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Evaluation of Storage Potential of *Jatropha curcas* L. Seeds

Henrique Duarte Vieira[1], Alessandra Olmo Dardengo[1], Márcia Terezinha Ramos de Oliveira[1], Pedro Amorim Berbert[1], Bruno Borges Deminicis[2*]

[1]State University of North Fluminense Darcy Ribeiro, UENF, Campos dos Goytacazes, Brazil
[2]Federal University of Southern Bahia, UFSB, Ilhéus, Brazil
Email: henrique@uenf.br, brunodeminicis@hotmail.com, maroli@uenf.br, pberbert@uenf.br, *brunodeminicis@gmail.com

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Abstract

Ensuring the physiological quality of the seeds depends on storage conditions. Since their quality cannot be improved, good conditions during this period will contribute on keeping them viable for a longer time, delaying the deterioration process. In the present study, the effect of five storage periods in a refrigerated chamber at 15˚C ± 1˚C, on the seeds viability during 30, 60, 90, 150 and 240 days of storage in glass containers was evaluated. Four replicates of twenty-five seeds per treatment were used and the data were compared by regression equation. It verified that, regardless of the storage time, the seeds when submitted to the drying temperature of 35˚C and 40˚C showed a significant linear reduction of germination, GSI and seed vigor after storage.

Keywords

Seed Technology, Drying and Germination

1. Introduction

Jatropha curcas L. is a tree from the family Euphorbiaceae, popularly known in Brazil as jatropha, purga pine, among other names [1]. The origin center of the species is undetermined, however, it is believed that Portuguese navigators from Central America and Mexico through the Island of Cape Verde and the Island of Guinea Bissau might have disseminated it to other countries in Africa and Asia [2] [3].

According to Freitas *et al.* [4] cotton seeds have a strong tendency to deteriorate due to the high oil content, requiring special attention and care during storage to maintain their viability and vigor. This aspect can also be considered valid for jatropha [5]. The seeds of oil plants are difficult for preservation during

storage since they are very prone to deterioration. Generally, the intensity and the speed of the deterioration process are linked to the chemical composition of the seeds [6]. However, the longevity of the seed during storage depends on factors such as water content, environmental conditions, packaging, microorganism's activity, among others besides the chemical composition [7].

Therefore, storage conditions are decisive for ensuring the physiological quality of the seeds and although the quality cannot be improved, good storage conditions can help maintain the seed quality for longer, slowing down the deterioration process [8] [9] [10]. This is because uncontrolled conditions of temperature and relative humidity during the storage period result in a fast reduction of germination [11]. Thus, there is great importance in the study of different types of conditions and times of storage of seeds.

Thereby, the objective of this study was to evaluate the physiological quality of jatropha seeds submitted to five storage periods, seeking to obtain the best conditions that minimize the loss of their quality standard.

2. Material and Methods

The work was carried out at the Agricultural Engineering Laboratories (LEAG) and Phytotechny (LFIT) of the Northern Fluminense State University Darci Ribeiro (UENF), Campos dos Goytacazes, RJ, Brazil. Seeds of *Jatropha curcas* L. were used from the "Capixaba Institute for Research and Technical Assistance and Rural Extension" (INCAPER), in the city of Linhares, State of Espírito Santo, Brazil. The fruit harvest and the processing were performed manually. The physiological potential before performing any convection drying procedure (control treatment) was evaluated in part of these seeds. The seeds of the control lot (without drying) showed 100% germination and 3.23 GSI.

The drying was interrupted only when the water content of the seeds was near equilibrium for the conditions under which the tests were performed by using five drying air temperatures 29˚C, 35˚C, 40˚C, 45˚C and 50˚C. During the drying process the trays with the samples were weighed periodically until reaching water contents from 49% to 12% moisture content (b.u.%); 49% to 13% b.u.; 47% to 12% b.u.; 48% to 7% b.u.; 47% to 9% b.u.

After drying, part of the sample was used to determine the final water content and another part used to perform the physiological quality tests. The water contents of the seeds were determined by gravimetry using the oven at 105˚C ± 1˚C for 24 hours in three replicates [12].

Germination and seed vigor were evaluated immediately after drying to determine the immediate effect of the air temperature on germination and in regular periods of storage to verify its latent effect. The remainder of the dried seeds was subdivided into 5 portions of approximately the same mass that were packed in glass vials of 150 ml with screw cap and sealed with Parafilm and then stored in a Biochemical Oxygen Demand (BOD) Chamber at 15˚C ± 1˚C in periods of

0, 30, 60, 90, 150 and 240 days.

The seed quality was evaluated throughout the germination testsin which four replicates of 25 seeds were sowed between sand and conditioned to germinate in a BOD chamber at a temperature of 35˚C. and 8/16 h light/dark photoperiod. The evaluation of the first count test was performed on the fifth day after sowing and with final count at 10 days of sowing according to Martins *et al.* [13]. The germination speed index (GSI) and germination percentage (%G) were calculated according to the methodology recommended by Maguire [14].

The variables calculated were as follows:

- Germination (G): calculated by formula G = (N/100) × 100, where: N = number of germinated at the end of the test. Unit: %.
- Rate of germination (GSI): calculated by the formula IVG = Σ(ni/ti), on what: ni = number of seeds germinating in the time 'i'; ti = time after test installation; i = 1. Unit: dimensionless.

3. Results and Discussion

In Figure 1 can be observed that as the storage time increases there is a negative effect on seed vigor. These results corroborate with studies carried out with soybean seeds by Martins *et al.* [15], who verified that, independently of the genotype the seeds that are kept at room temperature showed zero vigor as from 210 days, a marked decrease in germination generating almost 100% seed deterioration after 240 days storage.

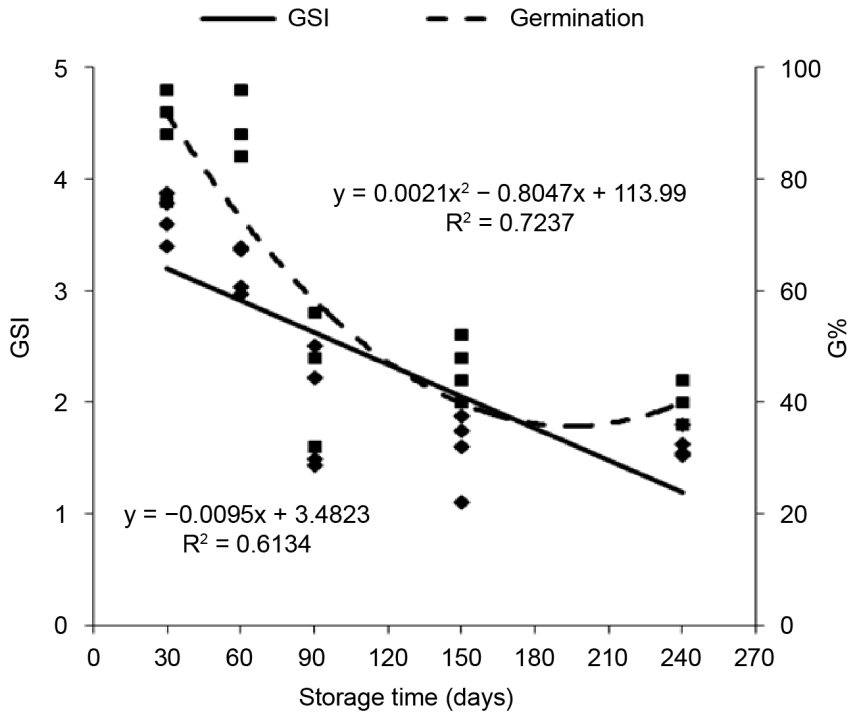

Figure 1. Germination speed index (GSI) and germination of the jatropha seeds submitted to a drying temperature of 29˚C and five storage times.

Gomes [16], using different packaging and storage conditions for cottonseeds verified after 12 months of storage that regardless of the conditions studied, seed germination decreased significantly. In the studies developed by Freitas *et al.*, [4], there was a marked fall in the two variables studied: vigor and germination of cottonseeds kept in laboratory conditions when compared to those in refrigerated room conditions at 10˚C.

The germination performance of the seeds throughout the storage in **Figure 1** noted that for seeds dried at a temperature of 29˚C with a final water content of 12% b.u. there was a significant decrease over the storage period.

In studies of storage of Jatropha seeds with water content in the range of 4 to 5% b.u., Gusman and Aquino [17] found only a small drop in germination when the seeds were maintained in impermeable packages.

Figueiredo *et al.* [18] studied the storage of castor bean seeds which showed a similar behavior to the jatropha maintained in laboratory conditions for six months in different types of packages. In this case, the authors verified that there was a reduction in the germination and vigor of the seeds conditioned in both permeable and semipermeable packages.

The storage of castor bean seeds also studied by Machado [19], which were done in paper bags for six months under environmental conditions. The author verified that from three months there was a reduction for both germination and germination speed.

In the drying process of the seeds at 35˚C (**Figure 2**) that reduced the water content to 13%, there was a drop in the seed vigor over the 240 days of storage.

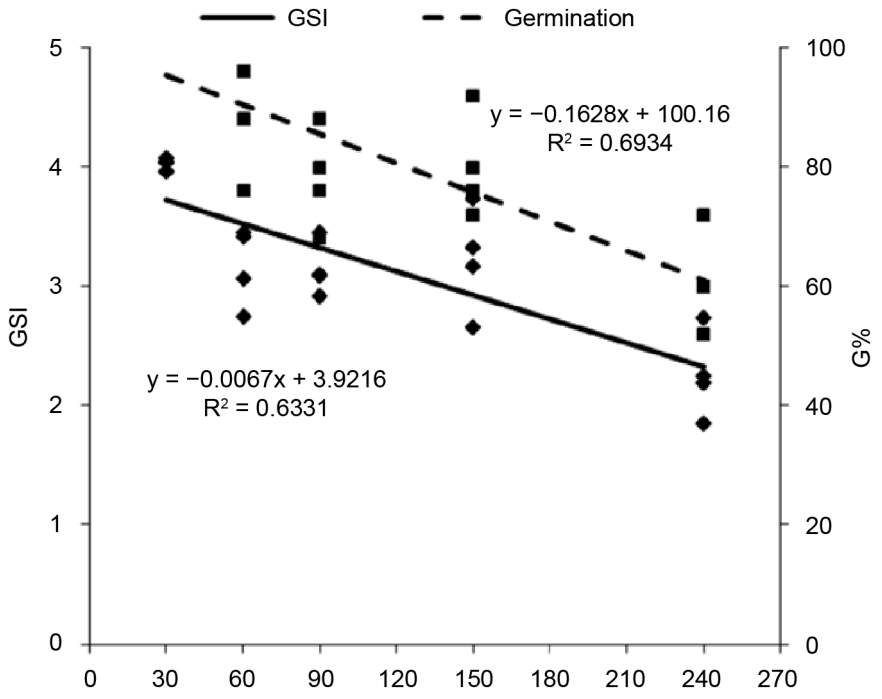

Figure 2. Germination speed index (GSI) and germination of the jatropha seeds submitted to a drying temperature of 35˚C and five storage times.

According to Mandarino and Roessing [20] moisture content above 13% may be critical for storage of oilseeds because problems such as: seed heating and structural modifications may occur. Marcos Filho [7] recommends that oil seeds should be stored with a moisture content lower than that indicated for amylaceous, between 8% and 10% [21]. Dias *et al.* [22] evaluating different environments and conservation packaging of jatropha seeds during 12 months of storage analyzed that there was a reduction in the physiological quality of the seeds kept in a laboratory environment independent of the packaging used and that the most adequate condition for storage of seeds should be in a plastic bag in a cold room (10˚C ± 2˚C, 55% ± 5% RH) that is with a low RH%.

For seeds submitted to a temperature of 35˚C and a moisture content of 13% it was observed that the storage conditions were gradually deteriorating to their quality reaching only 61% after 240 days of storage (**Figure 2**). According to Moncaleano-Escandon *et al.* [23] the rapid loss of vigor in jatropha seeds is due to high moisture content and storage conditions.

According to Marcos Filho [7], the joint action of high humidity and temperature accelerates the process of deterioration of orthodox seeds such as castor bean seeds reducing their longevity. Zonta *et al.* [24] also observed a decrease in the germination of the jatropha seeds during the storage when submitted to a temperature of 33˚C with a final moisture content of 8.5% b.u.

Pinto Junior *et al.* [25] observed that the seeds stored in glass package and refrigerator environment maintained their physiological quality and could be stored for 180 days. For the germination test, no significant effect was observed for the different environments and storage times (90 days, 87% and 180 days, 89%) and packaging (90 days, 87% and 180 days, 90%). Souza *et al.* [26] verified that seeds of *Tabebuia serratifolia* stored in laboratory environment (27˚C ± 3˚C and 62% ± 2% RH) showed total loss of vigor at 120 days of storage.

These results parallel the findings of Fanan *et al.* [27] in their castor bean seeds research where the vigor maintenance is explained by the fact that the water content of the seeds remained relatively low, between 6.2% and 6.7% in all treatments during the 12 months of storage. Peske [28] also states that high water content is the factor that most influences the physiological quality of the seed during storage.

The protein content may also contribute to the reduction of storage potential due to the high affinity of this substance to water, increasing the rate of deterioration of oilseeds [21].

For Worang *et al.* [29] the moisture content between 7.9% and 8.4% is considered safe for the storage of pinion seeds under normal environmental conditions. These authors found that seeds placed in plastic packages and stored under laboratory environmental conditions showed a reduction in germination from 89% to 75% after one month of storage; Decreasing to 53% in the sixth month.

Guzman and Aquino [17] examining the storage of jatropha seeds for 12

months at 0˚C observed that the germination fell from 96% to 55% during this period; under natural environmental conditions, however, after 12 months of storage, the seeds also lost their germination capacity. It appears the temperature combination of 40˚C with final water content of 12% b.u. caused a negative effect on the vigor of the jatropha seeds during the 240 days storage period (**Figure 3**).

The results obtained in the present study are similar to the findings of Amaral and Baudet [30] who analyzed the effect of the initial moisture content of the soybean seed (11.4% and 13.4%) and storage period of up to eight months. The authors verified that from the fifth month of storage, the seeds were severely compromised in terms of vigor.

According to Almeida *et al.* [31], the high content of moisture in the seeds combined with high temperatures, accelerates the degeneration processes of biological systems. Under these conditions the seeds lose their vigor rapidly and sometime later their germination capacity. Alvarez-Pardo *et al.* [32] analyzed seeds of sixteen species of orchids stored at 5˚C for up to 42 months verified that there was loss of viability as the storage period increased and for 12 months most of the species stocked at 5˚C in a desiccator with relative humidity at +6% water content, retained viability near 100%.

The results presented in **Figure 3** show that the jatropha seeds after being submitted to the drying temperature of 40˚C caused a marked decrease in germination and that with 150 days of storage the germination rate of the seeds

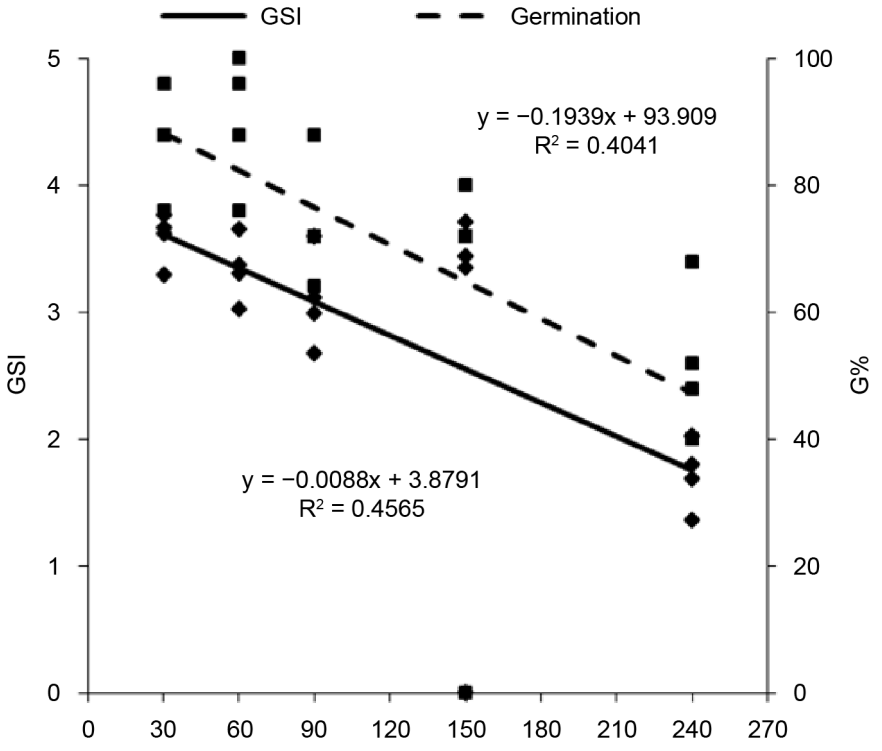

Figure 3. Germination speed index (GSI) and germination of the seeds of the jatropha submitted to the drying temperature of 40˚C and five storage times.

was 76% and when stored for 240 days dropped to 52%. For Guzman and Aquino [17] the storage temperature is not the major determinant for maintaining the physiological quality of the jatropha seeds, but the moisture content of the seeds is a factor that most influences the reduction of germination and vigor. For the same authors, seeds with a moisture content between 4% and 5% stored in impermeable packages can be stored for one year with little reduction in the percentage of germination. They have also found that the moisture content of 9.5% was detrimental to the quality of the seed.

These results differ from some work with oilseeds such as, for example, Zonta *et al.* [24], that had seeds dried at 43˚C maintained germination potential throughout storage. Also by Carvalho *et al.* [33] studying sunflower seeds found that they were tolerant to drying at temperatures of 40˚C preserving their germinative power by about 80%. For castor bean (*Ricinus communis* L.) stored in kraft paper under different natural environmental conditions, for one year, Fanan *et al.* [27] did not show great variations for germination of this species throughout the period stored.

Pinto Junior *et al.* [25] searching to identify suitable storage conditions for the maintenance of the physiological quality of jatropha seeds, evaluated three types of packages (Kraft paper bag, polyethylene bag and glass packaging) and three storage environments (laboratory with uncontrolled conditions, chamber refrigerated at 14 - 16˚C and refrigerator at 4˚C - 6˚C) they found that the seeds stored in glass packaging in the refrigerator maintained their physiological quality and could be stored for the period of 180 days. Almeida [34], storing cotton-seeds under different controlled temperature conditions for 150 days.

GSI and germination of seeds submitted to drying temperatures of 45˚C and 50˚C showed no significance change at 1% of probability without regression. Guedes *et al.* [35], evaluating the storage of Mastic seeds (*Pistacia lentiscus*) in different packages and environments observed a more accentuated reduction in GSI seeds stored in the laboratory, where climatic conditions are not controlled.

Lima *et al.* [36] monitored the viability of sesame seeds (*Sesamum indicum*) stored in paper bags, multifolium paper, black polyethylene and pet bottles and stored for 12 months in different environments: cold and dry chamber (10˚C and 55% RH), natural environment (30˚C - 32˚C and 75% RH), refrigerator (4˚C and 38% - 43% RH) and freezer (−20˚C). These authors noted that the seeds remain viable and with high GSI when stored in cold and dry chamber and in the refrigerator, regardless of the type of packaging used. This suggests that the low temperature decreases the respiratory activity of the seeds contributing to its conservation. Chaves *et al.* [37] concluded that refrigerated storage and refrigerated environments reduces the loss of physiological quality of jatropha seeds.

Pereira *et al.* [38] sought to identify the most suitable conditions for the storage of freshly harvested jatropha seeds dried to the moisture content of 7.2% and stored over a year, under the following conditions: laboratory environment

and cold chamber (±5˚C and 60% RH), in sacks of kraft paper, braided polypropylene and cardboard drum. They verified that there was a linear reduction of germination, GSI and seed vigor after storage in natural environment, in bag Kraft paper, braided polypropylene and cardboard drum. As for the physiological quality of the seeds verified by the same author, it was higher after storage in cold rooms, than in kraft paper packages, polypropylene braided and cardboard drum, in laboratory environment.

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Santoso *et al.* [39] evaluated germination of jatropha seeds stored in plastic bags under laboratory conditions and observed higher germination percentages for yellow seeds and brown fruits in relation to germination when compared to seeds of dry fruits. Nery *et al.* [40] tested different packages (paper, aluminum and polyethylene) and environmental conditions (cold room and ambient temperature) for the storage of Guanandi (*Calophyllum brasiliense*) and concluded that packaging in polyethylene and cold storage provided the best condition for the conservation of the seeds keeping them viable for a period of nine months.

4. Conclusion

Jatropha seeds, like those of many other species with high oil content, generally show a marked linear reduction over time in germination, GSI and seed vigor after storage at 15˚C, but this deterioration can be mitigated by drying seeds at 35˚C prior to storage.

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