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Genetic diversity for characteristics of 'Ubá' mango tree fruit

Diversidade genética para características dos frutos de mangueira 'Ubá'

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Abstract

The objective of this study was to evaluate the genetic diversity for physical and chemical characteristics of fruits of 47 'Ubá' mango accessions in the Zona da Mata Mineira. The fruits physiologically mature of the 47 accessions were coming from the experimental orchard of Fazenda Sementeira, located in the Municipality of Visconde do Rio Branco-MG, an orchard of the Federal University of Viçosa, MG. The fruits were harvested and analyzed for the following characteristics: fruit mass (g); flesh firmness; peel and pulp color; percentage of seeds, peel and pulp; titratable acidity (TA); soluble solids (SS); vitamin C; and carotenoids. A completely randomized design was used, with 47 accessions, four replications (plants per access), and twenty fruits per plot (five fruits per plant). Dissimilarity measures were obtained, and clustering techniques were applied for the subsamples. The most similar accessions were 34 and 48, and the most distant were 11 and 55; carotenoid content was the characteristic that most contributed to the divergence between accessions. The cluster analysis showed the formation of two groups by the Tocher and UPGMA methods, which demonstrates the existence of genetic variability in 'Ubá' mango trees in the Zona da Mata of Minas Gerais. In view of this, the accessions discussed here have potential for use in breeding programs, aiming at obtaining good materials for the industry.

Additional keywords: Clustering, *Mangifera indica* L., variability.

Resumo

O objetivo deste estudo foi avaliar a diversidade genética para características físicas e químicas de frutos de 47 acessos de manga 'Ubá', na Zona da Mata mineira. Frutos fisiologicamente maduros dos 47 acessos, provenientes do pomar experimental da Fazenda Sementeira, localizada no Município de Visconde do Rio Branco-MG, de um pomar da Universidade Federal de Viçosa-MG. Os frutos foram colhidos e analisados quanto às características: massa dos frutos (g), firmeza da polpa, coloração da casca e da polpa e percentagem de sementes, de casca e de polpa dos frutos, acidez titulável (AT), sólidos solúveis (SS), vitamina C e carotenoides. Foi usado o delineamento inteiramente casualizado, com 47 acessos, quatro repetições (plantas por acesso) e vinte frutos por parcela (cinco frutos por planta). Foram obtidas as medidas de dissimilaridade e aplicadas técnicas de agrupamento das subamostras. Os acessos mais similares foram o 34 e o 48, e os mais distantes, o 11 e o 55, sendo o teor de carotenoides a característica que mais contribuiu para a divergência entre os acessos. As análises de agrupamento mostraram a formação de dois grupos pelos métodos de Tocher e UPGMA, o que demonstra a existência de variabilidade genética em mangueiras 'Ubá', na Zona da Mata de Minas Gerais. Em razão disso, os acessos aqui comentados apresentam potencial para o uso em programas de melhoramento genético, visando à obtenção de bons materiais para indústria.

Palavras-chave adicionais: Agrupamento, *Mangifera indica* L., variabilidade,

Introduction

The mango tree was introduced in Brazil by the Portuguese in the 16th century. Over time, intra- and interracial hybridizations have generated hundreds of local, traditional (creole) varieties, which present variability for several plant and fruit characteristics (Pinto et al., 2004).

In Minas Gerais, there is a great diversity of mango trees, among them the traditional 'Ubá' variety, cultivated mainly in Zona da Mata, and in the eastern part of the state (Rufini et al., 2011). The traditional mango variety 'Ubá' has a great genetic diversity, mainly for fruit characteristics (Oliveira et al., 2013), which has been an inconvenience for the producer. From this material, superior cultivars can be obtained

regarding fruit characteristics. The use of measures of genetic divergence, obtained prior to cross-breeding, may help breeders to focus their efforts on the most promising combinations (Wagner Júnior et al., 2011).

Multivariate analysis techniques have been routinely used in the study of genetic divergence, since they simultaneously consider the evaluated variables of the genotypes, as well as their correlation (Condé et al., 2010). In clustering methods, the number of groups to be established is not known a priori, and different methods provide different results. The establishment of groups is done so that there is homogeneity within the group and heterogeneity between groups. This technique divides an original group of observations into several groups according to criteria of similarity or dissimilarity (Cruz, 2012).

The quantification of genetic diversity can be performed by means of agronomic, morphological, and molecular characters, among others (Amorim et al., 2007). However, it is important that the appropriate characters are selected, as reported by Chahidi et al. (2008), who showed that the use of plant and leaf characteristics is inefficient in the study of genetic divergence of tangerine (*Citrus reticulata*), with the fruit characters being more informative and useful in this case.

Among the characteristics that may support the evaluation of the quality of mangoes are: external appearance, flavor, aroma, fiber content, texture, nutritive value, size, mass, and shape of the fruits (Silva et al., 2012a). The objective of this study was to evaluate the genetic diversity of 'Ubá' mango accessions in an orchard in the Zona da Mata de Minas Gerais, based on the physical and chemical characteristics of the fruits.

Material and methods

The study was developed with fruits of 'Ubá' mango tree accessions cultivated in the experimental orchard of Fazenda Sementeira, located in Visconde do Rio Branco-MG, in Zona da Mata Mineira (21º00'37'' S latitude, 42º50'26'' W longitude, and altitude of 352m). The planting was carried out in December 2007, in spacing of 5 x 4 meters. The seedlings were grafted by cleft grafting; the 'Ubá' cultivar was used as rootstock, and the various accessions of 'Ubá' mango tree were used as grafts. The cultivation followed the techniques recommended for the crop in the region (non-irrigated planting).

For the evaluation, physiologically mature fruits of 47 acessions 'Ubá' mango tree were harvested in the 2010/2011 crop season. Immediately after the harvest, the fruits were transported to the Laboratory of Fruit Analysis of the University Federal Viçosa (UFV), where they were immersed in 100 µL/L sodium hypochlorite solution for 5 minutes for surface disinfestation and fruit washing. They were then treated with the fungicide Prochloraz (Sportak 450 CE, Hoeschst Schering AgrEvo UK Ltd., England) at the dose of 49.5 g/100 L of water for 10 minutes, and air dried. After drying, they were immersed in ethephon ([2-chloroethyl] phosphonic acid) (Ethrel, 240 g ethephon / L, Rhone-Poulenc, Agro Brazil LTDA) at the concentration of 1 g a.i. / L together with the adhesive spreader Adesil (760 g a.i. / L, Nufarm Indústria Química e Farmacêutica SA) at the concentration of 20 mL / 100 L for 5 minutes, and air dried.

The fruits were maintained at a temperature of 20 ± 1 ºC and 90% relative humidity until complete maturation, when the physical characteristics of fruit mass (g), flesh firmness, peel and pulp color, and percentage of seeds, peel and pulp were evaluated, in addition to the chemical characteristics of titratable acidity (TA), soluble solids (SS), vitamin C, and carotenoids.

Fruit mass was evaluated by gravimetry, in an electronic scale with 0.1 g precision. Flesh firmness was evaluated using a SHIMPO DFS 100 penetrometer with an 8-mm diameter tip, and the results were expressed as N. Peel and pulp color were evaluated by readings of the Minolta CR-10 colorimeter to determine the hue angle (°h), with the following indications: 0° = red; 90° = yellow; 180° = green; and 270° = blue (Minolta, 1994). Two readings were performed on opposite sides of the peel in the equatorial region of the fruits, in addition to an internal reading in the central region of the pulp. The evaluation of the percentage of seeds, peel and pulp was made by gravimetry.

Titratable acidity was determined by titration with 0.1N NaOH solution and phenolphthalein indicator. SS was determined using a digital refractometer (ºBrix), also observing the soluble solids / total titratable acidity ratio. The vitamin C content was determined by titration with the Tillman's reagent [0.1% 2,6-dichlorophenolindophenol (sodium salt)], according to the methodology described in AOAC (1997). The results were expressed as mg of ascorbic acid per 100 g of sample.

Approximately 2.0 g of the pulp were weighed to evaluate the carotenoids, being crushed in crucible with washed sand, 80% acetone, and a pinch of $CaCO_3$. The ketonic extract was filtered on filter paper and the volume completed to 25 mL. Absorbance readings were determined at 470, 646.8, and 663.2 nm, and the carotenoid levels determined according to the Lichtenthaler (1987) equations, in µg/mL extract.

A completely randomized design was used, with 47 accessions (treatments), four replications (four plants per access), and twenty fruits per plot (five fruits per plant). The means of the data obtained from each characteristic evaluated for the mango accessions were analyzed and compared. For this, the genetic dissimilarity study was carried out, using the mean Euclidean distance.

From the dissimilarity matrix generated, cluster analysis was performed by the UPGMA (unweighted pair-group method using arithmetic averages) and Tocher methods. The dissimilarity matrix was used to construct the dendrogram, according to the

Unweighted Pair-group Method using Arithmetic Averages - UPGMA (Sneath and Sokal, 1973). All statistical procedures were done using the GENES program (Cruz, 2012).

Results and discussion

Based on the dissimilarity matrix, it was observed that the accessions 34 and 48 were the closest ones (d = 0.26), that is, they presented less dissimilarity; and the most distant accessions were 11 and 55 (d = 3.06). The carotenoid content in the pulp was the characteristic with the greatest contribution to divergence, with 96.5%. The characteristic that contributed least to divergence was titratable acidity (0.0001%) (Table 1).

Table 1 - Relative contribution of evaluated characteristics to the genetic dissimilarity of 47 'Ubá' mango tree accesses in the Mata de Minas Gerais Zone.

Variable	(1)S.j	Value (%)
Carotenoids	45797591.68	96.50
Titritable acidity	62.41	0.0001
C vitamin	181560.74	0.38
Fruit mass	711412.78	1.45
Peel (%)	36915.87	0.08
Pulp (%)	498932.23	1.05
Seed (%)	28889.54	0.06
Soluble solids	4260.17	0.009
Firmness	56952.21	0.12
ºh of pulp	26276.20	0.056
ºh of peel	09936.55	0.23

(1) S.j: contribution of the variable x to the value of the Mean Euclidean Distance between the accessions i and i '.

Silva et al. (2012b) found titratable acidity and fruit mass as major variables in their work with different mango cultivars, which differed from the 'Ubá' mango accessions in Visconde do Rio Branco. Not with standing, this characteristic that supports the evaluation of mango quality can vary widely depending on the variety. Rufini et al. (2011), evaluating the genetic diversity of 'Ubá' mango accessions in the eastern part of Minas Gerais, found fruit mass as the main contributor to divergence of accessions, and acidity and pH were the characters with lower variability in the analysis of dissimilarity of the accessions. This fact can be explained because Rufini et al. (2011) did not evaluate the pulp carotenoids, so it is not possible to infer that the characteristic changed for the same variety, since, in the present study, fruit mass was the second major characteristic contributing to the dissimilarity of accessions (Table 1).

Regarding the clustering by the hierarchical method "UPGMA", based on the mean Euclidean distance (Figure 1), there is a similarity in the discriminant capacity of the accessions when compared to the Tocher method (Table 2). The clustering analysis by the Tocher optimization method, also based on the mean Euclidean distance, allowed the individualization of two groups (Table 2). Group 1 consisted of 46 accessions, and was divided into 12 subgroups, incorporating 98% of the 47 accessions evaluated. The accessions within each of the 12 subgroups presented homogeneous chemical characteristics, however the accessions of subgroups A and B showed characteristics with higher means. Group 2 was formed only by accession 55. According to Silva et al. (2014), the characters adopted are representative for the study of diversity when the dissimilarities between them are efficient to promote the formation of mutually exclusive groups.

The UPGMA cluster analysis, based on the physical and chemical characteristics of the 47 'Ubá' mango accessions, allowed the elaboration of the hierarchical dendrogram (Figure 1). In this method, the delimitation of the clusters is performed through the visual analysis of the obtained dendrogram, or established in points of high change in the dendrogram level (Milligan, 1981). Thus, the percentage of 70% was considered for genetic dissimilarity, verifying the formation of two distinct groups, as well as observed in relation to the clustering by the Tocher method. Group 1, with 46 accessions, had a genetic distance lower than 60%. Accessions 34 and 48 were the closest ones, confirming the data of the dissimilarity matrix, and presented similarity of slightly more than 10%, which shows a high genetic variability among the accessions. Silva et al. (2012b) found similarity higher than 20% in studies with 15 mango cultivars. Rufini et al. (2011) worked with 67 'Ubá' mango accessions in the eastern region of Minas Gerais and obtained the formation of 2 distinct groups, a group consisting of 12 accessions, and another group consisting of 55 accessions, that is, 82% of the accessions belonged to one group and presented similarity above 99% for the clusters.

Table 2 – Groups formed by the Tocher grouping method for the 47 hose accesses 'Ubá' in the Zona da Mata de Minas Gerais.

Groups	Subgroups	Accesses
1	A	34, 48, 54, 47, 45, 35, 53, 17, 31, 28, 24, 44, 27, 18, 4, 39, 2
	B	26, 33, 52, 32, 29, 14, 40, 23, 19
	C	3, 8, 37, 22
	D	7, 51, 30
	E	9, 10
	F	20, 21, 12
	G	5, 6
	H	16, 25
	I	13
	J	11
	L	56
	M	41
2		55

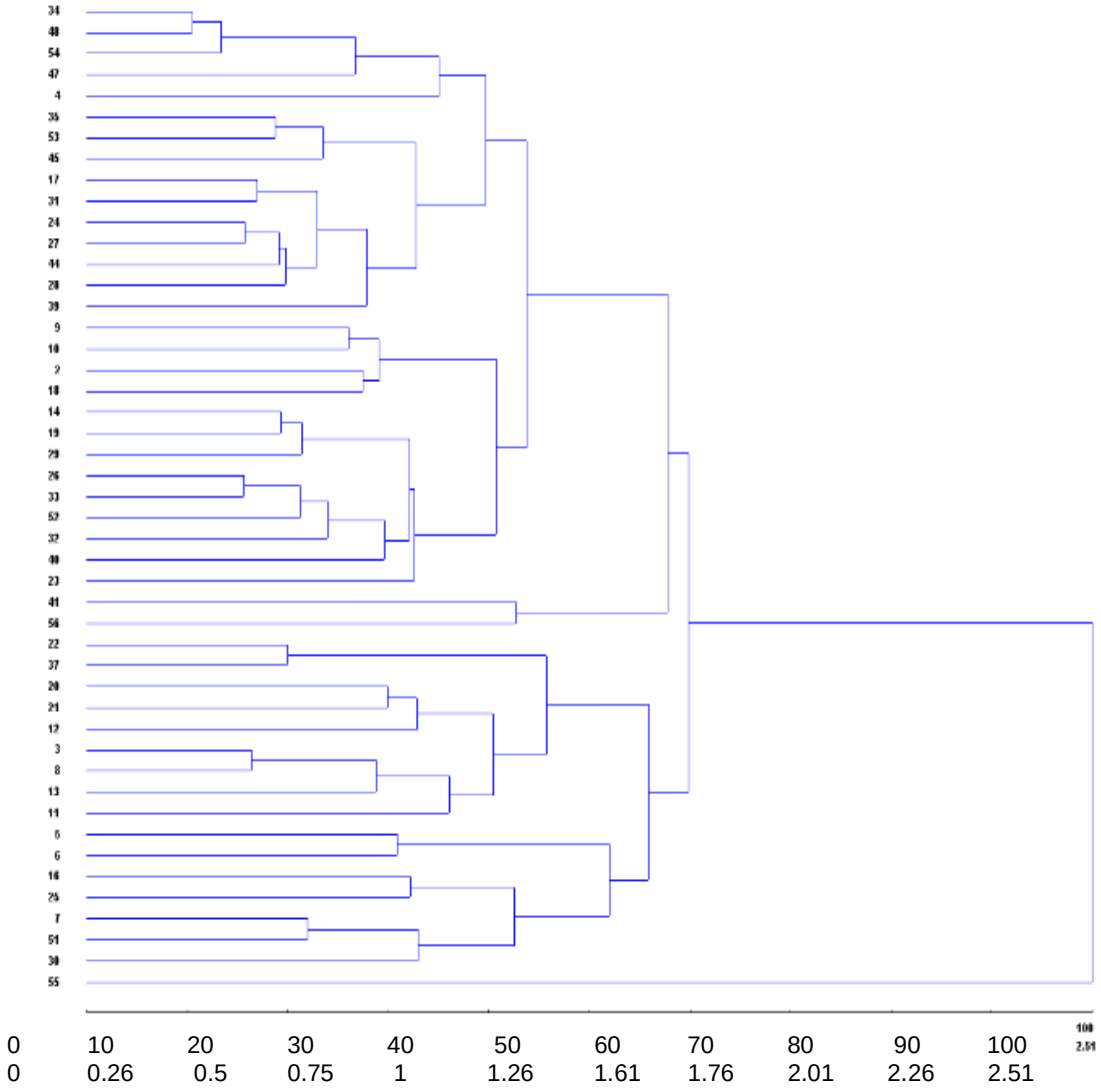

Figure 1 - Dendrogram of genetic dissimilarity among 47 'Ubá' mango tree accesses, obtained by the nearest neighbor method, using the generalized distance of Mahalanobis (based on 11 characteristics of the fruits) as a measure of genetic distance.

Conclusions

The 47 accessions analyzed showed variability in the chemical and physical characteristics of the fruits. The accessions that presented the highest similarity were 34 and 48, and the most distant ones were 11 and 55.

The characteristic which contributed most to divergence was carotenoid content.

In view of this, the accessions discussed here have potential for use in breeding programs, aiming at obtaining good materials for the industry.

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