



Fruit and Seed Biometrics and Influence on Germination of *Artocarpus heterophyllus* Lam. (Jackfruit)

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Authors' contributions

This work was carried out in collaboration among all authors. Author UNB initiated and conducted the field experiment. Authors ALPFM, IMJM, LCM, AOL, GFSSO and ACS managed and followed the field, collected and analyzed data wrote and edited the draft manuscript. All authors read and approved the final manuscript.

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ABSTRACT

This work aimed to characterize the biometry of fruits and seeds of *Artocarpus heterophyllus* Lam. and to verify its influence on germination. The fruits were collected from the matrices trees in the Jardim Botânico do Recife (JBR), Pernambuco. From 10 pathogen-free *A. heterophyllus* matrices, 50 fruits (multiple fruits, which in the research were considered as single fruit) and 500 seeds were collected, being measured length, width and thickness, using a tape measure (for fruits) and digital caliper (precision 0.001 mm) for the seeds, as well as weighing on a precision scale. The seeds were classified by size: Small (≤ 2.5 cm), medium (2.6 to 3 cm) and large (≥ 3.1 cm). The germination test was conducted in a greenhouse of the JBR, with a 50% shading screen. The

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container used was a 50 x 25 x 5 cm polypropylene tray with holes at the bottom to provide drainage. The obtained results allow inferring that the seed size did not influence the vigor on *A. heterophyllum* germination in a greenhouse. The variation found in fruit size and number of seeds per fruit, as well as field observations regarding fruit and seed morphology, pulp flavor and consistency, allows us to infer that there is a possibility of several varieties of the species occurring in the studied site.

Keywords: Forest seeds; jackfruit; invasive species.

1. INTRODUCTION

Seed and fruit studies can help in the knowledge of species genetic variability and seed size classification can be used to standardize plant germination, vigor and development [1,2]. The study of fruits can highlight the strategies of species dispersal and knowing the germination of seeds of forest species is fundamental for regeneration, forestry, conservation and utilization of genetic resources [3].

Species of Indian origin, belonging to the Moraceae family, the jackfruit (*Artocarpus heterophyllum* Lam.) Is a monoecious tree and its inflorescences sprout directly from the trunk and older branches [4,5,6]. The seeds are between 2 to 3 cm long, light brown or dark, being recalcitrant and can be stored for up to one month [7,8].

The spread is mainly due to barocoria, because the high number of fruits and seeds creates a seed bank with high germination efficiency and consequent concentrated populations of the species; and zoochory, by action of small rodents and marsupials [9]. Jackfruit has allelopathy, which makes it difficult to germinate seeds close to it [10].

Jackfruit seeds have large amounts of starch with potential for use in the food industry [11], representing good sources of protein and carbohydrates [12]. Jackfruit has several medicinal uses especially antioxidant, anti-inflammatory, antimicrobial, anticancer, and antifungal activity [13,14].

Seed size and mass may influence germination speed, with cases where smaller seeds germinate faster [15], others where larger seeds obtain better results [16]. From this perspective, according to the working hypothesis that seed size influences seedling germination and vigor, this research aimed to characterize the biometry of *A. heterophyllum* fruits and seeds and to verify their influence on seed germination.

2. MATERIALS AND METHODS

2.1 Fruit and Seed Collection Area

Fruit and seed collection occurred in a dense tropical forest fragment in the Jardim Botânico do Recife (JBR) area, with about 11.23 hectares, located on the banks of BR 232, km 7, Recife, Pernambuco, Brazil (Fig. 1).

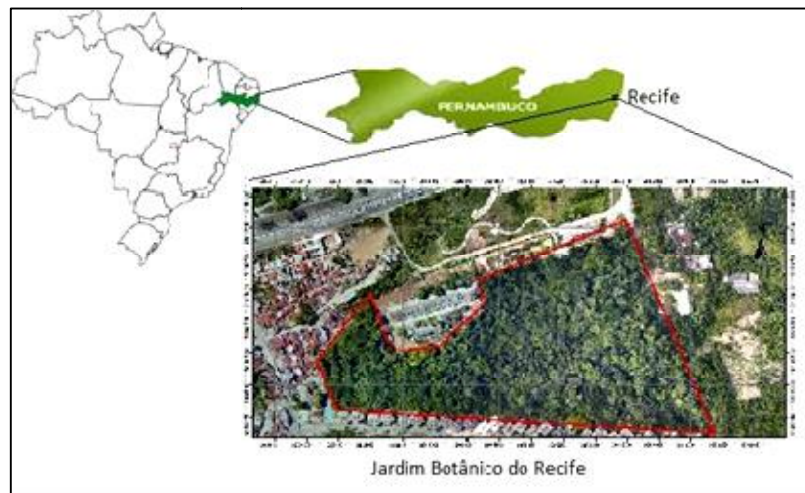


Fig. 1. Location of the urban forest fragment of the Jardim Botânico do Recife

2.2 Data Collect

Ten pathogen-free *A. heterophyllum* matrices were selected, from which 50 fruits were collected (multiple fruits, which in the research were considered as single fruit) and 500 seeds, being measured length, width and thickness, using a tape measure (for fruits) and digital caliper (precision 0.001 mm) for seeds and weighing was performed using a precision scale.

The seeds were classified by size: small (≤ 2.5 cm), medium (2.6 to 3 cm) and large (≥ 3.1 cm). At this stage, the number of seeds per fruit was also accounted for.

After separation, they were disinfected in 5% sodium hypochlorite solution for 10 minutes, and then washed in running water. In order to standardize germination, the seeds underwent pre-germination treatment, soaked in cold water for 12 hours and then sown.

The germination test was conducted in a greenhouse of the JBR forest nursery, with a 50% shading screen. The container used was a 50 cm x 25 cm x 5 cm polypropylene tray, containing holes in the bottom, to promote drainage. Sowing occurred on washed sand substrate, with daily irrigation, up to 60% of water retention capacity [17]. The experimental design was completely randomized, consisting of three treatments: Small, medium and large seeds, with four replications containing 50 *A. heterophyllum* seeds in each container.

The counting occurred daily until the 65th day, being considered germinated from the epicotyl emission and finalized with the germination

stabilization. For the biometric data, the mean, standard deviation and coefficient of variation were calculated and the results were classified in frequency histogram and analyzes performed in Microsoft Excel 2016 software.

The germination percentage and germination speed index (IVG) were calculated [18]. For seedling evaluation root and shoot length were measured and we quantified the number of leaves. The collected data were analyzed by analysis of variance (ANOVA), followed by Tukey test at 5% probability level.

3. RESULTS

3.1 Fruit and Seed Biometry

Among the parameters measured in *A. heterophyllum* fruits, the green mass presented the highest variability (2.6 to 14.9 kg), with a coefficient of variation of 55.15%, as shown in Table 1. This coefficient of variation was considered too high.

The green mass of seeds, as well as fruits, also presented high variation, the other characteristics had variation around 15%, as verified in Table 2.

As for seed size, 8.11% were classified as small, 39.53% as medium and 52.36% as large and the number of seeds per fruit ranged from 7 to 356, with an average of 88 seeds per fruit.

3.2 Seed Germination

The species *A. heterophyllum* presented hypogeal germination, started on day 14 and ended on day 53. The results obtained from

Table 1. Biometric parameters of *A. heterophyllum* fruits collected in the Jardim Botânico do Recife

	Mean	Minimum	Maximum	SD	CV (%)
Green mass (kg)	5.47	2.6	14.9	3.020	55.15
Length (cm)	29.21	17.8	44.1	7.047	24.12
Width (cm)	21.38	15.4	38.6	4.194	19.06
Thickness (cm)	20.94	16.6	27.8	5.969	28.49

* (SD) Standard deviation; (CV) coefficient of variation

Table 2. Biometric parameters of *A. heterophyllum* seeds collected in the JBR

	Mean	Minimum	Maximum	SD	CV (%)
Green mass (g)	3.870	1.940	9.880	1.184	30.60
Length (cm)	3.125	2.223	4.097	0.412	13.18
Width (cm)	1.554	0.868	2.603	0.289	18.59
Thickness (cm)	1.231	0.826	1.975	0.206	16.77

* (SD) Standard deviation; (CV) coefficient of variation

germination percentage and IVG were not related to seed size (Table 3). According to the statistical analysis performed by 5% ANOVA, there was no significant difference between treatments.

Regarding seedling development (Table 4), the bigger the seeds, greater length of the aerial part of the seedling. As for root, in treatment 2 no increasing pattern was observed.

4. DISCUSSION

The biometric parameters of green mass of fruits and seeds presented the highest variance in our data. Regarding fruit biometrics, Pushpakumara [19], studying the species *A. heterophyllum* in Sri Lanka, verified fruit length and width ranging from 16 to 70 cm and 12 to 34 cm, respectively.

The weight ranged from 1.6 to 20 kg, with an average of 7.1 kg. Other studies conducted with the species have registered larger sizes and weight, exceeding 30 kg [20]. According to the study by Phaomei and Pereira [21] the highest fruit weight recorded was 5.8 kg, with the lowest value in the order of 5.25 kg.

The high coefficient of variation values calculated for the biometric parameters, coupled with field observations on fruit morphology, flavor and pulp consistency may be indicative that there are different varieties of the species planted in the JBR. Another important issue is that the weight of the fruits explains the aggregate spatial distribution of the species in the area, given the dispersion by barocoria.

As to seed weight, Pushpakumara [19] verified length and width values ranging from 2.5 to 4.5 cm and 1.0 to 4 cm, respectively, while the weight ranged from 2.5 to 14 g. Khan [22], obtained weight variation between 1.5 to 14 g. Regarding seed size, 52.36% were classified as large. According to Malavasi and Malavasi [23], having large seeds brings benefits to the species, as they can better manage water stress situations. The size of the seeds confirms that their dispersal is performed by mammals and marsupials, as already described by Siqueira [24] and Pinto [9] in other areas. These animals often remove seeds from certain locations, taking them to long distances from the parent plant.

In India, Khan [22] concluded in his research that the success of *A. heterophyllum* regeneration seems to be influenced by the interactive effect of seed mass and light regimes, i.e. larger seeds had better germination performance, seedling survival and growth and on the ability to sprout after physical damage.

Silva et al. [2] inferred that *A. heterophyllum* germination was influenced by seed size, with small seed class presenting lower germination percentage (70%), statistically different from other treatments, which obtained 88%, 96% and 98% seed germination, medium, large and extra-large, respectively, that is, the vigor of the seeds was directly related to their size. According to Faria et al. [1], seed size does not influence germination and vigor results for all species, as, according to Hanley et al. [25], does not act on field development, which is related to reserves absorbed after germination and interaction with the environment.

Table 3. Germination (%) and germination speed index (IVG) of *A. heterophyllum* seeds in the JBR

Treatments	Average weight (g)	Germination (%)	IVG
T1: < 2.5 cm	2.82	46.8	3.71
T2: 2.5 < 3cm	4.22	40.5	3.47
T3: > 3.0cm	6.35	37.0	3.40

* Significant differences are indicated by asterisks (**) between treatment averages by ANOVA followed by Tukey test at 5% probability level

Table 4. Development of *A. heterophyllum* seedlings according to seed size

Treatments (seed size)	Seedling size (cm)	Root size (cm)	Number of leaves
T1: < 2.5 cm	16.11	10.03	3.03
T2: 2.6 < 3cm	16.93	7.23	3.14
T3: > 3.1 cm	18.21**	10.06	3.06

* Significant differences are indicated by asterisks (**) between treatment averages by ANOVA followed by Tukey test at 5% probability level

According to Khan [22], variation in seed mass influences seed germination in *A. heterophyllus* and the rapid and larger germination of heavy seeds can be attributed to the large food reserves of these seeds. In this study, the low percentage germination values may be related to the fact that the seeds are recalcitrant, corroborating the classification of these seeds regarding their storage, in the study by Silva et al. [26].

5. CONCLUSION

The variation found in fruit size and number of seeds per fruit, as well as field observations regarding fruit and seed morphology, pulp flavor and consistency, allows us to infer that there is a possibility of several varieties of the species occurring in the studied site, being advised to carry out genetic studies on this species in the Jardim Botânico do Recife.

The results showed that seed size of *Artocarpus heterophyllus* did not influence vigor on *A. heterophyllus* seed germination in a greenhouse. As to the development of the seedlings the bigger the seeds, the bigger was the length of the aerial part of the seedlings.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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