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STORAGE POTENTIALS AND INFLUENCE OF MOISTURE CONTENTS ON THE GERMINATION OF *Vitellaria paradoxa* C.F. GAERTN

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ABSTRACT

Viability of seeds of many tropical tree crops during storage is influenced by several factors among which are moisture content. However, the maintenance of Vitellaria paradoxa seed viability in storage has always been a concern. This study therefore investigated the potentials and influence of moisture content on germination of seeds of the species. Two hundred (200) seeds were selected and weighed. Ten (10) seeds were thereafter selected and oven dried at 60°C for 17 hours until they attained constant dry weight so as to determine moisture content (MC). Another seed lot of 10 was selected and sown in perforated germination trays containing washed and sterilized river sand as treatment 1 (T_1) replicated 4 times. The remaining 150 seeds were spread on a platform at ambient temperature (25 ± 2°C). At 2nd week, the moisture content was determined and 10 seed lot replicated 4 times were sown (T_2). The procedure was repeated at 4th week (T_3) and 6th week. Germination Percentage (GP), Germination Energy (GE), Mean Daily Germination (MDG), Peak Value (PV) and Germination value (GV) were determined. Data were subjected to analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) was used in means separation. The highest germination percentage (95%) was recorded for T_1 (MC = 23.33%), followed by T_2 (MC = 20.93%) with (67.5%) while T_4 (MC = 10.87%), had the least (40%). The freshly depulped sown seeds (T_1) had the highest MDG (1.85), PV (2.26), GV (3.82) and GE (52.2%) while T_4 had least values of 0.42, 0.71, 0.50 and 25% for MDG, PV, GV and GE respectively. There were significant differences among the treatments at P<0.05 and T_1 had the highest means (9.50± 0.13) while T_4 had the least (5.21± 0.81).The progressive decrease in moisture content with increased storage period intensified the loss of viability of the seeds. It is therefore recommended that seeds of V. paradoxa should be stored at the temperature where their moisture content will be conserved and should not be stored beyond 4 weeks at ambient temperature for average germination percentage.

Keywords: Viability, *Vitellaria paradoxa*, ambient temperature, moisture content.

INTRODUCTION

Maintenance of *Vitellaria paradoxa* seed viability in storage has always been a serious concern in the tropics as retention of high viability over a long period is necessary for the reproduction of this fruit tree crop. Longevity of seeds of many tropical tree crops during storage are influenced by several factors such as moisture content, temperature, relative humidity, initial viability and state of maturity at harvest. (Tatipata, 2009, Nagel and Borner, 2012).

The Knowledge about seed biology and the germination process of tree crops is very crucial in understanding natural regeneration, plantation establishment and their survival (Izquierdo *et al.*, 2017). Germination is a vital process in plant metabolism, responsible for embryo growth and development into a complete plant (Bewley *et al.*, 2012). This process comprises of water imbibition, cell stretching, cell division and cell differentiation into tissues. In consideration of germination process of a seed, knowledge about the mechanisms related to seed dormancy is very germane

(Bradbeer, 2013). Dormancy has an ecological function, since it constitutes a survival mechanism of the species, ensuring its viability until the environmental conditions are adequate for seedling establishment and growth (Nonogaki, 2014). On the other hand; it is an impediment to early germination, damaging the large-scale production of plants (Bradbeer, 2013). Dormancy is normally associated with intrinsic factors related to the seed itself, such as hardness and impermeability of the integument to water and gases, immature embryos, inhibitors, and abiotic factors such as temperature, light, humidity and substrate conditions (Nonogaki, 2014). However, seed impermeability to water and gases is commonly associated with many recalcitrant seeds such as *Vitellaria paradoxa* seeds (Iroko *et al*., 2012)

The Shea butter tree (*Vitellaria paradoxa* C.F Gaertn) belongs to the family *Sapotaceae* and grows widely in the savannah region of West African countries (Hall *et al.,* 1996). It is a deciduous dicotyledonous crop that has a gestation period varying from 15 to 20 years. It takes about 45 years to attain maturity but after this, it may continually produce Shea nuts for up to 200 years. The matured trees vary considerably in height with some reaching a height of over 14 m and a girth over 1.75 m (Yidana, 1994). It is recognized as a non-traditional export crop. The Shea tree is of high economic importance with high value attributed to its butter, obtained from dried Shea nuts, which is a ready source of fat in local diets (Lamien *et al*., 2007). Boffa (1999) described the butter to have characteristics similar to that of cocoa butter. It's use as a cocoa butter equivalence in the manufacture of confectionery and as an important ingredient in pharmaceutical and cosmetic industries which have all greatly increased its global demand. It is appreciated for its skin healing and protective properties (Schreckenberg, 2004; Popoola and Norbert, 2001).

Naturally, Shea tree grows and regenerates itself in the wild but it's slow and poor natural regeneration pattern due to long gestation period, impacts of bush fires and desertification have limited the domestication and genetic improvement of this crop. These limitations have necessitated ex-situ conservation of the plant (Bonkoungou, 2005). Seeds of *Vitellaria paradoxa* are desiccation sensitive; this means that they are recalcitrant in nature and thereby difficult to be successfully stored. (Bonkoungou, 2005). This study therefore looked into storage potentials and influence of moisture contents on the germination of *Vitellaria paradoxa* with a view to ascertaining the extent with which seeds can be stored and which moisture content enhances optimum germination.

MATERIALS AND METHODS

Fresh mature fruits of *Vitellaria paradoxa* were collected from Igboho in Oorelope Local Government Area of Oyo State in May 2018. The fruits were depulped for seed extraction. Two hundred (200) seeds of equal weight were selected. The weight of each seed was determined by weighing on a sensitive weighing balance. Ten (10) seeds were thereafter selected and oven dried at 60°C for 17 hours until they attained constant dry weight so as to determine moisture content. Another seed lot of 10 was selected and sown in perforated germination trays containing washed and sterilized river sand as treatment 1 (T_1) replicated 4 times. The remaining 150 seeds were spread on a platform at ambient temperature (25 ± 2°C). At 2nd week, the moisture content was determined and seed lot of 10 replicated 4 times was sown (T_2). The procedure was repeated at 4th week (T_3) and 6th week (T_4).

Germination trays were arranged in a mist propagator chamber and watered daily. The study was laid out in Completely Randomized Design. The germination counts were taken daily after the first emergence of each treatment for 12 weeks. The plumule up to 1 cm in length were considered as new emergent and marked each time with permanent marker on the germination tray to avoid double counting.

Germination Percentage (GP), Germination Energy (GE), Mean Daily Germination (MDG), Peak Value (PV) and Germination value (GV) were determined with the use of the following equations according to Schelin *et al*. (2003):

Germination Percentage (%) =

$$\frac{Total\ Seeds\ Germinated}{Total\ Seeds\ Sown}\ X\ 100 \ldots\ldots 1$$

Germination Energy (GE) is the percentage total of highest germination counts from the day it begins till when it starts diminishing divided by total seeds sown

$$GE = \frac{\ldots\ldots x+y+z}{Total\ Seeds\ Sown} \times 100 \ldots\ldots 2$$

Where: x = the first highest germination count, y = higher germination count, z = high germination count

Mean Daily Germination percentage (MDG): This is cumulative total percentage of germinated seeds divided by exact germination days.

$$MDG = \frac{Cumulative\ Total\ Percentage\ of\ Seeds\ Sown}{x} \ldots 3$$

Where: x = Exact germination day

Peak Value (PV) is the highest value calculated as MDG

Germination Value (GV) is the product of the last day MDG and PV

$$GV = Last\ day\ MDG \times PV \ldots\ldots\ldots\ldots 4$$

Moisture content (MC) percentage was determined by the equation:

$$MC = \frac{W1-W2}{W1} \times 100 \ldots\ldots\ldots\ldots 5$$

Where: W1 = Fresh weight of seeds and W2 = Dry weight of seeds.

The treatments were therefore as follows:

T_1 = Fresh seeds sown at of MC (23.33%)
T_2 = Seeds sown after 2 weeks at of MC (20.93%)
T_3 = Seeds sown after 4 weeks at of MC (15.02%)
T_4 = Seeds sown after 6 weeks at of MC (10.87%)

Data Analysis

Data were subjected to analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) was used in means separation.

RESULTS

Table 1 shows influence of storage period and moisture contents on germination percentage, MDG, PV, GV and GE of *Vitellaria paradoxa* seed. The highest germination percentage (95%) was recorded for T_1, followed by T_2 (67.5%) while T_4 had the least (40%).

The freshly depulped sown seed (T_1) at 23.3% moisture content had the highest MDG (1.85), PV (2.26), GV (3.82) and GE (52.2%) while T_4 had least values of 0.42, 0.71, 0.50 and 25% for MDG, PV, GV and GE respectively (Table 1).

The period of storage significantly influenced the moisture contents. At the end of 2^{nd}, 4^{th} and 6^{th} week of storage, the moisture contents of the seeds of *V. paradoxa* reduced to 20.93%, 15.02%, and 10.87% respectively. Table 2 shows that there were significant differences among the treatments at $P<0.05$ and T_1 had the highest means (9.50± 0.13) while T_4 had the least (5.21± 0.81) (Table, 3). As shown in figure 1, T_1 had the highest germinated seeds (38) followed by T_2 (27) and the least was T_4 (16).

Table 1: Influence of Storage Period and Moisture Contents on Germination Percentage (%), MDG, PV, GV and GE (%) of *Vitellaria paradoxa* Seeds.

Treatments	Germination Percentage (%)	Mean Daily Germination (MDG)	Peak Value (PV)	MDG (Final)	Germination Value (GV)	Germination Energy (GE) (%)
T_1	95	1.85	2.26	1.69	3.82	52.2
T_2	67.5	0.82	1.38	1.38	1.90	32.5
T_3	52.5	0.67	0.97	0.93	0.90	30
T_4	40	0.42	0.71	0.71	0.50	25

Table 2: Analysis of variance on Storage Potentials and Influence of Moisture Contents on the Germination of *Vitellaria paradoxa*

SV	df	SS	MS	F-cal	P-value
Treatments	3	48.19	16.06	59.31	0.000*
Error	12	3.25	0.271		
Total	15	51.44			

***=**significant at P<0.05

Table 3: Means separation for Storage Potentials and Influence of Moisture Contents on the Germination of *Vitellaria paradoxa*

Treatments	Means
T_1	9.50 ± 0.13^a
T_2	6.75 ± 0.11^b
T_3	5.25 ± 0.90^c
T_4	5.21 ± 0.81^c

Means with the same subscript are not significantly different at 5% level of probability by DMRT

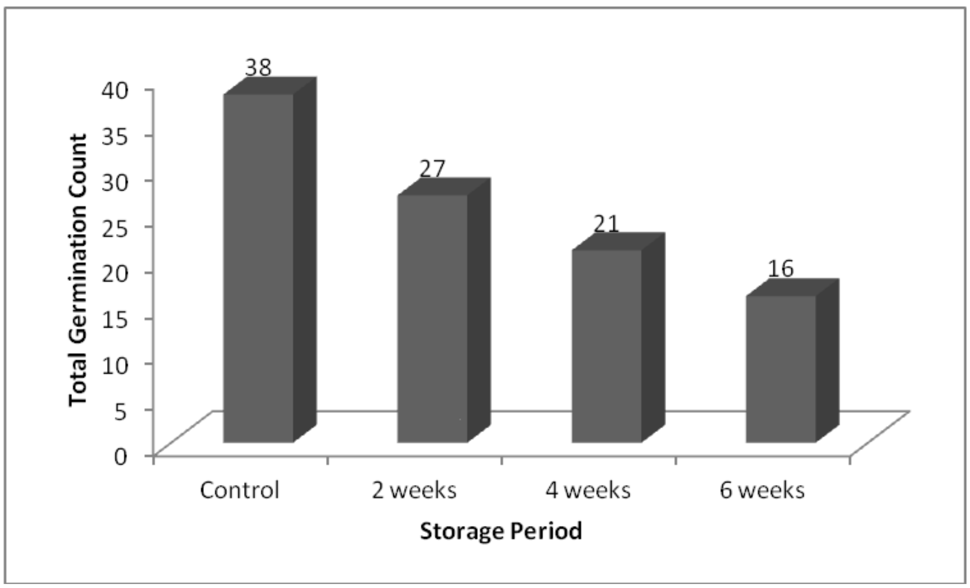

Fig. 1: Total Germination Count for different Storage Period of

DISCUSSION

The seed moisture content which is usually expressed in percentage is the most important parameter that influences the seed quality and its storage life (McDonald, 1999). The highest percentage of fresh seeds sown at of MC (23.33%) implies that moisture content plays major roles in the germination of seeds of *V. paradoxa*. According to Cibele *et al*., (2013) moisture content is a key factor in preservation of recalcitrant seed quality. Cellular water in the seeds has a strong relationship with macromolecular surfaces which enhances the stability of membranes and macromolecules. During the drying process of seeds, water gets loose and causes a myriad of metabolic modification (Berjak and Pammenter, 1997; Vargheese and Naithai, 2000). As a result of this process, growth regulators, quantity and types of proteins, cellulose, presence of free radicals, physical water status, among others are been affected (Cibele, *et al*., 20013). The moisture contents of the seeds of *V. paradoxa* at highest germination percentage could therefore be considered as critical moisture content since significant reduction in germination percentage was observed with decrease in moisture content (Berjak and Pammenter, 1997).

The Germination Energy (GE) of seeds (function of the product of MDG and PV) establishes the quality of seeds which is the main goal of seed production of high quality with good physiological, biochemical, and psychopathological characteristics (McDonald, 1999; Tomic *et al*., 1998). The higher value of MDG, PV, GV and GE of T_1 could be ascribed to the moisture content of the seeds. This corroborate the assertion of Cibele, *et al*., (20013) that a recalcitrant seed with optimum moisture is one of the most important factors determining the viability and germinability of a plant. This therefore implies that the use of good-quality, healthy and viable seeds are of utmost importance in the maintenance of an optimum plant density in a tree crop plantation. According to Ahmad, (2001), indicators of seed vitality (germination energy and germinability as well as emergence under normal environmental conditions) play a direct role and are the key factor in determining plant number per hectare, which is one of the three main components of yield. Seed quality also affects the rate and uniformity of emergence as well as the rate of initial plant growth.

Seed germination drastically reduced as moisture content decreased with increase in storage period. This is in line with the findings of kazeem *et al*. (2016) who observed that there was a gradual reduction in moisture content of seeds of *Ceasalpinia bonduc* when subjected them to different storage periods and storage temperatures where fresh seeds had highest germination percentage (100 %). This implies that the period by which seed maintains its ability to germinate after procurement depends on moisture content and can be used to determine the appropriate sowing period whether to sow immediately or dry to attain the desired moisture content. Reduction in the germination of seeds of *V. paradoxa* with elongating storage period and decreased moisture contents indicates that metabolism activities in the seed had been affected due to distorted biochemical events, leading to membrane degradation and decreased biosynthetic reactions. This eventually results in losses of several performance attributes, such as germination values, germination energy, increase of abnormal seedlings and loss of the germination potentials (Walters *et al*., 2005; Spears, 1995).

CONCLUSION

The progressive decrease in moisture content with increase storage period intensified the loss of viability of the seed as indicated by final germination. This established the recalcitrant nature of the seeds of *V. paradoxa*. It is shown that moisture content play key roles in the germination of *V. paradoxa* seeds. The moisture content of the fresh seeds enhances optimum germination values and germination energy of the seeds. It is evident that metabolic activities that aid germination were being inhibited as storage period of seeds increases and outwardly affect germination parentage.

Recommendations

It is therefore recommended from the findings of this study that seeds of *V. paradoxa* should be stored at temperature (lesser than room temperature) where their moisture content will be conserved. Then seeds should not be stored beyond 4 weeks at ambient temperature for average germination percentage.

REFERENCES

Ahmad, S. (2001): Environmental effects on seed characteristics of sunflower (*Helianthus annuus* L.). *Journal Agronomics and Crop Science*. 187. 213-216.

Berjak, P. and Pammenter, N.W (1997): Possible mechanisms underlying the differing dehydration responses in recalcitrant and orthodox seeds: desiccation-associated subcellular changes in propagules of *Avicennia marina*. *Seed Science and Technology*, 12(2): 365-384.

Bewley, J. D., Bradford, K and Hilhorst, H. (2012): Seeds: physiology of development, germination and dormancy. Springer Science and Business Media, p: 392.

Boffa, J.-M. (1999): *Agroforestry Parklands in sub-Saharan Africa*. FAO Conservation Guide No. 34. Food and Agriculture Organization of the United Nations, Rome. Pp 84.

Bonkoungou, E.G (2005): The Shea Tree (Vitellaria paradoxa) and African Shea Parklands, *Proceedings of the International Workshop on Processing and Marketing of Shea Products in Africa, Sénégal*, 4-6 March 2002. CFC Technical paper No 21, Food and Agriculture Organization. Rome.

Bradbeer, J. W (2013): Seed dormancy and germination. Springer Science and Business Media, p: 146.

Cibele, C. M, Bovi, M. L. A, Nakagawa, J (2003). Desiccation effects on germination and vigor of King palm seeds. Hort Brasileira 21: 88-92.

Hall, J. B., Aebischer, D. P., Tomlinson, H. F, Osei-Amaning and Hindle, J. R. (1996): *Vitellaria paradoxa*, a Monograph. School of Agricultural and Forest Sciences, University of Bangor. UK. pp. 105.

Iroko, O. A, Asinwa, I. O, Kareem A. A and Kazeem-Ibrahim, F (2013): Pre-treatment Effects on Seed Germination of *Vitellaria paradoxa* (C.F Gaertn.) Hepper *Scholarly Journal of Agriculture Science Vol. 3(4) pp 121-125.*Available Online *at http://www.scholarly-journals. Com/SJAS*

Izquierdo, N., Benech-Arnold R, Batlla, D., Belo, R. G and Tognetti, J (2017): Seed composition in oil crops: its impact on seed germination performance. In: Ahmad P (ed.) Oilseed crops: yield and adaptations under environmental stress. John Wiley and Sons p: 312.

Kazeem-Ibrahim, F., Akinyele, O. A and Asinwa, I. O. (2016): Influence of different storage temperatures and periods on the germination of *Caesaplinia bonduc* (L.) Roxb seeds. *Journal of Sustainable Environmental Management Vol. 13*, 71-82.

Lamien, N., Tigabu, M., Guinko S. and Oden, P. C. (2007): Variations in dendrometric and fruiting characters of *Vitellaria paradoxa* populations and multivariate models for estimation of fruit yield. Agroforestry Systems 69: 1–11.

McDonald, M. B. (1999). Seed deterioration: physiology, repair and assessment. *Seed Science. Technology.* **27:** 177-237.

Nagel, M and Borner, A. (2012): The longevity of crop seeds stored under ambient conditions. Seed Science Research. 2012; 20:1-12. *www.sciencedomaing.org*. Accessed on 27/1/2019

Nonogaki, H. (2014): Seed dormancy and germination—emerging mechanisms and new hypotheses. *Front Plant Science*, 5: 1-14.

Popoola, L and Norbert T.T (2001): Potentials of *Vitellaria paradoxa* Gaert F. In Agroforestry Systems in Benue State, Nigeria. *Nigerian Journal of Ecology*, 3: 65-73

Schelin, M., Tigabu, M., Eriksson, I and Sawadogo, L. (2003). Effect of scarification, gibberellic acid anddry heat treatments on the germination of *Balanties aegyptiaca* seeds from the Sudanian savanna in Burkina Faso. *Seed Science and Technology*, 31:605-617.

Schreckenberg, K. (2004): The contribution of shea butter (*Vitellaria paradoxa* C F Gaertner) to local livelihoods in Benin Forest Products, Livelihoods and Conservation-Case Studies of Non-Timber Forest Product Systems Jakarta, Indonesia: Center for International Forestry Research: 91–114.

Spears, J. F. (1995): An introduction to seed vigor testing. In: Van der Venter, H.A., ed. Seed vigor testing seminar. International Seed Testing Association, Zürich, p.1-9,

Tatipata, A. (2009): Effect of seed moisture content packaging and storage period on microchondria inner membrane of soybean seed. *Journal of Agricultural Technology*. 5(1): 51-54.

Tomic, Z., Z., Lugic, D., Sokolovic and Radivojevic, G. (1998): Germination and Germination Energy of forage crops to five years of age (In Serbian). *Plant Breeding Seed Production.* 5 (1-2). 55-60.

Vargheese, B. and Naithani, S.C (2000): Desiccation induced loss of viability and viability during storage in Neem (*Azadirachta indica* A. Juss) seeds. *Seed Science Technology*, 26: 485-496.

Walters, C., Wheeler, L. M and Grotenhuis, J. M. (2005): Longevity of seeds stored in a genebank: Species characteristics. *Seed Science Research.* 2005; 15:1-20.

Yidana, J. A. 1994. Studies in the shea tree. Reports, Cocoa Research Institute of Ghana. p. 10.