Pakistan Journal of Biological Sciences 11 (1): 135-138, 2008
ISSN 1028-8880

Phenotypic Diversity in *Terminalia catappa* from South Western Nigeria

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Abstract: The diversity amongst *Teminalia catappa* population in two different locations in the Lagos area of South Western Nigeria was investigated. Forty trees were sampled for twenty eight quantitative and twelve qualitative characters. Variability was observed in qualitative characters such as leaf shape and ripe fruit colour. Quantitative characters analyzed using multivariate statistical analysis showed high intraspecific variability for most of the characters determined. Cluster analysis using the unweighted pair group method using arithmetic mean (UPGMA) method revealed four main clusters which were not based on location of collection but on morphological characters. The trees were grouped into the main clusters based mainly on plant architecture. The result from the trees studied showed that selections based on traits such as fruit size, fruit colour and leaf sizes can be undertaken for future improvement or development of this tree crop in Nigeria.

Key words: Germplasm, variability, *Terminalia catappa*, cluster analysis, morphological, correlations

INTRODUCTION

Terminalia catappa Linn. an ornamental tropical tree belonging to the family Combretaceae is native to Southeast Asia. It is large deciduous stately tree with a characteristic pagoda shape (Mitchell, 1964). It is cultivated in Nigeria solely as a shade tree and for its fruits and seeds which are eaten as fruit as well as for medicinal uses (Oni and Bada, 1982). It is a perennial tree reaching a height of between 15-25 m and about 9 m in width of its symmetrical canopy (Edward and Dennis, 1964). They have shiny deciduous, obovate green leaves that are arranged in close spirals and turn red or copper gold before falling (Exell, 1954). The greenish yellow leaves are clustered in axillary spikes, small and inconspicuous. It usually commences flowering within 2-3 years of out planting but this may vary with site and genotype (Morton, 1985). The fruits which consist of the epicarp, fleshy mesocarp, stony mesocarp and kernel are ovoid in shape, laterally compressed with various sizes and colours at maturity (Thompson and Evans, 2006).

T. catappa is of economic importance as the trunk is used for furniture and cabinetwork. The medicinal uses of the leaves in the treatment of liver-related diseases, sickle cell disorders, cancer and anaemia have been reported in India, Brazil, Taiwan and Mexico (Sen *et al*., 1987). In Australia and India the trees are planted for soil conservation, coastal protection and beach stabilization (Maximo and Lanting, 1983). Despite the increasing economic importance of this tree, very little is known about the germplasm that exists in Nigeria and the genetic relationships between them. Population studies in *T. catappa* have suggested high variation in fruit size, fruit colour and leaf characteristics (Sen *et al*., 1987; Lepfosky, 1992). In Nigeria, the tree exists in major cities, towns and villages in Southern Nigeria as an ornamental or shade tree. The fruit, leaves and tree bark are used in some communities as food or herbs.

The objectives of this study was to therefore describe the relationship among the populations using morphological traits and to classify the trees into groups based on morphological traits. This method has been found useful in a number of tree crops such as olives, cashew and coconut (Samal *et al*., 2003; Arunachalam *et al*., 2005; Taamalli *et al*., 2006).

MATERIALS AND METHODS

Forty trees were randomly selected from two locations in the Lagos area of South Western Nigeria. Data on morphological characters such as leaf length and width; petiole length; fruit length and width; seed length and width; mesocarp, kernel and shell widths and spikelet number were recorded during the fruiting season in March-April 2006. Microscopic studies on the leaves to determine stomata and epidermal lengths and breadths on both abaxial and adaxial surfaces were also recorded. In all the observations, twenty measurements per tree for all characters being considered were measured. Length and width measurements were taken using the meter rule, while weights were determined using a weighing balance.

Nitric acid solution was used to separate the epidermal layers which were subsequently stained with safaranin. Measurements for the stomata and epidermis

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were taken using the stage and ocular micrometer on a calibrated light microscope. Crude protein, carbohydrate, fat and fibre were determined in % using the method outlined by Association of Official Analytical Chemists (AOAC, 1984). Crude fat was obtained by exhaustively extracting 3.0 g of the dry mesocarp in a soxhlet apparatus using chloroform as the extractant. Qualitative traits such as leaf apex, base, shape and margins; stomata venation and inflorescence types were determined according to Stace (1965). Ripe fruit and inflorescence colour and leaf texture were also determined.

The means, range, standard deviation and coefficient of variation (CV) were calculated. Correlation to determine the relationship among the characters was performed using SPSS 11.0 version. Cluster analysis was carried out on similarity matrix using UPGMA (unweighted pair group method using arithmetic average) in NYTSYS-PC version 2.02 programme (Rohlf, 1998).

RESULT

Results showed that there was a wide variation in most of the characters examined. Leaf length ranged from 8.58 to 17.30 cm with a mean value of 14.27 cm and coefficient of variation of 13.29% Table 1. Stomatal number on the abaxial surface showed less variation when compared with the number on the adaxial surfaces. Fruit weight with a coefficient of variation of 27.93% ranged from 23.8 g to a maximum of 72.68 g. There were also variations in the nutritional composition of the fruits with percentage protein and carbohydrate having a range of 1.18-6.25 and 2.19-7.50%, respectively. The variation showed that no two trees had the highest or lowest value consistently for the quantitative characters determined. Qualitative characters showed that leaves were simple with entire margins and reticulate venation in all trees. Inflorescence was green of raceme type while stomata type was anisocytic. However, there were observable differences in ripe fruit colour which was either a shade of green, yellow or purple, with 30% of the ripe fruits being yellow and yellowish green, respectively. Leaf apices, shapes, bases and texture also showed variation amongst the trees sampled.

Correlations were used to indicate the linear relationships among the traits. The correlations were significantly correlated when the R-value is greater than or equal to an absolute value of 0.381 at a probability of 0.05. Based on these the following characters had significant positive correlations leaf length and leaf width; wet mesocarp weight with plant height, fruit length and fruit breadth; fruit length and fruit width with fruit weight and % protein with % fibre (Table 2). Most of the negative correlations were not significant.

Table 1: Range of variation in quantitative characters of *T. catappa*

Characters	Range	Mean±SD	(CV%)
Leaf length (cm)	8.58-17.3	14.27±1.90	13.29
Leaf width (cm)	4.72-10.20	7.90±0.98	12.42
Petiole length (cm)	0.74-1.48	1.12±0.16	14.48
Fruit length (cm)	3.90-7.50	6.14±0.78	12.75
Fruit width (cm)	2.86-5.34	4.13±0.66	16.04
Seed length (cm)	2.24-2.64	2.53±0.03	1.15
Seed width (cm)	0.64-0.84	0.74±0.05	6.60
Epidermal length ab (μm)	37.0-62.90	45.97±7.99	17.38
Epidermal length ad (μm)	25.90-62.90	42.18±8.62	20.43
Epidermal width ab (μm)	14.80-29.60	22.48±3.59	15.99
Epidermal width ad (μm)	11.10-25.90	17.02±4.26	25.01
Stomatal length ab (μm)	18.50-29.50	22.29±2.29	10.29
Stomatal width ab (μm)	7.40-14.80	9.35±2.22	23.75
Stomatal length ad (μm)	18.50-25.90	23.13±2.87	12.42
Stomatal width ad (μm)	7.40-14.80	10.55±2.30	21.83
Spikelet number	69.0-112.0	93.13±9.30	9.98
Stomata number (ab)	1.00-5.00	2.35±1.41	16.61
Stomata number (ad)	18.0 -44.0	29.95±6.48	21.64
Fresh fruit weight (g)	23.83-72.68	43.85±12.25	27.93
Dry mesocarp weight (g)	1.94-4.28	2.42±0.73	30.16
Dry shell weight (g)	3.81-0.93	6.44±1.35	20.98
Dry seed weight (g)	0.80-0.93	0.87±0.04	4.26
Carbohydrate (%) in mesocarp	2.19-7.50	5.72±1.61	28.13
Protein (%) in mesocarp	1.18-6.25	3.60±1.31	36.38
Fibre (%) in mesocarp	22.0-37.0	30.83±3.36	10.90
Oil (%) in mesocarp	0.55-1.10	0.86±0.06	7.33

SD = Standard Deviation, CV = Coefficient of variation, ab = Abaxial, ad = Adaxial

Table 2: Correlation matrix of selected quantitative traits

Characters	LL	LW	PL	FL	FW	SL	SW	FW	DSHW	DSW	C (%)	P (%)	F (%)
LC	0.48*												
PL	0.26	0.07											
FL	-0.11	-0.10	0.00										
FW	0.02	0.00	0.03	0.70*									
SL	0.22	-0.40*	0.16	0.04	0.07								
SW	0.22	0.15	0.04	0.00	0.08	0.05							
FW	0.06	-1.10	0.11	0.74*	0.80*	0.01	0.15						
DSHW	0.17	0.13	0.05	0.35	0.71*	-0.10	0.00	0.80*					
DSW	0.05	-0.20	0.00	-0.10	0.00	-0.10	0.09	0.05	-0.10				
C %	-0.21	0.07	-0.10	-0.10	-0.80*	-0.40*	0.22	0.05	0.09	-0.10			
P %	0.21	0.08	0.11	0.22	0.18	0.01	0.64*	0.24	0.12	0.02	0.37		
F %	0.01	0.11	0.00	-0.10	0.08	0.07	0.04	0.11	0.16	0.31	-0.10	0.74*	
O %	0.26	-0.50*	0.07	0.01	0.06	0.57*	-0.20	0.00	-0.10	0.16	-0.10	-0.10	

*Significant at 0.05 level of probability, LL = Leaf Length, LB = Leaf width, PL = Petiole Length, FL = Fruit Length, FW = Fruit Width, SL = Seed Length, SW = Seed Width, FW = Fresh fruit weight, DSHW = Dry shell weight, DSW = Dry Seed Weight, C (%) = Carbohydrate (%), O (%) = Protein (%), F (%) = Fibre (%), O = Oil (%)

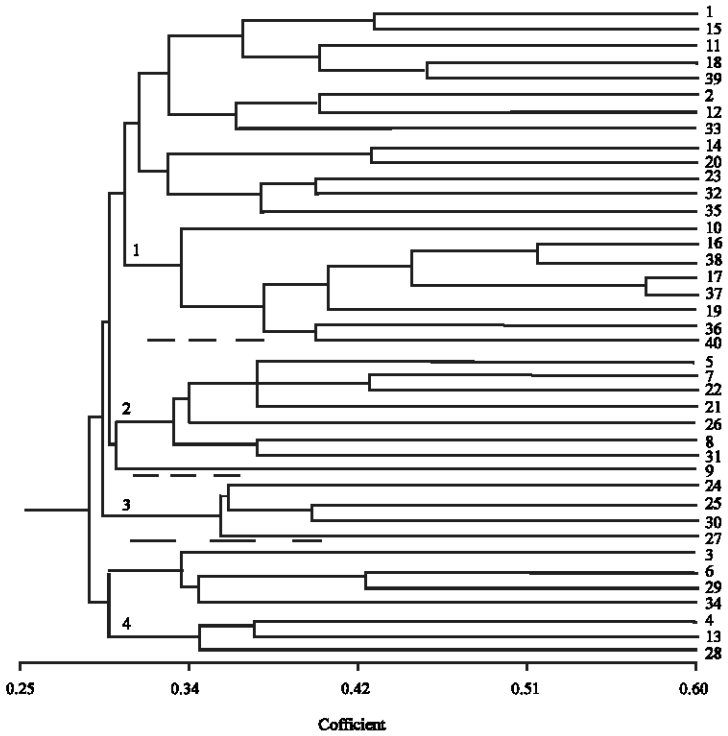

Fig. 1: Dendrogram showing 4 major clusters in 40 *Terminalia catappa* trees

Table 3: Cluster means for some selected characters in 40 *T. catappa* trees

Characters	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Leaf length	14.22	14.35	15.50	13.64
Leaf width	7.87	8.22	8.34	6.90
Petiole length	1.16	1.11	1.11	1.00
Fruit length	5.18	6.21	6.51	5.70
Fruit width	4.25	3.94	4.48	3.64
Fresh fruit weight	45.21	42.68	51.71	29.80
Seed length	2.53	2.53	2.53	2.52
Seed width	0.71	0.75	0.75	0.73
Dry seed weight	0.86	0.86	0.88	0.88
Dry shell weight	5.60	6.30	7.28	5.66
Carbohydrate (%)	5.22	5.49	5.89	5.38
Protein (%)	4.40	4.35	4.44	3.21
Fibre (%)	32.80	31.44	33.63	30.40
Oil (%)	0.54	0.82	0.87	0.87

Results obtained from the cluster analysis as shown by the dendogram which is based on similarity coefficient showed that the trees were divided into four main clusters (Fig. 1). Cluster No. 1, 2 and 4 had 21, 8 and 7 trees, respectively and these trees were from the two locations where the trees were sourced. Cluster No. 3 had 4 trees from the same location. Trees in cluster No. 1 and 2 had intermediate plant architecture as measured by the leaf and petiole characteristics (Table 3). Their fruits were of medium size generally between 40-48 g in size. The four trees in cluster No. 3 had the highest values for quite a number of characters such as leaf length and breadth, fruit weight (a mean value of 51.7 g), dry shell and seed weights and percentage carbohydrate, protein, oil and fibre. Trees in cluster No. 4 were represented by those that generally had small plant architecture and fruit characteristics.

DISCUSSION

With the exception of reports on the variation in fruit characteristics in *T. catappa* from Australia (Lepofsky, 1990; Walter and Sam, 1993) detailed reports on variability studies and genetic relationships within this species is lacking. This is because research on the crop is virtually non-existent, it may be because it is a tree crop, even though it is gaining importance as a medicinal crop and as a forest tree with varied uses. Grouping of the trees from the two locations by cluster analysis would be of practical use to both scientists and nursery farmers as representative trees from each cluster may be selected for use in an improvement programme.

The trees in this study were grouped on the basis of morphological characters into four clusters based mainly on leaf and fruit sizes rather than the location of collection. Tree crops may be affected by effect of environmental factors and this may limit the use of morphological/agronomic characters especially since they tend to carry over the effect of climatic factor in one year to other years (Oboh and Fakorede, 1999). However, it has been shown in olives which is also a tree crop that this is

not a limitation as grouping based on cluster analysis showed that agronomic/morphological characters had good repeatability with result from molecular markers such as RAPD (Samal *et al*., 2003).

This study however may be best described as a preliminary study as it considers only 40 trees from two locations in South Western Nigeria. Nevertheless, it has succeeded in establishing that using quantitative and qualitative characters in this tree *T. catappa* genetic diversity is present which can be further exploited in improvement programmes.

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