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PRELIMINARY EVALUATION OF STORAGE BEHAVIOR OF *COLA LEPIDOTA* (K. SCHUM) SEEDS

Okonkwo, H. O., Olubunmi-Koyejo, A., Oyediran, R. I. and Ejizu, A. N.

Swamp Forest Research Station, Onne, Forestry Research Institute of Nigeria, Forest Hill, Jericho, Ibadan, Oyo State
Corresponding Authors' email: okonkwo.ho@frin.gov.ng

Abstract
A preliminary study was conducted to provide information on the behaviour of *C. lepidota* seeds in storage prior to a proper investigation into different storage temperature regimes, methods and their effect on the viability and subsequent germination of the seed. *C. lepidota* seeds used in the study were collected from the Swamp Forest Research Station, Onne, Rivers State small plantation. Two storage methods, bare storage and storage in closed container and two temperature regimes, 4º C (refrigeration) and room temperature (30°C) were applied on the seed. There were a total of eighty-six (86) seeds allocated disproportionately to the treatments in a completely randomized design experimental layout. Data collected were number of decaying seeds and duration of decay (days). Due to non-normality of data after the Shapiro-Wilk test was conducted; the Kruskal-Wallis ANOVA was used for analysis, while Mann-Whitney test was used for pair wise comparison. The results showed that *C. lepidota* seeds decayed or dried up at an average rate of 1 seed/week when stored bare at room temperature (30°C); storage in closed container accelerated the rate of seed decay to 6 seeds/week; while refrigeration at 4º C significantly reduced rate of seed decay to 1 seed in 29 weeks. This shows that storage by refrigeration is the best way to keep *C. lepidota* seeds fresh for a longer duration of time, the worst storage condition is in closed container at room temperature (30°C), while, storage of the seeds bare at room temperature (30°C) could only sustain the seeds for a few days. This information will serve as a guide for seed storage and handling when *C. lepidota* seeds are collected for later propagation or when there is the need to transport the seed a long distance.

Keywords: Seed decay/drying, bare seeds, refrigeration, room temperature, closed container

Introduction

The contributions of wild fruits and nuts to the diets of rural dwellers in developing countries and their potential in ameliorating prevailing food and seed problems are enormous. Forest plants are important and cheap sources of vitamins, minerals, protein, carbohydrates and fats. Moreover, their dietary contribution is on the increase because they are available during most seasons, including strategic periods in the year when the conventional staples and vegetables are scarce (Asaah, 2012). West and Central regions of Africa have been known to hold great array of the *Cola* species among which are the commercial masticator kola-nuts (*C. acuminata* and *C. nitida*).

Monkey kola is a common name given to certain wild *Cola species* native to the sub-region. They include; *Cola pachycarpa* (White Monkey kola), *C. lateritia* (Red Monkey kola) and *C. lepidota* (Yellow Monkey kola). All these yield edible fruits of varying characteristic sweetness (Ogbu *et al.,* 2003). The species are common in southern Nigeria, where they are generally seen in local markets during the peak fruiting season between June and November. All the species are identified by various local names in South-Eastern Nigeria such as: *Achicha* or *Ochiricha* in Igbo and Ndiyah in Efik and Ibibio. The fruits are botanical follicle with several seeds, ranging from 1-8 seeds, and depending on species. Seeds consist of waxy aril, i.e. the fruit pulp or flesh. The waxy aril constitutes the edible portion of monkey kola species, while, the cotyledons are inedible. As underutilized indigenous fruit trees species, there are scanty research information on the monkey kola species. However, the nutrient contents of its economic product; the fruits, have been reported (Ogbu, *et al,* 2007). *Cola lepidota* is a small to medium sized tree of between 10 – 15m high under the home-garden conditions in which it often grows. The foliage is light green with pubescence and palmate. Flowering sand fruiting patterns are similar to *C. pachycarpa*. The fruits are multi-seeded but with fewer number of seeds per fruit unlike the other two species. Fruit skin is scaly

(i.e. *lepidopterous* texture) brown with yellow waxy endocarpic pulp (the aril) and flattened brown seeds. The species is widely distributed in South-East Nigeria, where it is found scattered in protected stands in home-gardens, farmlands and forests.

C. lepidota fruits are among the economic non-timber forest products (NTFP) of the South-East part of Nigeria. There is therefore the need to domesticate the species to increase its usefulness and extend its benefits beyond its natural range. The propagation of *C. lepidota* and possible conservation will be dependent on the ability to store the seeds especially in the face of high rate of deforestation and dwindled wild populations. *C. lepidota* seeds are fleshy and fairly large about 5cm long and 5cm wide (Okonkwo *et al.* 2019). Therefore being a tropical seed that are known to be recalcitrant (seeds that are shed with high water content, cannot withstand drying and hence need to be stored hydrated (Berjak and Pammenter (2017). Therefore, there is need to understand its behavior in storage *vis-à-vis* the need to store the seed for nursery propagation purposes. The study was hence designed to evaluate the storage behavior of *C. lepidota* seeds using two storage methods and temperature regimes. This is a preliminary study conducted to provide information on the durability of the seed in storage before a subsequent proper investigation into different storage temperature regimes, methods and their effect on the viability and subsequent germination of the seed. Understanding of the rate of seed decay in *C. lepidota* under different storage and temperature conditions will inform seed handling after collection, especially when the need to travel long distance or store the seed before propagation.

Materials and Methods

C. lepidota seeds used in the study were collected from the Swamp Forest Research Station, Onne, Rivers State small plantation, holding about 10 stands of the trees that are reproductively active. The area is located on Lat.4° 50' N and Long. 7° 03' E. Annual rainfall is 2500mm with a mean value of 75% relative humidity in February and 80% in July, with mean minimum temperature of 25°C (Okonkwo *et al.,* 2020).

Two storage methods, bare storage and storage in closed container and two temperature regimes; 4°C (refrigeration) and 30°C room temperature were applied on the seed (Table 1). There were a total of eighty-six (86) seeds allocated disproportionately to the treatments in a completely randomized design experimental layout. Data collected were number of decaying seeds, duration of decay (days) and decay rate was calculated as:

Mean daily decay rate (MDDR) = No. of decayed or decaying seed/no. of days1

Due to non-normality of data after the Shapiro-Wilk test was conducted; the Kruskal-Wallis ANOVA was used for analysis, while Mann-Whitney test was used for pair wise comparison.

Table 1: Storage methods, temperature regimes treatments and description

Treatment	Description
S 30°C	Bare seeds stored at 30°C (room temp.)
S 4°C	Bare seeds stored at 4°C (refrigeration)
SC 30°C	Seeds in covered container at 30°C (room temp.)

Result and Discussion

Rate of seed decay was highest in the seeds stored in closed container at room temp (SC 30ºC) at an average rate of 0.8 seeds/day, equivalent to approximately 6 seeds per week; followed by those stored bare at room temperature (S 30ºC) at an average rate of 0.2 seeds/day, equivalent to approximately 1 seed per week; while the lowest was recorded in seeds stored at (S 4ºC) at an average rate of 0.005 seeds/day equivalent to 1 seed in 29 weeks (Table 2 and Fig. 1).

Table 2: Mean daily decay rate of *C. lepidota* seeds under different storage methods and temperature regimes

Days	S30ºC	SC30ºC	S4ºC
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0.7	0
5	0	0.6	0
6	0	0.7	0
7	0	1.1	0
8	0	1.4	0
9	0.8	1.3	0
10	0.8	1.2	0
11	1	1.9	0.06

There were significant differences in rate of seed decay among storage methods and temperature regimes (Table 3). Pair wise comparison however showed that there were no significant differences in seed decay rates between bare seeds stored at 4ºC (S 4ºC) and bare seeds stored at room temperature (S 30ºC) (Table 4). There was however significant differences in rate of seed decay between seeds stored in closed container at room temperature (SC 30ºC) and bare seeds stored at 4º C (S 4ºC) (Table 5), and between bare seeds stored at room temperature (S 30ºC) and seeds stored in closed container at room temperature (SC 30ºC) (Table 6). This shows that storage by refrigeration is the best method to keep *C. lepidota* seeds fresh for a longer duration of time, while, the worst storage condition is in closed container at room temperature, and storage of the seeds bare at room temperature could only sustain the seeds for a few days. The inability of many tropical seeds to store for long without deterioration has been reported by many authors (Berjak and Pammenter, 2008: Asaah *et al.* 2011: Asomaning *et al.* 2011: Okonkwo *et al.* 2020). This behavior has been labeled recalcitrance and has been reported in fruit trees such as *Garcinia kola,* and *Allanblackia species* (Asomaning *et al.* 2011: Asaah 2012: Okonkwo *et al.* 2020). Although the study did not include seed viability and germination studies which normally follow this type of investigation, it shows how vulnerable to decay *C. lepidota* seeds can be. In seed collection exercises therefore, *C. lepidota* seeds should be propagated immediately after collection to minimize seed loss to decay/drying or otherwise stored refrigerated.

Table 3: Kruskal-Wallis ANOVA of *C. lepidota* rate of seed decay under different storage methods and temperature regimes

Sources	SS	df	MS	F	P value	Eta-sq	RMSSE	Omega Sq
Between Groups	3.7663	2	1.8831	9.8804	0.0005*	0.397	0.9477	0.3410
Within Groups	5.7178	30	0.1906					
Total	9.4841	32	0.2964					

Note: * = significant at 0.05 alpha level

Table 4: Mann-Whitney pair wise analysis of *C. lepidota* seed decay rate between bare seeds stored at 4ºC (S 4ºC) and those stored at room temperature (S 30ºC)

	S4ºC	S30ºC		
count	11	11	U	48^{ns}
median	0	0	mean	60.5
rank sum	114	139	std dev	10.243
U	73	48	z-score	1.172
U-critical	34		effect r	0.250

Note: U-critical < U = not significant at 0.05 alpha level

Table 5: Mann-Whitney pairwise analysis of *C. lepidota* seed decay rate between seeds stored in a closed container at room temperature 30ºC (SC 30ºC) and those stored bare at 4ºC (S 4ºC)

	SC30ºC	S4ºC		
count	11	11	U	$18^{sig.}$
median	0.7	0	mean	60.5
rank sum	169	84	std dev	13.569
U	18	103	z-score	3.095
U-critical	34		effect r	0.651

Note: U-critical >U = significant at 0.05 alpha level

Table 6: Mann-Whitney pair wise analysis of *C. lepidota* seed decay rate between seeds stored bare at room temperature (S 30º C) and those stored in closed container at room temperature (SC 30ºC)

	S30ºC	SC30ºC		
count	11	11	U	$30^{sig.}$
median	0	0.7	mean	60.5
rank sum	96	157	std dev	14.242
U	91	30	z-score	2.106
U-critical	34		effect r	0.449

Note: U-critical > U = significant at 0.05 alpha level

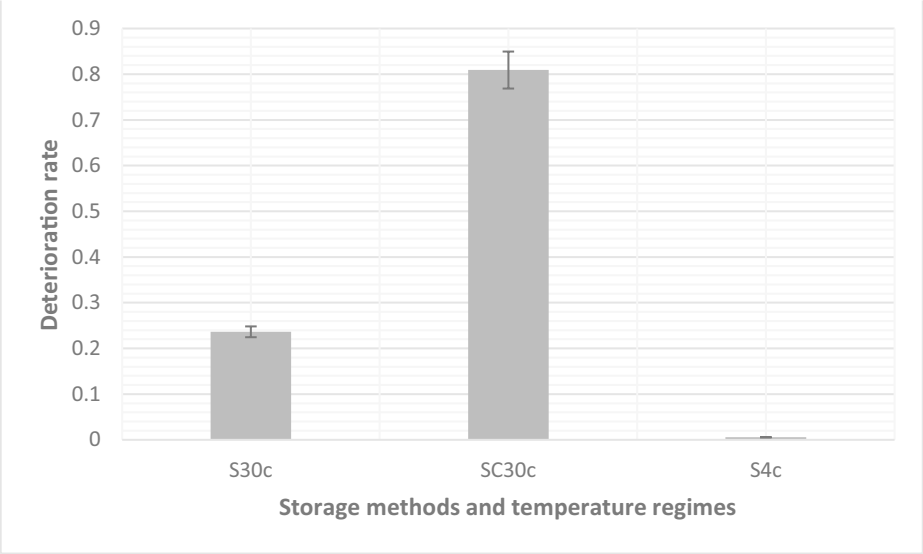

Figure 1: Average daily decay rate of *C. lepidota* seed under different storage methods and temperature regimes

Conclusion

Storage by refrigeration is the best way to keep *C. lepidota* seeds fresh for a longer duration of time, while, the worst storage condition is in closed container at room temperature and storage of the seeds bare at room temperature could only sustain the seeds for a few days. In seed collection exercises therefore, *C. lepidota* seeds should be propagated immediately after collection to minimize seed loss to decay/drying or otherwise stored refrigerated. Subsequent to this study, an investigation will be conducted to determine the effect of different storage methods and temperature regimes on *C. lepidota* seed viability and germination. This will also help to determine how long the seeds can be stored refrigerated before deterioration sets in.

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