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Biochemical Characterization of Jabuticaba (*Plinia cauliflora*) Varieties

A Jyothika [a*], B Bindu [b], S Simi [a], B Renjan [b] and Gopinath P Pratheesh [b]

[a] Department of Fruit Science, Kerala Agricultural University, College of Agriculture, Vellayani, Thiruvanathapuram, India.
[b] Farming Systems Research Station, Kerala Agricultural University, Sadanandapuram, Kottarakkara, Kollam, Kerala, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A study was conducted at the Department of Fruit Science, College of Agriculture, Vellayani, Kerala Agricultural University, to perform a biochemical analysis of Jabuticaba (*Plinia cauliflora*). Native to Brazil and belonging to the Myrtaceae family, this fruit tree has been introduced to Kerala, where several varieties were identified through a survey. No systematic study has been undertaken regarding the evaluation and morphological characterization of jabuticaba under Kerala conditions. So here an attempt is being made to locate the types of jabuticaba, which give high fruit quality under Kerala conditions. The evaluation of selected elite types will also help in the further crop improvement of jabuticaba and it is also a boon to the farmers. Hence , the present study is proposed for the characterization and evaluation of jabuticaba under Kerala conditions. The research focused on key biochemical parameters of the fruit, including total soluble solids (TSS),

**Corresponding author: E-mail: jyothikachandran123@gmail.com;*

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acidity, ascorbic acid, reducing sugars, total sugars, flavonoids, and anthocyanins. The Percoce variety had a high TSS of 18.8° Brix, indicating its natural sweetness. The Red Pouch and Aureana varieties recorded an acidity level of 1.9%. The Percoce variety also had notable levels of ascorbic acid (167.10 mg/100g), reducing sugars (8.4%), and total sugars (10%). The Escarlate variety showed the highest anthocyanin content in its skin (281.6 mg/100g), while the Red Crystal variety had the greatest flavonoid content (4.1 mg/100g). These results underline Jabuticaba's high nutritional value and provide useful information for farmers when choosing the best varieties for cultivation.

Keywords: Jabuticaba; anthocyanin; flavonoid; biochemical analysis.

1. INTRODUCTION

Jabuticaba, scientifically known as *Plinia cauliflora* and belonging to the Myrtaceae family, is native to the subtropical regions of southern and southeastern Brazil. Recently introduced to Kerala, this fruit crop is gaining attention due to its nutraceutical properties. Although commercial cultivation is limited to a few homesteads in Kerala, the fruit has significant marketing potential, especially in the food and pharmaceutical industries, thanks to its high content of anthocyanins and flavonoids.

Nutrient-dense, Jabuticaba is rich in essential vitamins such as B, C, and E, along with minerals like magnesium, potassium, and calcium. Its high antioxidant levels, particularly anthocyanins, help combat oxidative stress, reducing the risk of chronic diseases such as heart disease and certain cancers. While the fruit is commonly consumed fresh, it is also processed into various products such as vinegar, wine, liquor, juice, jam, jelly and marmalade.

Farmers have identified and adopted specific varieties of Jabuticaba that thrive in particular localities. However, the performance of these varieties can vary under different agro-climatic conditions. Therefore, selecting the best types to fully exploit the crop's yield potential is essential. To date, no systematic biochemical characterization of Jabuticaba has been conducted under Kerala's conditions. This study aims to identify Jabuticaba varieties with superior fruit quality in Kerala, providing valuable insights for crop improvement and benefiting local farmers.

2. MATERIALS AND METHODS

The current study was conducted at College of Agriculture Vellayani during October 2023 to May 2024. A preliminary survey was conducted across Kerala to identify and to locate jabuticaba trees. The preparation involved reaching out to farmers, identifying the trees, and conducting a study and collection of fruit. A total of fifty five, including both fruit-bearing and non-bearing varieties, were identified across four districts.From these, twenty fruit-bearing trees were chosen from different locations in the districts of Kasaragod, Kannur, Kollam, and Trivandrum, and the fruits were subsequently collected for biochemical analysis.

2.1 Determination of Total Soluble Solids (°Brix), Acidity, Ascorbic Acid, Total Sugar and Reducing Sugar

Total soluble solids (TSS) were measured using digital refractometers (Atago: 0 to 53%) and expressed in degree brix (º Brix). The acidity (AY) of the fruit pulp was assessed following the method, AOAC [1]. Ascorbic acid (AA) concentration was determined using the AOAC [1] procedure, with results expressed in mg/100g. The total sugar (TS) and reducing sugar (RS) content in the fruit pulp was quantified using the method outlined by Lane and Eynon [2].

2.2 Anthocyanin (mg 100g-1)

Estimation of anthocyanin (ANC) content was done using the spectrophotometric method described by Abdel-Aal et al. [3].

2.3 Flavanoid (mg 100g-1)

Flavonoid content (FLVD) Lin and Tang's [4] method was applied to determine FLVD.

2.4 Statistical Analysis

Principal Component Analysis (PCA) was used to evaluate and understand the relationships among various biochemical parameters [5].

3. RESULTS AND DISCUSSION

3.1 Total Soluble Solids *(°Brix)*

The total soluble solids ranged from 7.4º B to 18.8º B across the varieties, with an average of 13.06º B and a coefficient of variation of 0.296

percent. The highest level was observed in the Percoce variety, while the lowest was found in the PhitranthaBranca variety. A similar result was observed in Danner et al. [6] that the total soluble solids (TSS) content in jabuticaba germplasm was 17%. Lima [7] found TSS levels of 14.90º B in the Paulista variety and 14.13º B in the Sabará variety. Lima et al. (2008) report that soluble solids content is one of the most important tools for estimating fruit quality because it represents the concentration of sugars, organic acids, and other minor constituents. Bindu and Renjan [8] reported wide variability in TSS content of traditional juicy mangoes.

3.2 Acidity(%)

The acidity content ranged from 0.6% and 1.9%. The maximum value was recorded in variety Red pouch and Aureana (1.9%), while the minimum value was recorded in variety Branca and Red hybrid (0.6%). The total acidity in jabuticaba was reported to be high values when compared to other fruits, Oliveira et al. [9]. Bindu et al. [10] noted wide variability exists in table purpose traditional mangoes and they exhibited moderate acidity level. Guedes et al. [11] reported an average total acidity of 0.85% citric acid per $100g^{-1}$.

3.3 Ascorbic Acid(mg $100g^{-1}$)

The ascorbic acid content in jabuticaba exhibited significant variation, ranging from 16.3 mg/100 g^{-1} to 167.10 mg/100 g^{-1}, with a mean of 63.205 percent and a coefficient of variation of 0.38%. The Percoce variety recorded the highest ascorbic acid content at 167.10 mg/100 g^{-1}, while the Aureana variety had the lowest at 16.3 mg/100 g^{-1}. Similarly, Sabara variety, as described by Lima et al. (2023), demonstrated an even greater ascorbic acid content of 167.54 mg/100 g, highlighting the considerable variability in nutritional composition among jabuticaba varieties. Bindu [12] noted an ascorbic acid content of 40 mg/100 g^{-1} in papapya.

3.4 Total Sugar(%)

The total sugar content in this study ranged from 4.2 percent to 10 percent, with an average of 6.88 percent and a coefficient of variation of 0.218 percent. The Percoce variety had the highest total sugar content at 10 percent, while the Saupacia variety had the lowest at 4.2 percent. These results are similar to the findings of Prakash et al. (2007) in Jamun and Bindu [8] in Karpooram mango. Henrique et al. [13], reported that the total sugar content in the Sabara variety of jabuticaba was lower than the values found in this study, which was 1.3 percent. The higher sugar content observed in this study suggests that jabuticaba fruits may exhibit considerable variability in their sugar composition, influenced by environmental conditions, varietal differences, and the ripeness of the fruit at the time of harvest.

Table 1. Biochemical parameters of Jabuticaba varieties

SL. No	Variety	TSS(Brix^0)	Acidity(%)	Ascorbic acid (mg $100g^{-1}$)	Total sugar (%)
1	Sabara	17	1.5	67.4	7.7
2	Red hybrid	18.7	0.8	160.2	9
3	Percoce	18.8	1.7	167.1	10
4	Escarlate	18.6	1.8	57	4.9
5	Aureana	10.2	1.9	16.3	7.4
6	White esalq	12.2	1.1	57.4	7.6
7	Novak phitrantha	10.3	1.5	28.6	6.7
8	Lemon grass	16.9	0.7	25.2	6.8
9	Green crystal	17.5	1.1	69.6	7.4
10	Red pouch	10.7	1.9	28.8	6.7
11	Saupacia	13.4	0.7	89.1	4.2
12	Branca	10	0.6	54.8	6.6
13	Acupaulista	7.7	1.5	86.3	4.6
14	Pingo de mel	10.2	1.3	88.1	6.3
15	Red crystal variation	17.5	1.6	28.9	6.7
16	Red hybrid variation	11.8	0.6	57.5	9.7
17	Phitranthabranca	7.4	0.9	80.7	5.8
18	Branca mel	10.3	0.8	35.7	6.1
19	Plinia grandifolia	10.2	1	35.6	6.6
20	Peach phitrantha	11.8	0.8	29.8	6.8

Table 2. Reducing sugar, anthocyanin and flavonoid content in Jabuticaba varieties

SL. No	Variety	Reducing sugar (%)	Anthocyanin (mg 100g-^{1})	Flavonoids (mg 100g-^{1})
1	Sabara	2.7	280.5	2
2	Red hybrid	3.9	230	1.6
3	Percoce	5.4	177.7	1.7
4	Escarlate	2.7	281.6	1.4
5	Aureana	2.6	7.3	3.6
6	White esalq	0.8	6.5	1.9
7	Novak phitrantha	3.5	280.9	0.9
8	Lemon grass	2.6	7.4	4
9	Green crystal	1.5	4	3.6
10	Red pouch	3.2	160.4	1.2
11	Saupacia	1.8	199.5	2
12	Branca	2.8	7.1	3.2
13	Acupaulista	1.9	151.4	1.5
14	Pingo de mel	3.4	105.3	1.8
15	Red crystal variation	3.2	7.6	4.1
16	Red hybrid variation	4.9	280.4	0.9
17	Phitranthabranca	3.1	59.4	1.4
18	Branca mel	3.2	7.3	2.4
19	Plinia grandifolia	2.8	160.5	0.9
20	Peach phitrantha	2.5	160.4	0.9

Table 3. Summary statistics for biochemical parametersJabuticaba varieties

Descriptives	TSS (°B)	Acidity(%)	Ascorbic acid (mg/100g)	Total sugars (%)	Reducing sugar(%)	Anthocyanin (mg100g-1	Flavonoids (mg 100g -1)
Minimum value	7.4	0.6	16.3	4.2	0.8	4	0.9
Maximum value	18.8	1.9	167.10	10	5.4	281.60	4.1
Range	11.4	1.3	150.8	5.8	4.6	277.60	3.2
Mean	13.06	1.19	63.205	6.88	2.925	128.760	2.05
SE(M)	**0.865**	**0.101**	**9.234**	**0.335**	**0.236**	**24.240**	**0.24**
SD	**3.871**	**0.452**	**41.297**	**1.497**	**1.056**	**108.406**	**1.072**
CV (%)	**0.296**	**0.38**	**0.653**	**0.218**	**0.361**	**0.842**	**0.523**

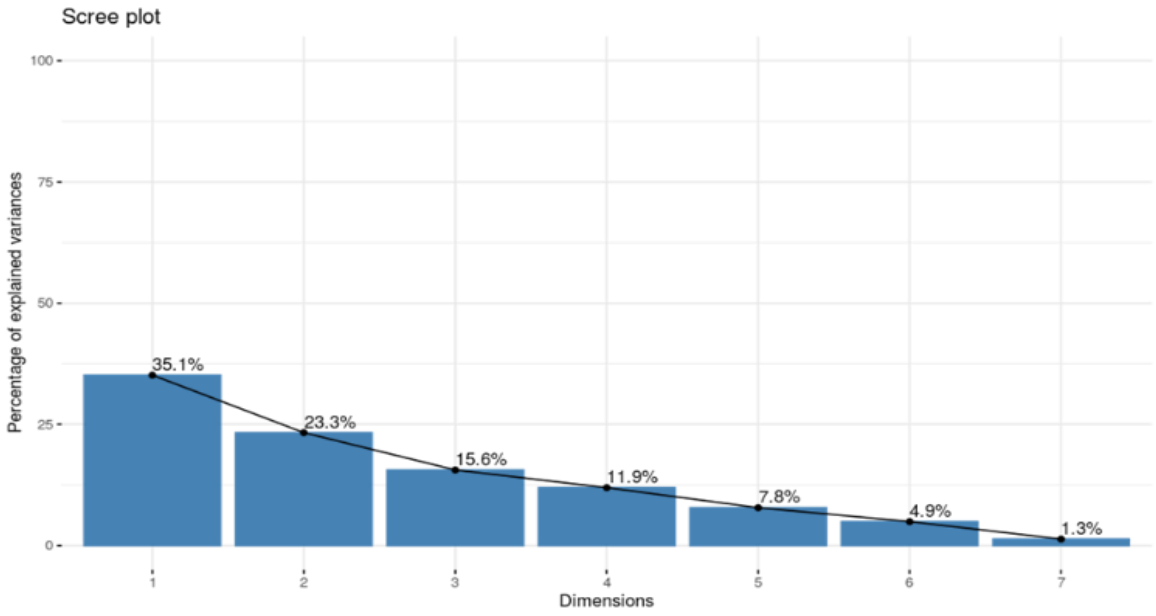

Fig. 1. Scree plot of PCA based on 7 biochemical parameters

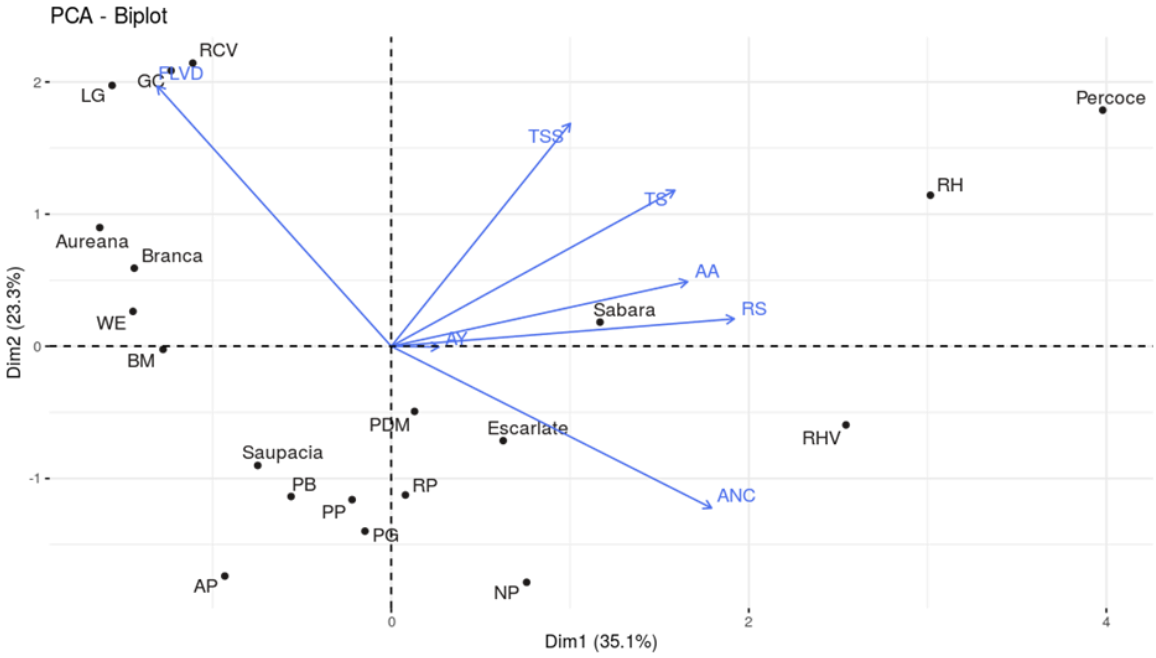

Fig. 2. PCA Biplot based on 7 biochemical parameters

3.5 Reducing Sugar(%)

The reducing sugar content in this study varied between 0.8% and 8.4%, with an average of 2.925%. The Percoce variety had the highest reducing sugar content at 8.4%, while the White Esalq variety had the lowest at 0.8%. These results are similar to those reported by Babu et al. [14] in jamun and Bindu [15] in Karpooram mango. However, another study by Henrique et al. [13] reported a lower reducing sugar content in jaboticaba of 0.9%, which is closer to the minimum value observed in this study. The variation in reducing sugar content between studies may be explained by differences in varietal characteristics, environmental conditions, and the methodologies used for sugar analysis.

Fig. 3. Jabuticaba tree with fruits

3.6 Anthocyanin(mg 100g-1)

Anthocyanin content ranged from 4 to 281.60 mg $100g^{-1}$, with an average of 128.760 mg $100g^{-1}$and a coefficient of variation of 0.842 percent. The highest anthocyanin levels were found in the Escarlate, variety, reaching up to 281.60 mg $100g^{-1}$, while the Green Crystal variety had the lowest content at 4 mg $100g^{-1}$.Similar result was found by Mattos et al.[16] ranges 58.92 to 284.09 mg $100g^{-1}$in Red , black and followed purple colour skin and Pantelidis et al. (2007) found similar result in yellow raspberry (cv. Fallgold) and gooseberry (cv. White Smith) cultivars, as well as the red currant cultivars, were characterised by the lowest anthocyanin content (1.3–7.8 mg $100g^{-1}$).

3.7 Flavanoid (mg $100g^{-1}$)

Flavonoid content of jabuticaba varieties ranged from 0.9 to 4.1 mg/$100g^{-1}$, with an average of 2.05 percent and a coefficient of variation of 0.523%. The Red Crystal variation displayed the highest flavonoid content, while the Red Hybrid, Novak Phitrantha, Plinia Grandifolia, and Peach Phitrantha varieties exhibited the lowest levels. These findings align partially with previous studies. For instance, Guedes et al. [11] reported a flavonoid content of 1.16 mg/$100g^{-1}$, and Pinto et al. [17-19] found a flavonoid content in the pulp ranging from 2.96 mg/$100g^{-1}$, both of which are lower than the values observed in this study [20-23].

4. CONCLUSION

Through the assessment of varieties based on using recorded biochemical observations, the following varieties were identified as elite among the twenty are Percoce, Sabara, Red crystal variation, Escarlate, Red pouch, Aureana, Novakphitrantha, White esalq and Red hybrid. The results of this study noted significant variation in both quantitative and qualitative traits, as well as in biochemical and organoleptic parameters among the different jabuticaba varieties. This variability highlights the potential for diverse uses and preferences related to fruit quality and composition. Understanding these differences is essential for further exploration and utilization of jabuticaba varieties, providing valuable insights for agricultural practices, breeding efforts, and fulfilling market demands.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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