

Evaluation of the electrical conductivity of forest seeds after digestive tract of wild birds

Avaliação da condutividade elétrica de sementes florestais pós trato digestório de aves silvestres

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Abstract

The production of seedlings encompasses the need for knowledge of plant physiology, mainly related to seeds and their minutiae. The seed is the vehicle that carries the full genetic potential of a cultivar with superior characteristics. Vigor can be described as that seed property that determines its emergence under unfavorable conditions. According to the International Seed Testing Association (ISTA). The process of reforestation can happen through the production of seedlings and, through seed dispersal, this can occur due to the action of the plant itself (autochory), water (hydrochory), wind (anemochory), animals (zoochory), etc. The current work aimed to investigate the feasibility of using the individual electrical conductivity test to evaluate the physiological quality of seeds of forest species after passage through the digestive tract of wild birds. The results allowed inferring that the forest seeds after digestive tract of wild birds presented low electrical conductivity at the individual level. Thus, the seeds in study no presented loss force after digestive tract of wild birds. Therefore, the birds only performed the role of individual dispersant.

Keywords: Ornithochoric; Electrical Conductivity; Forest Seeds

Resumo

A produção de mudas engloba a necessidade de conhecimento da fisiologia vegetal, principalmente relacionada às sementes e suas minúcias. A semente é o veículo que carrega todo o potencial genético de uma cultivar com características superiores. O vigor pode ser descrito como aquela propriedade da semente que determina sua emergência sob condições desfavoráveis. De acordo com a Associação Internacional de Testes de Sementes (ISTA). O processo de reflorestamento pode acontecer através da produção de mudas e, através da dispersão de sementes, isso pode ocorrer devido à ação da própria planta (autocoria), água (hidrocoria), vento (anemocoria), animais (zoocoria), etc. O presente trabalho teve como objetivo investigar a viabilidade do uso do teste de condutividade elétrica individual para avaliar a qualidade fisiológica de sementes de espécies florestais após passagem pelo trato digestório de aves silvestres. Os resultados permitiram inferir que as sementes da floresta após o trato digestivo das aves silvestres apresentaram baixa condutividade elétrica no nível individual. Assim, as sementes em estudo não apresentaram perda de vigor após o trato digestório das aves silvestres. Portanto, as aves só desempenharam o papel de dispersor individual.

Palavras-chave: Ornitocoria; Condutividade Elétrica; Sementes Florestais

1 Introduction

Forests play important roles in the ecosystem, among which we can highlight: CO₂ consumption, ecosystem services, habitat for several species, soil protection, income source, food and forest products, as well as being the source of biodiversity more important. In Brazil, special emphasis is given to the Amazon Rainforest, which despite the constant advances in deforestation is still considered the largest rainforest in the world (FAO, 2011).

The reproductive process of the superior plants happens from the meeting between the male and female gametes when the fertilization of the egg of the flower that gives rise to fruit and seeds takes place. The seeds have their origin from the cross between the male and female gametes of the flower. For this it is necessary to the action of pollinating agents, which can be: the wind, the insects and the gravity. However, it is important that the reproductive apparatus be developed, that is, suitable for reproduction, so that when transported the pollen grain, it can be allocated in the female flower in order to fertilize the egg (BESPALHOK; GUERRA; OLIVEIRA, 2018).

The production of seedlings encompasses the need for knowledge of plant physiology, mainly related to seeds and their minutiae. The seed is the vehicle that carries the full genetic potential of a cultivar with superior characteristics. It has attributes of genetic, physical, physiological and sanitary quality that gives it the guarantee of a good agronomic performance (BRASIL, 2003; FRANCO, 2016).

Vigor can be described as that seed property that determines its emergence under unfavorable conditions. According to the International Seed Testing Association (ISTA), vigor is an index of the degree of physiological deterioration and / or mechanical integrity of a batch of high germination seeds, representing its broad ability to establish in the environment. According to the Association of Official Seed Analysts (AOSA) seed vigor is taken as seed property that determines the potential for rapid and uniform emergence and for the development of normal seedlings under a wide range of field conditions (AOSA, 1983; HAMPTON; TEKRONY, 1995).

The process of reforestation can happen through the production of seedlings and, through seed dispersal, this can occur due to the action of the plant itself (autochory), water (hydrochory), wind (anemochory), animals (zoochory), etc. However, special attention should be given to the action of the birds, given their ample capacity of migration between the different environments. However there are few studies that relate the effect of zoochory, mainly ornithochory on the physiological quality of seeds (REIS, 2003; DARIO, 2004).

The most used method to evaluate the physiological quality of seeds is carried out based on the traditional germination test (PASSOS et al., 2008). However, such testing for seed of forest species may take weeks or even months to complete the results. Thus, the development and improvement of the methodology for rapid feasibility evaluation tests promises to make the production process more efficient and to aid decision making on seed lots. However, electrical conductivity tests with seeds of forest species are still scarce, especially those developed with the individual method, which provide greater fidelity to the results so that through this one can define the test by the mass methods. Stallbaun et al. (2015), using the individual electrical conductivity test with seeds of *Anadenanthera falcata* concluded that the applied method was compatible with the standard germination test. The current work aimed to investigate the feasibility of using the individual electrical conductivity test to evaluate the physiological quality of seeds of forest species after passage through the digestive tract of wild birds

2 Materials and Methods

An expedition was conducted in a fragmented area of Atlantic Forest in process of reforestation in the *campus* of the Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro (IFRJ) in the Municipality of Pinheiral, State of Rio de Janeiro (22°31'29.73"S; 43°59'37.08"W). One white-bearded manakin *Manacus manacus* (Linnaeus, 1766), one sayaca tanager *Tangara sayaca* Linnaeus, 1766, one rufous-bellied thrush *Turdus rufiventris* Vieillot, 1818 and one blue dacnis *Dacnis cayana* (Linnaeus, 1766) was captured with mist nets. The birds were kept in individual boxes with clean ground paper. After identification of the species, the bird was photographed and released. The seeds were taken from the fresh feces from each individual bird and identified according to the Manual of Identification and Cultivation of Native Arboreal Plants of Brazil (LORENZI, 2016). Seeds of the following species were shed by the birds: *Ficus calyptroceras* (Miq.) Miq., *Ficus enormis* (Miq.) Miq. and *Ficus obtusiuscula* (Miq.) Miq. (Rosales: Moraceae); and *Annona emarginata* (Schltdl.) H. Rainer, *Annona neosalicifolia* H. Rainer and *Xylopia brasiliensis* Spreng (Magnoliales: Annonaceae). After identification, asepsis was performed, leaving the seeds in sodium hypochlorite solution (2%) for 5 min and then washing under running water. In laboratory, drying was carried out in a germination chamber type BOD (CIENLAB and model CE-300/350-F) with a temperature of approximately 30 °C for 30 min. For conduct the electrical conductivity (EC) test, the recommendations proposed by Krzyzanowski et al. (1999), Flavio and Paula (2010) and Guollo et al. (2017) were followed with adaptations. The experimental design was completely randomized with six treatments with three replicates. The tests were performed by the individual method (by seed) for 36 hours. The seeds were placed in individual plastic containers containing 15 mL of distilled water and placed in a germination chamber with constant temperature of 25 °C. Additionally, the EC was evaluated in five soak periods: 2, 4, 6, 24 and 36 hours. The parameters of the study were evaluated using a multiparameter probe AKSO Combo 5 and the results were expressed in $\mu\text{S cm}^{-1}$.

The data were submitted to analysis of variance (ANOVA) and the means were compared by the Tukey test $p \leq 0.05$ of probability between the same ones (COSTA NETO, 1977; MILLER; MILLER, 1993).

3 Results and Discussion

The mean values of EC as a function of the different soak periods are shown in figure 1. Significant differences were observed in all the soak periods. It was found that the seed of *X. brasiliensis* presented the lowest EC value in all periods.

The species *F. obtusiuscula* was the one with the highest amount of leachate in 24 hs ($45 \mu\text{S cm}^{-1}$), which was the most permeable until the end of the imbibition period ($88 \mu\text{S cm}^{-1}$). None of the seeds under study had EC greater than $88 \mu\text{S cm}^{-1}$.

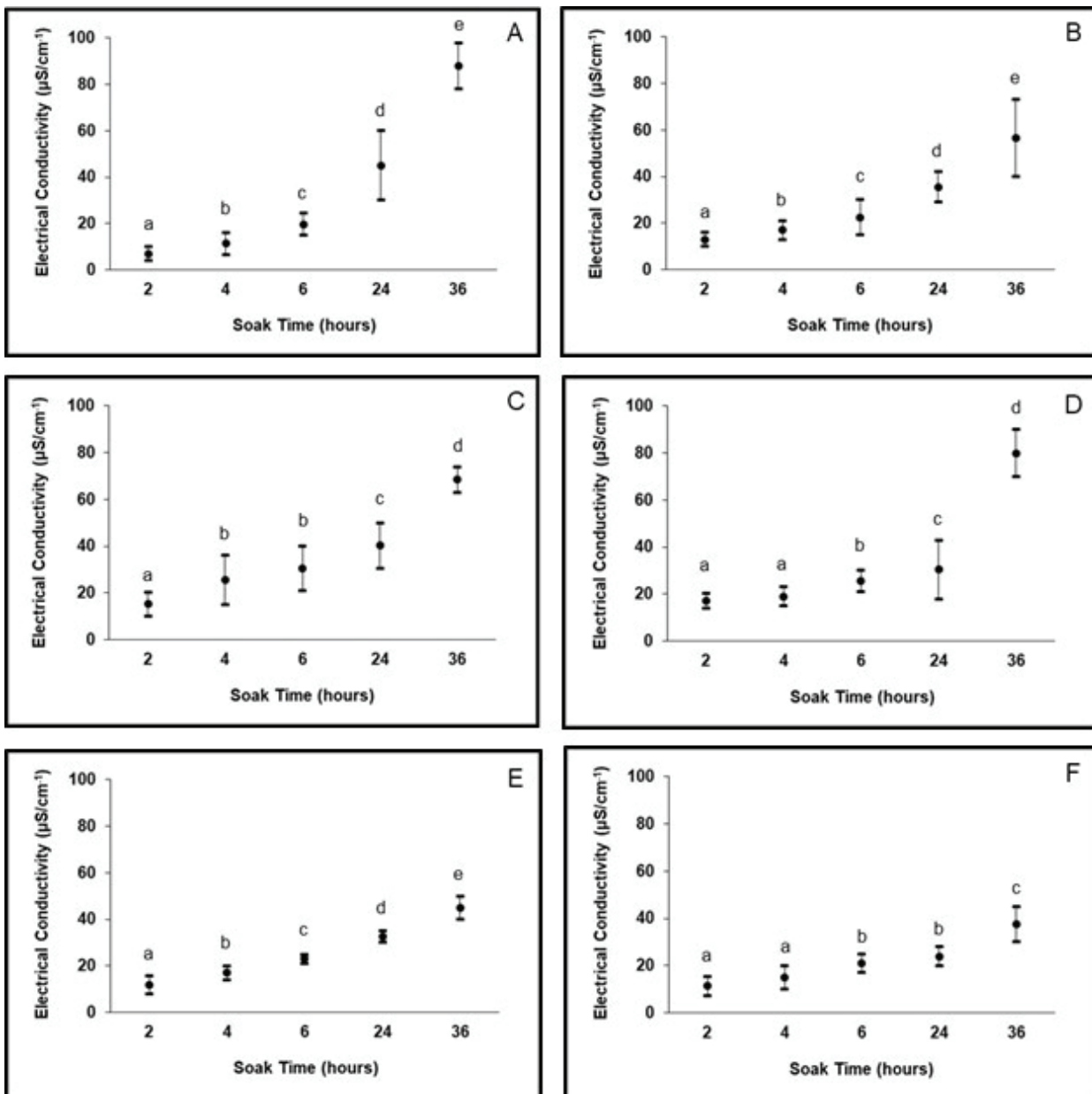
Increased EC can indicate inability to maintain membrane integrity, resulting in losses in germination (CHANG; SUNG, 1998). The seeds of *X. brasiliensis* showed higher ability to maintain high germination potential due to the lower EC observed over the test period.

Different values for EC were possible to be found when adopting the individual methodology for the test (MARCOS FILHO, 2015). However, data on individual EC of the species under study showed similar growth behavior.

The highest amount of leachate in the exudate occurs due to the loss of cell membrane integrity (BOTOTTI et al., 2008). As the seed grows older, its deterioration occurs, consequently, the loss of the integrity of the cell membrane

systems, causing an increase in its permeability, which results in leaching of electrolytes and higher electrical conductivity (SANTOS, PAULA, 2005; OLIVEIRA, 2012).

Figure 1 – Evaluation of the electrical conductivity in different times of seed soak: *Ficus obtusiuscula* (A); *Ficus enormis* (B); *Ficus calyptroceras* (C); *Annona emarginata* (D); *Annona neosalicifolia* (E); e *Xylopia brasiliensis* (F). Means followed by the same lowercase letter do not differ statistically from each other by Tukey test $p \leq 0.05$ probability



In the case of seeds with lower values of EC (high vigor), the reorganization of the membranes occurs faster, causing the release of exudates to be practically zero and when a seed is not viable or with low vigor, a higher release of exudates causes the increase of EC (MARCOS FILHO, 2015).

Several factors besides the seed imbibition period may have an influence on the results of the EC test, which can be cited: water quality and temperature, test environment temperature, seed water content, number of seeds used for seed test, genotype, the equipment used to read the EC, the presence of mechanical damages and injuries in the seeds and the

age of the seeds (DIAS; MARCOS FILHO 1996; VIEIRA; KRZYZANOWSKI, 1999; GASPAR; NAKAGAWA, 2002; MARCHI; CICERO, 2002).

Guollo et al. (2017) report that it is possible to infer that EC tests should be established specifically for each species, due to the differences found between them. There are variations in the absorption capacity for each type of seed, due to its shape, size and functionality of the pores, control of water exchange, waxy material that constitutes the epidermis of the integument and the degree of adhesion of the forehead to the cotyledon. These characteristics can be taken into account with regard to the time of imbibition of the seeds.

From the individual EC test, seed quality can be determined through viability and vigor, which represent different attributes of the seed (GUOLLO et al., 2017). According to Steere et al. (1981), the individual EC test was created to correct problems in performing the mass EC test with damaged or hard seeds, which present variations in the leaching capacity.

Thus, it is important to mention that the individual EC test is primordial with regard to establishing seed methodologies, due to the fact that through it is possible to prove the alterations of the reading in different conditions found in the seeds. However, there are few studies of individual EC related to forest seeds (GUOLLO et al., 2017). It is also understood that the fact that the seeds had been obtained from bird feces, the evaluation of the individual EC will contribute to the understanding of the physiological behavior of the forest seeds through ornithochoric dispersion.

4 Conclusions

The results allowed inferring that the forest seeds after digestive tract of wild birds presented low electrical conductivity at the individual level. It was found that the seed of *X. brasiliensis* presented the lowest EC value in all periods. The species *F. obtusiuscula* was the one with the highest amount of leachate in 24 hs ($45 \mu\text{S cm}^{-1}$), which was the most permeable until the end of the imbibition period ($88 \mu\text{S cm}^{-1}$). Thus, the seeds in study no presented loss force after digestive tract of wild birds. Therefore, the birds only performed the role of individual dispersant.

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