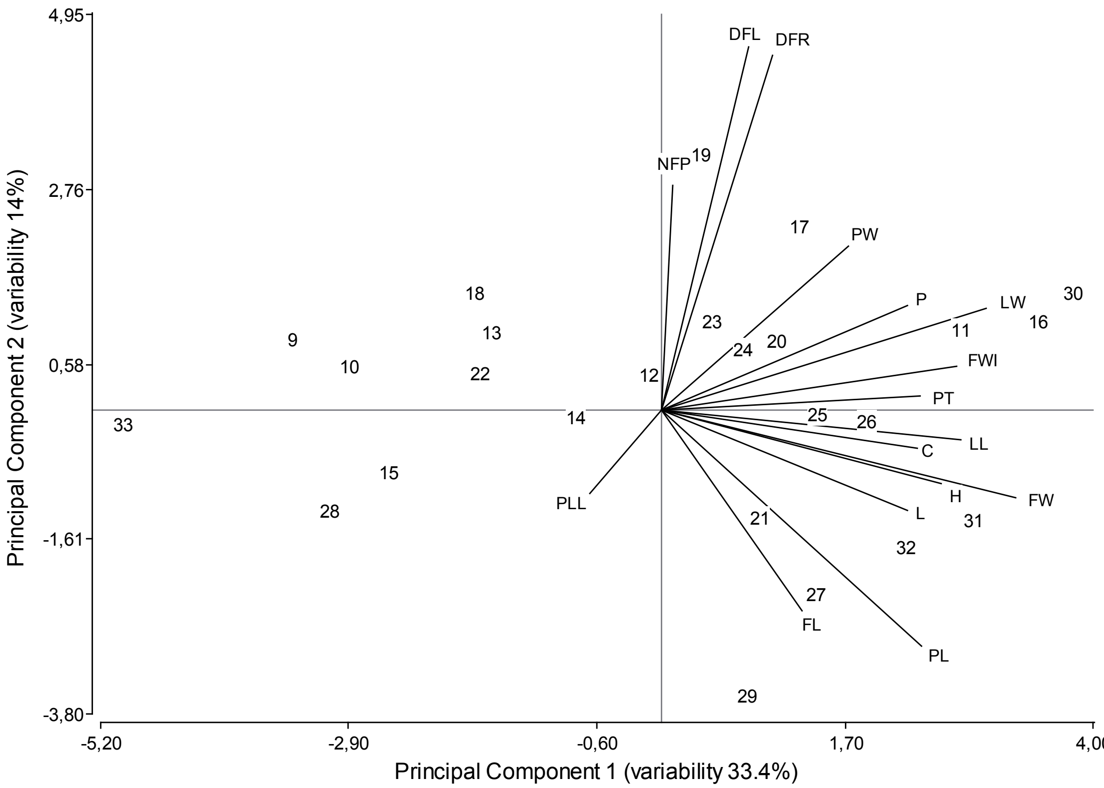

Figure 4. Distribution of 25 pepper accessions in the first and second primary components. (Variables codes are indicated in Table 4)

growth habit. Regarding phenological variables, accessions: 10, 12, 13, 14, 15, 22 and 28, were the earliest for flowering and fruiting; accession 27 showed fruits of greater length. Accessions 10, 12, 13, 14, 21 and 28 have less pungent fruits; and accessions 10, 14, 15, 17 and 31 have fruits with reduced pulp thickness.

Another important feature for paprika production is the uniformity of the fruits. The accessions that showed greater uniformity were: 13, 20 and 24. A more extensive description of the above entries can be found in the catalogue of "criollas" populations of pepper, tomato and pumpkin collected in Argentinean Andean valleys (Peralta *et al.*, 2008).

Regarding pungency the control (33) and the accession 28 were significantly different due to the absence of pungent fruits, while accession 16 presented the greatest pungency. The 22 remaining accessions were not statistically different among themselves (Figure 5). Ninety six percent (96%) of the evaluated samples presented different degrees of pungency. However, a great variation within each sample was found (the coefficient of variation was 55,3%).

DISCUSSION

This is the first study that deals with *Capsicum* landraces variability in Argentina. Information about crop management practices, seed conservation and food uses by small farmers was recovered. A significant number of recovered accessions are now maintained in the Germplasm Bank at E.E.A La Consulta INTA.

Morphological and agronomical characters allowed the characterization of 33 accessions into 3 groups. The phenotypic variability in "criollo" pepper germplasm was demonstrated through various multivariate methods. The variables that discriminate the groups in this study coincide with other evaluations made to characterize pepper introductions in other countries (Medina *et al.*, 2006; Pardey *et al.*, 2006; Bozokalfa *et al.*, 2009; Thul *et al.*, 2009). The number of fruits per plant was inversely related to their weight, this relation was also described by Zewdie & Zeven (1997), Portis *et al.* (2006), Somashekhar and Salimath (2008) and Schuelter *et al.* (2010).

The higher the soluble solids content, the lower

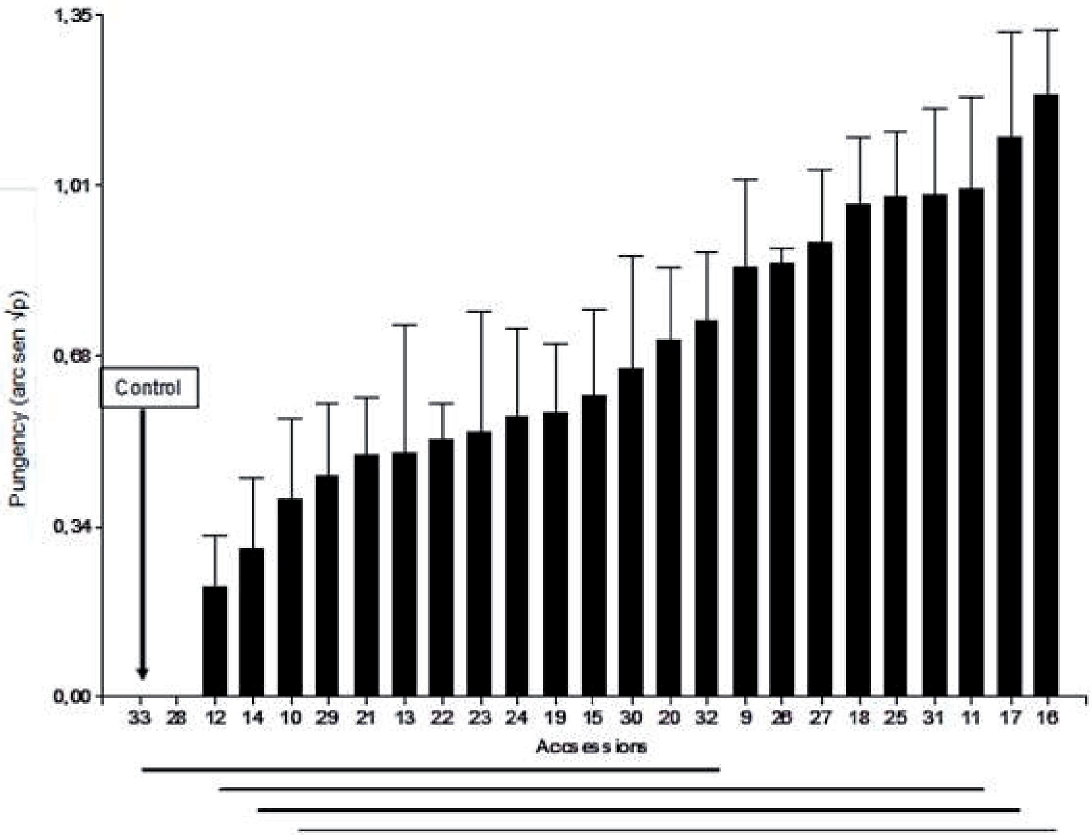

Figure 5 Pungency of 25 pepper accessions. (Numbers are indicated in Table 1 and bottom lines show significant differences according to the Tukey test ($p < 0.05$)

the water content in the fruit, this is a very important trait in *Capsicum* breeding for the dehydration industry (Lannes *et al.,* 2007). In our study accessions of Group III showed the highest soluble solids content (13,88).

On the other hand, fruit wall thickness and fruit weight were positive correlated, which was also previously reported by Lannes *et al.* (2007). These traits are important for the development of fresh market varieties, as pepper fruits with thicker pericarp are more resistant to postharvest and transportation damage.

As a result of pepper germplasm evaluation, 14 promising accessions were selected to be incorporated in a paprika breeding program, which is important for the local industry. A great variability for pungency was found in the evaluated germplasm; this fact was also found in other studies carried out in other countries (Nuez *et al.*, 1996; Zewdie & Bosland, 2000; Barbosa *et al.,* 2002). Argentine market demands sweet paprika, therefore pungency of the fruits, after the intensity of color, is considered one of the most important features for cultivar selection. This variability would allow selecting plants with less pungency within the entries that have other important features for breeding (Rêgo *et al.*, 2011a). This result confirms the concern that farmers indicated during the collection trips, regarding the increase of pungency in recent years. It should be noted that pepper prices paid to growers decreases with the proportion of spicy fruits (Occhiuto, 2009). Our results suggest that isolated areas, where spicy peppers are not produced along with sweet paprika, should be used in order to avoid seed contamination problems.

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