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Effect of Storage in Different Environments and Packages on Germination of Amburana cearensis (Allemao) A. C. Sm. Seeds

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Abstract— *Seeds should be stored properly in order to minimize the deterioration process. Therefore, the aim of this work was to evaluate the germination of Amburana cearensis seeds after storage in different packaging and environments. Seeds were stored in two packages (plastic and paper bags) under three different conditions: laboratory (30±5°C/66% RU); germination chamber (20±2°C/86% RU) and cold chamber (±10±2°C/77% RU) during 3, 6, 9 and 12 months. Seeds water content and germination were evaluated before and after the storage period. Seeds stored in germination chamber had higher values of water content either in plastic or paper bags. Physiological quality of A. cearensis seed was affected by the storage environment only when packed in paper bags, which showed 50% decreased germination as of 9 months in cold chamber.*

Keywords— physiological quality, vigour, water content.

I. INTRODUCTION

Amburana cearensis (Arr. Cam.) A.C. Smith, Fabaceae, is a widely distributed tree in South-American drylands. In Brazil it occurs in several biomes (Caatinga, Cerrado and dryer areas of Pantanal and Rainforest) and is one of the typical species at Caatinga biome, where it is deciduous, shedding leaves during the dry season (Lorenzi, 2008). These trees can reach up to 10 m at Caatinga and up to 20 m in the forest area (Lorenzi, 2008). As a form of adaptation, this species shows variations in flowering and fruiting timing in each region it occurs, dispersing winged seeds with no dormancy and ready to germinate upon the first rains at the start of the rainy season (Maia, 2008). These trees are commonly used for their quality as fine and rare woods for the furniture industry and seeds, due to the pleasant exhaled odor, are used to perfume clothes (Hilton-Taylor, 2000). *A. cearensis* is also used in home medicine and leaves and seeds ethanolic extracts are known antibiotic, antibacterial, anti-inflammatory and smooth muscle relaxant (Leal et al., 2003; Sá et al., 2011; Figueredo et al., 2013).

Due to uncontrolled exploitation of natural resources of Caatinga causing severe degradation of vegetation, mainly due to deforestation aiming replacement of formerly forested areas with agricultural activities and without allowing the species regeneration *A cearensis* is listed as endangered by the IUCN (Hilton-Taylor, 2000).

A. cearensis can be recommended for restoration aiming recovery of degraded areas due to its fast growing seedlings (Sampaio et al., 2007), by showing plasticity to light variations and growth pattern, ability to tolerate extreme drought conditions and presenting foliar phenology following the climate of the Caatinga region (Ramos et al. 2004).

Seeds usually exhibit, mainly by physiological maturity, the highest quality in terms of weight of dry mass, germination and vigour. As of this period occurs a progressive decline in seed quality, through the process of deterioration. Seeds should be stored properly in order to minimize the deterioration process. Thus, storage allows to preserve seed quality until sowing (Corbineau, 2012; Yang et al., 2013). The volume of fruit/seed (reproductive output) produced each year in many perennial plants, fluctuates dramatically. A biennial mode of fruit/seed production designated ‘alternate bearing’, such that a tree's yield alternates between high fruit load (ON) and low fruit load among the years (Smith and Samach, 2013). This is typically observed in commercial tree species, and also in native wild species such as *A. cearensis*. Therefore, seed storage is necessary to ensure that the annual demand, allowing the stock to low production year (Bewley et al., 2013). The effective preservation of seeds depends on their moisture content and on the storage temperature, which can present a problem in developing countries where the costs of cold storage are prohibitive (Zheng et al., 1998).

Therefore, the aim of this work was to evaluate the germination of *Amburana cearensis* seeds after storage in different packaging and environments.

II. MATERIAL AND METHODS

Amburana cearensis seeds were harvested from six mother plants at the Legal Reserve of Projeto Salitre, Lagoa Grande, Pernambuco State, Brazil (9° 33’ 22’’ S, 40° 40’ 0’’ W). The experimental design was completely randomized, with an absolute control (fresh seeds) and a 4x3 factorial scheme (storage time x environment), for each package in which the seeds were conditioned.

The seeds were processed by removing all impurities, such as fruit remains and wings and immediately stored in two types of packages (plastic and paper bags) under three different conditions: laboratory environment (30±5°C/60±6% RU); cool moist chamber (20±2°C/86±2% RU) and cold chamber (10±2°C/77±2% RU) during 3, 6, 9 and 12 months. Before and after the storage periods seeds were evaluated for water content (%) and germination (% of normal seedlings).

Water content (WC): was obtained by oven method at 105 °C±3 °C for 24 hours, using two samples of 10 seeds and the results expressed as a percentage based on seed fresh weight (BRASIL, 2013).

Germination test: was carried out with four replicates of 50 seeds, distributed between germitest-type paper soaked with distilled water at a proportion of 2.5 times the dry paper weight. Seeds were germinated in B.O.D. chamber at 30±1° C and 12h photoperiod. Assessments of normal seedlings were performed as recommended by the Rules for Seed Testing (BRASIL, 2013).

Results were submitted to analysis of variance using F test at 5% probability. The means among storage time and environments were compared by Tukey test and fresh seeds were compared to the averages of stores seeds by *t* test, all at 5% probability.

III. RESULTS AND DISCUSSION

The initial WC of *Amburana cearensis* seeds was 5.27% and during storage in lab environment (30±5°C/60±6% RU) seeds maintained constant WC in either packages (paper or plastic). In cold chamber (10±2°C/77±2% RU) seeds maintained around 6.5% WC in plastic bags and around 9% in paper bags. Although, when stored 6 months in paper bags at moist chamber (20±2°C/86% RU) seeds WC was already higher than 12% (Table 1).

The small variations in the water content of *Amburana cearensis* seeds stored in plastic bags did not significantly influence their germination, with more than 90% normal seedlings after one year storage. On the other hand, seeds stored in paper bags, however, presented lower physiological quality after 9 months storage, in cold and cool chambers (Table 2) , despite of their higher WC (Table 1).

According to Bewley et al., 2013, orthodox seeds can withstand dehydration to around 5%. This ability of *A. cearensis* to withstand low water content explains its amazing ability to withstand the extremes of prolonged dry time.

Despite low WC of seeds, those kept in plastic bags at all environments studied showed no differences in germination (Table 2). On the other hand, seeds packed in paper bags may be influenced by factors related to the water content, reaching the end of storage time with lower germination in cool and cold environments. Plastic bags or containers act as a barrier in protecting the seeds, decreases the metabolism of the seeds and consequently decreases the deterioration (Reis et al., 2012). In *A. cearensis* seeds, plastic bags appeared to have avoided or decreased exchanges of gas exchange between the seeds and the environment in which they were stored.

Experimental data confirmed that the ultra dry seeds (less than 5% WC) maintain their genetic stability after storage or accelerated ageing. In consequence, these seeds did not suffer any significant change either in the proportion of seeds that germinate or in their vigour, moreover, they aged more slowly and tolerated storage at ambient temperatures better than other conditions (Yang et al., 1995).

A. cearensis seeds are rich in oleic acid, which have high content of unsaturated fatty acids and are less stable than the saturated lipids (Garcia et al., 2007).

Lipid content has been related to seed longevity characteristics, with the widespread idea that seeds with a high lipid content are more sensitive to deterioration than other non-oil seeds (Balešević-Tubić et al., 2010), although some authors using different species did not find any correlation (Walters et al. 2005; Probert et al. 2009). It is more likely, though, that lipid content is related to longevity, depending on the storage conditions, decreasing longevity in high moisture environments (Mira et al., 2015) and cold treatment which induce lipid peroxidation (Boca et al., 2014).

IV. CONCLUSION

Based on the results obtained it can be concluded that the physiological quality of the *Amburana cearensis* seeds was affected by the storage environment only when in permeable packages.

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Table.1: Water content (%) of Amburana cearensis seeds stored in different packing and environments during 3, 6, 9 e 12 months. Petrolina-PE, Brazil.

Paper bags				Plastic bags				Storage time (months)
	Environments				Environments			
Mean	**Cold chamber**	**Cool moist chamber**	**Laboratory environment**	**Mean**	**Cold chamber**	**Cool moist chamber**	**Laboratory environment**	
7.4983	7.4150 bB	9.1450 aC	5.9350 cB	6.3683	6.8400 bA	6.5150 aC	5.7500 bB	**3**
9.9233	9.5500 bA	12.9400 aB	7.2800 cA	7.5817	6.4000 bA	9.9600 aA	6.3850 bAB	**6**
10.3217	9.6200 bA	14.1100 aA	7.2350 cA	7.2917	6.7050 bA	8.2050 aB	6.9650 bA	**9**
9.6500	9.1450 bA	13.4000 aAB	6.4050 cAB	7.3817	6.8550 bA	8.7800 aB	6.5100 bA	**12**
9.3483β	8.9325	12.3988	6.7137	7.1558β	6.7000	8.3650	6.4025	**Mean**
5,5270α				5,5270α				**Fresh seeds**
3.87				3,08				**CV (%)**

*Means followed by the same letter capital letters in the column and lowercase on the line do not differ by Tukey test at 5% probability. Greek letters between fresh seeds and averages of stored seeds indicate differences at 5%.

Table.2:Germination (%) of Amburana cearensis seeds stored in different packing and environments during 3, 6, 9 e 12 months. Petrolina-PE, Brazil.

Paper bags				Plastic bags				Storage time (months)
	Environments				Environments			
Mean	**Cold chamber**	**Cool moist chamber**	**Laboratory environment**	**Mean**	**Cold chamber**	**Cool moist chamber**	**Laboratory environment**	
94.00	94.00 aA	96.00 aA	92.00 aA	94.00 A	96,00	90,00	96,00	**3**
94.67	84.00 aA	100.00 aA	100.00 aA	97.33 A	98,00	98,00	96,00	**6**
78.67	48.00 bB	90.00 a A	98.00 aA	93.33 A	96,00	92,00	92,00	**9**
66.67	54.00 bB	56.00 bB	90.00 aA	92.67 A	96,00	94,00	88,00	**12**
83,50β	70.00	85.50	95.00	94,30α	93.50 a	96.50 a	93.00 a	**Mean**
96,0096α				96,00α				**Fresh seeds**
12.46				8.09				**CV (%)**

*Means followed by the same letter capital letters in the column and lowercase on the line do not differ by Tukey test at 5% probability. Greek letters between fresh seeds and averages of stored seeds indicate differences at 5%.