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Original Research Article

Genetic Diversity and Importance of Loofah Traits

ABSTRATC

The aim of this work was to estimate the genetic diversity of loofah accessions (*Luffa cylindrica* L.) by multivariate analyses techniques and to verify the importance of the traits evaluated on the study of genetic divergence. Two trials were achieved in the municipality of Mossoró, Rio Grande do Norte State, Brazil. The trial was carried out in incomplete block design, composed by two experiments in complete randomized blocks with four regular treatments and two treatments common to both experiments, totaling ten treatments, with three replications. Each loofah accession composed one treatment. Eleven descriptors (three quantitative and eight qualitative) were measured to quantify the genetic divergence, using as a measure of dissimilarity the Gower algorithm, one joint analysis considering the quantitative and qualitative descriptors simultaneously. The UPGMA hierarchical method was used to group the genotypes. The Singh criterion was used to quantify the contribution of the traits to the genetic divergence. It was verified that there are accessions of great divergence. The accessions BUCHA06 and BUCHA22 were the most divergent among the others, and accesses BUCHA06 and BUCHA10 were considered the most similar. The median portion fibers texture, the upper portion fibers texture and the fruit mass were most important traits to estimate the genetic divergence.

Keywords: Gower Algorithm; genetic distance; grouping analyses; *Luffa cylindrica* L.

1. INTRODUCTION

The genus Luffa composes a very diversified group, originated probably from the Asia continent, holding seven species. Among them, the most cropped is Luffa cylindrica L., known as loofah [5].

Loofah is a climbing herbaceous vegetable, with axillary tendrils to support the plant. In Brazil, the loofah is mainly cropped in small farms by family staff. Loofah has a very important socio-economic role, as profitable as maintaining the work in the field [16, 1]. In the Northeast region of Brazil, loofah grows spontaneously in nature, moreover, it can be found in alongside of roads and on rivers margins, besides of the family staff production [17].

Researches have been conducted regarding to different functionalities of the loofah. Especially by companies looking for technological properties of its fibers, since the loofah

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fibers present physical, mechanical, thermal and chemical properties [2, 11, 23]. Also, the medicinal properties of loofah have been exploited since the plant contains bioactive compounds with antibacterial, antifungals and antioxidants effects [20]. Considering all them and the search for sustainable products, the fields of loofah have expanded due to the increasing demand for this product [6].

However, even with such an increasing production of loofah, most of the Brazilian cultivars do not come from breeding programs. They originate from family agriculture fields that carry out phenotype selection of loofah fruits year after year [15]. Thus, the fruits present some limitations, such as the lack of uniformity in size, in color, in diameter, and in thickness, among other traits [14].

The existence of genetic variability is notorious among the cultivars since there is genetic diversity within the species. That is a key factor for success in a breeding program [10]. Thus, the germplasm banks play an important role in the study of genetic divergence. They guide better work strategies that must be taken since it will define the most divergent groups and direct crossings to obtain segregating populations [4,27].

The aim of this work was to study the genetic divergence of loofah, by multivariate analyses techniques and to verify the importance of the traits to genetic divergence studies.

2. MATERIAL AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY (ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)

Ten loofah accessions (Luffa cylindrica L.) collected in Rio Grande do Norte State and belong to the loofah germplasm bank of the Federal Rural University of Semi-Arid (UFERSA) were evaluated (Table 1).

Table 1. Loofah accessions (Luffa cylindrica L.)

Accession	Point of collection	Geografic coordinates
BUCHA01	Mossoró-RN	05°12.548’S 37°20.186’W
BUCHA03	Mossoró-RN	05°12.386’S 37°19.779’W
BUCHA06	Mossoró-RN	05°09.770’S 37°20.480’W
BUCHA10	Mossoró-RN	05°09.143’S 37°20.493’W
BUCHA12	Mossoró-RN	05°09.707’S 37°20.493’W
BUCHA19	Apodi-RN	05°32’S 37°52’W
BUCHA20	Apodi-RN	05°39’S 37°47'W
BUCHA21	Apodi-RN	05°32’S 37°52’W
BUCHA22	Apodi-RN	05°39’S 37°47'W
BUCHA25	Apodi-RN	05°39’S 37°47'W

The trials were carried out at the Experimental Vegetable Garden of the Agronomic and Forest Sciences Department (UFERSA), Campus Mossoró RN, at 5º11' S, 37º 20' W and 18 m of altitude. The climate, according to the Köppen classification is BSWh', with a dry season (from June to January) and a rainy season (from February to May) and the temperature ranging from 21.3 to 34.5º C. The annual average rainfall is about 625 mm [8].

The seeds underwent a cut with pruning shears in the opposite part of the hilum to overcome the dormancy [19], then they were sown in polystyrene trays with 128 cells and remained in

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the greenhouse until the emergence of the second definite expanded leaf, when they were transplanted to the field.

The experimental design was incomplete blocks [22], with two randomized complete blocks with four regular treatments and two treatments common to both trials (BUCHA19 and BUCHA20) composed of three replications, and each plot consisted of four plants. The trials were conducted in the vertical-type cultivation system spacing 3.0 m wide and 5.0 m long. The cropping techniques were carried out according to region loofah requirements [1]. Controlled pollinations were carried out to obtain endogamic progenies. The first trial was achieved from January to August 2012, and the second trial, from February to August 2013.

The traits evaluated were the fruit mass - FRM (g.plant-1) weighing the whole fruits; the fiber mass - FBM (g) removing of the peel; the peel mass - PLM (g); the lower portion fibers texture - LPT, the median portion fibers texture – MPT, and the upper portion fibers texture - UPT (values ranging from 1 to 3, where 1 corresponds to a softer texture and 3 rougher texture); the ease of seed release - ESR (values obtained in scale of notes ranging from 1 to 3, where 1 corresponds to easy release, 2 to average easy release, and 3 to hard release); the length of the fruit - LOF (cm), the measurement of the floral scar at the peduncle insertion, measured with a graduated ruler (cm); the diameter of the lower portion - DLP (mm) measuring the diameter of the fruit next to the floral scar, with a digital caliper; diameter of the median portion - DMP (mm), with a digital caliper; diameter of the upper portion - DUP (mm) measuring the fruit next to the peduncle insertion, with a digital caliper. For evaluation of the traits, at least one fruit per plant was used, totaling twelve fruits per loofah accession [13].

The cluster analysis was performed considering quantitative and qualitative descriptors simultaneously, according to the Gower algorithm [12]. The hierarchical groupings from the genetic distance matrix were obtained by the Unweighted Pair Group Method with Arithmetic (UPGMA) method as a measure of dissimilarity. To identify the significance of the traits for genetic divergence the relative contribution of each trait was estimated [25].

The multivariate analyses were accomplished using the genetic-statistical software Genes [9].

3. RESULTS AND DISCUSSION

Results should be clearly described in a concise manner. Results for different parameters should be described under subheadings or in separate paragraph. Table or figure numbers should be mentioned in parentheses for better understanding.
The measurements of genetic dissimilarity (Table 2) estimated by the Gower algorithm featured a variation from 0.1755 to 0.5501. The accessions BUCHA06 and BUCHA22 were identified as the most dissimilar among each other (D^2= 0.5501), followed by BUCHA01 and BUCHA20 (D^2=0.5356). However, the accessions BUCHA06 and BUCHA10 were considered the most similar as they featured the minor distance (D^2= 0.1755), being originated from the same municipality.

Table 2. Distance estimates of the closer and more distant accessions of loofah, basing on the distance of the Gower algorithm

Accession	Minor D^2	Closer accession	Major D^2	More distant accession
BUCHA01	0.2482	BUCHA03	0.5356	BUCHA20
BUCHA03	0.2334	BUCHA10	0.4601	BUCHA19

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BUCHA06	0.1755	BUCHA10	0.5501	BUCHA22
BUCHA10	0.1755	BUCHA06	0.4501	BUCHA25
BUCHA12	0.2073	BUCHA10	0.4826	BUCHA25
BUCHA19	0.2662	BUCHA12	0.5266	BUCHA25
BUCHA20	0.3044	BUCHA21	0.5356	BUCHA01
BUCHA21	0.2717	BUCHA22	0.4886	BUCHA06
BUCHA22	0.2717	BUCHA21	0.5501	BUCHA06
BUCHA25	0.3002	BUCHA22	0.5300	BUCHA06

The accessions BUCHA06 and BUCHA25 featured the major distance in three combinations relating the others, being the most divergent. Based that, it is possible to infer about the most promising biparental crossings since the more divergent the parents are, the more segregating populations can be obtained by intensifying the favorable alleles combination [4]. Thus, one of the main objectives of breeding programs is to obtain superior populations. So, the primary steps to achieve this result is choosing adequately the parents, that are usually dissimilar and of interesting traits [26].

The distance observation between the ten accessions was possible using the Gower distances matrix UPGMA method, forming three distinct groups (Figure 1). According to Quintal et al. [21], the distance proposed by Gower allows a better estimation of genetic divergence, by analyzing jointly the quantitative and qualitative traits. The 89% distance cut was considered, basing the method of Mojena [18]. The first group was the largest group, consisting of five accessions (50%). The second group was composed by accesses BUCHA19 and BUCHA20 only. The third group was composed of the accessions BUCHA21, BUCHA22, and BUCHA25.

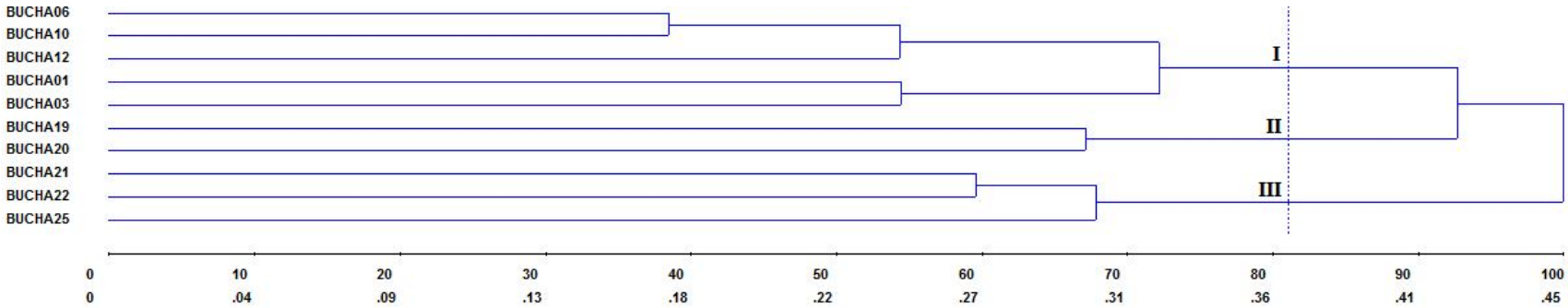

Fig. 1. Dendrogram illustrating the dissimilarity pattern obtained by the UPGMA method, based on the distance of the Gower algorithm in loofah accessions

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Some advantages are possible to achieve by using the multivariate analyses techniques, among them it is possible to highlight the importance of each trait studied out of all the accessions evaluated. According to the criteria proposed by Singh [25], in terms of relative contribution to genetic divergence (Table 3), the most contributing traits to the genetic divergence were the median portion fibers texture (10.20%), the upper portion fibers texture (10.31%) and the fruit mass (10.05%). On the other hand, the trait presenting the smallest contribution was the diameter in the upper portion of the fruit (7.22%).

Table 3. Relative contribution of the traits to genetic divergence in loofah, estimated by the method proposed by Singh (1981)

Trait	S. j.	(%)
FRM	85.98	10.05
FBM	63.83	7.46
PLM	80.90	9.46
LPT	82.84	9.69
MPT	87.28	10.20
UPT	88.17	10.31
ESR	80.50	9.41
LOF	75.04	8.77
DLP	69.61	8.14
DMP	79.42	9.29
DUP	61.77	7.22

In the study of genetic divergence in Luffa cylindrica accessions, Blind [7] evaluated twelve accessions from seven Brazilian states, the fruit mass was one of the traits less contributing to genetic variability (1.62%). The fruit mass in the present work was one of the traits contributing highly to group formation.

Usually, when the relative contribution of a trait is small, the researcher advice discarding the analyzes of the same in future studies as a way to reduce labor costs and time [3, 24]. However, according to Medeiros [17], discarding these traits it is not appropriate because they are evaluated under different conditions, their behavior may differ and their contribution may be altered.

4. CONCLUSION

-There is a genetic divergence among the loofah accessions studied.

-The Gower algorithm was efficient, demonstrating the possibility of simultaneous analysis of quantitative and qualitative descriptors, thus allowing greater efficiency in the knowledge of genetic divergence.

- The texture traits in the medial portion fibers, the upper portion fibers texture and the fruit mass were the most important to estimate the genetic divergence.

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