GERMPLASM COLLECTION AND ROOTSTOCK PRODUCTION OF SOME HIGH VALUE INDIGENOUS FRUIT TREES FOR INTEGRATION WITH RUBBER IN AGROFORESTRY SYSTEMS IN NIGERIA

[1*]Anegbeh, P.O., [1]Okere, D.O., [2]Eguavoen, O.I., [3]Onyema U.N. and [4]Awah, A.A.

[1] Agronomy Department, [2]Executive Director's Office, [4]Research Outreach Department, Rubber Research Institute of Nigeria, P. M. B. 1049, Benin City, Nigeria
[3]Crop Science Department, Edo State College of Agriculture, Igouriakhi, Benin City, Nigeria.

**Corresponding author*: paul_anegbeh@yahoo.com

ABSTRACT

Collection missions were undertaken and germplasm of some high-value indigenous fruit trees (Irvingia gabonensis, Dacryodes edulis, Garcinia kola, Cola accuminata and Tetracarpidium conophorum) were collected. Each germplasm species was collected from different locations. Irvingia gabonensis was collected from Uzebba village in Owan West LGA, Dacryodes edulis was collected from Igouriakhi in Ovia South-West LGA, Cola accuminata was collected from Ekiosa in Ikpoba Okha LGA, while Garcinia kola and Tetracarpidium conophorum were collected from Oba market in Oredo LGA, in Edo State, Nigeria. These germplasm samples were collected from the crown of the trees when they were mature and ripe for collection. Additionally, some germplasm were collected and bought from the markets. The germplasm samples were taken to a nursery at Iyanomo in Ikpoba Okha LGA of Edo State, Nigeria. The samples were processed and propagated using a mixture of topsoil and decomposed cow dung on a ratio of 2 : 1 and thoroughly watered following specific procedures and techniques suitable for each species sampled as developed by Researchers and the CFC/RRIN Project in Nigeria. With good management practices, high germination of 68% was recorded for Irvingia gabonensis, 100% for Dacryodes edulis, 76% for Garcinia kola, 96% for Cola accuminata, and 92% for Tetracarpidium conophorum.

Keywords: Agroforestry, Conservation, Fruit trees, Germplasm, Income generation, Livelihood.

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INTRODUCTION

Germplasm is often synonymous with genetic material. It is the name given to seed or other materials from which plants are propagated. Germplasm collection is, therefore, a collection of genetic materials or genotypes of particular species, from different sources and geographical sites, used as source material in plant breeding or plant propagation (Day-Rubenstein and Heisey, 2003).

Germplasm collection and domestication of high value indigenous fruit trees arose as a result of the need to conserve wild fruit tree species, which

are declining in the natural ecosystem. As a result of decreasing level of species of high value indigenous fruit tree species in the natural ecosystem, concerted efforts are being made by Agricultural Institutions and rural communities to preserve these fruit trees through germplasm collection and conservation. Mainly, these conservation practices involve domesticating and propagating the plants, and establishing them in farmers' fields in a joint effort between Researchers and Farmers (Anegbeh, 2011; Okafor 2005).

Germplasm collection together with propagation of high value indigenous fruit trees is important because it provide sustainable livelihood to rural farmers through their cultivation by providing fruit foods and promotion of income generation avenues to farmers; development of improved planting materials for farmers and protection of the environment from desert encroachment or deforestation and degradation besides conserving the trees in gene banks. A germplasm bank is an organized collection of seeds or other genetic materials (each genotype entered being called an accession) from which new cultivars may be generated.

Objectives of the study:

- To carry out germplasm collection of the following indigenous fruit trees: *Irvingia gabonensis* (Bush mango), *Garcinia kola* (Bitter cola), *Dacryodes edulis* (Native pear), *Kola accuminata* (Native cola), and *Tetracarpidium conophorun* (African walnut) and propagate them for domestication.
- To determine the germination percentages, speed and germination rate of their fruits for integration in rubber-based agroforestry systems.

MATERIALS AND METHODS

Mature fruits or germplasm of five high-value indigenous fruit tree species were collected and used for the study. The plant species used include: *Irvingia gabonensis* (Bush mango), *Dacryodes edulis* (Native pear), *Garcinia kola* (Bitter kola), *Kola accuminata* (Native kola), and *Tetracarpidium conophorum* (African walnut). A survey was carried out to identify where these fruit trees are located and the time of fruiting and fruit maturity prior to germplasm collection missions. These species were collected from March to November 2011 from farmers' fields and from markets. *Irvingia gabonensis* (Figure 1) was collected from Uzebba village in Owan west local government area of Edo state. *Garcinia kola* (Figure 3) and *Tetracarpidium conophorum* were collected from Ekiosa market in Oredo local government area of Edo state, Nigeria. *Kola accuminata* (Figure 4) from Ikpoba Okha local government area, while *Dacryodes edulis* (Figure 5) was collected from Igouriakhi in Ovia South-West local government area of Edo state. These germplasm samples were collected from the crown of the trees when they were mature and ripe for collection.

Processing and propagation of fruits and seeds: All the fruits types collected were taken to Iyanomo for processing before propagation in the nursery. Iyanomo is a town located at south-south region of Ikpoba-Okha local government of Edo state, Nigeria. The vegetation of Iyanomo is rain forest vegetation with annual average rainfall of 2000mm-2500mm and annual average temperature of 24^oC-30^oC. The soil of Iyanomo is acidic with pH range of 4 to 5 and suitable for good growth of rubber and some other tree crops. Iyanomo is located on longitude 5^o 34' to 5^o 38'E; latitude 6^o 8'N to 6^o 11'N and Altitude range of 19m to 42m. It is predominantly occupied by Binis and Ishans mixed with other tribes (Igbos, Urobos and Efiks). Different procedures were used for the processing (Figure 2) and propagation of the different species.

Polythene pots were purchased for the propagation prior to processing of the seeds. The perforated nursery (polythene) bags were filled with topsoil mixed with decomposed cow dung using a ratio of 2:1. The polythene pots were arranged in a nursery in Randomized Complete Block (RCB). There were 5 treatments (species) and each treatment was replicated 5 times. The polythene pots were watered thoroughly after filling.

Irvingia gabonensis: The fruits of *Irvingia gabonensis* were allowed to ripe, but without decay, for ease of depulping (i.e. removing the fleshy part of the fruit) and depulping was done by macerating the fruits with hands. This is necessary because the active acid in the decaying fruit can cause germination inhibition of the seeds. The seeds were then washed and spread under shade to dry for a day before sowing (Figure 2). *Garcinia kola:* The ripe pods of *Garcinia kola* were broken in order to extract the fresh seeds or nuts. Using the methods of Anegbeh et al. (2006), the nuts were washed in pure water and scarified by slightly cutting the side of the edge of the nuts. The process enables the nuts to imbibe water through the cut points and this facilitates germination.

Cola accuminata: The pods of C*ola accuminata* were carefully open with a sharp knife and the nuts were extracted prior to sowing.

Dacryodes edulis: The fruits of *Dacryodes edulis* (Figure 5) were carefully opened with a sharp knife, and the seeds were carefully extracted from the fruits. The exercise was carefully done without causing injuries to the seeds. This is a form of scarification which allows early and even germination of seeds.

Tetracarpidium conophorum: Pods of *Tetracarpidium conophorum* were covered, because of the hard nature of the pods, and allowed to soften before the seeds were extracted and washed in tap water prior to sowing.

Processed seeds of the 5 species were sown in polythene pots containing a mixture of top soil and sawdust. The pots were properly labelled (Figure 6), and thoroughly watered so that the pots were kept moist at all time but without getting waterlogged. This process continued daily until the seedlings emerged (Gill and Bamidele, 1981) and reach the first true-leaf stage. In the nursery, the criterion for germination was a visible protrusion of the shoot apex or epicotyl on the surface of the soil (Godchild and Walker, 1971; Djavanshir and Pourbeik, 1976), and the appearance of 1.5 mm plumule above the soil was considered as seedling emergence (Gill and Bamidele, 1981). Germination in the nursery was monitored daily using the rules and procedures of ISTA, (1993), from date of commencement of germination until when germination was constant. The values obtained at each count were summed up at the end of the germination test and converted into cumulative percent germination.

Parameters Measured: Using the methods of Anegbeh (1997), the percentage germination was calculated, by expressing the number of germinated seeds as a percentage of all seeds sown, using the following formula:

$$\textbf{Percentage germination} = \frac{\text{Total number of germinated seeds}}{\text{Total number of seeds sown}} \times 100$$

Germination Rate was calculated by dividing the number of normal seedlings per species obtained at each count by the number of days seeds took to germinate (Djavanshir and Pourbeik, 1976).

Germination Rate = Total number of seeds germinated
Number of days in the germinator

Figure 1: *Irvingia gabonensis* fruits. Figure 2: Processing of *I. gabonensis* fruits.

Figure 3: *Garcina kola* **Figure 4: *Cola acuminata*** **Figure 5: *Dacryodes edulis***

Figure 6: Management of seedlings in the nursery.

Germination Speed was calculated by determining the number of days required for 50% of the germinating seeds to emerge.

Thereafter, the seedlings were maintained for one year in the nursery and watered daily. To prevent diseases, pests, and to avoid competition for water and nutrients, the pre-field stock management techniques of Anegbeh (1997) which are watering, hand weeding of the polythene pots containing the germinated seeds, root pruning, and weeding of the nursery environment were employed prior to budding.

Statistical Analysis: Data collected were analyzed using descriptive statistics of simple percentage.

RESULTS AND DISCUSSION

Over five thousand seeds of each of the species were collected from different villages (Table 1), processed in the nursery at Iyanomo and germinated. The five species differed significantly ($P<0.05$) in germination percent, germination rate and germination speed indicating a wide range of variations among the species studied (Table 2). The germination curves for the seeds sown under the germination conditions were similar to a typical germination curve. Germination was first observed in *Dacryodes edulis* 2 Weeks after sowing (WAS), while *Irvingia, Cola* and *Tetracarpidium* germinated after 3 Weeks. *Garcinia* seeds germinated 10 WAS. After the initial delay Weeks, a rapid phase commenced and lasted until 13 Weeks for *Gacinia*, 8 Weeks for *Irvingia* and 6 Weeks for *Cola* and *Tetracarpidium*. A constant phase then started and continued until the germination test was terminated after 14 Weeks (Fig. 7).

Germination of *Dacryodes* tended to peak earlier than other species (3WAS), followed by *Cola*, *Tetracarpidium, Irvingia* and *Garcinia*. The lowest germination was exhibited by *Irvingia* (67.61%) while the highest germination was recorded for *Dacryodes* (99.69%). The germination speed (the time or days required for 50% percent of the germinating seeds to sprout) and the germination rate (total number of seeds germinating in the germination period) are shown in Table 2.

The performance of the seed lots has been classified into three groups for the five species. It was observed that high germination percentages of 99.69% were obtained from seeds of *Dacryodes.* Also, germination percentages of *Cola* and *Tetracarpidium* were 94.83 89.74% respectively, while *Irvingia* and *Garcinia* belonging to the third group have 67.61 and 73.79% respectively (Table 2). The highest germination rate of 4.76seed/day was found in *Dacryodes*, followed by *Cola* with 2.29seed/day. The lowest rate of 0.84seed/day was obtained for *Garcinia*. It is obvious that the seeds of the five different species differ in germination reflecting possible high level of genetic variability in the species. This result agrees with study of six agroforestry tree species made by Anegbeh, (1997) who concluded that variations in control of dormancy and germination responses may more closely reflect the high level of genetic variability in tree species. Though most of the seeds germinated freely, the seeds of *Dacryodes*, *Cola*, and *Tetracarpidium* had maximum germination percentages of 99.69%, 94.83% and 89.74% respectively. Germination of *Irvingia* was less than 70%, which was probably due to lack of viability since there was no variation in collection time, seed sowing and the pre-treatments necessary for good germination were applied on seeds of *Irvingia*. Other Workers attributed variations in seed germination to pH, seed maturity, genetic and environmental factors (Anegbeh *et al*, 2006).

The results of this study suggest that the mechanisms controlling the germination of tree species are internally consistent. This work has shown that

collection of germplasm of desirable characters of tree species from diverse ecosystems and propagating in a particular ecosystem is useful in a rubber-based agroforestry system. The tables presented above show that germination percentage and germination rate of each germplasm species collected is significantly high enough to achieve mass propagation of seedlings of these high-value indigenous fruit trees prior to budding and grafting.

The difficulty in germinating and propagating of the indigenous fruit trees by local farmers can be overcome when proper procedures and techniques are used. Therefore, this work has confirmed the work of Anegbeh *et al,* (2004) and Asaah *et al*, (2003) that high value indigenous fruit trees could be collected by farmers, germinated, and propagated through human intervention with high germination rates and percentages. Through this means the germplasm species are conserved from total declining from natural ecosystem (Anegbeh, 2011). The results also reveal that the species can be successfully germinated on a relatively good medium. It is concluded that establishment of the selected five high-value indigenous fruit species in rubber-based agroforestry systems in Iyanomo and farmers' fields is an achievable goal.

Table 1: Identification, source and number of germplasm of selected high-value fruit trees collected in Edo State for rubber-based agro forestry systems

Species	Common name	Location	Local govt. Area	No of seeds collected
Irvingia gabonensis	Bush mango	Uzebba	Owan West	5206
Dacryodes edulis	African pear	Igouriakhi	Ovia South West	5116
Garcinia kola	Native cola	Ekiosa	Ikpoba Okha	5150
Cola acuminate	Bitter cola	Oba Market	Oredo	5125
Tetracarpidium conophorum	Walnut	Oba Market	Oredo	5117

Table 2: Germination indices of some high-value fruit trees at Iyanomo in rain forest vegetation zone

Species	Seedling Production	Germination Rate	Germination Speed	% germination
Irvingia gabonensis	3520	1.21	49	67.61
Dacryodes edulis	5100	4.76	14	99.69
Garcinia kola	3800	0.84	84	73.79
Cola acuminate	4860	2.29	28	94.83
Tetracarpidium conophorum	4592	1.88	35	89.74

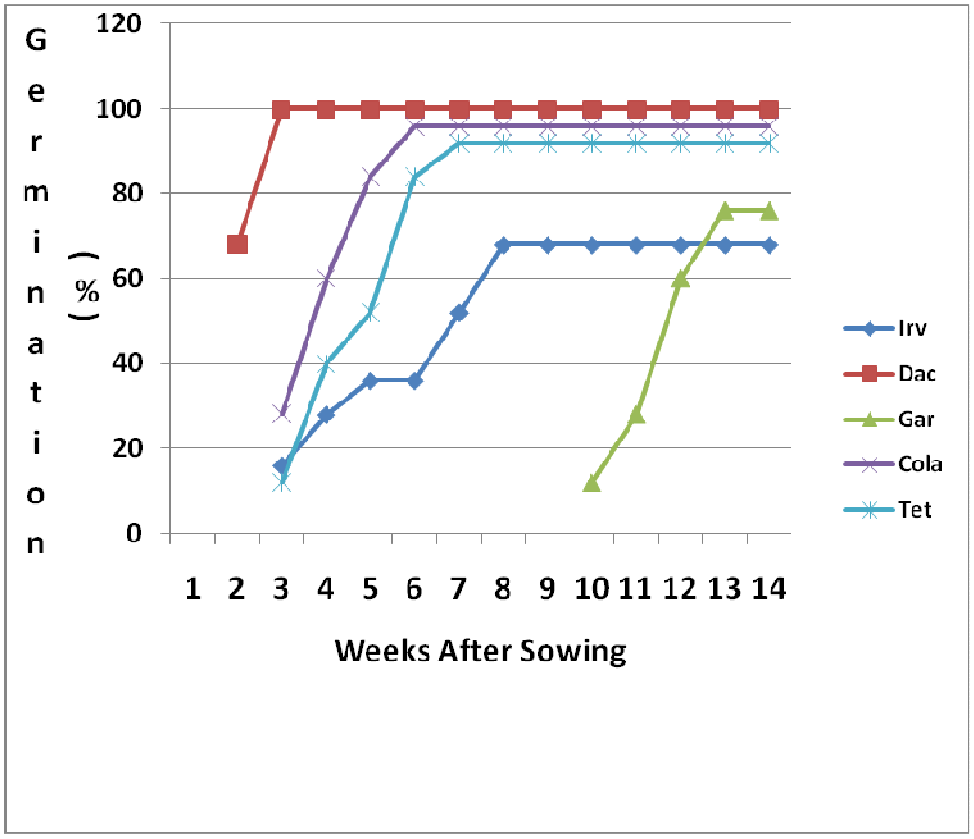

Figure 7: Cumulative germination of five high-value fruit trees in Nigeria.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

- Germplasms of *Dacryodes edulis* and *Garcinia kola* had the highest germination rate and speed respectively than *Irvingia gabonensis, Cola acuminate* and *Tetracarpidium conophorum germplasms.*
- *Dacryodes edulis, Cola acuminata* and *Tetracarpidium conophorum* germinated better with the highest germination percentage than other fruit trees.
- High value indigenous fruit trees (*Irvingia gabonensis, Dacryodes edulis, Garcinia kola, Cola accuminata and Tetracarpidium conophorum)* can be collected, germinated and propagated by human intervention if proper procedures and techniques are followed. This has erased the popular and negative belief that these fruit trees are difficult to germinate and propagate by human intervention.

RECOMMENDATIONS

- There is need for farmers, rural communities and Agricultural Institutions as well as town planners to engage in meaningful collection, propagation and domestication of high value indigenous fruit trees.
- Considering their importance and the need to conserve them from extinction, it is recommended that farmers should engage themselves in meaningful propagation especially through vegetative propagation techniques of the indigenous fruit trees. These efforts will not only enhance their income, but also

sustain their livelihood and protect the environment.

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