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# Viability of seeds of some tropical tree species during storage

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**Abstract**

For most forest species the irregularity of fruiting, low seed production and spatial distribution of trees, make it impossible to supply seeds to meet seedling production programs. On the other hand, to prevent subsequent years of low production and maintain seed viability, it is necessary to adopt adequate storage procedures. Therefore, the objectives of the study were to evaluate the influence of water content and storage conditions on the physiological potential of seeds of *Colubrina glandulosa* Perkins (Rhamnaceae), *Chloroleucon dumosum* (Benth.) G.P. Lewis (Fabaceae), *Enterolobium contortisiliquum* (Vell.) Morong (Fabaceae), *Mimosa bimucronata* (DC.) O. Kuntze (Fabaceae) and *Sapindus saponaria* L. (Sapindaceae), which are native tree species in tropical forests in South America. The seeds were placed in paper packaging and glass packaging and stored in a laboratory environment (uncontrolled), during storage periods of zero (recently harvested), three, six, nine, 12 and 15 months. For each storage period, the water content and physiological potential of the seeds were evaluated. The design was entirely randomized with four repetitions of 25 seeds. The germination (G) and germination uniformity (U) data were subjected to analysis of variance in a 2 x 6 factorial arrangement (two types of packaging x six storage periods), and application of polynomial regression. Seeds of *Colubrina glandulosa*, *Chloroleucon dumosum*, *Enterolobium contortisiliquum*, *Mimosa bimucronata* and *Sapindus saponaria*, packed in paper packaging or glass packaging, and stored under uncontrolled conditions of natural environment, presented higher G and U, in the storage period of 15 months. The physiological potential of the seeds can be maintained for a long time, as long as they are packed in a glass container with an adequate initial water content. With a water content of 8.2, 8.1, 7.9, 8.4% and 12.1%, the seeds of *Colubrina glandulosa*, *Chloroleucon dumosum*, *Enterolobium contortisiliquum*, *Mimosa bimucronata* and *Sapindus saponaria*, respectively, maintain the viability during storage. Therefore, the solution to store these seeds would be to rigorously dry them, and then use waterproof packaging. It is recommended that for the storage of seeds of these tree species, they are previously packaged in glass containers.

**Keywords:** germination uniformity. physiological potential. water content. waterproof packing.
**Abbreviations:** G_germination; U_germination uniformity.

**Introduction**

The purpose of storage is to maintain physical, physiological and sanitary attributes of the seeds, for later sowing and obtaining healthy plants (Sahu et al., 2017). In order to guarantee the maintenance of the forest seed regulatory stock and prevent subsequent years of low production, it is necessary to use techniques that allow to maintain the viability of the seeds for the longest possible time, reducing deterioration processes (Wencomo et al., 2017).
Assessing the behavior of seeds in relation to storage is also essential to understand the ecological environment where the species has evolved and or is currently found (Felix et al., 2017). It is worth mentioning that storage conditions change with the species and time in which the seeds will be stored, requiring the use of appropriate packaging (Silva et al., 2018).
In addition, endangered plants in tropical forests may have germplasm conserved through storage (Léon-Lobos and Ellis, 2018). In turn, the irregularity of fruiting, low seed production and spatial distribution of trees, in most forest species, make it difficult to supply seeds to meet seedling production programs. (Oliveira et al., 2017).
The species *Colubrina glandulosa* Perkins (Rhamnaceae), *Chloroleucon dumosum* (Benth.) G.P. Lewis (Fabaceae), *Enterolobium contortisiliquum* (Vell.) Morong (Fabaceae), *Mimosa bimucronata* (DC.) O. Kuntze (Fabaceae) and *Sapindus saponaria* L. (Sapindaceae) are native trees, occurring in tropical forest in South America, with wood, ecological, ornamental and phytotherapic potential, and which, in general, present different ecotypes (Melo Junior et al., 2018; Lorenzi, 2016; Melo et al., 2018; Neves et al., 2018).

**Table 1.** Water content (%) of tree species from tropical forests, packed in paper packaging and stored in a laboratory environment.

| Storage Period (months) | *Colubrina glandulosa* | *Chloroleucon dumosum* | *Enterolobium contortisiliquum* | *Mimosa bimucronata* | *Sapindus saponaria* |
|---|---|---|---|---|---|
| 0 | 7.9 | 8.9 | 7.8 | 7.7 | 12.1 |
| 3 | 10.2 | 9.1 | 10.9 | 10.7 | 12.5 |
| 6 | 14.7 | 14.9 | 13.7 | 12.4 | 16.7 |
| 9 | 15.3 | 15.2 | 14.1 | 13.3 | 17.2 |
| 12 | 16.1 | 16.9 | 16.8 | 13.9 | 17.9 |
| 15 | 17.4 | 17.8 | 17.7 | 14.4 | 18.2 |

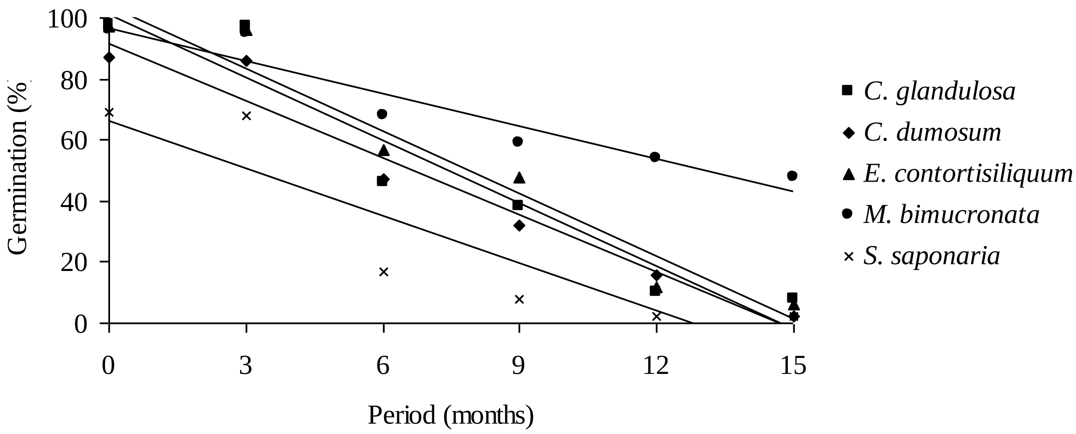


**Fig 1.** Germination (%) of tree species from tropical forests, packed in paper packaging and stored in a laboratory environment. *C. glandulosa* = -6.8476x + 100.86 R2 = 0.9191; *C. dumosum* = -6.1905x + 91.429 R2 = 0.9568; *E. contortisiliquum* = -6.819x + 103.81 R2 = 0.9492; *M. bimucronata* = -3.5429x + 96.571 R2 = 0.9127; *S. saponaria* = -5.1619x + 66.381 R2 = 0.8144.

Therefore, the objectives of the study were to evaluate the influence of water content and storage conditions on the physiological potential of seeds of *Colubrina glandulosa*, *Chloroleucon dumosum*, *Enterolobium contortisiliquum*, *Mimosa bimucronata* and *Sapindus saponaria*.

**Results and discussion**

***Influence of water content***

Seeds of *Colubrina glandulosa*, *Chloroleucon dumosum*, *Enterolobium contortisiliquum*, *Mimosa bimucronata* and *Sapindus saponaria*, packed in paper packaging and stored under uncontrolled conditions in the natural environment, allowed a greater exchange of water vapor in the period of 15 months (Tables 1 and 2). Probably, the glass containers prevented or hindered the exchange of water vapor between the seeds and the surrounding environment, making the effects of high daytime temperatures not so drastic.

***Storage according to packaging***

It was verified by Figures 1-4 that, when the water content of the seeds of *Colubrina glandulosa*, *Chloroleucon dumosum*, *Enterolobium contortisiliquum*, *Mimosa bimucronata* and *Sapindus saponaria*, kept in paper bags and glass bottles, in a laboratory environment, remained below of the 13%, the seeds showed higher germination (G) and uniformity of germination (U) during the storage period of 15 months.

On the other hand, there was a significant decrease in G and U, in seeds of *Colubrina glandulosa*, *Chloroleucon dumosum*, *Enterolobium contortisiliquum* and *Sapindus saponaria* at the beginning of six months. The decrease was observed in seeds of Mimosa bimucronata, with the paper packaging at nine months, when the water content remained above 13% (Figures 1 and 3). According to José et al. (2018), this was because more water vapor entered the seed, which may have resulted in the gradual consumption of embryo reserves.

In seeds of *Vochysia divergens* (Oliveira et al., 2018), *Araucaria angustifolia* (Hennipman et al., 2017), *Calophyllum brasiliense* (Nery et al., 2017) and *Myrsine parvifolia* (Ri et al., 2017), it was found that the effect of the water content in the seeds during storage, was mainly due to intensifying breathing.

With the storage time, the seeds may try to adjust to the new relative humidity of the ambient air, and consequently, acquiring a higher water content and a new hygroscopic balance, as there would have been a change in the relative humidity of the packaging air (Pereira et al., 2017).

Generally, the reduction of factors, such as the luminosity, temperature and relative humidity of the ambient air, make the metabolism of the seed to be reduced and the microorganisms responsible for its deterioration, stay out of action, increasing its viability (Schneider et al., 2017).

The seeds of *Colubrina glandulosa*, *Chloroleucon dumosum*, *Enterolobium contortisiliquum*, *Mimosa bimucronata* and *Sapindus saponaria* were classified as having orthodox behavior, according to the flowchart of Hong and Ellis (1996), as they maintained their viability, even with the reduction of the water content, indicating a behavior of typical tropical ecological adaptation.

According to Figures 2 and 4, under normal environmental conditions, the physiological potential of the seeds can be maintained for a long time, as long as they are packed in a glass container with an adequate initial water content. Therefore, in the Amazon region of Brazil, where is characterized by high temperatures and high relative

**Table 2.** Water content (%) of tree species from tropical forests, packed in glass packaging and stored in a laboratory environment.

| Storage Period (months) | *Colubrina glandulosa* | *Chloroleucon dumosum* | *Enterolobium contortisiliquum* | *Mimosa bimucronata* | *Sapindus saponaria* |
|---|---|---|---|---|---|
| 0 | 8.2 | 8.1 | 7.9 | 8.4 | 12.1 |
| 3 | 8.9 | 8.3 | 8.8 | 8.5 | 12.5 |
| 6 | 9.2 | 9.4 | 9.1 | 8.7 | 12.8 |
| 9 | 9.6 | 12.3 | 9.5 | 9.3 | 13.5 |
| 12 | 11.4 | 13.4 | 10.7 | 10.6 | 14.4 |
| 15 | 11.7 | 13.7 | 11.9 | 10.8 | 14.7 |

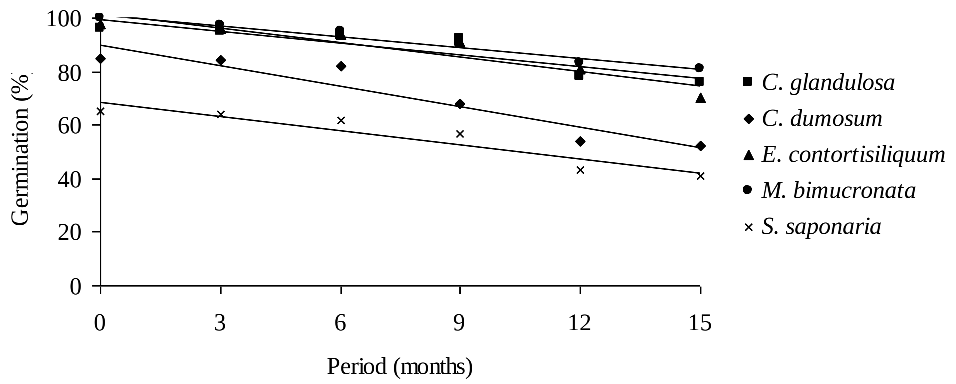


**Fig 2.** Germination (%) of tree species from tropical forests, packaged in glass containers and stored in a laboratory environment. *C. glandulosa* = -1.4476x + 99.19 R2 = 0.8307; *C. dumosum* = -2.5619x + 90.048 R2 = 0.903; *E. contortisiliquum* = -1.7905x + 101.76 R2 = 0.8685; *M. bimucronata* = -1.3524x + 101.14 R2 = 0.9666; *S. saponaria* = -1.7905x + 68.762 R2 = 0.8807.

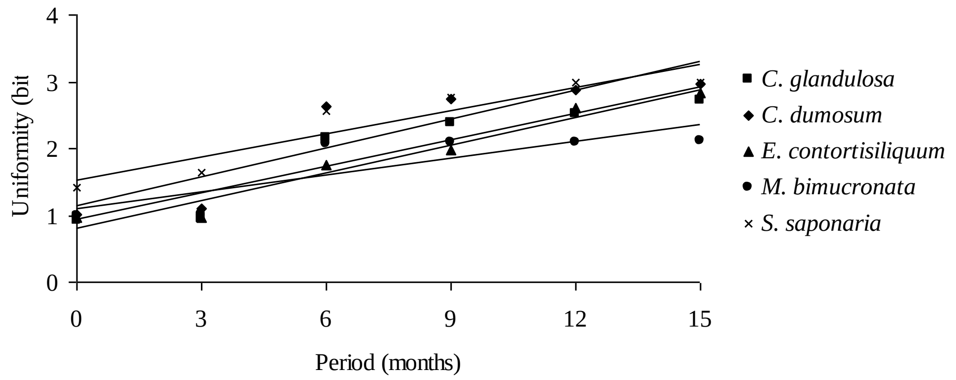


**Fig 3.** Germination uniformity (bit) of seeds of tree species from tropical forests, packed in paper packaging and stored in a laboratory environment. *C. glandulosa* = 0.1321x + 0.9488 R2 = 0.8653; *C. dumosum* = 0.145x + 1.1377 R2 = 0.7986; *E. contortisiliquum* = 0.1378x + 0.8183 R2 = 0.9582; *M. bimucronata* = 0.0843x + 1.0974 R2 = 0.7005; *S. saponaria* = 0.1152x + 1.5369 R2 = 0.8748.

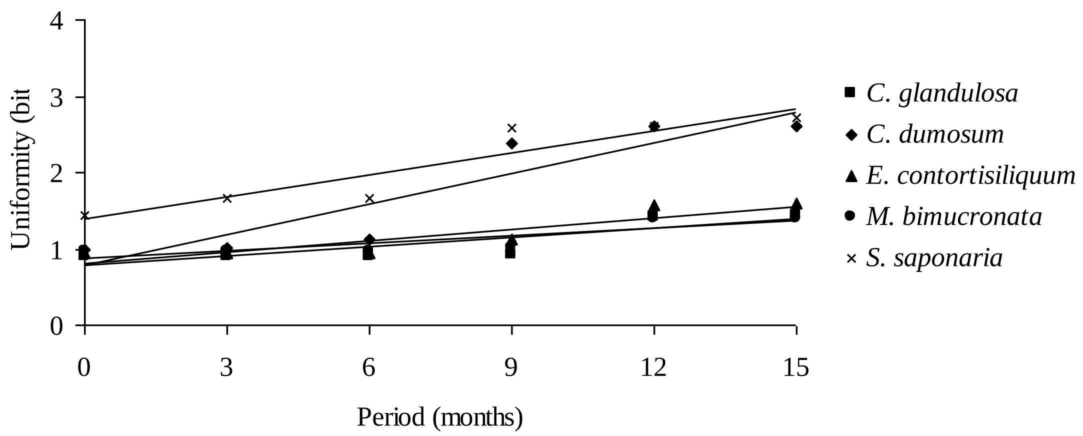


**Fig 4.** Germination uniformity (bit) of seeds of tree species from tropical forests, packed in glass packaging and stored in a laboratory environment. *C. glandulosa* = 0.0402x + 0.7838 R2 = 0.7118; *C. dumosum* = 0.1337x + 0.7805 R2 = 0.8426; *E. contortisiliquum* = 0.0502x + 0.808 R2 = 0.8109; *M. bimucronata* = 0.033x + 0.8704 R2 = 0.7395; *S. saponaria* = 0.0969x + 1.3871 R2 = 0.8694.

humidity, the solution for storing seeds would be to rigorously dry them, and then to use impermeable packaging. Seeds of *Colubrina glandulosa*, *Chloroleucon dumosum*, *Enterolobium contortisiliquum*, *Mimosa bimucronata* and *Sapindus saponaria*, coming from humid tropical forests, could germinate faster and soon after their dispersion, otherwise, as reported by Becerra-Vázquez et al. (2018), could lose viability, since the soils in these environments are constantly humid. Therefore, the success in establishing these tree species, under natural conditions, would be more related to the quantity and annual frequency of produced seeds.

**Materials and methods**

The work was conducted at the Phytotechnics Laboratory and at the Plant Propagation Laboratory, at the Engineering and Agricultural Sciences Campus, at the Federal University of Alagoas, Rio Largo, AL, Brazil.

***Plant material***

To obtain seeds, ripe fruits of ten trees of *Colubrina glandulosa*, *Chloroleucon dumosum* and *Enterolobium contortisiliquum*, and eight trees of *Mimosa bimucronata* and *Sapindus saponaria* were harvested in forest fragments, in the municipalities of Bom Conselho/PE (9º 10' 11'' S, 36º 40' 47'' W, 654 m altitude, BSh), Arapiraca/AL (9º 45' 6'' S, 36º 39' 37'' W, 260 m altitude, Aw), Penedo/AL (10º 17' 15'' S, 36º 34' 57'' W, 27 m altitude, Aw), Garanhuns/PE (8º 53' 25'' S, 36º 29' 34'' W, 896 m altitude, As) and Maceió/AL (9º 37' 40'' S, 35º 44' 18'' W, 59 m altitude, Am), respectively, between March and December 2018.

After harvesting, the fruits were sent to the laboratories for manual extraction, cleaning and homogenization of the seeds.

***Storage according to packaging***

The seeds were placed in paper packaging and glass packaging, and stored in a laboratory environment (uncontrolled), during zero storage periods (Newly harvested), three, six, nine, 12 and 15 months. For each storage period, the water content and physiological potential of the seeds were evaluated. The methodology used to propose the classification of seeds in terms of storage capacity was based on the methodology proposed by Hong and Ellis (1996).

***Determination of water content***

The greenhouse method was used at 105 ± 3 ºC for 24 hours (Brasil, 2009). Two samples were placed (1 g of seeds) for *Colubrina glandulosa*, two samples (4.5 g of seeds) for *Chloroleucon dumosum*, two samples (five seeds) for Enterolobium contortisiliquum, two samples (25 seeds) for *Mimosa bimucronata*, and four samples (25 seeds) for *Sapindus saponaria* (Melo Junior et al., 2018; Silva et al., 2014; Farias et al., 2019; Melo et al., 2018; Neves et al., 2018).

***Seed viability during storage***

First, the seed tegument was manually scarified with sandpaper on the side of the upper third of the seed, opposite the micropyle (Brasil, 2009).

Then, seeds of *Colubrina glandulosa* and *Mimosa bimucronata* were placed between vermiculite in the Biochemical Oxigen Demand (B.O.D.) at 30 ºC, seeds of *Enterolobium contortisiliquum* and *Sapindus saponaria* were placed to germinate between two sheets of paper towel wrapped in rolls in the B.O.D. at 25 ºC, and *Chloroleucon dumosum* seeds were placed to germinate on a sheet of paper in plastic boxes in the B.O.D. at 30 ºC (Melo Junior et al., 2018; Melo et al., 2018; Farias et al., 2019; Neves et al., 2018; Silva et al., 2014).

Seeds that produced seedlings classified as normal were considered to be germinated, with the first and last counting carried out, respectively, at seven and 14 days for *Enterolobium contortisiliquum*, *Mimosa bimucronata* and *Chloroleucon dumosum*, at three and 30 days for Colubrina glandulosa, and at seven and seven 35 days for *Sapindus saponaria* (Brasil, 2013).

Germination (G) and germination uniformity (U) were analyzed (Labouriau and Valadares, 1976; Labouriau, 1983; Carvalho et al., 2005):

Germination: $gi$ = (Σ$ki$=1ni/N) x 100, ni being the number of seeds germinated in time $i$ and N the total number of seeds placed to germinate;

Germination uniformity: U = –Σ$ki$=1Filog2Fi ≍ Fi = ni/Σ$ki$=1ni, where Fi is the relative frequency of germination, ni the number of seeds germinated in time $i$ (number corresponding to the $i$ nth observation) and $k$ the last day of germination.

***Experimental design and statistical analysis***

The experimental design was the Entirely Randomized, with four replications of 25 seeds. G and U data were submitted to analysis of variance, in a 2 x 6 factorial arrangement (two types of packaging x six storage periods), and polynomial regression application (Ferreira, 2014).

For data with non-normal distribution, the transformation of the arc sine √% was performed.

**Conclusions**

Seeds of *Colubrina glandulosa*, *Chloroleucon dumosum*, *Enterolobium contortisiliquum*, *Mimosa bimucronata* and *Sapindus saponaria*, packed in paper packaging or glass packaging, and stored under uncontrolled conditions in the natural environment, showed greater germination and germination uniformity, during the storage period of 15 months. The physiological potential of the seeds can be maintained for a long time, as long as they are packed in a glass container, with an adequate initial water content.

The solution for storing these seeds would be to dry them thoroughly, and then use waterproof packaging.

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