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RESEARCH ARTICLE

Leaf and Flower Characterization of Abiu (*Pouteria caimito* Radlk.) at Two Locations in Bogor Region, West Java, Indonesia.

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Abstract

Abiu is a species introduced into Indonesia from the tropics of the Amazon and has been developing for several years. Information on the characteristics of the abiu plant are still limited compared to other introduced fruit species. This research aims to identify the characteristics of the abiu plants in two locations in the Bogor region, West Java, Indonesia. The research was conducted at Balumbang Jaya village, the sub-district of Dramaga, the village of Mekarsari, the sub district of Cileungsi, Bogor, West Java. Further observation was conducted at Post-harvest Laboratory and Micro Technic Laboratory, Department of Agronomy and Horticulture IPB. The field study was conducted in January to July of 2018. This research was descriptive and no treatment was applied on the plant samples. Sampling was done randomly with as many as 15 plants at each location. Observations and measurements were conducted on the number of branches, leaves and flowers on 10 samples per plants. The results showed that there is morphological diversity of flowers and leaves at the two locations. The length, width, and weight of leaves and flowers in Balumbang Jaya were larger than those in Mekarsari. Different environments may contribute to the diversity of abiu leaves and flowers in the two locations.

Keyword: agroclimate, identification, morphology, Sapotaceae

Introduction

Plant resources are of fundamental importance for human survival and development. Various species of tropical fruits need to be continuously explored and domesticated, one way is by introducing native and unknown being through the introduction of the native and unknown species. New fruit species as germplasms from around the world have been introduced to many regions of Indonesia. The agro-climate similarity between the area of the origin of the introduced fruits and agro-climates in the territory of Indonesia is an important consideration in germplasm introduction. Abiu plant (*Pouteria caimito* Radlk.) originates from the area of the tropical Amazon (Clement, 1989). Abiu has been introduced to Indonesia in the last several decades; however, information on the development of variations, cultural practices, and the potential of abiu in Indonesia is still lacking compared to the other introduced commercial fruits in the markets.

Abiu is a tropical species that is found to grow at an altitude of 500-2500 m above sea level and is generally propagated by seeds. Abiu is from the Sapotaceae family which has berry fruits (Campbell and Ledesma, 2003). Abiu species includes evergreen trees which have a short flowering and fruiting include age compared to other Sapotaceae plants. Abiu grows optimally in soil with good drainage, sandy to heavy clay texture, and neutral pH (Lim and Ramsay, 1992). The first flowers appear when the plant is three-years-old, and the fruit is ready for harvest about three months later (Campbell and Ledesma, 2003). Abiu fruits have elliptical, clear white flesh and contain 1-4 seeds. A soft texture and yellow peel color at the fully ripe stage are exhibited at harvest time (Campbell *et al.,* 2010).

Abiu fruit has beneficial elements for human health such as antioxidants (Franca et al., 2016; Montero et al., 2018), antimicrobial (Abreu et al., 2019, Fernadez et al., 2020), and phenolic compounds (Filho *et al*., 2018). The antioxidants in the abiu leaves function

by refusing free radicals and preventing degenerative disease (Sousa et al., 2019). Every 100 g of Abiu fruit contain protein 0.81 g, fat 0.49 g (Aguiar and Souza, 2014), carbohidrate 14.5-36.3 g, thiamine 0.02-0.04 mg, ascorbic acid 11- 49 mg, and vitamin B 0.2 mg (Love da Paull, 2011).

Observations and measurements of the morphological characters can be used to measure and describe the variabilities in plants. Development and improvement of abiu cultivation can be started by a description of the plant's morphological characteristics. TThis study aims to identify the leaf and flower characteristics of the abiu (*Pouteria caimito* Radlk.) plants grown at two locations in Bogor region, West Java, Indonesia.

Materials and Methods

The field experiment was conducted at Balumbang Jaya village, the sub-district of Dramaga Mekarsari village, the sub-district of Cileungsi, and the Bogor district, West Java. The research was conducted from January to June 2018. Plants in Balumbang Jaya were three years old, with a planting distance of 3 x 4 m. Plants in Mekarsari were 8 years old with a spacing of 4 x 5 m. Compound NPK fertilizer (16:16:16) at 500 g per plant was applied two times during the experiment, i.e. in January and May in each location. Irrigation and pest control were applied as needed.

This study was descriptive research, there were no treatments applied to the plants. A total of 15 plants in each location were selected for this experiment. In each plant 10 leaves and 10 flowers were sampled to be observed. All the samples were labeled properly. The characterization of the leaf and flower of the abiu plant was based on several observed variables. The variables were taken from non-destruction samples and destruction samples.

The observation and measurement from non-destructive samples were conducted on (1) flower organs: flower length and fruit set. The fruit set is calculated as the number of flowers that were successfully developed into young fruits (± 2 cm in size) on each brunch; (2) stem organ: the angle of branches to the main stem; (3) leaf organ: leaf length, leaf width, leaf shape, leaf tip shape and leaf base shape. Shape variables refer to plant botany described in Descriptor for avocado (IPGRI, 1995) in a modified version. Destructive samples were used to describe the flower morphology by cutting the flower using a knife, pincette and observation using a stereo microscope (Carton SCW-E). The measurement of flower parts was done using a trinocular compound microscope (Olympus BX51) and DP2-BSW program.

Data were classified into qualitative and quantitative. Qualitative data were presented in the form of percentage values from the total samples. Quantitative data and the percentage of the qualitative data were statistically analyzed using Minitab program. The t-test was run at a level (α = 5%) to compare the average values between the two locations.

Result and Discussion

Study Site Environment

Experimental fields were located in two sites, Balumbang Jaya village at Balumbang Jaya sub-district , and Mekarsari village at Cileungsi sub-district, Bogor district, West Java, Indonesia. Balumbang Jaya village is located at latitude 6°30" − 6 °45" S, and longitude 106 °30" − 106 °45" E and with an altitude ± 300 m asl. Mekarsari village is located at latitude 6°.43" − 6°.41"S and longitude 106° 05" – 106°.98" E with an altitude ± 70 m asl. During the experiment, Balumbang Jaya village had an average air temperature of 25.1°C, rainfall 241 mm per month, and air humidity of 86%, while Mekarsari had an average air temperature of 25.9°C, rainfall 232 mm per month, and air humidity 83% (BMKG, 2018). Both locations are classified as having humid tropical climates.

The statistical analysis results of the statistical analysis indicated that the mean of almost all growth variables is greater at Balumbang Jaya than those at Mekarsari, although some variables are not significantly different. Vegetative variables such as leaf length, leaf width, and the angle of brunches at Balumbang Jaya are significantly different than those at Mekarsari. Generative variables such as stamen diameter, pistil diameter, and fruit set also have significantly different values between locations. The difference in variables between the two location was probably due to differences in altitude, where Balumbang Jaya has a higher altitude than Mekarsari (Table 1). Hovenden and Schoor (2006) reported that the leaf morphology of *Nothofagus cunninghamii* is related to altitude, and related to temperature. Genotype had a significant effect on leaf morphology of this species, but in the field, there was also an effect from altitude. In terms of generative variables, Fabbro and Korner (2003) reported that alpine grown in higher altitude allocated three times more of their above-ground biomass to floral structures than alpine grown in lowland area.

Leaf Morphology

Leaf morphology was observed based on the shapes of leaf, leaf base, and leaf tip. The abiu leaves in both locations had a lanceolate shape, however, the

Table 1. Morphology of Abiu in Balumbang Jaya and Mekarsari, Bogor, West Java, Indonesia

Character	Balumbang Jaya	Mekarsari
New growth flush colour	Pale green, yellowish	Pale green, yellowish
Lamina shape	Lanceolate	Lanceolate
Leaf tip	Acute 54.7%, Acuminate 45.3%	Acute 34.7%, Acuminate 65.3%
Leaf bases	Acute 64%, cuneate 36%	Acute 80.7%, Cuneate 19.3%
Leaf size (length, width) (cm)	16.87; 5.6	14.57; 4.51
Angle of brunch on stem (°)	68.3	53.1
Flower length (mm)	6.42	5.89
Number of sepal	4	4
Number of petal	8	8
Number of stamen	4	4
Stamen length (mm)	3.76	3.08
Anther size (length, diameter) (mm)	0.89; 0.51	0.76; 0.46
Pistil size (length, diameter) (mm)	4.86; 0.44	4.45; 0.36
Ovary size (length, diameter)	0.96; 1.23	0.89; 1.28
Number of flowers per plant	64.9	76.35
Number of fruits	2.82	1.7
Fruit set (%)	4.34	2.23
Harvest time (weeks after anthesis)	10.02	10.08

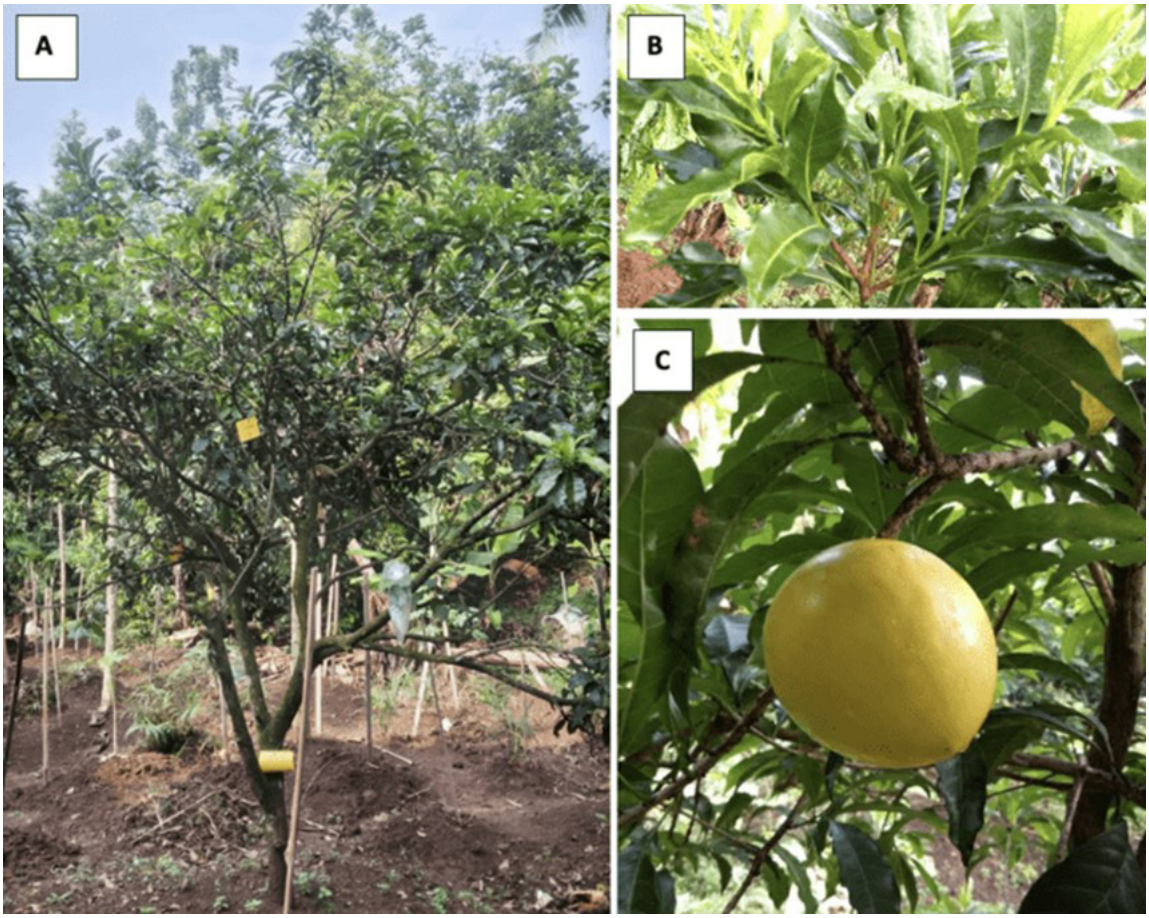

Figure 1. Morphology of abiu: A) the whole plant, B) leaves and branches, and C) fruit

shapes of the leaf base and the leaf tip varied. The shape of the leaf base of the abiu plant is classified as acute and cuneate, while the shape of the leaf tip of the abiu plant is classified as acute and acuminate. The shape of the base of the abiu leaves at the two locations was dominated by acute as much as 64.00% at Balumbang Jaya and as 80.70% at Mekarsari. The shape of the base of the abiu leaves at Balumbang Jaya was mostly (54.70%) acute, whereas at Mekarsari are mostly (65.30%) acuminate (Table 2).

in Mekarsari. However, plant age may also be a factor affecting leaf size. The Abiu plants at Mekarsari are eight years old whereas at Balumbang Jaya they are three years old. Performance of the Abiu leaves are presented in Figure 1a.

Morphology of Flower

The flower size at Balumbang Jaya was larger than that of Mekarsari. In both locations the flower has

Table 2. Percentages of the shape of leaf, of leaf base, and of leaf tip at the two locations

Location	Leaf shape	Leaf base shape		Leaf tip shape	
	Lanceolate (%)	Acute (%)	Cuneate (%)	Acute (%)	Acuminate (%)
Balumbang Jaya	100.00	64.00	36.00	54.70	45.30
Mekarsari	100.00	80.70	19.30	34.70	65.30
CV (%)	0.00	31.66	22.02	16.78	13.55
Significance	Ns	*	*	*	*

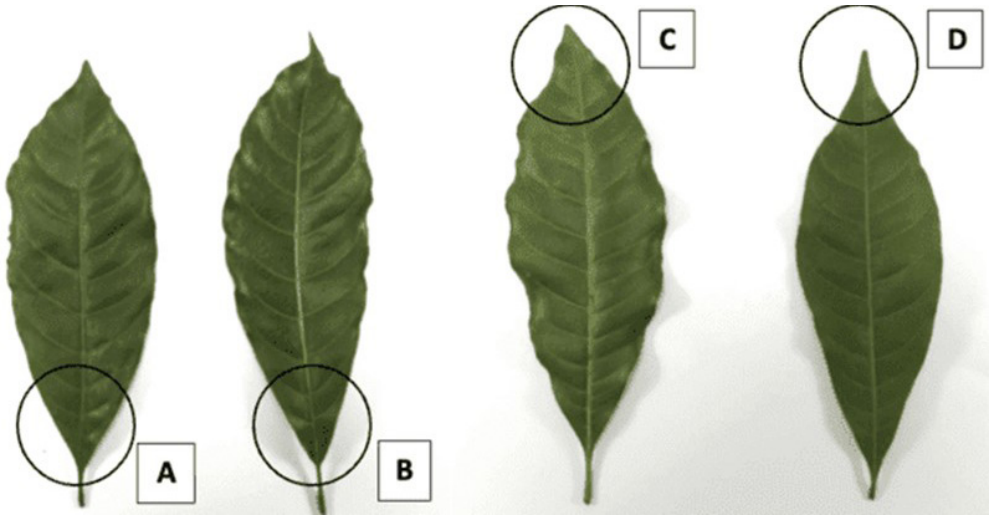

Figure 2. Leaf morphology of abiu: A) leaf bases acute, B) leaf bases cuneate, C) leaf tip acute, D) leaf tip acuminate

Leaf Size and Angle of the Branches on the Main Stem

The leaf size of abiu plants and the angle of branches on the stem were significantly different between locations. Abiu leaves (their length and width) were longer at Balumbang Jaya than at Mekarsari (Table 2). Leaf size differences may be caused by the environmental conditions of the two locations. The leaf is the plant organ most sensitive to environmental condition such as temperature, rainfall, nutrient deficiency and pest and disease attacks. Environmental conditions in Balumbang Jaya of slightly lower temperatures and higher rainfall possibly contributed to better plant growth than those

four sepals and eight petals. The Sepals overlap to form calyx to protect the other young organs. The four sepals are placed alternately. Sepals in the outer place were smaller than those in the inner ones. The Flower petals of the abiu plants are arranged close together in the form of corolla tubes at the side near the receptacle and then they split into eight sheets (four sheets bigger and four sheets smaller) at their edges. Moreover, four stamens stick out from the inner part of the petal sheet, with the size at Balumbang Jaya being larger than that of at Mekarsari. (Table 3). The size of the abiu flower organ at Balumbang Jaya was larger than that at Mekarsari, except for the diameter of the ovary (Table 4). Different environmental conditions may also affect the growth of the flowers.

Table 3. Leaf size and the angles of brunches on stem at Balumbang Jaya and Mekarsari

Location	Leaf size		Stem
	Length (cm)	Width (cm)	Angle of branches (º)
Balumbang Jaya	16.87	5.60	68.30
Mekarsari	14.57	4.51	53.10
CV (%)	14.59	14.73	26.22
Significance	*	*	*

Note: ns = not significant; * = significant according to t-test at P <0.05

These different conditions may be attibuted to the different leaf sizes at the different locations which indicated that the abiu plant at Balumbang Jaya grew better than at Mekarsari. The performance of Abiu flower is presented at Figure 1B and 1C.

Flower Number and Fruit Set

The inflorescence of the abiu is arranged in single or group. Abiu flowers appear on the leaf base and on the print sites of the fall down leaves along the branches, so that it is called ramiflorous. Beside those, abiu flowers may appear on the main stem so that is called cauliflorous. The percentage of cauliflorous flowers are very small compared with that of ramiflorous flowers. The number of flowers and the harvest time of the abiu fruits were not different between two locations. However, the fruit set and the number of fruits at those locations

Table 4. Morphology of abiu sepal, petal, and stamen at two locations in Bogor, West Java

Location	Flower length	Number of sepal	Number of petal			Stamen	
			Big	Small	Total	Number	Length
	(mm)						mm)
Balumbang Jaya	6.42	4	4	4	8	4	3.76
Mekarsari	5.89	4	4	4	8	4	3.08
CV (%)	12.69	0	0	0	0	0	20.75
Significance	*	ns	ns	ns	ns	ns	*

Note: ns = not significant; * = significant according to t-test at P <0.05

Table 5. Morphology of abiu flower (anther, pistil, and ovary) at two locations

Location	Anther		Number	Pistil		Ovary	
	Length	Diameter		Length	Diameter	Length	Diameter
	(mm)	(mm)		(mm)	(mm)	(mm)	(mm)
Balumbang Jaya	0.89	0.51	1	4.86	0.44	0.96	1.23
Mekarsari	0.76	0.46	1	4.45	0.36	0.89	1.28
CV (%)	18.14	23.01	0	10.89	18.88	15.06	15.97
Significance	*	*	ns	*	*	*	ns

Note: ns = not significant; * = significant according to t-test at P <0.05

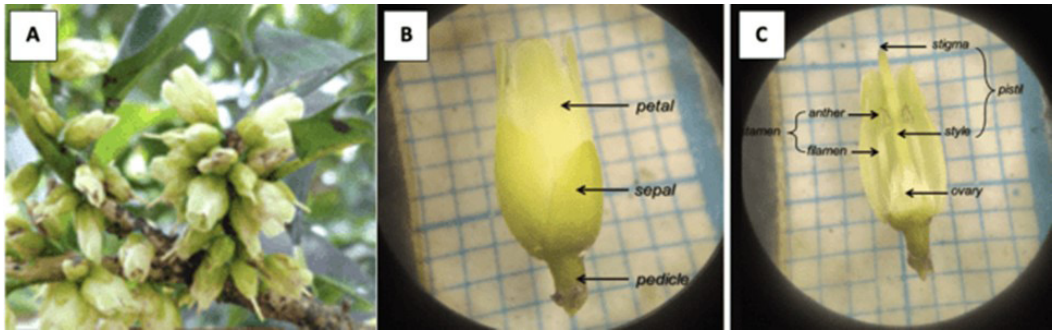

Figure 3. Flower morphology of abiu: A) inflorescences; B) flower parts; C) a close-up of flower parts.

were differed significantly. The average of fruit set and fruit number at Balumbang Jaya each was 4.34% and 2,82 fruit higher than those at Mekarsari namely 2.23% and 1.70 fruit (Table 5). Heinz (1983) stated that environmental conditions influence the growth of abiu. This indicates that the environmental conditions at Balumbang Jaya, such as lower temperature and higher rainfall were more favorable to support the process of fruit formation than at Mekarsari. *Lora et al.* (2009) stated that higher temperature might increase the speed of stigma desiccation on the second day of the flower cycle, so that pollination process and fruit set fruit-set may have been less effective compared to those before. On the other hand, Lopez and Dejong (2007) reported that fruit development rates of peaches were high under higher temperatures; however the trees may not have been capable of supplying resources rapidly enough to support the potential fruit growth rates that accompanied the higher temperatures.

Abiu takes about 11 weeks to develop from ovule to harvest (Figure 4). Generally, the shape of abiu fruit is round and oval and has white flesh with a soft texture. The taste of the fruit is sweet when it is ripe (75 – 100% yellow). Abiu fruit harvested in fully-ripe conditions have soluble solid content (SSC) value 10.04°Brix, while at 12 days after storage period the SSC had increased to 12.33°Brix (Arif et al. 2022). Abiu fruit diameter is 6 – 7 cm and the weight varies between 150 – 250 grams. One abiu fruit has 1 – 2 seeds. The seeds of abiu are blackish brown (Figure 5) and firm like sapodilla seeds.

Conclusion

Our study revealed that the abiu plants grown in the two geographical location have morphological variations. The morphological diversity of flowers and leaves occurred at the individual level. Statistical tests showed that the length, width, and weight of leaves and flowers from the plants in Balumbang Jaya were longer and larger than those grown in Mekarsari. The plants at Balumbang Jaya also have more fruit set and fruit numbers per plant. Environmental conditions may cause diversity in the character of leaf and flower

Table 6. Abiu flower formation at two locations in Bogor, West Java

Location	Number of flowers per plant	Number of fruits	Fruit set (%)	Harvest time (WAA)
Balumbang Jaya	64.90	2.82	4.34	10.02
Mekarsari	76.35	1.70	2.23	10.08
CV (%)	62.01	64.67	68.49	10.08
Significance	ns	*	*	ns

Note: WAA = week after anthesis. ns = not significant; * = significant according to t-test at P <0.05

Figure 4. Abiu fruit growth, development and maturation.

Figure 5. An abiu fruit and abiu seeds.

at both locations. However, genetic and phenological studies are required to identify the diversity of abiu for further development and commercialization of this species.

References

Abreu, M. M., Nobrega, P.D.A., Sales, P.F., Oliviera, F.R.D., and Nascimento, A. A. (2019). Antimicrobial and antidiarheal activities of methanolic fruit peel extract of *Pouteria caimito*. *Pharmacognosy Journal* **11**, 944-950.

Aguiar, J.P.L. and Souza, F.C.A. (2014). Soluble and insoluble fibrin some Amazonian fruit with low energy density. *Food and Nutrition Sciences* **5**, 1415-1419.

Arif, A.B., Susanto, S., Widayanti, S. M., and Matra, D. D. (2022). Effect of ripening stage on postharvest quality of abiu (*Pouteria caimito*) fruit during storage. *Agricultural and Natural Resources* **56**, 441-454.

[BMKG] Badan Meterologi Klimatologi dan Geofisika. (2018). "Data Cuaca Desember 2017 – Mei 2018". Stasiun Klimatologi Bogor.

Campbell, R.J. and Ledesma, N. (2003). The sapodilla and green sapote's potential in tropical America. *Journal of Tropical Horticulture* **46**, 55-56.

Campbell, R.J., Ledesma, N., Zill, G., and Herrera, J.C. (2010). Collection pouterias (*Pouteria* spp.), Sapodilla (*Manilkara zapota*) and caimito (*Chrysophyllum caimito*) for the creation of new market. *Journal of the American Pomological Society* **6**, 24-27.

Clement, C.R. (1989). A center of crop genetic diversity in Western Amazonia. *Bio Science* **39**, 623-631.

Fernandez, I.M., Chagas, E.A., Maldonado, S.A.A., Takahashi, J.A., Aleman, R.S., Filho, A.A.M., Santos, R.C.D., Ribeiro, P.R.E., Fantes, J.A.M., Chagas, P.C., and Melo, A.C.G.R. (2020). Antimicrobial activity and acetilcolinesterase inhibition of oils and Amazon fruit extracts. *Journal Medicinal Plant Research* **14**, 88- 97.

Franca, C.V., Perfeito, JPS., Resck, I.S., Gomes, S.M., Fagg, C.W., Castro, C.F.S., Simeoni, L. A., and Silveira, D. (2016). Potential radical scavenging activity of *Pouteria caimito* leaves extracts. *Journal of Applied Pharmaceutical Science* **6**, 184-188.

Filho, A.A.M., Costa, A.M.D.C., Fernandez, I.M., Santos, R.C.D., Chagas, E.A., Chagas, P. C., Takahashi, J.A., and Perraz, V.P. (2018). Fatty acids, physical-chemical properties, minerals, total phenols and anti- acetylcholinesterase of abiu seed oil. *Chemical Engineering Transactions* **64**, 1-7.

[IPGRI] International Plant Genetic Resources Institute. (1995). "Descriptors for Avocado (*Persea* spp.)". International Plant Genetic Resources Institute.

Heinz, H. (1983). Some field observation on *Pouteria caimito, P. campechiana, Diospyros digyna* and *Solanum topiro* under humid tropical condition (Turrialba, Costa Rica). *Journal of the American Society for Horticultural Science* **27**, 111-116.

Hovenden, M.J., and Schoor, J.K.V. (2006). The response of leaf morphology to irradiance depends on altitude of origin in *Nothofagus cunninghamii. New Phytologist* **169,** 291-297.

Lim, T.K., and Ramsay, G. (1992). Abiu – a new fruit with potential for the Northern Territory. *Acta Horticulturae* **321**, 99-105.

Lora, J., Testillano, P.S., Risueño, M.C., Hormaza, J.I., and Herrero, M. (2009). Pollen development in *Annona cherimola* Mill. (Annonaceae). Implications for the evolution of aggregated pollen. *BMC Plant Biology* **9**, 129-139.

Love, K. and Paull, R.E. (2011). "Abiu". College of Tropical Agriculture and Human Resources, University of Hawai.

Montero, I.F., Chagas, E.A., Filho, A.A.D.M., Saravia, S.A.M., Santos, R.C., Chagas, P.C., Ednalva, and Duarte, D.R.D.S. (2018). Evaluation of total phenolic compounds and antioxidant activity in amazon fruit. *Chemical Engineering Transactions* **64**, 649-654.

Sousa, L.C.R.D., Junior, A.R.D.C., Carvalho, M.G.D., Silva, T.M.S.D., and Ferreira, R.O. (2019). UPLC-QTOF-MS analysis of extracts from the leaves of *Pouteria caimito* (Sapotaceae) and their antioxidant activity. *Journal of Bioscience and Medicine* **7**, 91-101.