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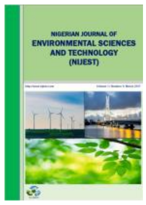

Phenotypic (Fruit and Seed Characters) Selection of *Dacryodes edulis* (Don. G. Lam H. J.) Tree for Vegetative Propagation

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ABSTRACT

The study was conducted to identify superior D. edulis trees using phenotypic characters (fruit and seed size) as the criteria to select candidate trees for subsequent multiplication through vegetative propagation. Five D. edulis compound trees were randomly selected within Onne community in Eleme LGA Rivers state in a preliminary effort to assist households in the selection and multiplication of desirable tree phenotypes. Seeds were extracted by softening fruit with warm water at 57°C. Fruit and seed length (mm), breadth (mm), and thickness (mm) were taken using veneer caliper. Size of fruit and seed was calculated as: length × breadth × thickness. The experiment was a completely randomized design in its layout and data analysis was carried out using analysis of variance and regression after a normality test was conducted using Shapiro-Wilk. The results showed that highest mean fruit size (79.38 ± 3.99 mm) was recorded in tree 3 and the lowest was tree 5 (29.60 ± 1.48 mm): while, highest seed size (34.78 ± 2.47 mm) was recorded in tree 3 and the lowest in tree 4 (15.58 ± 0.99 mm). Highest within tree fruit size variability was recorded in tree 1 (24%) and the lowest in tree 4 (12%): while the highest within tree seed size variability was recorded in tree 2 (28%) and the lowest in tree 5 (15%). There was however a significant difference in fruit and seed size between the trees. Pairwise comparison showed that tree 1 was not significantly different from tree 2 in fruit and seed size. There was a significant positive correlation between fruit and seed size among the trees. This implies that selection for large fruit size automatically selects for large seeds size. Large fruited trees can therefore be multiplied from these trees using vegetative propagation.

Keywords: Phenotype, Selection, Fruit, Seed, Multiplication

1.0. Introduction

Fruits generally are valued for their health benefits due to their possession of phytochemicals highly essential for the maintenance of a sickness free body. For example, fruits consumption has been related to reduced risk of cardio-vascular disease, obesity, cancer, nutrient deficiency related diseases etc. while traditional tropical home gardens have been associated with increased rural household fruit intake due to the diversity of fruit trees they hold (Wang *et al.*, 2014; Bertoia *et al.*, 2015; Onyekwelu *et al*., 2015; Okonkwo *et al*., 2020). A lot more people therefore are changing diet and lifestyle by increasing the quantity and frequency of fruits intake to either improve or maintain health status due the growing awareness of the importance of fruits to human health.

The result of this is an increasing global and local fruit trade volume (Huang, 2004). Nigeria's annual fruit import value is to the tune of millions of dollars with the attendant flooding of our local markets and grocery stores with imported fruits (European Commission, 2020). Fruit importation not only kills the awareness and development of indigenous fruits but also comes with health risks associated with the chemical preservatives used to prevent the fruits from deterioration and decay during the long period of shipping and storage before sale (Callen *et al.* 2018). These chemical preservatives have been associated with the increased incidence of diseases such as cancer and other deadly sicknesses in the country (Sharma, 2015).

Fruits consumption is highly beneficial to health and wellbeing of the body but equally important is the need to eat them fresh or with lesser additives or preservatives (Sharma, 2015). Tropical rural households who source their fruits from homegardens have been reported to be healthier than those who do not (Okonkwo *et al*., 2020). The need to promote and improve indigenous fruit trees is therefore an urgent one. Many indigenous fruit trees that are more nutritious than their imported counterparts remain unimproved and wild (Onyekwelu *et al.*, 2015). Yet they continue to support rural households through supplementary incomes, diet and livelihood diversification (Bharucha and Pretty, 2010; Chao, 2012). The local trade value and volume of many indigenous fruit trees has never been evaluated yet their presence in our local markets during their seasons remain ubiquitous. Equally unattended to is a survey of the extent of the tree stands or populations supplying these fruits as many of them are sourced from isolated stands in home gardens or compound trees.

D. edulis is an indigenous fruit tree that is well known to the southern parts of Nigeria (Waruhiu *et al*., 2004). Although the tree is valued for timber and fuelwood, by far the most popular produce of the tree is the fruit, which is eaten together with maize. Like other indigenous fruits, *D. edulis* fruit trade and use plays significant role in the life and economy of many people in Nigeria (Tchoundjeu *et al*., 2002). The trade is such that supports households through the provision of supplementary income, livelihood diversification, job creation, and nutrition (Schreckenberg *et al*., 2002; Wynberg *et al*., 2002; Awono *et al*., 2002). An assessment of the value chain of *D. edulis* is required to fully quantify the role of the fruit in the local economy.

In the face of dwindling forest resources due to deforestation the need to domesticate *D. edulis* has become paramount vis-à-vis the dearth of natural populations and low cultivation (Olajuyigbe, 2018). *D. edulis* fruit supply presently is mostly from tree stands within home gardens and isolated trees within homesteads. Propagation of *D. edulis* has mostly been from seed. Yet vegetative propagation of the species holds the promise of improvement and increased cultivation of the species. Through vegetative propagation phenotypically superior genotypes desirable to the farmer (large fruits, better taste and volume of production) can be multiplied for subsequent deployment for cultivation (Asaah, 2012; Smykal *et al.,* 2018). Although clonal propagation is said to reduce genetic diversity, increase risk of disease incidence, reduced capacity for adaptation to changing environmental conditions (Ingvarsson and Dahlberg, 2018). It has been used to encourage the cultivation of important but little cultivated indigenous fruit trees in the face of dwindling forest resources (Meyer and Purugganan, 2013; Smykal *et al.*, 2018). A study was therefore conducted to identify superior *D. edulis* trees using phenotypic characters such as fruit and seed size as the criteria to select candidate trees/genotype for subsequent multiplication through vegetative propagation.

2.0. Methodology

2.1. Materials

Five *D. edulis* trees were randomly selected within Onne community (Figure 1) in Eleme LGA Rivers state for the study in a preliminary effort to assist households in the selection and multiplication of desirable tree phenotypes. The area is located on Lat.4^{o} $72^{'}$ N and Long. 7^{o} $15^{'}$ E. Annual rainfall is 2500mm with a mean value of 75% relative humidity in February and 80% in July. The mean minimum temperature is 25° C.

Figure 1: Onne community
Source: Google maps (2021)

2.2. Methods

Twenty-five (25) fruits were subsequently randomly harvested from the trees (Atangana *et al.*, 2002). Seeds were extracted by softening fruit with warm water at 57^{o}C. Fruit and seed length (mm), breadth (mm), and thickness (mm) were taken using veneer caliper. Size of fruit or seed was calculated as (IPGR, 2003):

$$Fruit\ or\ seed\ size\ = length\ \times breadth\ \times thickness \quad (1)$$

The experiment was a completely randomized design in its layout with a total of 125 seeds and data analysis was carried out using analysis of variance and regression after a normality test was conducted using Shapiro-Wilk.

3.0. Results and Discussion

Highest mean fruit size was recorded in tree 3 and the lowest was tree 5: while, highest seed size was recorded in tree 3 and the lowest in tree 4 (Table 1). Highest within tree fruit size variability was recorded in tree 1 and the lowest in tree 4: while the highest within tree seed size variability was recorded in tree 2 and the lowest in tree 5 (Table 1). There was however a significant difference in fruit and seed size between the trees (Tables 2 and 4). Pairwise comparison showed that tree 1 was not significantly different from tree 2 in fruit and seed size (Tables 3 and 5). This is agreement with Okafor (1983) who on the basis of the significant difference in fruit size between *D. edulis* trees differentiated the species into two sub-species. This was later countered by Anegbeh *et al.* (2005) who reported that the tree-to-tree differences in fruit size in *D. edulis* was continuous and that there was no need to separate the species into two. The results of Anegbeh *et al.* (2005) were corroborated by Waruhiu *et al.* (2004) who confirmed significant continuous variation among *D. edulis* trees in Cameroon. Atangana *et al.* (2002) also reported significant differences in fruit characteristics of *Irvingia gabonensis* while Onyekwelu *et al.* (2015) reported significant differences in fruits and seed characteristics of *Garcinia kola, Chrysophyllum albidum,* and *Irvingia gabonensis.*

There was a significant positive correlation between fruit and seed size among the trees (Table 6). This implies that selection for large fruit size automatically selects for large seeds: this is a drawback since large seeds means lesser fruit pulp mass. Figure 2 therefore showed that the tree to be selected for large fruit sized cultivar multiplication is tree 3 but the tree also has the largest seed size while the tree 4 which has the lowest seed size recorded second to the lowest fruit size. This is contrary to

Atangana *et al*. (2002) who reported weak correlation between fruit and seed size in *Irvingia gabonensis.* Therefore *D. edulis* tree selection for fruit size improvement will require the use of the ideotype concept of Atangana *et al*. (2002) where an ideal fruit and seed size is conceived and trees with fruits and seed size closest to the ideotype are selected for multiplication. Nevertheless, selection based on superior fruit size will still lead to the development of an improved cultivar since large fruits have larger fruit pulp than smaller fruits.

Table 1: Fruit and seed size variation among *D. edulis* trees

D. edulis trees	Mean fruit size (mm)	Coefficient of variation (%)	Mean seed size (mm)	Coefficient of variation (%)
Tree 1	49.79 ± 4.72	24**	25.39 ± 1.98	20
Tree 2	54.07 ± 3.79	18	24.68 ± 2.75	28**
Tree 3	79.38 ± 3.99**	13	34.78 ± 2.47**	18
Tree 4	39.01 ± 1.79	12*	15.58 ± 0.99*	16
Tree 5	29.60 ± 1.48*	13	17.62 ± 0.99	15*

*Note: ** = Highest: * = lowest*

Table 2: ANOVA of fruits size variation among the *D. edulis* trees

Sources	SS	df	MS	F	P value	Eta-sq	RMSSE	Omega Sq
Between Groups	35411.39	4	8852.848	117.2776	1.69E-40*	0.796303	2.165895	0.788175
Within Groups	9058.354	120	75.48628					
Total	44469.75	124	358.627					

*Note: * = significant ($p < 0.05$)*

Table 3: Pairwise t-test analysis of fruit size variation of *D. edulis*

Group 1	Group 2	p-value	mean
Tree 1	Tree 2	0.171902^{ns}	4.2884
Tree 1	Tree 3	2.55E-12*	29.5992
Tree 1	Tree 4	0.000224*	10.7724
Tree 1	Tree 5	8.83E-09*	20.1896
Tree 2	Tree 3	6.91E-12*	25.3108
Tree 2	Tree 4	3.85E-08*	15.0608
Tree 2	Tree 5	5.14E-13*	24.478
Tree 3	Tree 4	8.39E-19*	40.3716
Tree 3	Tree 5	8.82E-21*	49.7888
Tree 4	Tree 5	3.46E-10*	9.4172

*Note: * = significant ($p < 0.05$); ns = not significant ($p > 0.05$).*

Table 4: ANOVA of seed size variation among the *D. edulis* trees

Sources	SS	df	MS	F	P value	Eta-sq	RMSSE	Omega Sq
Between Groups	5739.843	4	1434.961	56.36784	1.12E-26*	0.652649	1.50157	0.63922
Within Groups	3054.85	120	25.45708					
Total	8794.693	124	70.92494					

*Note: * = significant ($p < 0.05$).*

Table 5: Pairwise t-test analysis of seed size variation of *D. edulis*

Group 1	Group 2	p-value	mean
Tree 1seed	Tree 2 seed	0.68216^{ns}	0.7132
Tree 1seed	Tree 3seed	5.58E-07*	9.3888
Tree 1seed	Tree 4 seed	2.76E-10*	9.8152
Tree 1seed	Tree 5 seed	5.18E-08*	7.7784
Tree 2 seed	Tree 3seed	2.45E-06*	10.102
Tree 2 seed	Tree 4 seed	1.04E-06*	9.102
Tree 2 seed	Tree 5 seed	4.88E-05*	7.0652
Tree 3seed	Tree 4 seed	3.34E-15*	19.204
Tree 3seed	Tree 5 seed	6.85E-14*	17.1672
Tree 4 seed	Tree 5 seed	0.006456*	2.0368

*Note: * = significant (p < 0.05); ns = not significant (p > 0.05)*

Table 6: Regression analysis of relationship between *D. edulis* fruit and seed size

Multiple R	0.951892
R Square	0.906098
Adjusted R Square	0.874798
Standard Error	6.658523
Regression p-value	0.012575*
Coefficient (seed size)	2.364336
Intercept	-5.45393
Regression df	1
Residual df	3
Observations	5

*Note: * = significant (p < 0.05)*

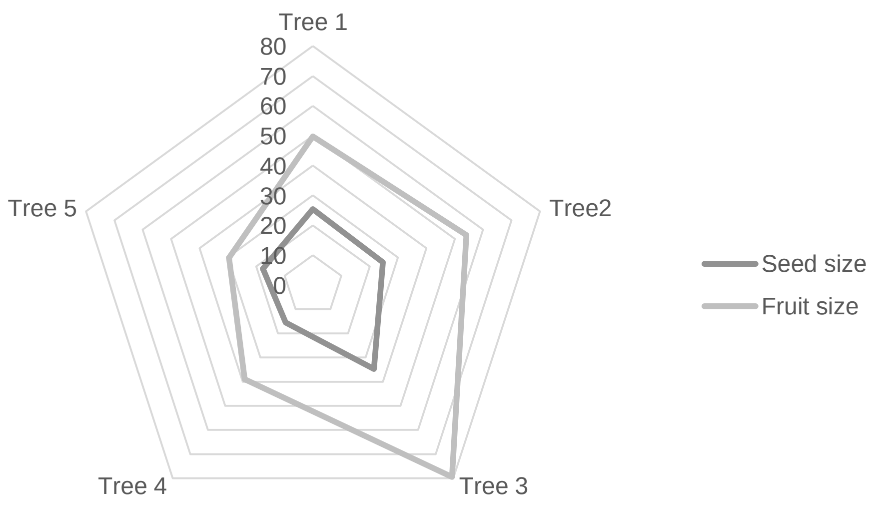

Figure 2: Selection for large fruit size in *D. edulis* tree for multiplication through vegetative propagation

4.0. Conclusion

D. edulis fruit and seed size varied significantly among the five trees studied. This provided opportunity for selection for large fruits among the trees. Tree 3 recorded the largest fruit size and therefore the choice candidate for selection for large fruits. However due to a strong positive correlation between fruit size and seed size among the trees selection for large fruits inadvertently selected for large seeded fruits. In a situation where fruits are collected from a wider range of landscape and varying ecozones it is possible to draw up an ideotype based on the farmers stated fruit and seed preferences and then identify trees with fruits and seed characteristics nearest to the ideotype and select them for multiplication. Nevertheless, selection for large fruit size in the case of the present study is still acceptable since larger fruits have large fruit pulp than smaller fruits.

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