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Ankita Aman
Department of Entomology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Samik Sengupta
Department of Entomology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Ruby Rani
Department of Entomology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Muneshwar Prasad
Department of Entomology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Aditi Bharti
Department of Entomology, Chandra Shekhar Azad University of Agriculture and Technology, Nawabganj, Kanpur, Uttar Pradesh, India

Corresponding Author:
Ankita Aman
Department of Entomology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Studies on bio-chemical attributes of different accessions of Palmyrah Palm fruit (*Borassus flabellifer* L) in Bhagalpur district of Bihar

Ankita Aman, Samik Sengupta, Ruby Rani, Muneshwar Prasad and Aditi Bharti

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Abstract
The palmyrah palm (*Borassus flabellifer* L) is a minor tropical fruit which belongs to family Arecaceae. India stands first in the world in terms of its wealth of palmyrah palm with a population nearly 122 million palms. The fruits, fruit sap, young tuberous seedlings of palmyrah palm are used as food. Despite this indisputable utility, with the exception of coconut, arecanut, date and oil palm, somewhat less attention has been given to the improvement of palms as compared to other tree crops. An experiment was conducted at BAU, Sabour during the year 2016-2017 to study the biochemical properties of Palmyrah palm fruit collected from Bhagalpur district. The finding had shown that TSS differed significantly among the different accession of palmyrah fruit and highest TSS was recorded in AC-3 (15.96 ºBrix). Maximum acidity was found in AC-3 i.e. 0.97% and minimum in AC-13. Results also revealed significant variation in Total sugar, reducing sugar and non reducing sugar among all the accession of palmyrah fruit. Result revealed that phenols and carotenoids have been found non significant in palmyrah fruit but fruit is good source of carotenoids.

Keywords: Palmyrah palm, accession, biochemical attributes

Introduction
The palmyrah palm (*Borassus flabellifer* L) is a minor tropical fruit which belongs to family Arecaceae subfamily *Borassoideae* and genus *Borassus*. Vengaiah *et al.* (2012) [12] had reported that India stands first in the world in terms of its wealth of palmyrah palm with a population nearly 122 million palms. In India it is grown in Tamil Nadu, Andhra Pradesh, Bihar, Orissa, West Bengal and other southern states of India. Tamil Nadu is a potential centre for the growth and development of palm products industry to a greater extent so as to attract foreign exchange by way of export of Palm Products. It has great economic potential and every part of the palm is useful in one way or the other. From nutritional point of view, the pulp is rich in sugar, an excellent source of vitamin A and a good source of vitamin C, apart from the usual content of minerals and other vitamins. These desirable characteristics make the pulp useful for food additive to enrich nutritional values (AOAC 1990) [1]. The chief product of the palmyrah palm is the sweet sap (toddy) obtained by tapping the tip of the inflorescence, as is done with the other sugar palms and coconut palm. Toddy can be obtained from the young inflorescence The chief product of the palmyrah palm is the sweet sap (toddy) obtained by tapping the tip of the inflorescence, as is done with the other sugar palms and coconut palm. Vengaiah *et al.* (2015) [11] had reported TSS of the pulp as 16.5 Brix. Carotenoids varied from 26.61 to 27.42 mg/100gFM. Very less work has been done with respect to biochemical parameters.

Material and Methods
The survey of palmyrah palm plants was carried out in Bhagalpur district during the year 2016-2017. 15 accessions of Palmyrah palm collected from different locations of Bhagalpur. The fruits were collected at maturity stage and transported through corrugated fibre boxes with paddy straw and paper and brought to laboratory. The three fruits were used for taking observations for the quality parameters such as total soluble solids, titrable acidity and

ascorbic acid content etc. TSS of the fruits were recorded at room temperature using hand refractometer and were expressed in terms of percentage. Determination of titrable acidity by standard titration method (AOAC, 2000) [2] and expressed as per cent malic acid. TSS/Acid ratio was calculated by dividing the TSS with total acidity. Total sugars content of fruit pulp was determined as per "Lane and Eynon Method" (Ranganna, 1986) [8]. Fifty ml filtered juice was mixed with 100 ml distilled water and then neutralized with normal NaOH solution using phenolphthalene as indicator. Two ml of lead acetate solution (45%) was added in the solution and allowed to stand for ten minutes. Then 8 ml of potassium oxalate solution (22%) were added and total volume was made upto 250 ml by adding distilled water. After that 5 ml of the extract was taken in burette and titrated against 10 ml mixed Fehling solution (5 ml Fehling solution A + 5 ml Fehling solution B) using methylene blue as indicator. The end point was indicated by decolourization of the solution. The following formula was used for determining the total sugar in fruits.

$$\text{Total sugar (\%)} = \frac{\text{Factor for Fehling Solution x Dilution}}{\text{Titre x Weight of sample taken}} \text{ x } 100$$

Where, factor for Fehling solution denotes the gram of invert sugar given by, Factor = (titre × 2.5)/100. Reducing sugars were estimated by 'Lane and Eynon' method as described by Ranganna (1986) [8]. The extract were taken and titrated against 10 ml of mixed Fehling solution using methylene blue as indicator. Sufficient amount of extract was run to reduce Fehling solution treated and boiled for 2 minutes. The end point was identified when the discoloration of indicator to reduce. Results were expressed as percentage of reducing sugar.

$$\text{Reducing sugar (\%)} = \frac{\text{Sugar mg of invert x Dilution x 100}}{\text{Titrable Value of samples x Weight per volume x 1000}}$$

The total phenolic content of the fruit was determined by the method of Singleton *et al*. (1999) [10]. 5 g of fruit sample was crushed in 10 mL of 80% ethanol. After homogenization, the sample was centrifuged at 10,000 RPM for 20 min at 4 °C. The supernatant thus obtained was used for estimating total phenolics. Now 2.9 mL of distilled water, 100 µL of sample extract and 0.5 mL of 2 N Folin–Ciocalteu reagent were added and mixed in a test tube. After 3 min, 2 mL of 20% of the Na2CO3 solution was also added and absorbance was recorded at 760 nm using a spectrophotometer. Gallic acid was used to produce a standard calibration curve. The total phenolic content was expressed as mg gallic acid equivalent per 100 g FW and was estimated by using following formulae

$$\text{Total phenol content} = \frac{\text{O.D.} \times \text{Volume made up (with 80\% ethanol)} \times 100}{\text{Aliquot taken} \times \text{weight of sample} \times 1000}$$

Total carotenoids was determined by the method of Roy (1973) [9] with some modifications. In which 5 g of palmyrah pulp was crushed in acetone till the tissue became colourless. Then the extracted solution was poured into a separating funnel. To it, petroleum ether and small amount of sodium sulphate solution was added and shaken rigorously. Then the separating funnel was kept undisturbed to separate the carotenoids from acetone to petroleum ether layer. After that, coloured solution was separated in a 50 ml volumetric flask and the volume was adjusted with petroleum ether. Finally, the sample absorbance was measured at 452 nm in a spectrophotometer, using petroleum ether as blank. The results was expressed as mg 100 g^{-1} FW (fresh weight) basis.

$$\text{Total Carotenoids content} = \frac{3.87 \times \text{O.D.} \times \text{volume made up}}{\text{Weight of sample x 100}} \times 100$$

Results and Discussion

The different accession of Palmyrah palm has been shown in Plate no.1. Data pertaining to biochemical characteristics of fruits of Palmyrah palm are presented in Table 1. The chemical composition among the various accession of Palmyrah palm varied which showed that the selected accessions varied from each others. The average TSS of accessions of Palmyrah palm ranged from 13.63 to 15.96°Brix with mean value is 14.82°Brix and each accession have different content of TSS indicating this variation due to the differences in characters of the collected accession. The present findings is different from the results of Chaurasiya, *et al.* (2014) [5] who observed a higher value of TSS as the pulp of palmyrah palm were stored in ambient storage and under refrigerated condition. The sugar content in Palmyrah palm also varied from 5.78% to7.36% with average value of 6.51%. The findings are in sharp contrast to the results of Chaurasiya, *et al.* (2014) [5] who observed a higher sugar content after storage. The possible reason behind the increase in total sugar content during storage might be due to the partial hydrolysis of complex carbohydrates. The Palmyrah palm accessions have maximum carotenoid content (33.35mg/100g pulp) and minimum carotenoid content (21.21.mg/100g pulp) was recorded in Palmyrah palm accession. The Palmyrah palm accession have significantly lower vitamin C content ranging between 19.28 to 23.60 mg/100g pulp weight. The variation among the palmyrah palm accession might be due to genetic characters. Such variation among the accession of Palmyrah palm were also recorded by Vengaiah *et al*. (2015) [11] but differ from the findings of Chaurasiya, *et al.* (2014) [5] who observed a very low ascorbic acid content of 1.11 mg/100 g and 1.66 mg/100 g when the pulp was stored under ambient and refrigerated condition respectively. The reduction in ascorbic acid content was due to oxidation of ascorbic acid into dehydro ascorbic acid by oxidase enzyme like ascorbic acid oxidase. This variation can be due to the method used for estimation or the environmental factors. The range of phenols content in different accession of palmyrah fruit was found (4.25 to 7.17 mg GAE/g) which showed very high difference from the findings of Ali *et al*. (2010) [3] who reported phenol content 274.20 mg/100g FM. This difference exist due to the differences in unit taken and method used for the extraction.

Accession no. 1 Accession no. 6

Accession no. 8 Accession no. 10

Plate 1: Different accession of Palmyrah fruit plant

Table 1: Variability of biochemical characteristics of fruit of Palmyrah palm

Treatments	TSS (Brix)	Acidity (%)	TSS: TA ratio	Ascorbic acid (mg/100g)	Carotenoids (mg/100 g FW)	Phenols (mg GAE/g FW)	Reducing sugar (%)	Non reducing sugar (%)	Total sugar (%)
AC-1	15.80^{ab}	0.66^{d}	24.11^{de}	23.60^{a}	31.66	5.86	3.93^{a}	2.81^{efgh}	6.89^{bcde}
AC-2	13.69^{ef}	0.89^{ab}	15.37^{d}	22.95^{ab}	33.35	5.81	3.68^{bc}	3.17^{cde}	7.02^{abc}
AC-3	15.96^{a}	0.86^{bc}	18.70^{fg}	21.84^{cd}	24.18	4.56	3.09^{e}	4.05^{a}	7.36^{a}
AC-4	15.31^{abc}	0.43^{g}	35.39^{a}	21.39^{de}	21.56	4.57	3.56^{cd}	2.54^{gh}	6.23^{fg}
AC-5	13.72^{def}	0.44^{g}	31.30^{ab}	21.32^{de}	22.11	7.17	3.75^{ab}	1.69^{j}	6.58^{def}
AC-6	14.90^{abcde}	0.87^{bc}	17.20^{g}	20.96^{def}	25.79	5.63	2.91^{ef}	3.55^{bc}	6.64^{cde}
AC-7	14.93^{abcd}	0.97^{a}	15.34^{g}	19.28^{i}	21.22	5.19	3.02^{ef}	3.3^{cd}	6.49^{ef}
AC-8	15.19^{abc}	0.51^{fg}	29.59^{bc}	21.38^{de}	25.18	4.73	3.68^{bc}	2.11^{i}	5.91^{gh}
AC-9	14.95^{abc}	0.64^{de}	23.65^{e}	20.73^{efg}	26.39	5.90	3.06^{e}	2.84^{efg}	6.05^{gh}
AC-10	14.51^{cdef}	0.57^{ef}	25.73^{cde}	20.40^{fgh}	23.45	5.00	3.65^{bc}	2.43^{hi}	6.20^{fg}
AC-11	14.71^{bcdef}	0.87^{bc}	16.94^{g}	23.11^{ab}	21.21	4.60	2.94^{ef}	3.81^{abc}	6.95^{bcd}
AC-12	14.27^{cdef}	0.66^{d}	21.90^{ef}	22.62^{bc}	24.15	3.33	3.38^{d}	3.55^{bc}	7.11^{ab}
AC-13	13.63^{f}	0.79^{c}	17.26^{g}	20.02^{ghi}	27.96	5.19	3.01^{ef}	2.73^{fgh}	5.87^{gh}
AC-14	15.06^{abc}	0.47^{g}	32.03^{ab}	19.74^{hi}	26.60	5.21	3.51^{cd}	3.03^{def}	6.70^{cde}
AC-15	15.79^{ab}	0.57^{def}	28^{bcd}	21.66^{d}	24.32	4.25	2.87^{f}	2.76^{fgh}	5.78^{h}
					NS	NS			

Conclusion

The average TSS of Palmyrah palm was 14.82 ° Brix, while the TSS of Palmyrah palm ranged from 13.63 to 15.96 ° Brix. The maximum TSS content (15.96°Brix) was recorded in accession no.-3 which was found statistical at par with accession no.-1 (15.80°Brix), accession no.-15 (15.79°Brix). The titrable acidity of Palmyrah palm was found to be 0.67 per cent and it ranged from 0.43 to 0.97 per cent. The lowest titrable acidity (0.43%) was obtained in accession no.-4. The carotenoid content of palmyrah palm was found to be 25.27 mg/100 g pulp weight while as the average carotenoid content of palmyrah palm ranged from 21.21 to 33.35 mg/ 100 g pulp and no significant difference were noticed in the accession. Maximum carotenoid content (33.35mg/100g pulp) was recorded in accession no.-2 and minimum was in accession no.-11 (21.21mg/100g). The maximum TSS/acid ratio (35.3) was recorded in accession no.-4, which is statistically at par with accession no.-5 and accession no.-14. The maximum total sugars (7.36%) was recorded in the accession no.-3, which was significantly higher than rest of the other accessions under investigation. The ascorbic acid content of Palmyrah palm was found to be 7.75.mg/100 g pulp weight while as the vitamin C content of Palmyrah palm ranged from 19.28 to 23.61 mg/100 g pulp. On the basis of results and discussion made so far, it may be concluded that the accessions no.-3 was found best in terms of TSS, total sugar and antioxidant.

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