CARACTERIZACIÓN MORFOLÓGICA DE ACCESIONES SILVESTRES DE GUAYABA

MORPHOLOGICAL CHARACTERIZATION OF WILD ACCESSIONS OF GUAVA

Liliana Jiménez Lozano, Martha Isabel Almanza Pinzón, Jaime Eduardo Muñoz Flórez

Facultad de Ciencias Agropecuarias, Universidad Nacional de Colombia -Sede Palmira. A.A. 237. Palmira, Valle del Cauca. Colombia. Author for correspondence: jemunozf@palmira.unal.edu.co

REC.: 12-12-08 ACEPT.: 12-03-09

RESUMEN

Se realizó la caracterización morfológica de 22 accesiones silvestres de guayaba *Psidium guajava* L. 14 colectadas en el municipio de Restrepo (Valle del Cauca), seis en Armenia (Quindío) y dos en Pereira (Risaralda). Se utilizaron 12 descriptores cuantitativos y 10 cualitativos de tallo, hojas y frutos; el análisis de agrupamiento se realizó mediante el coeficiente de Dice-Nei-Li y el promedio aritmético no ponderado (UPGMA). La mayor variabilidad se halló en los descriptores peso de la pulpa (CV = 55.92%), peso (CV = 45.23%), y acidez del fruto (CV = 44.75%). El análisis de agrupamientos con base en caracteres cuantitativos permitió establecer cuatro grupos: las accesiones del grupo A (Armenia), presentaron valores promedio de los descriptores de la calidad del fruto (grados Brix, acidez del fruto y relación grados Brix/acidez) y valores altos de contenido de pulpa. La mayoría de accesiones del grupo C (Restrepo) tuvieron altos valores de calidad del fruto y bajo contenido de pulpa. El grupo B, constituido por accesiones de Armenia y Pereira, se diferenció por valores bajos en los descriptores de rendimiento del fruto (peso del fruto, de la pulpa y diámetro de la cavidad seminal). Las accesiones del grupo D (Restrepo) mostraron valores promedios en calidad y rendimiento del fruto. Los descriptores cuantitativos se reunieron en tres variables sintéticas para rendimiento y calidad del fruto que representaron 76.86% de la variabilidad total.

Palabras clave: *Psidium guajava* L.; diversidad genética; características cualitativas; características cuantitativas.

ABSTRACT

Quantitative and qualitative morphological characterization of 22 wild accessions of guava *Psidium guajava* L. collected in Restrepo (Valle del Cauca), Armenia (Quindío) and Pereira (Risaralda) was performed. Twelve (12) quantitative and ten (10) qualitative descriptors of stem, leaves and fruits were used. The Dice- Nei Li coefficient and the UPGMA were used

for the cluster analysis. Dendrograms and principal components analysis were used. The highest variability was associated with fruit descriptors, pulp weight (CV = 55.92 %), fruit weight (CV = 45.23 %) and acidity (CV = 44.75 %). The cluster analysis using quantitative characters formed four groups: accessions from group A (Armenia) showed mean values of fruit quality descriptors (Degrees Brix, fruit sourness and relation between Degrees Brix /sourness) and high pulp content. The majority of accessions of group C (Restrepo) had high quality fruit values, and low pulp content. Group B, formed by accessions from Armenia and Pereira, was differentiated by low yield descriptors values (fruit and pulp weight and seminal cavity diameter). Accessions from group D (Restrepo) showed mean values in quality and fruit yield. Quantitative descriptors were joined in three synthetic variables for yield and fruit quality that represented 76.86% of the total variation.

Key words: *Psidium guajava* L.; genetic diversity; qualitative characters; quantitative characters.

INTRODUCTION

The guava (*Psidium guajava L.*) is a key fruit species in the Colombian rural economy, and an industrial product for the manufacture of food, drinks and pharmaceutical products. Its aroma is thermostable and its nutritional properties are unmatched by other crops: vitamin C content is five times greater than citric fruits; and 16 vitamins have been recorded, as well as essential amino acids (tryptophan, lysine and methionine), although almost 60% of the vitamin content is still to be determined (Lozano *et al.*, 2002).

Guava trees commonly form part of home gardens, or are found distributed in pastures and hedges, up to altitudes of 1800m. Seed dispersal is by birds, cows and man (Escobar, 2005). The small number of commercial crops that exist have been developed from two varieties delivered by the Colombian Agricultural Institute (ICA), with which production of up to 40 t ha^{-1} has been achieved. Despite the promising commercial potential, and the expansion of cultivated area for this crop, there is a lack of scientific research and choice of varieties to supply the needs and expectations of farmers and industrialists (Pronatta, 2001).

Species characterization involves estimating the existing variability across the population of individuals (Franco and Hidalgo, 2003). It is possible to find guava genotypes that differ in production and superior quality, as a consequence of the allogamous nature of the species (Lozano *et al.*, 2002). Escobar (2005) examined morphological traits of accessions in the Colombian Guava Collection (ICA-CORPOICA-Palmira), and identified those with the greatest agronomic potential (in terms of productivity, fruit size and color, and degrees brix) to be 1838,1459-8, 477,988-4,440-A, 328 and 235. Rueda *et al.* (2006) did not find any relationship between geographic origin and genetic grouping based on RAPDs (Random Amplified Polymorphic Markers).

Sanabria *et al.* (2005) characterized morphologically the native guava trees of the department of the Valle del Cauca, and concluded that the high genetic diversity of the department was not sufficiently represented in the Colombian guava collection. The accessions CA1 and CA6 presented sizes and pulp yield with potential for commercialization. Thus, the present study aimed to continue the morphological characterization of the wild trees in the departments of Valle del Cauca, Quindió and Risaralda.

MATERIALS AND METHODS

Adult trees of 22 wild accessions of *P. guajava* of different ages were evaluated *in situ* in the departments of Quindió (6 accessions), Risaralda (2 accessions) and Valle del Cauca (14 accessions). The trees were located at altitudes between 1070 and 1500 masl.

Morphological characterization was carried out using 22 descriptors (12 quantitative and 10 qualitative) of the stem, leaves and fruit. The quantitative descriptors associated with fruit were: length; diameter; fruit and pulp weight; diameter and weight of the seed cavity; mesocarp thickness; degree brix; acidity; and the relationship degrees brix /acidity. Those descriptors associated with the size of the tree were: height; and trunk circumference. Qualitative traits associated with the fruits were: form and branching of the tree; stem pigmentation; internal and external color; texture and smell; form and intensity of leaf color. Between 10 and 20 fruits per tree were used. Descriptors were selected based on the guidelines used for the maintenance of the Colombian Guava Collection, and those descriptors used by Sanabria et al. (2005) in trees under production.

The characters of tree height, trunk circumference, branching, stem pigmentation, and tree form were registered at the time of collection. Qualitative descriptors related to color were determined using the Mullsen table. Soluble solids or degrees brix (PGB) were measured with a refractometer. The percentage of acidity (PA) was obtained from one (1) ml of fruit pulp dissolved in 10 ml of distilled water, titrated with NaOH at 0.5 N, using phenolphthalein as an indicator. The percentage of acidity was calculated as: $(V*N*Pe/VM)*100 = \%$, where V: Volume in ml of NaOH consumed; N: normality of NaOH; Pe: $0.64 gmeq^{-1}$; VM: sample volume. The relationship degrees brix /acidity is the ratio of degrees brix (PGB) and the percentage of acidity (PA) = PGB/PA

A basic descriptive analysis (range, mean, standard deviation, coefficient of variation) was performed to estimate the behavior of the accessions for each quantitative descriptor. A frequency analysis was carried out for the qualitative morphological descriptors. The quantitative descriptors were analyzed with multivariate techniques: Cluster analysis and Principal Component Analysis. Data analysis was carried out in the statistical package NTSYS version 2.02 (Rohlf, 1997).

For the grouping analysis, the basic data matrix was transformed to a distance matrix through the application of the Dice distance (Nei, 1972). UPGMA (Unweighted pair-group average) was used to obtain the patterns of relationships between the accessions under study, using strict consensus to compare the dendrogram groups produced by each matrix. The cophenetic matrix of the dendrogram was calculated to evaluate the goodness of fit of

cluster analysis and obtain an index of the degree of distortion of the dendrogram. Principal component analysis was performed from the matrix of correlations obtained from the quantitative morphological descriptors.

RESULTS AND DISCUSSION

Quantitative traits

The standard deviation and the coefficient of variation (CV) indicated high variability within the group of accessions studied: greater than 20% in 83% of the quantitative descriptors evaluated (Table 1). The largest CVs oscillated between 43 – 56% for pulp weight (55.92%), fruit acidity (46.75%), fruit weight (45.23%), and the relationship degree brix / acidity (42.53%) The descriptors associated with the size of the tree presented a high CV for trunk circumference (38.39%) and an intermediate one for tree height (27.86%). These data corroborate the results obtained by Sanabria *et al.* (2005), in relation to the high genetic diversity in the species in the Cauca Valley, and confirm the importance of these descriptors for studies of morphological, agronomic, and fruit quality characterization.

Pulp weight had a significant statistical correlation ($p<0.05$) with fruit weight, length and diameter, and the mericarp thickness. This indicates that the accessions studied present excellent characteristics for both commercial and crop improvement aims.

Table 1. Basic data for the quantitative morphological descriptors evaluated in 22 accessions of guava ***Psidium guajava*** in the Departments of Valle del Cauca, Quindío and Risaralda**.**

Descriptor	Range	Mean	C.V%
Fruit length (cm)	2.5-9.2	5.68	23.41
Fruit diameter (cm)	25.8-63.8	50.45	17.84
Fruit weight (g)	10-153.5	75.96	45.23
Pulp weight (g)	4.4-128.2	50.84	55.92
Seed cavity diameter (cm)	2.3-4.9	3.44	19.48
Weight seed cavity (g)	5.6-45.8	25.14	35.36
Fruit mesocarp thickness (cm)	0.40-1.40	0.79	37.97
Degree brix (%)	2.4-12.3	8.08	23.39
Fruit acidity (%)	0.28-1.01	0.77	46.75
Ratio degree brix / acidity (%)	4.1-27.1	11.24	42.53
Circumference of tree trunk (cm)	9-78	42.95	38.39
Height of tree (m)	3-9	5.85	27.86

Cluster analysis based on the quantitative morphological descriptors revealed four large groups (Figure 1). The accessions of group A collected in Armenia (13A, 14A, 17A y 18A) presented optimal relationships between fruit quality (degree brix, fruit acidity, and degree brix/acidity), and high fruit pulp content. The balanced relationship of the three descriptors for fruit quality yields good organoleptic traits in the guava (Corpoica, 2004).

The group B, comprising the accessions from Armenia (15A y 16A) and two from Pereira (19P y 20P), registered low values in fruit weight, pulp weight, and diameter of seed cavity, important traits in the production of conserved guava shells in syrup.

The majority of accessions in Group C (Restrepo) were notable for high values in fruit quality descriptors (degree brix, fruit acidity and degree brix/acidity), and low pulp content. This type of material with high acidity has potential for the production of conserves and desserts (Proexant, 2004).

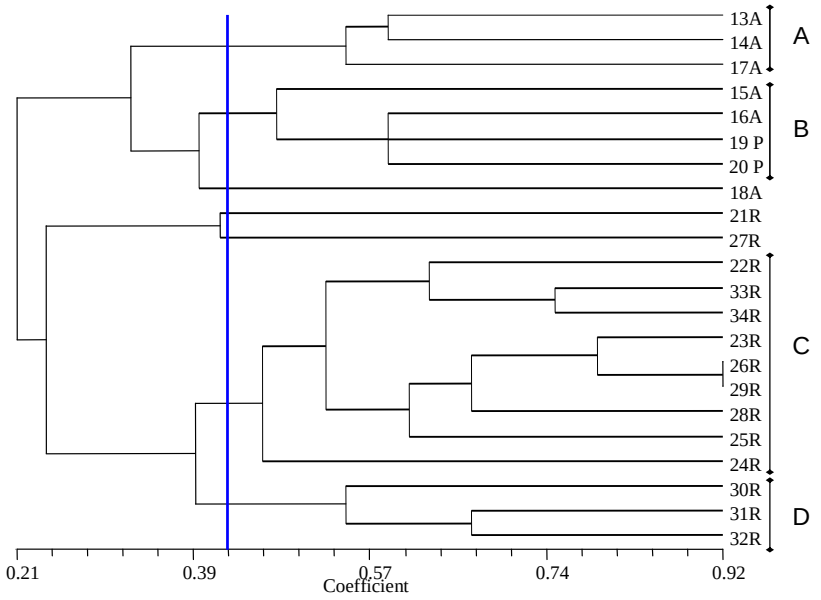

Figure 1. Dendrogram of the quantitative morphological characteristics in 22 accessions of *Psidium guajava* collected in the Departments of the Valle del Cauca, Quindío and Risaralda**. Dice Distance** Coefficient: 0.426. Cophenetic correlation coefficient: r = 0.78, p<0.002. A: Armenia (Quindio), P: Pereira (Risaralda), R: Restrepo (Valle del Cauca).

Group D, conformed by three accessions from Restrepo (30R, 31R, 32R), was differentiated by mean degree brix and fruit acidity and weight, and diameter and length of the fruit, all important descriptors for the commerce of fresh fruits (Escobar, 2005).

The fruits of the accessions 21R, and 27R were small and with contrasting values of degree brix and acidity, high for accession 21, and low for 27.

In the principal component analysis, the first three components explained 76.86% of total variation of the quantitative descriptor (Table 2). The CP1 was related to fruit weight, diameter and length, and pulp weight; while CP2 and CP3 were related to fruit quality (degree brix, and acidity, and degree brix/acidity).

Table 2. Principal Component Analysis with quantitative morphological descriptors of 22 accessions of *Psidium guajava* collected in the Departments of Valle del Cauca, Quindío and Risaralda.

Principal components (CP)	**Value**	**Absolute variation**	**Accumulated variation (%)**
1	5.816	48.47	48.47
2	2.137	17.82	66.29
3	1.264	10.54	76.86

Qualitative characteristics

The accessions were differentiated qualitatively with the descriptors: round form of fruit; external yellow color; internal pink color; smooth texture; medium – strong smell. The round form predominated in the three collection sites, followed in importance by the pear-shaped fruit. Bacarin *et al.* (1994) and Escobar (2005) indicated that these types of fruit are the most common in guava trees in Colombia.

The accessions frequently presented external yellow tones, and internal pink tones. According to Araujo *et al.* (1999) fruit color varies from white to red, through yellow. Absence of pigment is recessive, and linked to other traits, which facilitate the selection process. According to Díaz (1991) the producer, or campesino, and the buyer or consumer have marked differences in preference for the fruits with strong tones between pink and intense red.

Two types of fruit texture were observed: smooth and rough. The latter predominated in the materials from Armenia and Pereira, with the smooth texture most common in the material from Restrepo (64.29%).

The predominant fruit aroma was medium-strong in Armenia (66.67% occurence), and Restrepo (71.43% occurrence), and also in the two accessions from Pereira. Díaz (1991) stated that the characteristic aroma of the guava fruit is very variable, ranging from very penetrating to a smooth and agreeable one.

The predominant tree form was obloid (66.64% in Armenia, one accession in Pereira and 71.43% in Restrepo). The most frequent branching in Armenia and Restrepo was medium, with 66.67% and 64.29% respectively. In materials in Pereira, scarce branching was most frequent. However, these descriptors can differ greatly, depending on the age, or pruning of the trees in different collection sites.

In stem pigmentation, the most frequent color was brown for all the zones evaluated, and green-brown in 21.43% of the accessions in Restrepo. Light brown and red-brown obtained an equal percentage in the accessions from Restrepo. According to CORPOICA (1999) stem coloration of guava trees is generally light brown. For Mata and Rodríguez (1990) the chestnut red color is predominant, but studies do not exist regarding this pigmentation.
Medium green leaf color was the most common in all accessions. Lanceolated leaf form was the most common in Pereira and Restrepo, with a frequency of 50% and 78.57% respectively. In Armenia the most common leaf form was elliptical in 50% of the materials. Escobar (2005) reported that the predominant leaf form in Colombian accessions in the germplasm bank of CORPOICA was elliptical- oblong and elliptical-lanceolate, and of a dark green color.

CONCLUSIONS

- There is high variability in the qualitative variables of the guava fruit, forming groups in accordance with their geographic origin.
- The component that best explained the variation was related to fruit weight and dimensions.
- The most frequent external fruit color was yellow and internal pulp color was pink.

ACKNOWLEDGEMENTS

To Mario García, William Escobar, Reinel García Palomino, Andrés Mauricio Posso, Diego Marmolejo, members of the Molecular Biology Laboratory, of the National University of Colombia – Palmira campus.

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