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FRUITS SOFTENING IN *Dacryodes edulis* (G. Don) H.J. Lam AND THEIR IMPLICATIONS ON GERMINATION AND MORPHOLOGICAL TRAITS

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ABSTRACT

Dacryodes edulis (G. Don) H.J. Lam is a highly sought multipurpose fruit tree species that is value for its edible fruit pulp which are consumed when soften mostly by the use of hot water. A study was carried out to document the possible effect of fruit softening on the growth and morphological traits of *Dacryodes edulis* with the view of creating a balance for both the consumer and the nursery managers for rapidly multiplication of the species. Fruits of *D. edulis* were subjected to various fruit softening viz: T1=Natural softening (allowed the pulp to soften naturally), T2=Warm water softening (50^{o}c water to soften the pulp), T3=Hot water softening (100^{o}c water to soften the pulp) and T4=No softening (freshly manual extraction without softening). The seeds were sown in well-labeled germination trays in a completely randomized design with five replicates. Data were collected on number of leaves, leaf length, leaf breadth, plant height, and collar diameter and biomass accumulation. Results showed that T1 had the highest percentage of 83.33% with mean days of 18 followed by T4 which recorded germination percentage of 82.30% with mean days of 21.T3 Seeds did not germinate. Various fruit softening differs from each other as indicated by significant difference (p=0.05) among the various morphological traits examined in this study. T1 recorded the highest for all the morphological traits examined except plant height whereas T2 recorded the least.T1 had the highest number of leaves (24.65) followed by T4 (21.73) T2 had the least number of leaves (19.23). The study concluded that *Dacryodes edulis* cannot be regenerated from seeds softened in hot water because the seeds cannot withstand high temperature.

Keywords: *Dacryodes edulis*, fruit softening, germination, morphological traits.

Introduction

Fruits house the seeds which are genetic materials that carry heritable traits in plants. According to Evans and Turnbull (2004), seeds are expensive, scarce and precious. Seeds of tropical forest species are objects of commerce applicable to various end-uses. These species, according to Leakey and Tomich, (1999) and Leakey, (2010), have traditionally provided communities and households with their everyday needs for food and other necessity.

With rapid forest depletion in the tropics, the supply regime of these useful forest produce is severely threatened and this has a negative effect on the well-being and welfare of local people who depend on these produces, Hence the need for reforestation. The regeneration of species is usually limited by unavailability of seeds, failure to germinate among other factors (Adebisi *et. al.*, 2011).

D. edulis is an agroforestry plant species belonging to the Buseraceae family. It is one of the most important edible fruit trees indigenous to the Gulf of Guinea and Central African regions. The species of edulis are perennial

plants growing to 40m tall. Phenotypic variations among the species are enormous (Waruhiu *et al.*, 2004). The flowers are yellow and are arranged in large inflorescence. The fruit is an ellipsoidal drupe which varies in length from 4 to 12 cm. The skin colour of the mature fruit is dark blue or violet while the immature colour is pink (Anegbeh *et al.*, 2005).

Dacryodes edulis contributes to rural incomes, supplements the local diet and is used in traditional and modern therapies (Schreckenberg *et al*., 2006; Omonhinmin, 2012). The fruits are boiled in hot water or roasted to soften the pulp before eaten and the value of the fruit lies in its pulp which is a good source of proteins, fats and carbohydrates that could be used to alleviate malnutrition in children (Ajayi and Adesanwo, 2009; Duru *et al*., 2012).

The fruit form an important part of the diet of people in West and Central Africa being rich in vitamins and containing 63.5% fat, 24.2% protein and 9.2% carbohydrate (Mbofung *et al.*, 2002).

Ajayi and Adesanwo, (2009) stated that protein content of *D. edulis* is greater than that of maize (10%), rice (8%), sorghum (11%) or wheat (8–13%). The fruits are rich in minerals and have some medicinal properties. In addition to the use of *D. edulis* fruits as a staple food, there is growing interest in preparing fruits into jams, jellies, and in the extraction of the oil for cooking or use in the margarine, soap and perfume industries. The kernels have been found suitable for use as animal feeds. (Sonwa *et al.*, 2002).

Pulp softening of edible fruit tree eaten when fermented such as *D. edulis* remains a key factor both for the nursery managers and the populace who depend on this species for food and other vital needs, therefore finding a common ground becomes a necessity. Therefore this study was conducted to find out the possibility of germinating seeds from fermented fruits and its effect on various morphological traits of *D. edulis* for mass production of seedlings for rapid domestication the species.

Materials and Methods

Source of fruit collection

Mature fruits of *Dacryodes edulis* were collected from Forestry Research Institute of Nigeria, Ibadan Southern Nigeria. FRIN is located on the longitude 07023'18"N to 07023'43"N and latitude 03051'20"E to 03051'43"E.

Fruit softening, extraction and experimental procedure

Fruits were softened and extracted according to the following treatment:

T1 Natural softening (allowed the pulp to soften naturally)

T2 Warm water softening (50^{o}c water to soften the pulp)

T3 Hot water softening (100^{0}c water to soften the pulp)

T4 No pulp softening (No pulp soften, depulped fresh fruits)

Experimental set up and design

Germination study

Seeds from softened seeds were sown in well-labeled germination trays containing well drained soil of P^{H} close to 7.0 according to treatment. The experiment was set up at the screen house of nursery section of Sustainable Forest Management of Forestry Research Institute of Nigeria, Ibadan in a completely randomized design.

Watering was done daily in the morning. Daily observation of germination was done until no further germination could be

observed for about a week. Germination was said to have taken place when the plumule emerges above the soil surface. The treatments were replicated five times. Data on mean days of germination and germination percentage were collected

Morphological traits assessment

At the end of germination study, uniform seedlings were selected from each of the treatment and transferred into polythene pots of dimension 17x15cm filled with top soil and arranged in a completely randomized design with five replications. Data collection started after 6 weeks of planting and spanned for 6 months.

Data collection

Number of leaves: Physical counting of the leaves
Leaf length (cm): measuring from the base to the tip of the selected leaves and averaged with the aid of ruler
Leaf breadth (cm): measuring across the centre of the selected leaves and averaged with the aid of ruler
Plant height (cm): measuring from the base of the plant (soil level) to the tip of the seedling
Collar diameter (mm) taken with the aid of digital veneer caliper and
Biomass (g): Seedlings were carefully uprooted and separated into root, stem and leaves. Fresh weight were taken, afterward oven dried till a constant weight were achieved.

Data analysis

Analysis of variance (ANOVA) was carried out using Statistical Analysis System (SAS 2000), significant differences were further separated with Duncan multiple range test (DMRT) at 5% level of probability. Results were presented in tables and figures.

Result

The analysis of variance (ANOVA) for the effect of fruit softening on the germination of *D. edulis* is presented in table 1. All the treatments are different (p=0.05) from each other. Table 2 shows the mean effect of seed germination percentage of *D. edulis* as influenced by fruit softening. T1 and T4 had higher germination percentage effect of 83.33% and 81.30% respectively which were significantly different (p=0.05) from others. T3 had a very low germination percentage of 0.07 which was significantly different from others. Table 3 shows the effect of fruit softening on days of germination of *Dacryodes edulis.* Seeds from T1 germinated at a early day of 18 which was statistically different from each others followed by T4 of 21 days. It took 0.07% of seeds from T3 37 days to germinate.

Table 1: Analysis of variance (ANOVA) for the effect of fruit softening on the germination of *Dacryodes edulis*

Source of Variation	*SS*	*Df*	*MS*	*F*	*F crit*
Treatment	14421.28	3	4807.09	2776.61	4.07**
Error	27.707	16	1.731		
Total	14448.987	19			

**** Significant p=0.05**

Table 2: Mean effect of seed germination percentage of *Dacryodes edulis as* influence by fruit softening

Fruit fermentation	Mean germination percentage
Natural softening	83.33a
Warm water softening (50^{o}C)	35.81b
Hot water softening (100^{o}C)	0.07c
No softening (freshly manure extraction)	81.30a

Mean followed by the same alphabet are not significantly different from each other according to Duncan multiple range at 5% probability level.

Table 3: Effect of fruit fermentation on mean days of germination of *Dacryodes edulis*

Treatment	Days of germination
Natural softening	18d
Warm water softening	25b
hot water softening	37a
No softening	21c

Fruit softening had significant effect *($p > 0.05$)* on all the morphological traits measured (Table 4). Table 5 shows the mean effect of fruit softening on morphological characteristics of *D. edulis. S*eedlings from naturally softened fruits (T1) had the highest number of leaves (24.65) which was significantly different from others whereas warm water (T2) recorded the least number of leaves (19.23). Also T1 had the highest leaf length of 11.98cm which was closely followed by T4 (11.64cm) whereas T4 had the least leaf length of 7.06cm. T4 had the highest leaf breadth of 5.69cm followed by T1 (5.34cm) whereby T2 recorded the least value of 4.53cm. T1 recorded the highest value for collar diameter r(5.88mm) and biomass(10.01g) which was significantly different (*$p<0.05$*) from T2 values of (3.57mm) and (6.21g) respectively . T4 had the tallest plant of 23.01cm whereas T2 had the shortest plant of 18.01cm

Table 4: Analysis of variance for the effect of fruit fermentation on morphological characteristics of *D. edulis*

SV	DF	No of leaves	Leaf length	Leaf breadth	Plant height	Collar diameter	Biomass
Fruit softening	2	83.05**	98.23**	140.52**	61.91**	143.27**	32.52**
Error	12	91.34	21.32	22.87	108.97	3.03	81.22
Total	14						

** significance at P=0.05

Table 5: Mean effect of fruit softening on morphological characteristics of *D. edulis*

Treatment	No of leaves	Leaf length	Leaf breadth	Plant height	Collar diameter	Biomass
Natural softening	24.65a	11.98a	5.34a	22.83a	5.88a	10.01a
Warm water softening	19. 23c	7.06b	4.53b	18.01b	3.57c	6.21c
No pulp softening	21.73b	11.64a	5.69a	23.01a	4.29b	8.94b

Mean followed by the same alphabet in a column are not significantly different from each other according to Duncan multiple range at 5% probability level.

Discussion

Providing appropriate technique that can be easily adopted by local farmers remains a veritable means for rapid domestication of useful tropical species (Leakey *et. al*., 2004). Gbademosi (2013) submitted that this is important in nursery and field establishment of forest crops and further stated that this method will be easily demonstrated to peasant farmers. Eyo (2009) further submitted that seed germination is important in propagation and breeding programme as well as for testing and using germplasms.

Seeds of *D. edulis* from pulp softened in hot water had little or no germination. This may be a consequence of seed death, which may be due to inhibition, oxygen starvation and high temperature. This agrees with Hartmann *et al.* (2007) and Kramer (1983) who noted the harmful effect of restriction of oxygen supply during some critical metabolic stage of germination. It was clear that the seed coat and the cotyledon could not withstand high temperature due to the thin nature of the outer coat of the seeds. A higher percentage germination and lesser days of germination of natural and no softening seeds is an indication that *D. edulis* naturally can germinate and establish quickly by just allowing the fruits to soften before seed extraction or extract the seeds from freshly collected fruits before sowing. However, care should be taken in extracting seeds from fresh fruits to avoid splitting the seeds because the seeds of *D. edulis* come in multiple lobes attached to the cotyledon embedded in a thin layer seed coat. The decrease in germination and increase in days of germination from warm water fruit softening to hot water fruit softening is an indication that *D. edulis* seeds are temperature dependent, this is in line with Amira and Mohamed, (2013) who reported negative relationship between increasing water temperature and time to germinate of seeds. This invariably implies that seeds from boiled or roasted fruits consumed cannot be used for regeneration purposes.

Seed germination is the most crucial stage that affects seedling growth and establishment (Tian *et. al.*, 2014). The fruit softening differs from each other as indicated by significant difference (p=0.05) among the various morphological traits examined in *D. edulis* seeds. The effect of fruit softening affected the growth of all the morphological parameters assessed. Number of leaves, collar diameter and biomass were significantly enhanced when seeds are naturally softened. Seeds from natural softening and no softening (fresh depulped) had the same higher effect on leaf breadth, leaf length and plant height.

Since these seeds were not subjected to oxygen starvation and other physiological stress in warm water , they exhibited higher germination percentage and subsequent higher morphological traits when compared to the warm water softened seeds. This shows that *D. edulis* seeds are temperature dependent as high temperature had effect on both the germination and development of the species.

Conclusions

D. edulis cannot be regenerated from seeds softened in hot water. Naturally fruit softened seeds and manually removed seeds are recommended to promote the germination process and improve the early establishment of seedlings in the nursery.

This method is equally desirable since most of the naturally fermented fruits are mostly the rotten fruits that cannot be consumed by man nor sold in the market. These are readily available to local peasant farmers and nursery managers to accelerate the domestication of the species.

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