GLOBAL JOURNAL OF PURE AND APPLIED SCIENCES VOL. 6 NO. 3, JUNE 2000:375-378
COPYRIGHT (C) BACHUDO SCIENCE CO. LTD. PRINTED IN NIGERIA ISSN 1118-0579

COMPARATIVE STUDIES ON SEED MORPHOLOGY, MOISTURE CONTENT AND SEED GERMINATION OF TWO VARIETIES OF *IRVINGIA GABONENSIS*

P. J. NYA, D. N. OMOKARO and A. E. NKANG

(Received 7 December 1998; Revision accepted 21 March 2000)

ABSTRACT

The germination potential of two varieties of *Irvingia gabonensis* have been examined in relation to their mosture content and seed morphology. Studies showed that there were no significant differences in values of seed density, embryo size and cotyledon size between the varieties although *gabonensis* recorded slightly higher seed cavity value (3.8cm) relative to variety *excelsa* (3.5cm). Results showed that variety *gabonensis* recorded higher germination value (48%) relative to *excelsa* (40%) although the difference was not significant. Moisture content (MC) values for whole fruit, whole seed and embryo were significantly ($P = 0.05$) higher in variety *gabonensis* relative to *excelsa*. Naked embroys and seeds extracted from decomposing fruits recorded significantly ($P = 0.05$) higher moisture contents and germination values relative to those from freshly collected seeds. Pretreating seeds by drying at 28°C for 48 hours followed by rehydration (Steeping in water for 24 hours) resulted in significantly ($P = 0.05$) increased germination capacity and decreased germination time in both varieties. The treatment reduced germination time from 24 and 30 days to 18 and 16 days in seeds extracted from decomposing fruits and *excelsa* and *gabonensis* respectively.

Keywords: *Irvingia gabonensis,* germination, seed morphology.

INTRODUCTION

The fruits of *Irvingia gabonensis* (bush mango), a non-timber forest resource is of high nutritive and dietary value with its large store of fat and protein. Consequently, the seeds have high economic value, generating local and foreign exchange and thus a source of livelihood for many rural dwellers (Okafor, 1981; Agbor, 1986; Falconer, 1990; Atte, 1994 and Bisong, 1994).

The trees are found growing in the wild in the rain forest and are rarely cultivated. In recent times however, some cultivation is being carried out by local farmers in areas where indigenous agricultural systems favour the cultivation of the trees (Okafor, 1990 and Donna *et al.*, 1994). Okafor *et al.*, (1994) reported that regeneration by means of seeds gives a low success rate. Nya (1997) reported differences in the expression of germination capacity in the varieties, namely *gabonensis* (sweet variety) and *excelsa* (bitter variety).

The purpose of this present work was to investigate some seed pretreatment methods that may stimulate expression of maximum germinability and attempt to establish a relationship between the reported differential seed germination potential of the two varieties and their seed morphology and moisture contents.

MATERIALS AND METHODS

Fruits of *Irvingia gabonensis* var. *gabonensis* and and var. *excelsa* were collected from Agwagune rain forest, Cross River State, Nigeria. Two hundred freshly picked fruits of each variety of approximately the same size and physiological maturity (Yellowish colouration) were immediately depulped to extract the seeds. Another batch of 200 fruits were kept in a cool shady place for 7 days after which the seeds were extracted from the decomposing fruit pulps. Seeds extracted from the freshly picked and decomposing fruits were used for morphological studies, moisture content (MC) determination and germination studies.

Morphological Studies

Morphological studies carried out on the seeds were cotyledon/embryo size, seed density and seed cavity measurements. Cotyledon/embryo length was measured as the distance from the tip of one end of the cotyledon to the opposite end by a meter

P. J. NYA, Department of Biological Sciences, University of Calabar, Calabar, Nigeria.
D. N. OMOKARO, Department of Biological Sciences, University of Calabar, Calabar, Nigeria.
A. E. NKANG, Department of Biological Sciences, University of Calabar, Calabar, Nigeria.

rule. Seed density was measured as the volume of water displaced by the seed when immersed in water contained in a measuring cylinder. Seed density was subsequently calculated as follows:

$$\text{Density (g/cm}^3\text{)} = \frac{\text{Weight (mass) of seed (g)}}{\text{Volume of seed (cm}^3\text{)}}$$

The seed cavity was measured from the micropylar end to the point of embryo attachment with a meter rule according to the method of Odum (1971). All measurements were made on three replicates, 20 seeds from each variety randomly selected for uniformity of size.

Moisture Content Determination

Fifty fruits and seeds each extracted from freshly picked and decomposing fruits of both varieties were selected for uniformity of size. The seeds were divided into 4 lots containing 10 seeds each for each extraction method per variety. Moisture content (MC) of whole fruit, whole seed and embryo were determined on fresh weight basis after drying to constant weight at 80°C for 24 hours and calculated as follows:

$$\text{Relative Moisture Content (RMC)} = \frac{\text{Fresh weight of Fruit/Seed} - \text{Dry Weight of Fruit/Seed}}{\text{Fresh Weight of Fruit/Seed}} \times \frac{100}{1}$$

Isolation of Embryos

Embryos were extracted from freshly picked depulped fruits and decomposing fruits by cutting open the hard testa by means of a portable electric saw. Care was taken to avoid damaging the embryos during isolation.

Germination Tests

All germination tests were carried out in germination boxes (40cm x 30cm x 4cm), with saw dust mixed with sand serving as germination medium. The medium was washed several times to eliminate water-soluble contaminants. The germination boxes were perforated at the bottom to allow for easy drainage of excess water. The boxes were arranged in a randomized complete block design with 4 replications in the University of Calabar botanical garden.

Emergence of radicle through the seed coat by more than 3 mm was used as criterion for germination of seeds. The seeds were watered daily and the number of germinated seeds recorded daily. All data were subjected to an analysis of variance and the standard error (S.E) of means were compared.

Seed Pretreaments

Four replicates of 10 seeds for each variety were subjected to two treatment methods before sowing in moist sawdust. One batch was dried for 48 hours at 36°C before sowing in moist sawdust. Another batch was treated similarly but was rehydrated (Steeping in water for 24 hours) before sowing. Germination counts were made daily.

RESULTS

Morphological Studies

There were no significant differences in seed density, embryo size and seed cavity in both varieties of *Irvingia gabonensis* although seeds of variety *gabonensis* had slightly higher values for embryo size (3.5cm) and seed cavity (3.8cm) relative to 3.4cm and 3.5cm respectively for variety *excelsa* (Table 1).

TABLE 1: COMPARATIVE SEED MORPHOLOGY AND GERMINATION OF *IRVINGIA GABONENSIS* VARIETIES

Seed Parameters	Variety	
	excelsa	*gabonensis*
Seed density (g/cm³)	0.97 ± 0.14	0.96 ± 0.12
Embryo size (cm)	3.4 ± 0.54	3.6 ± 0.47
Cotyledon size (cm)	7.54 ± 0.25	7.55 ± 0.31
Seed cavity (cm)	3.5 ± 0.30	3.8 ± 0.29
Germination capacity (%)	40 ± 0.23	48 ± 0.41

The parameters are reported as mean ± S.E of 5 readings

Moisture Content

Moisture content values of whole fruit were significantly (P = 0.05) higher in freshly picked lots than in decomposing fruits of both varieties (Table 2). In contrast, moisture content values of whole seeds and naked embryos were significantly (P = 0.05) higher in decomposing fruits than in freshly picked fruits of both varieties. Whereas variety *excelsa* recorded 74.7% and 67.9%, variety *gabonensis* recorded 81.3% and 78.7% moisture content values for the freshly picked and decomposing fruits respectively (Table 2). The fruit and seed components of variety *gabonensis* recorded significantly (P = 0.05) higher moisture

TABLE 2: MOISTURE CONTENT OF FRESHLY PICKED AND DECOMPOSING FRUITS OF *IRVINGIA GABONENSIS (MEAN* ± S.E)

Fruit Components	Variety *excelsa*		Variety *gabonensis*	
	Moisture Content (%)		Moisture Content (%)	
	Freshly Picked Fruits	Decomposing Fruits	Freshly Picked Fruits	Decomposing Fruits
Whole Fruit	74.7±1.3	69.9±0.3	81.3±0.15	78.7±1.4
Whole Seed	43.3±0.5	47.3±0.15	50.5±0.03	53.4±0.9
Embryo	20.1±0.04	22.2±0.2	21.6±0.7	23.3±0.34

content values relative to *excelsa*. However, there were no significant differences in moisture content values of embryo in both varieties.

Table 3 shows that seeds from freshly picked and decomposing fruits of variety *excelsa* with initial moisture content values of 43.4% and 47.3% recorded 0% and 20% germination at 60 and 36 days after sowing.

TABLE 3: EFFECTS OF DRYING AND REHYDRATION ON GERMINATION OF SEEDS FROM FRESHLY PICKED AND DECOMPOSING FRUITS OF *IRVINGIA GABONENSIS* VARIETY *EXCELSA* (MEAN ± S. E)

Seed Treatment	Seed from freshly picked fruits			Seeds from decomposing fruits		
	Moisture content of seed (%)	Germination time (days)	Maximum germination (%)	Moisture content of seeds (%)	Germination time (days)	Maximum germination (%)
Control (untreated)	43.3 ± 1.3	60 ± 1.0	0 ± 0	47.3 ±1.2	36 ± 1.2	20 ± 0.05
Dried for 48 hours without rehydration	34.6 ± 0.8	41 ± 0.05	40 ± 0.05	32.7 ±1.2	24 ± 0.03	40 ± 0.8
Dried for 48 hours and thereafter rehydrated for 24 hours	37.4 ± 0.8	36.0 ± 1.8	40 ± 1.0	46.3±0.53	18 ± 0.05	60 ± 0.8

Drying of seeds at ambient temperature (28°C) for 48 hours to moisture content values of 34.6% and 33.7% resulted in about 40% germination in seeds for both freshly picked and decomposing fruits of variety *excelsa* respectively.

TABLE 4: EFFECTS OF DRYING AND REHYDRATION ON GERMINATION OF SEEDS FROM FRESHLY PICKED AND DECOMPOSING FRUITS OF *IRVINGIA GABONENSIS* VARIETY *GABONENSIS* (MEAN ±S.E)

Seed Treatment	Seed from freshly picked fruits			Seeds from decomposing fruits		
	Moisture content of seed (%)	Germination time (days)	Maximum germination (%)	Moisture content of seeds (%)	Germination time (days)	Maximum germination (%)
Control (untreated)	50.5 ± 1.5	32 ± 1.2	20 ± 0.08	54.4 ± 0.8	28 ± 0.03	20 ± 0.30
Dried for 48 hours without rehydration	35.6 ± 0.8	30 ± 0	40 ± 0	34.3 ± 0.3	30 ± 1.1	60 ± 0.06
Dried for 48 hours and thereafter rehydrated for 24 hours	40.5 ± 0.8	28±0.5	60 ± 1.5	46.5±0.04	16 ± 0.02	80 ± 1.5

Seeds from freshly picked and decomposing fruits, with initial moisture contents of 50.5% and 53.4% recorded 20% germination each 32 days and 28 days after sowing respectively (Table 4). Drying of the seeds for 48 hours to moisture content of 35.6% and 34.3% resulted in 40% and 60% germination at 30 days after sowing respectively. Subsequent rehydration of the dried seeds for 24 hours to moisture contents of 40.5% and 46.5% resulted in 60% and 80% germination, 26 and 16 days after sowing in seeds from freshly picked and decomposing fruits respectively (Table 4).

DISCUSSION

The results suggest that the observed differences in the germination capacities of the two varieties may not be related to differences in seed morphology. No significant differences in seed density, embryo size and seed cavity were found in both varieties of *Irvingia gabonensis*. However, differences in germination potentials of the two varieties may be attributable to the differences in moisture content of fruits and seed components (except embryo) which were significantly ($P = 0.05$) higher in variety *gabonensis* relative to *excelsa*. Although there were no significant differences in the moisture content values of embryos of both varieties, embryo moisture content (MC) value for *gabonensis* was always slightly higher than *excelsa* from both freshly picked and decomposing fruits. It is probable the embryos of variety *gabonensis* have higher capacity to absorb more moisture from the seed components relative to variety *excelsa* and hence the resultant higher germination capacity. The higher moisture content in freshly picked fruits relative to decomposing fruits may be associated with the loss of some moisture and organic matter during decomposition at ambient temperatures. The higher moisture content of the seed (kernel) and embryo of decomposing fruits relative to freshly picked seeds suggests that there may be an after ripening period during which the seed continues to take up water and other substances from the mesocarp (Omokaro, *et al.*, 1999).

The higher germination percentage and reduced germination times recorded in seeds from the decomposing fruits relative to those from freshly picked fruits further supports this contention, and suggests that the embryo may have undergone further physiological and biochemical changes during the period (Khan, 1982; Bewley and Black, 1982). Further reductions in germination time and improvements in germination capacity were obtained with the drying and rehydration treatments of seeds from both freshly picked and decomposing fruits. Such treatments are beneficial as they may cause cracks in seed coats (Bewley and Black, 1982), thus enhancing leaching of endogenous inhibitors and emergence of the radicle. Seeds from the decomposing fruits appear to take up significantly more water with the drying/rehydration treatments and are suggestive of weaker seed coat walls and/or the increased accumulation of hydrophilic substances. Further investigations along these lines are going on and will be the subject of a forthcoming paper.

ACKNOWLEDGEMENT

Dr. Omokaro and Dr. Nkang acknowledge with thanks the support of the University of Ca[illegible]ar

Senate Research Grant for the on-going studies in the physiology and biochemistry of *Irvingia gabonensis* seeds.

REFERENCES

Agbor, L. O. N., 1986. Economic Assessment of *Irvingia gabonensis* (Ambrylecomte et O'Rorke) Baill in Cross River State of Nigeria. M.Sc Thesis, University of Ibadan.

Atte, D., 1994. Land and Forest of Cross River State. A Participatory, Appraisal of Rural Peoples Perceptions and Preferences. A Report Prepared for the Cross River State Forestry Project (ODA Assisted) CRFD, Calabar, Nigeria. Pp. 1 – 33.

Bewley, J. D. and Black, M., 1982. Physiology and Biochemistry of Seeds. Vol. 1: Development, Germination and Growth. Springer – Verlag, Berlin. pp. 9 – 12

Bisong, F. E. 1994. Family Systems, Human Ecology and Resource Conservation in Cross River State Rain Forest. Draft Report in Relation to the Formulation of a Strategic Plan for Sustainable Management of Cross River Forest Resources Project (ODA Assisted) Calabar, Nigeria. pp11 – 21.

Donna, M. A., Ogar, A. F. and Out, I. I. 1994. A User Survey on *Irvingia gabonensis* in Cross River State, Nigeria: Local Storage Methods of Bush Mango. A Paper Presented at the Pregermplasm Collection Meeting on *Irvingia gabonensis* organized by ICRAF, Nairobi, Kenya, held at I. I. T. A. Ibadan, Nigeria. pp. 1 – 43.

Falconer, J. 1990. Major Significance of Minor Forest Products: The Local Use and Value of Forests in the West African Humid Forest Zone. Community Forest Note 6, Food and Agricultural Organisation, Rome, Italy. pp. 18 – 41.

Khan, A. A. 1982. The Physiology and Biochemistry of Seed Development Dormancy and Germination. Elservier Bio-Medical Press, New York. pp.185 – 371.

Nya, P. J. 1997. Comparative Studies on Seed Morphology, Seed Germination and Early Seedling Development in Two Varieties of Bush Mango (*Irvingia gabonensis*) var. *excelsa* and var. *gabonensis*. M.Sc. Thesis, University of Calabar, Nigeria. pp12 – 46.

Odum, E. P. 1971. Fundamentals of Ecology. Third Ed., W. W. Saunders Company, Philadelphia. pp. 300 – 350.

Okafor, J. C. 1981. Woody Plants of Nutritional Importance in Traditional Farming Systems of the Nigerian Humid Tropics. Ph.D Thesis, University of Ibadan. pp. 14 – 20.

Okafor, J. C. 1990. Development and Selection of Commercially Viable Cultivars from Forest Species of Fruits. Proceedings of the Twelveth (12th) Plenary Meeting of Act Fat. Symposium, I. Hamburg.. 1990: pp. 16 – 25.

Okafor, J. C., Omorondion, F. I. and Amaza, F. 1994. Non-Timber Forest Products: Draft Report prepared for the National Tropical Forestry Action Programme (NTFAP). Forestry Management, Evaluation and Co-ordinating Unit. (FORMECU), Federal Department of Forestry, Abuja – Nigeria. pp. 1- 20.

Omokaro, D. N., Nkang, A. and Nya, P. J. 1999. Effects of Desiccation and Subsequent Dehydration on the Germination of *Irvingia gabonensis* var. *excelsa* Seeds. Seed Science and Technology (In Press).