Storage of *Tabebuia caraiba* (Mart.) Bureau seeds in different packaging and temperatures[1]

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ABSTRACT - *Tabebuia caraiba* (Mart.) Bureau, commonly known as Silver Trumpet Tree is a forestal species, belonging to Bignoniaceae family, which can be utilized as medicinal plant or in landscaping of urban and rural areas; besides producing large mechanical resistance wood. Despite its wide use and ecological importance, basic studies on storages of their seeds are scarce. This way, the objective of this study was to determine the most adequate packaging and the best temperatures, for storing seeds of *T. caraiba*. For this, seeds were stored in two types of packaging: Kraft paper bags and transparent polyethylene bags; which were then stored during 150 days under three different environments: laboratory normal environment (25±2 °C); cold chamber (8±2 °C); and refrigerator (6±2 °C). After periods of 0, 30, 60, 90, 120, and 150 days, seed moisture content, percentage of emergence, emergence speed index, and seedling length were evaluated. Seeds of *T. caraiba* kept in packaging of paper and polyethylene bags and stored at laboratory environmental condition, have lost more quickly their vigor along the storage period. For storage, it is recommended the maintenance of *T. caraiba* seeds in polyethylene bags into cold chamber; and/or polyethylene bags or Kraft paper bags into refrigerator.

Index terms: emergence, vigor, seed preservation.

Armazenamento de sementes de *Tabebuia caraiba* (Mart.) Bureau em diferentes embalagens e temperaturas

RESUMO - *Tabebuia caraiba* (Mart.) Bureau, conhecida popularmente por craibeira, pertencente à família Bignoniaceae é uma espécie florestal utilizada na medicina popular e na arborização urbana e rural; além de produzir madeira de alta resistência mecânica. Apesar de seu uso e importância ecológica, os estudos básicos sobre o armazenamento de suas sementes são escassos. Desta forma, o objetivo neste estudo foi determinar as embalagens mais adequadas e as melhores temperaturas, para o armazenamento de sementes de *T. caraiba*. Para tanto, as sementes foram acondicionadas em dois tipos de embalagens: sacos de papel Kraft; e sacos de polietileno transparente; e armazenadas por 150 dias, em três ambientes: natural de laboratório (25±2 °C), câmara fria (8±2 °C) e geladeira (6±2 °C). Após períodos de 0, 30, 60, 90, 120 e 150 dias foram determinados: grau de umidade; porcentagem de emergência; índice de velocidade de emergência e comprimento de plântulas. As sementes de *T. caraiba* acondicionadas nas embalagens de papel e polietileno e armazenadas no ambiente de laboratório perderam mais rapidamente o vigor ao longo do armazenamento. Para o armazenamento recomenda-se a manutenção das sementes em sacos de polietileno em câmara fria; e/ou em saco de polietileno ou de papel Kraft em geladeira.

Termos para indexação: emergência, vigor, conservação de sementes.

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Introduction

Tabebuia caraiba (Mart.) Bureau is a forestal species, belonging to the family Bignoniaceae, and is popularly known in Brazil as craibeira, para-tudo, caraibeira, or ipê-amarelo-da-caatinga. In US and other English-speaking countries it is commonly known as Silver Trumpet Tree. It is an ornamental tree widely used for forestation and landscaping as well as for uses in popular medicine, in the form of syrup made from its bark, for treatment of hepatitis, anemia, and verminous diseases. Despite the efficacy and safety of its used have not yet be scientifically proved; an infusion made of its bark has been used for treatment of ulcerous gastritis, rheumatism, bacterial diseases, and inflammations (Lorenzi, 2002). In addition, its wood is moderately heavy, and widely used for general carpentry services, construction, manufacture of sports artifacts, and carved art-works (Braga, 1976; Lorenzi, 2002).

The seeds of *T. caraiba* are estenospermic, with opposite lateral wings, placed in a superposed manner along the septum, with a lobated and depressed shape; the color of tegument varies according to seed maturation stage, being of lilac color before dehiscence of fruits and varying from white-brownish to light-gray at dispersal; with leathery texture, rugous, and lined, and in some seeds grooved and shiny; the hilum of these seeds are clearly visible, heterochromatic, located in a prominence at the seed base, forming a depressed point (Ferreira and Cunha, 2000). Also according to these authors, the seed germination is epigeal; the seedling is fanerocotyledonary, with emission of roots at four days after sowing, with rupture of tegument at the seed base, in the portion opposite to hilum.

In some forestal species, the seed viability is naturally maintained for long periods, while seeds of other species deteriorate rapidly (Villela and Peres, 2004), since deterioration is an irreversible and unavoidable process; the speed of this process, however, can be controlled. This manner, for seeds stored under adequate conditions, the speed of deterioration process can be lessened, allowing maintenance of their viability for periods longer than those occurring under natural conditions (Figliolia and Piña-Rodrigues, 1995).

For forest species, in most of times it is difficult to keep viability and vigor of seeds. For that reason, factors affecting their longevity during storage, such as: moisture content; packaging permeability; temperature; and relative humidity, should be considered when the objective is to extend longevity and prolong viability of these seeds (Carneiro and Aguiar, 1993).

The high moisture content of seeds, combined with high temperatures, accelerates the natural processes of biological systems degeneration; in a way that seeds rapidly loose their vigor and, some time after, also loose their germination capacity (Azevedo et al., 2003). To reduce to a minimum the deterioration process of seeds it is necessary that, after harvest, such seeds are adequately stored, thus allowing control of deterioration process; once such process cannot be avoided (Villela and Peres, 2004).

Seed deterioration is also associated to characteristics of packaging containing them, and depends on higher or lower easiness for water vapor exchange between seeds and the atmosphere and on conditions of environment in which seeds remain during storage (Marcos-Filho, 2005). Therefore, the packaging used in storage must help in decreasing the speed of deterioration process by maintaining the initial moisture content of seeds stored, aiming at diminishing respiration (Tonin and Perez, 2006). Thus, the choice of packaging depends on the plant species, on the moisture content of seeds, and on conditions and period of seed storage (Marcos-Filho, 2005).

For the seeds of *Tabebuia serratifolia* (Vahl.) Nich. the use of paper packaging is not recommended (Souza et al., 2005); while seeds of *Jacaranda cuspidifolia* Mart., can be store under either room temperature or refrigerated environment (Scalon et al., 2006). Packaging of paper and/or plastic, have been indicated for storing seeds of *Jacaratia corumbensis* O. Kuntze (Cavalcanti and Resende, 2007). The moisture content of 40%, associated to temperature of 10 ºC, allowed conservation of seeds of *Cupania vernalis* Cambess during a period of 240 days (Vieira et al., 2008). Seeds of *Apeiba tibourbou* Aubl., can be stored under normal environment of laboratory using as packaging either Kraft paper bags or polyethylene bags (Matos et al., 2008). The packaging into cans and maintenance into refrigerator were an adequate condition for storing seeds of *Tabebuia roseo-alba* and *Tabebuia impetiginosa* (Borba-Filho and Perez, 2009). For the same authors, however, seeds of *T. impetiginosa* may also be packaged into polyethylene bags, Kraft paper bags, or into cans and stored into cold chamber.

The knowledge of the behavior of forest seeds viability, especially seeds of *T. caraiba*, under different storage conditions is extremely important for a rational management of the species; besides allowing widening the period of availability of seeds with high germination and vigor for continuous production of new seedlings with satisfactory quality. Therefore, the objective of this study was to determine the most adequate packaging and most proper temperatures for storing seeds of *T. caraiba*.

Material and Methods

The seeds of *Tabebuia caraiba* used in the experiment were obtained from mature fruits (7.5 cm to 15.5 cm long; and pod-like in shaped), with brownish color, which were harvested from 10 matrix-plants phenotypically superior, healthy, vigorous, and with good production, distant at a minimum of 20 m from each other, in an area located in municipality of Campina Grande, State of Paraiba, Northeast of Brazil, in January 2009.

Assessments were performed at the Seed Analysis Laboratory, Department of Plant and Environmental Sciences, of Agrarian Sciences Center, Federal University of Paraiba (CCA-UFPB), at Areia Campus, State of Paraiba, Brazil.

After harvest, fruits were brought to laboratory where processing was performed by manually threshing the seeds; which were then kept in the shade under laboratory conditions for naturally drying for five days (27±3 ºC and 64±20% RH). Afterwards, seeds were homogenized and placed into packages of Kraft paper bags or polyethylene bags (0.04 mm thick) and stored under the following conditions: natural environment in the laboratory (±25 °C); into cold chamber (8±2 °C and 55% RH); and common refrigerator (6±2 °C), during periods varying from 0 to 150 days (0, 30, 60, 90, 120, and 150 days). At beginning of storage, and afterwards at each 30 days, samples of seeds each were removed from each packaging and environment for assessing the following characteristics: moisture content; emergence; emergence speed index; and seedling length.

The moisture content of seeds was determined at beginning of storage and at each 30 days, using four subsamples of 25 seeds each, for each treatment. Seeds were placed into an oven at 105±3 °C, for 24 h (Brasil, 2009), with modifications on number of seeds and replications. The seedling emergence test was carried out under greenhouse conditions with four replications of 25 seed each, for each treatment, which were evenly distributed in furrows into 40 cm x 40 cm x 11 cm dimensions plastic trays, containing washed and sterilized sand, which were then daily irrigated for substrate moisture maintenance. The counts were daily performed from the eighth to the 21st day after seeding, by computing only seedling that had emitted the epicotyl; and results were expressed in percentage.

The emergence speed index (ESI) was determined by daily counting the number of emerged seedling from the eighth to the 21st day after sowing and according to Equation ($ESI = \frac{E_1 + E_2 + ... + E_n}{N_1 + N, + ... + N_n}$), proposed by Maguire (1962); where: ESI = emergence speed index; E_1, E_2, and E_n = number of normal seedlings daily emerged; N_1, N_2, and N_n = the number of days from sowing until the first, second, and the last counting. At the end of emergence test, normal seedlings from each replication were measured (from root extremity until the apex of aerial part) with the aid of a ruler divided in centimeter; results were expressed in centimeters per seedling.

A completely randomized experimental design, with the treatments arranged into a 2 x 3 x 5 factorial scheme [2 types of packaging (Kraft paper bags and polyethylene bags) x 3 environments (laboratory, cold chamber, and refrigerator) x 5 storage periods (0, 30, 60, 90, 120, and 150 days)], with four replications of 25 seeds each, were used in the experiment; data obtained were subjected to ANOVA and polynomial regression.

Results and Discussion

Seeds from the genus *Tabebuia* are classified as orthodox and should be stored with moisture content around 8% (Figliolia, 1988). For this reason, the seeds of *Tabebuia caraiba* were stored with initial moisture content of 8.04% (Figures 1A, 1B and 1C). For the orthodox seeds, the moisture content is one of the most important factors for maintenance of their viability along time, once its reduction caused decrease on metabolic activity; which prolongs viability of seeds (Fowler, 2000). Cunha et al. (1992) did not find viability loss after drying of seeds of diverse species of *Tabebuia* until close to 4% or 5% moisture content, thus proving their orthodox behavior.

When seeds were packaged into polyethylene bags, there was a slight variation on moisture contents during the experimental period as compared to initial moisture content (8.04% to 11.70% in the laboratory; 8.04% to 9.00% in cold chamber; and 8.04% to 8.50% in the refrigerator), thus demonstrating the efficiency in the maintenance of moisture contents originally obtained and the reliability on the comparisons performed during the storage (Figures 1A, 1B and 1C). In the Kraft paper packaging stored under laboratory environment, it has been detected a higher variation in the moisture content of seeds, which have reached circa 19% moisture content at the 150th day (Figure 1A). As related to seeds stored into Kraft paper bags and stored into refrigerator there has been reduction in moisture content starting from beginning of storage, when they have reached 4.79% moisture, at the end of storage period (Figure 1C).

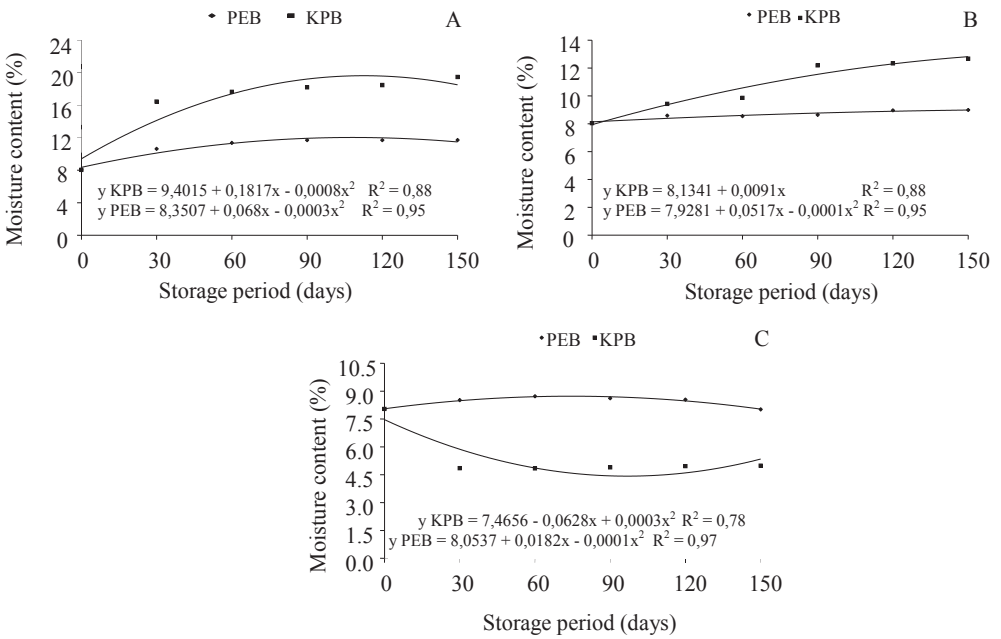

Figure 1. Moisture content of seeds of *Tabebuia caraiba* as a function of storage period into different packaging (KPB= Kraft paper bags; PEB= polyethylene bags) and environments (A = laboratory (±25 °C); B = Cold chamber (8±2 °C and 55% RH); C = refrigerator (6±2 °C).

At beginning of storage, the emergence of seedlings was circa 98% for all storage conditions (Figures 2A, 2B, and 2C). However, when seeds were packaged in whatever the studied packaging and stored at the laboratory environment, there has been significant reduction of percentage of emergence at the first assessment, with total loss of viability starting from 90 days of storage (Figure 2A). The so fast loss on germination of seeds kept into all packaging studied and stored at laboratory environment, is surely related with the trend of moisture content elevation along time, for seeds kept into porous packaging; especially due to higher relative humidity and variations on temperature; while the increase on moisture content of seeds stored into impermeable packaging is due to their increased respiratory activity. According to Bonner (1978), the gaseous exchanges do not occur for seeds stored into impermeable packaging, due to their high respiration rates, and as consequence of restriction of entry and exit of gases inside the package; what can intensify seed deterioration and consequently cause their death. Therefore, it becomes clear that moisture content of seeds and the temperature of the storage environment are determinant factors on *T. caraiba* seeds conservation.

It was also detected that for seeds of *T. caraiba* packaged into Kraft paper bags and polyethylene bags, kept under refrigerator environment, there have been no drastic reduction on emergence percentage, whose percentages were maintained around 57% (Kraft paper bags) and 46% (polyethylene bags) along the 150 days of storage (Figure 2C). In cold chamber, however, it was observed a significant reduction only at 150 days of storage, for seeds packaged in polyethylene bags; reaching 29% for Kraft paper bags and 0% in polyethylene bags (Figure 2B).

Similar behavior to what was observed with seeds of *Tabebuia roseo-alba*, was also identified with seeds of *T. caraiba*, when in the refrigerator environment and between bags of Kraft paper or polyethylene, it was verified that there has been no reduction on the percentage of germination (Borba-Filho and Perez, 2009). On seeds of species of the genus Tabebuia, it was also detected a strong variation on quality during storage (Carvalho, 1994), probably due to the fact that seeds also possess short viability period; what represents difficulties on the establishment, or on cultivation techniques, for reforesting of areas degraded, besides limiting natural dispersion of the species (Pinto et al., 1986).

Due to low longevity of seeds of Trumpet Trees, Kano et al. (1978) have reported that their use in reforesting is restricted, once in seeds with initial germination of 81% and moisture content of 9.1%, stored into permeable packaging, progressive reductions have occurred on physiological quality during the storage, until the total loss of germination capacity, at 240 days. In preserving seeds of *Tabebuia chrysotricha* (Mart. ex A. DC.) Standl., Carvalho et al. (1976) have obtained favorable results with the

storage into refrigerator at 10±2 °C, for approximately 150 days: a fact that was also evidenced for seeds of *T. caraiba*.

The fast loss of viability under laboratory normal environment and the efficient conservation of the physiological quality of seeds, when stored into refrigerator, were also detected for seeds of *Tabebuia serratifolia* (Vahl.) Nich stored into polyethylene packaging (Souza et al., 2005). Besides data obtained in other research works it is possible to affirm that results herein obtained strengthen information on the germination capacity behavior of *T. caraiba* seeds during storage, thus allowing drawing preservation strategies for the species.

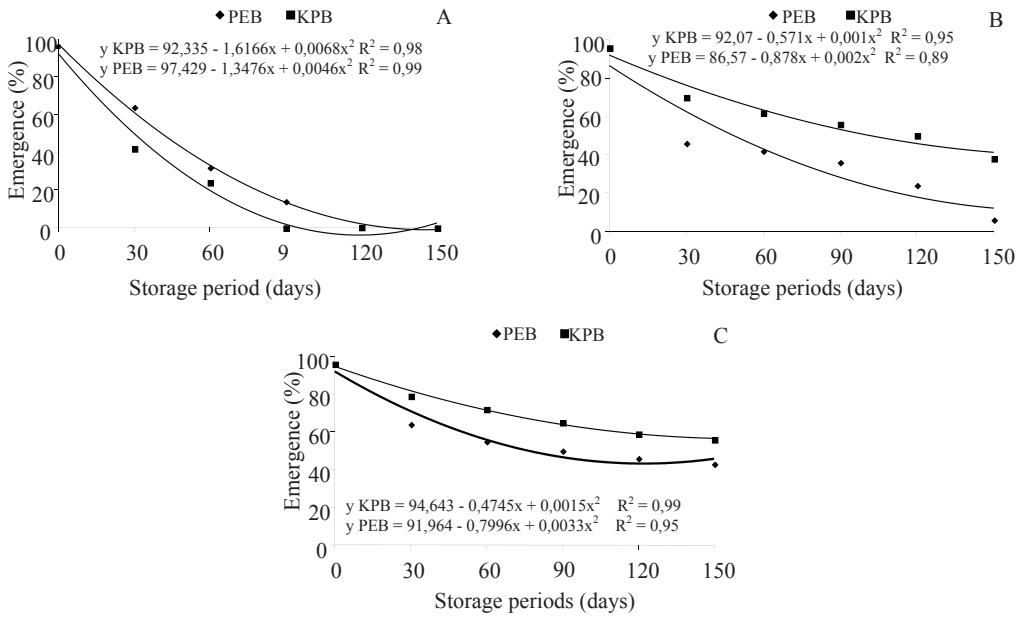

Figure 2. Emergence of seedlings of *Tabebuia caraiba* as a function of storage period into different packaging (KPB= Kraft paper bags; PEB= polyethylene bags) and environments (A = laboratory (±25 °C); B = Cold chamber (8±2 °C and 55% RH); C = refrigerator (6±2 °C).

Differently from what was observed for seeds of *T. caraiba*, for seeds of *Tabebuia aurea* Benth. & Hook. F. ex. S. Moore, when packaged into paper packaging and stored under normal environmental conditions (±24 °C), their viability has surpassed 90 days (Oliveira et al., 2006). The combination of moisture contents and temperatures of: 11.9% at 10 °C; 11.9% at -12 °C; and 13.6% at -12 °C, respectively, have favored the preservation of seeds of *Tabebuia chrysotricha* (Martins et al., 2009).

When the vigor of seeds of *T. caraiba* was assessed by the emergence speed index (Figure 3); it has been found that values obtained before storage were 2.16, and then reducing linearly in the laboratory environment, for both the packaging, becoming negative starting from 120 days storage period (Figure 3A). In the refrigerator environment, it was observed a negative linear decrease of vigor for seeds packaged into polyethylene bags or paper bags, being more evident in the paper packaging, in which the ESI reached 1.68 at 150 days; while that into polyethylene bags the ESI was 1.99 (Figure 3C).

Similar behavior was observed in seeds of *Tabebuia serratifolia* (Souza et al., 2005) what, under laboratory environment lost totally their vigor (assessed by ESI) in both the packaging, while in the refrigerator, the preservation was efficient into polyethylene bags. When seeds of *T. caraiba* were maintained into cold chamber environment, there was a linear negative reduction, which was more evident in the ESI found at 120 days storage; independent of the packaging used (Figure 3B).

The longevity of viability of seeds is related to many factors, especially the storage time. This is true, if one considers that all chemical components of a living being are unstable, in a short or long term, and then becomes a different entity as the time passes (aging process); what leads the seeds to gradual and constant deterioration, at larger or smaller speed (Cabral et al., 2003). Souza et al. (2005) have also observed reduction of vigor on seeds of *Tabebuia serratifolia* stored under cold chamber conditions along the storage time. Seeds of *Tabebuia impetiginosa*, maintained

under environments of refrigerator or cold chamber, independent of the packaging used, kept high their ESI, until 300 days of storage (Borba-Filho and Perez, 2009).

Length of seedlings of *T. caraiba* that were originated from seeds stored into refrigerator and cold chamber have had small reductions, being more vigorous when originated from seeds stored into both the packaging used (Figures 4B and 4C). In the refrigerator environment, for all packaging tested, there has been reduction on length of seedlings, whose values at the 150th day of storage, were 16 cm (for paper packaging) and 15 cm (for polyethylene packaging) (Figure 4C).

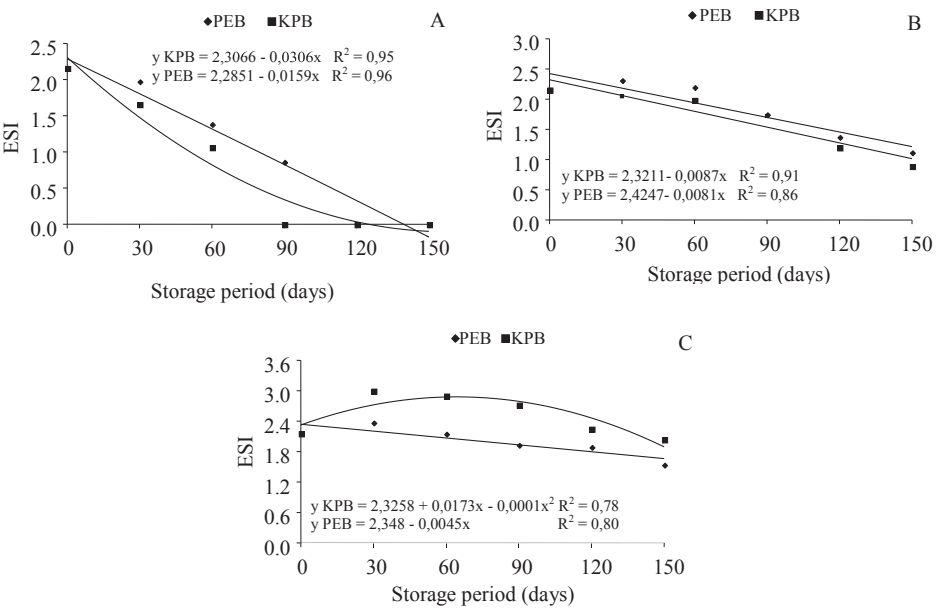

Figure 3. Emergence speed index of *Tabebuia caraiba* seedlings as a function of storage period into different packaging (KPB= Kraft paper bags; PEB= polyethylene bags) and environments (A = laboratory (±25 °C); B = Cold chamber (8±2 °C and 55% RH); C = refrigerator (6±2 °C).

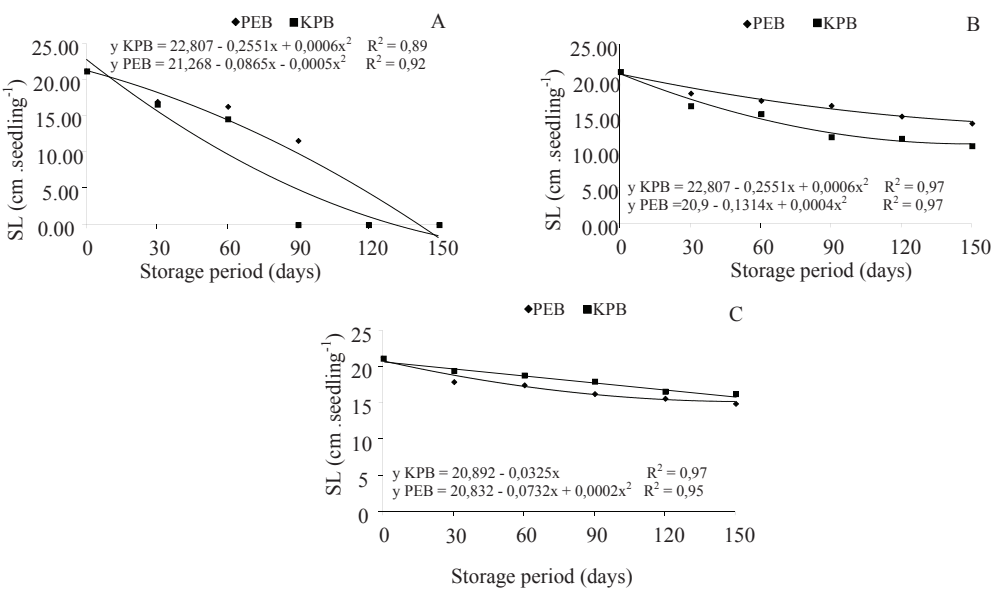

Figure 4. Seedling length (SL) of *Tabebuia caraiba* as a function of storage into different packaging (KPB= Kraft paper bags; PEB= polyethylene bags) and environments (A = laboratory (±25 °C); B = Cold chamber (8±2 °C and 55% RH); C = refrigerator (6±2 °C).

Under laboratory conditions, it was detected drastic reductions on values for length of seedlings originated from seeds stored in both studied packaging, being thus verified a larger influence of such variable, on the vigor of the seeds (Figure 4A). This reduction was more evident on length of seedlings originated from seeds stored into paper packaging, which have become null after 90 days storage. In face of these results, it is verifiable that under laboratory conditions the seed deterioration is very drastic, due to the occurrence of oscillations either on temperature or on moisture content.

Reduction on the values for length of root and aerial parts of seedling of *Tabebuia serratifolia*, obtained from seeds stored under laboratory environment and packaged into paper bags was detected only after 120 days (Souza et al., 2005). Seeds of *Moringa oleifera* Lam., however, stored at natural environment for six months still produced vigorous seedlings (Bezerra et al., 2004). Seedlings of *Peltophorum dubim* (Spreng) Taubert from seeds stored into cold chamber were more vigorous (Perez et al., 1999).

Conclusions

For storage, the seeds of *Tabebuia caraiba* should be packed into polyethylene bags and kept into cold chamber and/or into polyethylene bags and Kraft paper bags and kept into refrigerator.

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