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PHYSIOLOGICAL QUALITY OF *TALISIA ESCULENTA* (CAMBESS.) RADLK. STORED SEEDS

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ABSTRACT

The *Talisia esculenta* (Cambess.) Radlk., Family Sapindaceae, is native to the Amazon, widely distributed in the Northeast of Brazil, where it has significant economic and ecological potential. However, there are no storage technologies for prolonged periods of its seeds. This study aimed to evaluate the physiological quality of stored seeds of *Talisia esculenta* submitted to different drying periods. The seeds were dried for 0, 6, 12, 18, and 24 hours and stored in the refrigerator for up to 60 days. A completely randomized experimental design was used, with treatments distributed in a 5 x 7 factorial scheme (drying and storage period), in four replications of 25 seeds. The moisture content, percentage of emergence, first emergence count, emergence speed index, length, and dry mass of seedlings were evaluated. The viability and vigor of the seeds decreased during storage according to the drying period. Seeds stored with moisture content between 39.88 and 41.40% remain viable and vigorous for 40 days. However, those stored with 45.70% moisture content lose viability and vigor after 20 days of storage.

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INTRODUCION

Storage is a fundamental practice to maintain the physiological quality of seeds. It controls the speed of deterioration and, consequently, delays their viability loss (AZEVEDO et al., 2003). The main seed conservation technique aims to reduce its metabolism by lowering the moisture content or temperature (KOHAMA et al., 2006). However, recalcitrant seeds retain high moisture at the end of maturation, do not tolerate water loss below their critical level (15 to 35%), and do not withstand low temperatures without losing viability (GARCIA et al., 2015). The drying of recalcitrant seeds results in a decline in their viability (ROBERTS, 1973). Nevertheless, there is a considerable variation in sensitivity to seed desiccation between species. Thus, partial drying can contribute to the conservation of these seeds, even for those that tolerate desiccation to values slightly below the initial moisture content, considering that during this process, the safe, critical, and lethal moisture content for each species are respected (CHIN, 1988). *Talisia esculenta* (Cambess.) Radlk., belongs to the Sapindaceae family, known as pitombeira or pitomba, a forest tree native to the Amazon (ACEVEDO-RODRÍGUEZ, 2015). It reached the Northeast and Southeast of Brazil due to the extraction of its species (CAVALCANTI et al., 2001). Currently, this species has a widespread occurrence in the Caatinga, Cerrado, and Atlantic Forest Biomes of Brazil (ACEVEDO-RODRÍGUEZ, 2015). This species has wood, forestry, and commercial potential. It is used in civil construction for internal structures and is used for reforestation in riparian forest areas (LORENZI, 2016). Seeds are the main means of propagation of *Talisia esculenta* (ROMAHN, 2007), which have a high percentage of germination but are very sensitive to desiccation and storage conditions in a natural environment (ARAÚJO et al., 1994), which results in a sowing period restricted to a few days after fruits harvesting. Considering the challenges faced to preserve the viability of recalcitrant seeds during storage and that the study of seed technology is effectively the starting point for the rational use and exploration of native Brazilian species, this study aims to assess the physiological quality of stored seeds of Talisia esculenta submitted to different drying periods.

MATERIALS AND METHODS

The experiment was carried out at the Seed Analysis Laboratory of the Centro de Ciências Agrárias (CCA), Universidade Federal da

Paraíba (UFPB). A voucher of this species is deposited at the Herbarium Jayme Coêlho de Moraes (EAN), CCA/UFPB, identified as: 'BRAZIL. Paraíba: Areia, s.d., M.L.M. Silva s.n.' (EAN 25774) as a testimony specimen. The seeds of *Talisia esculenta* were obtained from ripe fruits (brown colored pericarp), harvested from the crown of ten parent trees located in the municipality of Areia (6°58'12'S and 35°42'15'W), Paraíba, Brazil. The seeds were manually extracted from the fruits, packed in polyethylene buckets, and submitted to fermentation in a laboratory environment (average temperature of 25 ºC and relative humidity of 75%) for five days. After fermentation, the seeds were manually rubbed in sand and washed in running water for complete removal of the pulp (CARDOSO et al., 2015), placed on paper towels, and placed in a forced-air circulation oven, at of 35°C, for periods of 0 (not dried), 6, 12, 18 and 24 hours. After each drying period, the seeds were removed from the greenhouse, determined their moisture content, packed in transparent polyethylene bags, and stored in a refrigerator (10 ± 3 ºC) for up to 60 days. The seeds moisture content was determined initially (seeds not dried), and at the end of each drying period (0, 6, 12, 18 and 24 hours) by the greenhouse method at 105 ± 3 ºC, for 24 hours, the results were expressed in percentage, based on the wet weight of the seeds (BRASIL, 2009), in four replications of five whole seeds per treatment. The following tests were performed initially (seeds not stored) and every ten days of storage (periods of 10, 20, 30, 40, 50, and 60 days):

Seedling emergence - the tests were set up under a greenhouse environment, under natural lighting, without temperature and relative humidity control, using four replications of 25 seeds per treatment. Seeds were sown in polyethylene trays (49 x 33 x 7 cm) containing sieved and sterilized sand, moistened daily, with a watering can. The number of seedlings that emerged (seedlings with the epicotyl above ground level, having primary root and shoot present) were counted on the seventeenth and thirty-fifth day after sowing when the seedling emergence stabilized. The results were expressed in percentage.

First emergence count - performed together with the emergence test, counted the number of emerged seedlings on the seventeenth day after sowing. The results were expressed in percentage. Seedling emergence speed index - determined together with the emergence test, through daily counts of emerged seedlings, from the seventeenth to the thirty-fifth day after sowing, the index was calculated according to the formula proposed by Maguire (1962).

Seedling length and dry mass - The primary root and shoot length of the seedlings were determined at the end of the emergence test; the normal seedlings were measured with a graduated ruler andthe results expressed in centimeters. After the measurements, the roots and shoots were individually packed in kraft paper bags and placed in an oven with forced air circulation at 65 °C for 48 hours. After this period, the samples were weighed on a scale (0.001 g accuracy), and the results were expressed in g.

Experimental design and Statistical analysis - A completely randomized design was used, with treatments distributed in a factorial scheme 5 x 7 (moisture content and storage period) and four replications of 25 seeds per treatment. Data were submitted to analysis of variance and polynomial regression, the linear and quadratic models were tested, and selected the most significant with greater R^2. The software SISVAR® (FERREIRA, 2007) was used.

RESULTS AND DISCUSSION

The *Talisia esculenta* seeds were stored at moisture content levels of 45.70; 43.90; 41.40; 40.98 and 39.88%, these values resulted from drying in an oven at a constant temperature of 35 ºC, for periods of 0 (seeds not dried), 6, 12, 18 and 24 hours, respectively. Seeds with high moisture content at maturity, such as *Talisia esculenta*, are generally sensitive to desiccation and have a short life, especially in low-temperature conditions and high relative humidity (LEONHARDT et al., 2010). As observed in Figure 1, data of the emergence percentage of *Talisia esculenta* seedlings fit to the quadratic regression model in all moisture content levels, reaching a maximum estimated value of 89.52%, after 2 days of storage, for seeds with 41.40% moisture content (12 hours of drying). During storage, a significant decrease in the percentage of seedling emergence was observed, regardless of the moisture content of the stored seeds, which indicates that *Talisia esculenta* seeds do not withstand long periods of storage, typical of recalcitrant seeds. Nevertheless, it could be observed that seeds that had the drastic decrease in the emergence (30 and 27%) after 40 days of storage were those with the highest moisture content (45.70 and 43.90%, respectively), and those that were dried for the shortest periods (0 and 6 hours, respectively). This is probably due to a higher respiratory rate and more active metabolism, which results in faster deterioration.

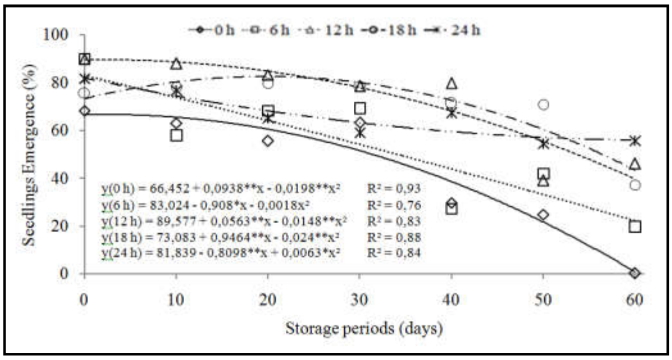

Figure 1. **Seedlings emergence of *Talisia esculenta* (%) from seeds submitted to different drying periods**

Similarly, the moisture content of Eugenia uniflora L. seeds also decreased according to the drying period, which did not tolerate drying in an oven at 37 ºC for periods longer than 20 hours storage in the refrigerator for more than 20 days, with a critical moisture level for germination of 30% (COMIN et al., 2014). Evaluating *Araucaria angustifolia* (Bertol), Garcia et al. (2014) found that the moisture content between 44 and 45% did not affect the viability of the seeds during a storage period of 180 days in a refrigerator at 5 °C. The oven-drying of *Achras sapota* L. seeds at 30 °C reduced the moisture content from 36 to 11 and 7% and also drastically decreased the seedlings emergence (PRADO et al., 2014). After 30 days of storage, an incidence of fungi was observed in the seeds of *T. esculenta* stored with 45.70% moisture content (seeds not dried). This probably contributed to the viability loss of these seeds since, according to Goldbach (1979), fungi are one of the main agents that negatively affect the conservation of recalcitrant seeds. In Figure 2, it can be observed that the seeds not dried and stored with 45.70% moisture content, maintained their vigor for 20 days of storage, after that a significant decrease in the emergence occurred, and at 54 days, no seeds emerged, while those stored with 43.90% moisture content (6 hours of drying) a mean value of 3.14 was obtained and the data did not fit any polynomial regression model in this treatment.

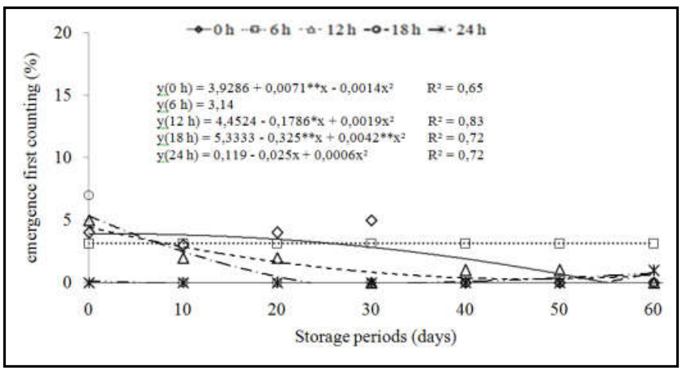

Figure 2. Emergence first count of *Talisia esculenta* seedlings from stored seeds submitted to different drying periods

The seeds stored with the 40.98 and 39.88% moisture content (18 and 24 hours of drying, respectively) had the lowest percentage of seedlings emerged at the end of the storage period (0.9 and 0.1%, respectively), which indicates that drying over 12 hours significantly affected the vigor of the seeds. The negative effect of high moisture on the physiological quality of *Talisia esculenta* seeds is evident since the seeds stored with 43.90% moisture content (6 hours of drying) did not present significant decreases when compared to the seeds not dried (45.70%). However, their storability was higher in seeds with a lower moisture content (40.98 and 39.88%). These results corroborate partially with those obtained by Berjak and Pammenter (2008), stating that recalcitrant seeds do not tolerate water loss and are damaged at different levels during drying and storage.
Prado et al. (2014) found a decreasing tendency in the vigor of *Achras sapota* seeds due to the decrease in moisture content from 36 to 7% in the emergence first count. Similarly, in seeds of Inga laurina Willd, Barrozo et al. (2014) observed a decrease in the germination first count when the moisture content decreased from 52 to 40.69% after drying under greenhouse. Rapid germination is a plant species strategy to establish itself in a given environment as quickly as possible, taking advantage of favorable environmental conditions, such as temperature and water availability. Also, the less time the seed remains in the soil, the lower the risk of pathogens contamination (FERREIRA and BORGHETTI, 2004). When vigor was assessed by the emergence speed index (Figure 3), it can be observed that seeds of *Talisia esculenta* stored with 45.70% moisture content (seeds not dried) had the lowest index (0.65). In contrast, for those seeds stored with 43.90% moisture content (6 hours of drying), a linear decrease was observed. Seeds stored with 41.40% moisture content (12 hours of drying) had the highest emergence speed index (1.0) after 15 days of storage with a significant decrease after 50 days. For seeds stored with 39.88% moisture content (24 hours of drying), the mean value of the emergence speed index of 0.59 was obtained, and the data did not fit any regression model.

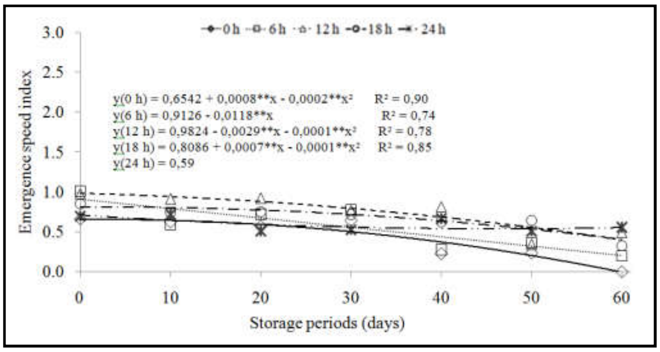

Figure 3. Emergence speed index of *Talisia esculenta* seedlings from stored seeds submitted to different drying periods

The fast decrease in the germination speed, and the percentage of emergence, with superiority of the stored seeds with 41.40% moisture content (12 hours of drying), indicates that this moisture level maintains viability for a longer period under the conditions of the experiment. The emergence speed index of *Inga laurina* seedlings decreased and went from 52 to 36.11% when the moisture content decreased due to drying under greenhouse; however, an increase in the seedling emergence speed was observed when the seeds were dried in a laboratory environment, for up to 13 hours, resulting in seeds with 40.95% moisture content (BARROZO et al., 2014). Cardoso et al. (2015) observed a significant decrease in *Talisia esculenta* in the emergence speed of seeds with an initial moisture content of 44, 41, and 46% when the seeds were dried for more than six hours, regardless of the temperature used. For the primary root length (Figure 4), it was observed that seedlings stored with 45.70% moisture content (seeds not dried) had a greater length (14.47 cm) when stored for 22 days. The data of the stored seeds with the moisture content of 43.90, 41.40, and 39.88% (6, 12, and 24 hours of drying, respectively) did not fit any regression model, with a mean length of 13.08 cm for the first two moisture contents and 11.34 cm for the latter. After 30 days of storage, a drastic decrease in the primary root length was observed from seeds stored with 45.70% moisture content (seeds not dried). In contrast, a tendency to maintain the vigor until 50 days of storage was observed for seeds submitted to drying.

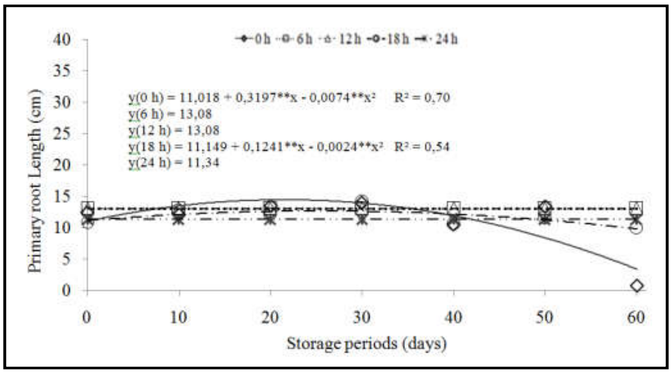

Figure 4. Primary root length of *Talisia esculenta* seedlings from stored seeds submitted to different drying periods

Similar to the primary root length, the shoot length of *Talisia esculenta* seedlings (Figure 5) showed a tendency to withstand vigor, except for those from seeds stored with 45,70% moisture content (seeds not dried), with values of 8.40 cm, after 16 days of storage, and a drastic decrease after 50 days of storage. The longest shoot length (8.83 cm) was obtained from seedlings of seeds stored with 41.40% moisture content (12 hours of drying) after 12 days of storage. The data obtained for the stored seeds with 43.90 and 39.88% moisture content (6 and 24 hours of drying, respectively) did not fit any regression model, with a mean shoot length of 7.91 and 7.12 cm, respectively.

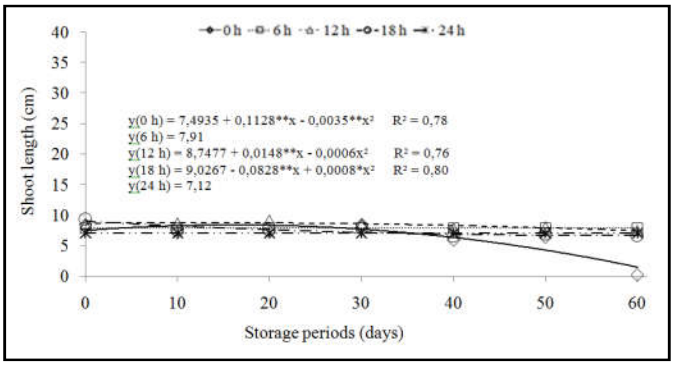

Figure 5. Shoot length of *Talisia esculenta* seedlings from stored seeds submitted to different drying periods

The primary root and shoot length of *Eugenia uniflora* seedlings were negatively affected by the drying period of the seeds, after 14 hours of drying. After drying for 48 hours, the seedlings had the most significant adverse effects, where seedlings with the shortest lengths were originated (COMIN et al., 2014). In a similar study, Prado et al. (2014) observed a linear decrease in the length of *Achras sapota* seedlings, as the moisture content of the seeds decreased from 36% (freshly processed seeds) to 7% (oven-drying for 24 h at 30 °C). According to Cardoso et al. (2015), drying compromises the seed tissues, especially those of reserve, resulting in less transference to seedling growth. Normal seedlings with higher mean root or shoot length are considered to be more vigorous, and vigorous seeds originate seedlings with a higher growth rate due to the greater translocation capacity of their reserves and greater assimilation of these by the embryonic axis (VIEIRA and CARVALHO, 1994). In Figure 6, it is observed that the seeds of *Talisia esculenta* stored with 41.40 and 39.88% moisture content (12 and 24 hours of drying) originated seedlings with a greater root dry mass until up to 20 days of storage. This data did not fit any regression model with mean values of 1.17 and 1.15 g, respectively. The highest root dry mass (1.35 g) was obtained after 9 days of storage for seeds stored with

43.90% moisture content (6 hours of drying). A significant decrease in the root dry mass of seedlings from seeds stored with 45.70% moisture content (seeds not dried) was observed after 30 days, while for seeds stored with 43.90% moisture content (6 hours of drying), a linear decrease was observed.

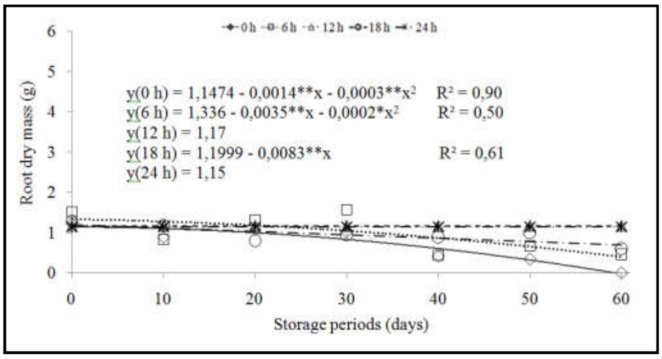

Figure 6. Root dry mass of *Talisia esculenta* seedling from stored seeds submitted to different drying periods

During germination, the more vigorous seeds provide greater dry mass transference from their reserve tissues to the embryonic axis, originating seedlings with greater weight due to a more significant dry mass accumulation (NAKAGAWA, 1999). According to Arrigoni-Blank et al. (1997) and Corvello et al. (1999), the physiological quality decrease of seeds during storage is due to the degenerative transformations typical of deterioration. As observed in Figure 7, the highest shoot dry mass weight (1.50 g) was also obtained from seedlings originated from seeds stored with 45.70 % moisture content (seeds not dried) after 6 days of storage. After this period, a drastic decrease was observed after 40 days of storage. Data of the seedlings dry mass from seeds stored with the moisture content of 43.90 and 39.88% (6 and 24 hours of drying) did not fit any regression models, with mean values of 1.31 and 1.34 g, respectively. A linear behavior was verified for the data of seedlings dry mass from stored seeds with 41.40% moisture content (12 hours of drying). It can be observed that the vigor remained significantly high until up to 40 days of storage.

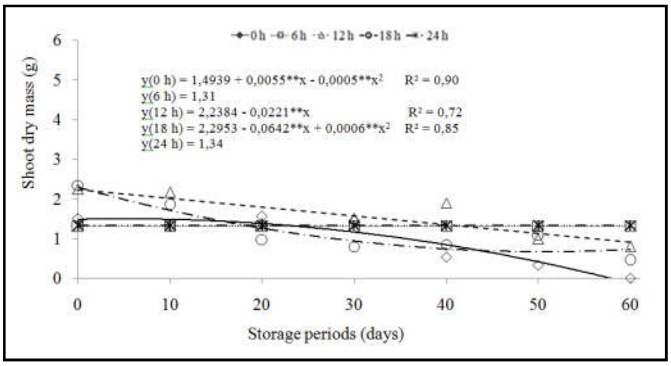

Figure 7. Shoot dry mass of Talisia esculenta seedlings from seeds stored after different periods of drying

Talisia esculenta seeds stored with an initial moisture content of 40.65% resulted in a gradual increase in the dry mass content of roots and shoots of the seedlings, when these seeds reached 43.33% of moisture content, after 50 days of storage in a cold chamber and polyethylene bags (SENA et al., 2016). Cardoso et al. (2015) observed a linear decrease in dry mass of Talisia esculenta seedlings as the drying period of the seeds was extended from 0 to 36 hours at 45 °C. The results obtained in this study indicate that the successful conservation of *Talisia esculenta* seeds during storage is closely related to their moisture content. For recalcitrant seeds, it is essential to correlate moisture variations to germination and vigor, aiming to observe the physiological changes due to storage conditions.

CONCLUSIONS

Seeds of *Talisia esculenta* stored with 39.88 and 41.40% moisture content maintain viability and vigor when stored in polyethylene bags in the refrigerator for 40 days; The storage of *Talisia esculenta* seeds with 45.70% moisture content negatively affect the physiological quality of the seeds with loss in vigor and viability after 20 days of storage.

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