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Sample Dimension for Evaluating Characters of Yellow Mombin

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Abstract

The objective of this study was to determine the sample size needed to evaluate characters of mature fruits of yellow mombin (*Spondias mombin* L.). 100 fruits were evaluated from plants grown under a shading system. In the laboratory, these fruits were measured by the characters: longitudinal length (mm); equatorial diameter (mm); fruit mass (g); yield of pulp (%); total soluble solids—*TSS* (˚Brix); titratable acidity—*TA* (% citric acid) and ratio (*TSS*/*TA*), being calculated the measures of central tendency and dispersion, and verified normality. Next, the sample size for each character was determined. For experimental evaluation of cajámirim fruits, considering an accuracy of 10% around the mean, 40 fruits per treatment should be evaluated, considering a completely randomized experiment.

Keywords

Spondias mombin L., Error of Estimation, Sampling

1. Introduction

Among the fruit species of economic importance for Brazil, the most important are those belonging to the genus Spondias, represented by red mombin, otaheite apple, Brazil plum and yellow mombin, with relevance to mombin, due to their multiplicity of use and agroindustrial potential [1]. In Brazil, mombin plants are found mainly in the North and Northeast States, where their fruits receive different denominations, such as cajá, cajá true, cajá-mirim or taperebá. participa-

tion in the agribusiness of the Northeast region, mainly by commercialization for consumption as fresh fruit and pulp processing, which has great acceptance in the market for its exotic flavor, excellent quality and commercial value as raw material in the preparation of juices, popsicles, ice creams, nectars and jellies [2].

Due to the nutritional value, associated to the economic and social importance of the mombin, several works have been carried out in the last years culminating with the selection of some clones, which were evaluated regarding the characteristics of the plants [3] and fruits [3] [4]. However, despite the real and potential importance of this fruit, there is little technological information about it [1].

In agricultural researches, the sizing of the sample required for the estimation of the mean of a given character is important when the population can not be measured, demands excessive time, financial and human resources [5]. The sample size is directly proportional to the variability of the data and the desired reliability in the estimation, being inversely proportional to the estimation error allowed a priori by the researcher [6] [7] [8]. The larger the sample size, the greater the precision of the experiment, with a reduction in the sample mean-variance, although the demand for resources is also high. On the other hand, small sample size may reduce experimental accuracy [7].

In this way, the sample size for fruit characters has been determined for several crops such as melon [9], orange fruit [10], peach [5] [11], apple [12], pineapple [13], passion fruit [14] and papaya [15].

However, studies that determine the sample size needed to evaluate physical-chemical characteristics of fruits of *Spondias mombin* L. were not found in the literature, despite the existence of papers that p ortray the quantification of their physical-chemical characteristics [1] [2] [4] [16] [17].

Thus, the objective was to determine the sample size required to evaluate seven physical-chemical characters in mature fruits of *Spondias mombin* L.

2. Material and Methods

The fruits of *Spondias mombin* L. used in this work were harvested in an orchard located at Santa Angélica ranch (19.357˚ S latitude, 40.067˚ W longitude and 40 m altitude), in the municipality of Linhares, in the northern state of Espírito Santo, Brazil. Fruits of native plants were harvested in a shading area at maturation stage 4 (100% of the yellow bark) according to [1], in the morning and transported to the laboratory for plant breeding.

The selection of 100 fruits was carried out after the elimination of those damaged or imperfect, which were evaluated in terms of characters: *LL* (longitudinal length, in mm); *ED* (equatorial diameter, in mm); *FM* (fruit mass, in g); *PY* (pulp yield, in%); *TSS* (total soluble solids, determined by bench refractometer and expressed in ˚Brix); *TA* (titrable acidity), determined by volumetric titration with indicator using NaOH 0.1 M and expressed as percentage of citric acid mass per volume of pulp in m/v, as described by the [18]; and ratio (*TSS/TA*).

From the data of the characters evaluated in the 100 fruits of *Spondias mom-*

bin L., the descriptive statistics (mean, minimum, maximum, standard deviation and coefficient of variation) were calculated. To verify the possibility of using the Student t distribution in the estimation of the optimal sample size, we tested the hypotheses regarding to asymmetry (H_o: asymmetry = 0, by the t test with p = 0.05), to Kurtosis (H_o: kurtosis = 3, by the t-test with p = 0.05) and adherence to the normal distribution by the Lilliefors test (p = 0.05) [7].

The number of fruits to estimate the parameters of an infinite population to a desired level of accuracy was based on the half-range of the confidence interval for the mean, pelaEquação 1 [6] [19]:

$$n = \frac{\left(t_{\alpha/2} s\right)^2}{\left(em\right)^2}$$

On what: n is the sample size (number of fruits); $t_{\alpha/2}$ is the critical value of the Student t distribution, whose area the right is equal to $\alpha/2$ with $(n-1)$ degrees of freedom, and with 5% probability of error; s is the sample standard deviation; e is the relative error in the mean estimate (e = 0.01; 0.02; 0.04; 0.04; 0.05; 0.06; 0.07; 0.08; 0.09 and 0.10); m is the sample arithmetic mean.

To know the percentage error (e%) around the average, committed with the use of 100 fruits as simple, was used Equation (2) [19]:

$$e\% = \frac{t_{\alpha/2} S}{\sqrt{nm}}$$

Statistical analyses were performed using software R [20].

3. Results and Discussion

Measures of central tendency, variability, asymmetry and kurtosis, and the Lilliefors test of the evaluation of the seven characters of mature fruits of *Spondias mombin* L. are presented in **Table 1**. All the characters presented a normal distribution of the sample data, although the fruit mass (*FM*) and the ratio showed significant asymmetry by the t test ($p < 0.05$) and the *FM* showed significant kurtosis by the t test ($p < 0.05$). Therefore, in relation to normality, it can be inferred that the data of the seven characters offer credibility to the study of sample size based on Student's t distribution [7].

The evaluated fruits presented the following means: 33.79 mm for longitudinal length (*LL*); 24.91 mm for equatorial diameter (*ED*); 13.35 g for fruit mass (*FM*); 61.67% pulp yield (*PY*); 1.70% titratable acidity (*TA*); 10.91 ˚Brix of total soluble solids (*TSS*); 6.56 ratio. These average values are close to those found for mature fruits of yellow mombin fruits by [1] [2] [4], with the exception of the ratio values, which were slightly lower. This difference can be explained by the variability among the fruits harvested in this work since they were from seminiferous propagation plants, while the authors worked with clones selected for higher *TSS* values.

The magnitude of the coefficient of variation (CV%) ranged from 11.62% for yield (*PY*) to 32.02% for *FM* (**Table 1**). In the evaluation of pineapple fruit

Table 1. Mean, minimum, maximum, standard deviation (SD), coefficient of variation (CV%), asymmetry (AS), kurtosis + 3 (KT) and normality test results (Lilliefors, L) for eight characters measured in 100 mature fruits by *Spondias mombin* L.

Character(1)	Mean	Minimum	Maximum	SD	CV%	AS(2)	KT(3)	L(4)
LL	33.79	20.03	47.86	4.54	13.42	0.0082ns	3.6705ns	S
ED	24.91	17.95	33.62	3.38	13.57	0.1564ns	2.7951ns	S
FM	13.35	4.82	28.54	4.28	32.02	0.9549*	4.4266*	S
PY	61.67	40.42	77.47	7.17	11.62	−0.4161ns	3.1425ns	S
TA	1.70	1.18	2.37	0.27	15.60	0.4263ns	2.7121ns	S
TSS	10.91	7.32	15.02	1.58	14.50	0.0922ns	2.5881ns	S
Ratio	6.56	3.71	10.31	1.36	20.75	0.5966*	3.3974ns	S

(1)LL = longitudinal length, in mm, ED = equatorial diameter, in mm, FM = fruit mass, in g, PY = pulp yield, in %, TSS = total soluble solids, in ˚Brix, TA = titrable acidity, in % of citric acid and ratio = TSS/T). (2)Asymmetry differs from zero by the t-test, at a 5% probability level. ns = non-significant. (3)Kurtosis differs from three by t-test, at a 5% probability level. ns = non-significant. (4)S = Normal distribution by the Lilliefors test (P > 0.05).

characters, [13] also obtained higher CV for fruit mass. This suggests that, in order to obtain the mean estimate, with a certain precision, the sample size of *PY* and *FM* are the lowest and the highest, respectively, among the evaluated characters.

The sample size for the mean estimation, with an estimation error equal to 1% of the mean is 4028 fruits for the *FM* character (**Table 2**). High value for sample size has already been verified in fruit size sample studies for other crops, such as in peach, where 4213 fruits are required to estimate pulp firmness after refrigerated storage with 1% of mean estimation error [11]. These high sample sizes show that in practice, 1% sampling is infeasible because the estimated sample size may be larger than the number of observations available for evaluation.

In this study, with the use of 100 fruits, the greatest relative error was 6.35% for *FM* (**Table 2**). For this case, a good solution may be to admit a greater relative error as done by [21] in the character evaluation of yellow passion fruit. These authors assumed a 10% error. With this same percentage of error, 40 yellow mombin fruits are needed for determination of *FM*. With the same 40 fruits, the relative error will be less than 5% for *LL*, *ED*, *PY* and *TSS*. If the researcher assumes a 5% error, the following sample sizes (number of fruits) are required: *LL* (28); *ED* (29); *FM* (161); *PY* (21); *TA* (43); *TSS* (33); Ratio (68). The results were expected, because the sample size decreases when the error allowed around the mean increases (for example, from 5% to 10%). which is perceived for the *FM* character, where for a 10% error we have 40 fruits, whereas a 5% error is necessary 161 fruits.

The occurrence of variability of sample size for different characters measured in fruits has been reported for peach [5] [11], pineapple [13], apple [12] and papaya [15].

Table 2. Sample size (number of fruits) for the estimation of the average of eight characters of fruits of *Spondias mombin* L. harvested mature, for the relative errors of estimation equal to: 0.01; 0.02; 0.03; 0.04; 0.05; 0.06; 0.07; 0.08; 0.09; 0.10 of the mean estimate, and error of estimation as a percentage of the mean (e%) estimate, based on 100 evaluated fruits.

	Relative error of estimation										
Character[(1)]	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	e%
LL	711	178	79	44	28	20	15	11	9	7	2.67
ED	729	182	81	46	29	20	15	11	9	7	2.72
FM	4028	1007	448	252	161	112	82	63	50	40	6.35
PY	531	133	59	33	21	15	11	8	7	5	2.30
TA	1068	267	119	67	43	30	22	17	13	11	3.27
TSS	826	206	92	52	33	23	17	13	10	8	2.87
Ratio	1692	423	188	106	68	47	35	26	21	17	4.11

[(1)]LL = longitudinal length, in mm, ED = equatorial diameter, in mm, FM = fruit mass, in g, PY = pulp yield, in %, TSS = total soluble solids, in °Brix, TA = titrable acidity, in % of citric acid and ratio = TSS/T).

Thus, when planning an experiment to be conducted with yellow mombin fruits, under conditions similar to those adopted in this study, in a completely randomized experimental design, for the estimation of the mean of each treatment with 10% accuracy, 40 fruits per treatment should be evaluated. If the experiment was planned with five replicates per treatment, eight fruits per replicate (40/5 = 8) would be sampled, that is, eight fruits per plot. Also, if the experiment were evaluated four treatments, the researcher would have to use 160 fruits to perform such experiment (4 × 40 = 160 fruits per treatment).

It should be noted that the sample size presented in this paper (Table 2) is for fruits harvested from seminiferous propagation plants and reflects a practice that is usual in extractive exploitation of mombin in Brazil, especially in the Northeast region [22]. The sample size required may be lower than those found here when the fruits come from clonal selections since *Spondias mombin* L. is a species with high genetic variability when propagated by seeds [23].

4. Conclusion

For experimental evaluation of yellow mombin fruits considering an accuracy of 10% around the mean, 40 fruits per treatment should be evaluated, considering a completely randomized experiment.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Rodrigues, H.N.B., Souza, P.A., Coelho, E.L., Souza, F.X. and Freitas, R.V.S. (2012) Qualidade de frutos de cajazeiraemdiferentesestádios de maturaçãoprovenientes de clones cultivados no Ceará CE. *Revista Caatinga*, **25**, 38-43.

[2] Soares, E.B., Gomes, R.L.F., Carneiro, J.G.M., Nascimento, F.N., Silva, I.C.V. and Costa, J.C.L. (2006) Physical and Chemical Characterization of Yellow Mombin Fruits. *Revista Brasileira de Fruticultura*, **28**, 518-519. https://doi.org/10.1590/S0100-29452006000300039

[3] Souza, F.X., Costa, J.T.A., Lima, R.N. and Crisostomo, J.R. (2006) Growth and Development of Clones Hog Plum Cultivated in Apodi Plateau, Ceará, Brazil. *Revista Brasileira de Fruticultura*, **28**, 414-420. https://doi.org/10.1590/S0100-29452006000300017

[4] Coelho, E.L., Souza, P.A., Souza, F.X., Silva, M.S. and Costa, J.T.A. (2010) Caracterizaciónfísico-química de los frutos de los clones cajazeiracapuan y lagoaredonda y sometidos a la poda. *Revista Verde de Agroecologia e Desenvolvimento Sustentável*, **5**, 46-52.

[5] Toebe, M., Both, V., Cargnelutti Filho, A., Brackmann, A. and Storck, L. (2011) Sample Size to Evaluate the Flesh Firmness and Epidermis Color in Peach and Apple. *Revista Ciência Agronômica*, **42**, 1026-1035. https://doi.org/10.1590/S1806-66902011000400027

[6] Cochran, W.G. (1977) Sampling Techniques. 3rd Edition, John Wiley & Sons, New York, 428 p.

[7] Zar, J.H. (2010) Bioestatistical Analysis. 5th Edition, Pearson, Upper Saddle River, 944 p.

[8] Bussab, W.O. and Morettin, P.A. (2012) Estatísticabásica. 7th Edition, Saraiva, São Paulo, 540 p.

[9] Nunes, G.H.S., Torquato, J.E., Sales Júnior, R., Ferreira, H.A. and Bezerra Neto, F. (2006) Size Sample for Estimating the Total Soluble Solid Contents in Yellow Melon Plots. *Revista Caatinga*, **19**, 117-122.

[10] Avanza, M.M., Bramadi, S.J. and Mazza, S.M. (2010) Optimal Sample Size for Evaluate the Growth Pattern of "Valencia Late" Orange Fruit. *Revista Brasileira de Fruticultura*, **32**, 1154-1163. https://doi.org/10.1590/S0100-29452010005000132

[11] Toebe, M., Both, V., Brackmann, A., Cargnelutti Filho, A. and Thewes, F.R. (2012) Sample Size to Estimate the Average Peach Characters at Harvest and after Cold Storage. *Ciência Rural*, **42**, 209-212. https://doi.org/10.1590/S0103-84782012000200004

[12] Toebe, M., Both, V., Thewes, F.R., Cargnelutti Filho, A. and Brackmann, A. (2014) Sample Size for Estimate the Average of Characters in Apples. *Ciência Rural*, **44**, 759-767. https://doi.org/10.1590/S0103-84782014000500001

[13] Krause, W., Storck, L., Lúcio, A.D., Nied, A.H. and Gonçalves, R.Q. (2013) Optimum Sample Size for Fruits Characters of Pineapple under Fertilizations Experiments Using Large Plots. *Revista Brasileira de Fruticultura*, **35**, 183-190. https://doi.org/10.1590/S0100-29452013000100021

[14] Schmildt, E.R., Alexandre, R.S., Siqueira, A.L., Mayrinck, L.G. and Schmildt, O. (2017) Sample Dimension for Evaluating Physical and Chemical Characters of Wild Passion Fruit. *Revista Ceres*, **64**, 109-111. https://doi.org/10.1590/0034-737x201764020002

[15] Schmildt, E.R., Schmildt, O., Salinas, I., Hueso, J.J., Pinillos, V. and Cuevas, J. (2019)

Sample Size for the Evaluation of "BH-65" Papaya Fruits under Protected Cultivation. *Revista Brasleira de Fruticultura*, **41**, 1-9. https://doi.org/10.1590/0100-29452019107

[16] Rufino, M.S.M., Alves, R.E., Brito, E.S., Silveira, M.R.S. and Moura, C.F.H. (2009) Quality for Fresh Consumption and Processing of Some Non-Traditional Tropical Fruits from Brazil. *Fruits*, **64**, 361-370. https://doi.org/10.1051/fruits/2009032

[17] Silvino, R.C.A.S., Silva, G.C.T. and Santos, O.V. (2017) Nutritional-Functional Quality and Morphological Parameters of Fruit Cajá (*Spondias mombin* L.). *Revista Desafios*, **4**, 1-9.

[18] Instituto Adolfo Lutz (2005) Conservasvegetais, frutas e produtos de frutas. In: Instituto Adolfo Lutz, Ed., *Cap. XV Métodosfísico-químicosparaanálise de alimentos*, 4th Edition, Anvisa, Brasília, 571-591.

[19] Felfili, J.M., Roitman, I., Medeiros, M.M. and Sanchez, M. (2011) Procedimentos e métodos de amostragem de vegetação. In: Felfili, J.M., Eisenlohr, P.V., Melo, M.M.R.F., Andrade, L.A. and Meira Neto, J.A.A., Eds., *Fitossociologia no Brasil: Métodos e estudos de caso*, Vol. 1, Editora UFV, Viçosa, 86-121.

[20] R Core Team (2018) R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna.

[21] Coelho, A.A., Oliveira, E.M.S., Resende, E.D. and Thiébaut, J.T.L. (2011) Dimensionamento Amostral Para Caracterização da qualidadepós-colheita do maracujáamarelo. *Revista Ceres*, **58**, 23-28. https://doi.org/10.1590/S0034-737X2011000100004

[22] Souza, F.X. (2000) Efeito do porta-enxerto e do método de enxertianaformação de mudas de cajazeira (*Spondias mombin* L.). *Revista Brasileira de Fruticultura*, **22**, 286-290.

[23] Sacramento, C.K. and Souza, F.X. (2000) Cajá (*Spondias mombin* L.). FUNEP, Jaboticabal, 42 p.