INTERNATIONAL JOURNAL OF NATURAL AND APPLIED SCIENCES (IJNAS), VOL. 3, NOS.1& 2 (2008) P. 54 – 61, 3 TABLES, 1 FIG.

# Morphological and phenotypic variations in *Irvingia gabonensis*

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**ABSTRACT**

Studies were conducted to assess the range of phenotypic variation in morphological characters and seed germination potentials within the natural populations of bush mango (*Irvingia gabonensis*) collected from different ecological zones. Results show that fruit colour in Akamkpa and Ikom zones were recorded as greenish yellow, Yakurr (Green), Etung (Brownish) and Boki (Bright reddish yellow). The fruit shape in Akamkpa and Yakurr were observed to be oblique and Ikom and Boki to be spheroid while that of Etung zone was ovoid. The best average fruit and seed sizes (length and width) were obtained from Ikom ecological zone (10.61 cm and 6.80 cm) and (7.20cm and 4.76cm) respectively while the least were obtained from Akamkpa zone (6.71 cm and 3.69 cm) and (4. 60 cm and 2.22 cm) respectively. This study has also shown that the highest fruit and seed weights were obtained from fruits sourced from Ikom ecological zone (80.3g and 23.4g) respectively. Germination time (25 days) decrease significantly ($P < 0.05$) with a corresponding increase in germinability (50%) with seeds obtained from Ikom ecological zone. A highly significant ($P < 0.05$) variation in germination value among the seeds collected from the different ecological zones were recorded. Results show that Ikom had 7.92 Etung (4.74) while Akamkpa (18). There was a positive relationship between the amount of rainfall, germinability and morphological parameters with seeds sourced from the five ecological zones. The best relationship was recorded with fruits/seeds sourced from Ikom ecological zone between rainfall and fruit weight ($r = 0.93$: $p < 0.05$) seeds length ($r = 0.88$: $p< 0.05$), seed weight ($r = 0.71$:$P<0.001$), thickness of seed coat ($r = 0.74$:$P<0.00$) and thickness of mesocarp ($r = 0.89$:$P<0.05$) while fruits/seeds from Boki Zone also recorded positive relationship between rainfall and mesocarp thickness ($r = 0.76$:$P<0.001$). A strong relationship was also recorded between germinability and seed weight ($r = 0.70$:$p < 0.001$) with seeds sourced from Ikom while Etung recorded ($r = 0.76$: $p< 0.001$), hence these traits can be taken into consideration while selecting superior seed material for better germination vigour. The occurrence of higher seed weights with low germination percentage in moderately wet zones is evident from the study. It is recommended that knowledge of such differences may be important in breeding programmes.

## INTRODUCTION

The moist tropical forests of West and Central Africa are endowed with natural resources and have abundant biodiversity (FAO, 1983), especially trees that provided foods (fruits, nuts), fuel, fibers, medicines and various other products, including construction and building materials (Ladipo *et al.* 1996). *Irvingia gabonensis* is one of these forest resources which in recent times have become very important products.

Irvingia *gabonensis* (*Aubry-lecomte ex o" Rouke)* Baill, the bush mango is a medium sized evergreen tree. It belongs to the family *Irvnigiaceae (order Rutales*) which is a small tropical family containing two genera (klaiedoxa, Desbordesia) and the genus *Ivingia* which contains three species (Irvingia *gabonensis*, *Irvingia* smithii and *Irvingia grandifolia*) all occurring in West and Central Africa (Okafor, 1975).

Irvingia *gabonensis* produces edible fruits and seeds.

The sustainability of these natural resources has been the concern of various workers including, the Nigerian National Research Council, (1991) and International Centre for Research in Agro Forestry (ICRAF) (1999), particularly with continued clearing and selective exploitation of forests (Palmberg, 1984).

Irvingia *gabonensis* is one of such fruits that have suffered neglect or inadequate attention over the years. This is due to scarcity brought about by lack of intensive cultivation, the abundance of supplements and ignorance of the value of its by – products (Agbor, 1994). A field survey carried out by ICRAF identified Irvingia *species* as priority wild fruit tree species for domestication. The reports further revealed substantial intraspecific phenotypic differences among Irvingia *species* (Ladipo *et al.* 1996).

The domestication of under-utilized tree species through deliberate selection and management of superior traits within agroforestry is a multifaceted process in which a progressively closer interaction between people and tree resources takes place (Wiersum, 1996 and Simons, 1996). The improvement of indigenous trees valued for their traditionally important fruits offers a flexible means by which to add to poverty reduction and enhanced food security to the global challenges faced today through reducing deforestation and environmental degradation (Leakey, 2001).

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Manuscript received by the Editor July 5, 2006; revised manuscript accepted October.19, 2007
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The participatory approach to the domestication of these products provides a new model for tree improvement as it empowers subsistence farmers to improve their own livehoods in ways that are also environmentally and socially desirable (Leakey, 1999b) and in accordance with the convention on Biological Diversity (Tchoundjeu *et al*. 2002).

This paper is therefore aimed at checking for varietal differences in Irvingia *gabonensis*, using seeds collected from different ecological zones and also determine their seed morphological characters and germination rates, with a view of providing understanding of phenotypic variation of importance to a tree domestication programme for the species and its effective utilization.

## MATERIALS AND METHODS

Freshly harvested fruits of *Irvingia gabonensis* were sourced and obtained from Akamkpa, Yakurr, Etung, Ikom and Boki rainforest zones of Cross River State, Nigeria. Five hundred fruits each from the five ecological zones were brought to the laboratory within 4 hours of collection. Two hundred fruits from each zone were allowed to soften naturally by placing them in polyethylene bags for 7 days under a shaded tree in the University of Calabar botanical garden. Subsequently, on the expiration of the duration, the fruits were depulped to extract the seeds by carefully washing off the soft mesocarp with tap water. Some extracted seed lots were immediately sown and the remaining divided into replicated batches at random.

However, three hundred fruits each from the zones were used for morphological and phenotypic studies. The phenotypic studies were based on fruit colour, fruit size, and fruit shape. While the morphological parameters were determined based on fruit width and length, fruit weight, seed width end length, seed weight. Thickness of seed coat and thickness of mesocarp were also determined. The fruit colour was assessed according to (Korneup and Wanscher, 1984). The variation in fruit shape was assessed according to Ladipo (1995).

The fruit width and length and seed width and length were determined with a centimeter ruler while fruit and seed weights were determined by using a weighing balance. The fruits were thereafter cut open by means of an electric saw for the determination of seed coat thickness and mesocarp thickness. The thickness of mesocarp and seed coat thickness were determined using a centimeter ruler.

The impact of latitude and longitude of these study sites were assumed to be constant, but much light was thrown on rainfall which in this study was considered as more influential in determining the phenotypic variation in *Irvingia gabonensis* fruits. The detailed information on fruit sources is presented in Table 1.

Germination tests were carried out in polyethylene bags (25cm x 1.5cm x 8cm) filled with sawdust mixed with top-soil serving as a germination medium (Nya *et al*. 2000). The medium was washed several times to eliminate water soluble contaminants. Twenty (20) extracted seeds from each of the 5 ecological zones were sown in the polyethylene bags and arranged in a Completely Randomized Design (CRD) (Gomez and Gomez, 1984) with 5 replications in the university of Calabar Botanical garden. The emergence of the radical by more than 3mm was used as criterion for germination of whole seed. The germination percentage and daily germination count were recorded for a period of 60 days. Daily germination counts were recorded and germination value (GV) was calculated according to the equation of Czabator (1962). All data were subjected to an analysis of variance and the standard errors of means were compared. Linear correlation and regression analysis was also carried out in order to ascertain the level of relationship between rainfall, germinability and morphological characteristics in the different ecological zones.

## RESULTS

It was specified that only mature and ripe fruits were used to assess colour variation. Results show that fruit colour in Akamkpa and Ikom zones were recorded as greenish yellow, Yakurr (green), Etung (Brownish), Boki (Bright reddish yellow) (Table 2). The fruit shape in Akamkpa and Yakurr zones was observed to be oblique, and Ikom and Boki to be spheroid while that of Etung zone was avoid (Fig. 1).

The best average fruit and seed sizes (length and width) were obtained from Ikom ecological zone (10.61cm and 6.8cm) and (7.02cm and 4.76cm) respectively while the least were obtained from Akamkpa zone (6.71cm and 3.69cm) and (4.60cm and 2.22cm) respectively.

It is shown that the highest fruit and seed weights were obtained from fruits sourced from Ikom ecological zone (80.3g and 23.4g) respectively (Table 2).

Germination time (25 days) decrease significantly ($P<0.05$) with a corresponding increase in germinability (50%) with seeds obtained from Ikom ecological zone. Seeds sourced from Etung gave 40% germination in 35 days while those from Akamkpa, Boki and Yakurr recorded 20% germination each after 39, 38 and 44 days respectively (Table 2). A highly significant ($P<0.05$) variation in germination value among the seeds collected from the different ecological zones were recorded. Results show that the highest germination value 7.92 was obtained from seed sourced from Ikom zone, followed by Etung (4.74) seed source.

**Table 1. Geographic locations of *Irvingia gabonensis* fruit sources**

| S. No | Fruit source | State | Latitude ($N^o$) | Longitude ($E^o$) | Rainfall ($mmy^1$) (mean annual rainfall) |
|---|---|---|---|---|---|
| 1 | Akamkpa | Cross River | $05^o$-19-02″ | $08^o$-21-30″ | 3250 |
| 2 | Boki | Cross River | $09^o$-50-37″ | $12^o$-32-03″ | 2750 |
| 3 | Etung | Cross River | $05^o$-52-30″ | $08^o$-42-44″ | 3250 |
| 4 | Ikom | Cross River | $05^o$-58-30″ | $08^o$-42-30″ | 3750 |
| 5 | Yakurr | Cross River | $05^o$-48-32″ | $08^o$-04-51″ | 2750 |

Source: Department of Geography and Regional Planning, University of Calabar, Calabar, 2005

**Table 2. Morphological Characteristics of fruits of *Irvingia gabonensis* from the different seed sources (Mean ± S.E.)**

| Morphological characteristics | Seed Sources | | | | |
|---|---|---|---|---|---|
| | **Akamkpa** | **Yakurr** | **Etung** | **Ikom** | **Boki** |
| **Fruit colour** | **Greenish yellow** | **Green** | **Brownish yellow** | **Greenish yellow** | **Bright reddish yellow** |
| **Fruit shape** | **Oblique** | **Oblique** | **Ovoid** | **Spheroid** | **Spheroid** |
| **Fruit length (cm)** | **6.71±0.8** | **7.56±0.5** | **9.44±0.1** | **10.61±1.1** | **10.16±0.6** |
| **Fruit width (cm)** | **3.69±0.6** | **4.9 ± 0.3** | **5.6 ± 0.7** | **6.8 ± 0.7** | **6.6 ± 0.4** |
| **Fruit weight (g)** | **45.6±0.1** | **64.9±1.1** | **70.6±1.2** | **80.3 ±1.7** | **78.6±2.3** |
| **Seed length (cm)** | **4.6 ± 0.2** | **5.41±0.6** | **6.61±0.6** | **7.02 ±0.7** | **7.06±0.7** |
| **Seed width (cm)** | **2.22±0.1** | **3.16±0.7** | **3.66±0.3** | **4.76±0.4** | **4.01±0.6** |
| **Seed weight (g)** | **15.6±0.6** | **15.5±0.4** | **17.9±0.1** | **23.4±0.6** | **21.1±0.7** |
| **Germination (%)** | **20 ± 1.5** | **20 ± 1.0** | **40 ± 1.6** | **50 ± 1.1** | **20 ± 1.2** |
| **Germination period (days)** | **39 ±1.34** | **44 ± 0.1** | **35 ± 1.2** | **25 ± 1.6** | **38 ± 1.2** |
| **Germination value** | **1.8 ± 0.1** | **2.59±0.2** | **4.7 ± 0.4** | **7.92±0.1** | **3.73±0.1** |

The least (1.8) was obtained from seeds sourced from Akamkpa zone. However, results show that there was a positive relationship between the amount of rainfall, germinability and morphological parameters with seeds sourced from the five ecological zones (Table 3).

The best relationship was recorded with fruits/seeds sourced from Ikom ecological zones between rainfall and fruit weight ($r = 0.93$:$p < 0.05$); seed length ($r = 0.88$: $p < 0.05$), seed weight ($r = 0.71$:$p < 0.001$), thickness of seed coat ($r = 0.74$:$p < 0.001$), and thickness of mesocarp ($r = 0.89$: $p = 0.05$) while fruits/seeds from Boki zone also recorded positive relationship between rainfall and mesocarp thickness ($r = 0.76$:$p < 0.001$) (Table 3).

Similarly, a strong relationship was also recorded between germinability and seed weight ($r = 0.70$: $p < 0.001$) with seeds sourced from Etung ecological zones while those from Ikom recorded ($r = 0.76$:$P < 0.001$) (Table 3).

Results also show that a positive relationship existed between rainfall and germinability in Etung ($r = 0.74$: $p < 0.001$) and in Ikom zone ($r – 0.86$: $p < 0.05$) Table 3).

## DISCUSSION

Environmental deviation effects on phenotypic characters are generally negligible under controlled conditions. Apart from genetic factors, germination is influenced by seed source (Allen, 1961). However, in this study, fruit characteristics exhibited significant correlation with climatic factors and indicated a high intraspecific variability which is typical of an out breeding tree species.

This finding shows that fruits of *Irvingia gbonensis* sourced from the five ecological zones possess fruits of various colours (greenish yellow, bright reddish yellow and rusty brown) and that bright reddish yellow was more attractive and market appealing. This result is in line with previous report from Sedgley and Griffin, (1989), who observed that fruit pigmentation is a major attribute in fruit marketing, for example, red apples have greater consumer appeal than green ones. However, it has been found from this study that the variability in fruit weight, fruit length, fruit width as well as seed weight and seed width may be considered as important attributes in the domestication of the species especially as its kennel is consumed as a nutritious staple food. This result is in agreement with previous report from Bawa, (1976) who observed that considerable variation exists within and between populations of tropical trees and that variability is the building block for trait improvement through breeding or genetic selection. It is evident from this study that a marked variation existed in the different seed parameters examined among the different seed sources. Consequently, there was strong relationship between seed weight and germination percentage in the different seed sources indicating a suitable base for the consideration of seed weight in delineating and understanding the geographic variation. This result may also be possible due to cumulative effects of both internal (maternal) and external (environmental) conditions prevailing during the process of development as earlier reported by Harper *et al*. (1970).


Fig.1. Variation in fruit shapes of *Irvingia gabonensis*

Thus the result of this study also show that higher fruit and seed weights recorded better germination performances, which went to confirm previous reports by Salazar (1989), Sniezko and Stewart, (1989), and Vakashasya *et al*. (1992). This study has also revealed that seed sources from heavy rainfall areas such as Ikom and Akamkpa ecological zones gave higher fruit weight than moderate rainfall areas.

It has been established from the present study that fruit, seed and germination behaviour, exhibited a climate pattern of variation among the seeds sourced from the different ecological zones. The germination percentage and germination value showed strong positive correlations with fruit weight and mesocarp thickness and seed length, suggesting that these traits can be taken into consideration while selecting superior seed material for better germination vigour. The occurrence of higher seed weight and germination percentage in heavy wet zones and lower seed weight with low germination percentage in moderately wet zones is evident from the study. It is recommended that knowledge of such differences may be important in breeding programmes.

**Table 3. Correlation between rainfall, germinability and fruit components with regression for fruits of *irvingia gabonensis***

| | Akamkpa | | Yakurr | | Etung | | Ikom | | Boki | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Fruit component** | **Rainfall ($mmy^1$)** | **Germ.** | **Rainfall ($mmy^1$)** | **Germ.** | **Rainfall ($mmy^1$)** | **Germ.** | **Rainfall ($mmy^1$)** | **Germ.** | **Rainfall ($mmy^1$)** | **Germ.** |
| **Fruit length** | **-0.37** | **0.22** | **-0.31** | **0.31** | **-0.35** | **0.34** | **-0.69** | **0.41** | **-0.64** | **-0.45** |
| **Fruit width** | **0.47** | **0.29** | **0.35** | **0.35** | **0.52** | **0.46** | **-0.46** | **0.44** | **0.36** | **0.59** |
| **Fruit weight** | **0.74*** | **0.57** | **0.61** | **0.56** | **0.56** | **0.64** | **0.93**** | **0.66** | **+0.64** | **0.64** |
| **Seed length** | **0.66** | **0.56** | **-0.61** | **0.66** | **0.39** | **0.56** | **0.88**** | **0.65** | **-0.34** | **-0.57** |
| **Seed width** | **-0.42** | **0.39** | **0.40** | **0.44** | **0.41** | **0.44** | **-0.56** | **0.60** | **0.64** | **0.61** |
| **Seed weight** | **0.64** | **0.60** | **0.64** | **0.56** | **+0.55** | **0.70*** | **-0.71*** | **0.76** | **0.36*** | **0.70*** |
| **Thickness of seed coat** | **-0.39** | **0.56** | **0.43** | **0.50** | **0.37** | **0.41** | **0.74*** | **0.62** | **0.49** | **-0.42** |
| **Thickness of mesocarp** | **0.48** | **0.41** | **0.58** | **0.45** | **0.51** | **0.36** | **0.89**** | **0.58** | **0.76*** | **0.46** |
| **Rainfall vs Germ.** | **0.68** | | **0.60** | | **0.74*** | | **0.86**** | | **0.63** | |

* Significant at $p < 0.001$ level of significance

** Significant at $p < 0.05$ level of significance.

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