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Comparative study of physio-chemical properties of Kendu fruit variety

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Abstract
Kendu fruit belong to the Ebenaceae family and Diospyros species and is considered to be minor forest produce (MFP) in India. It is a rich source of antioxidants, phenols, alkaloids, essential oil, flavonoids, saponin, tannin and terpenoids. Fruits from Maharashtra and Jharkhand state of India were procured and its physiochemical analysis were performed. Juice yield of fruits of Jharkhand was more than Maharashtra. pH of the Jharkhand Kendu fruit was found out to be 4.46 and for Maharashtra it was 4.26. Titratable acidity (TA) of fruit from Maharashtra was 0.63% CAE and 0.71% CAE for Jharkhand fruits. Total phenolic content and Total flavonoid content was almost similar for both the fruits from different states. Antioxidant (DPPH) inhibition activity for Maharashtra and Jharkhand fruits was 61.13% and 67.62% respectively. Reducing sugar (RS) for Maharashtra was 1.048 mg/ml and for Jharkhand was 2.24 mg/ml.

Keywords: Kendu, Juice yield, phenol, flavonoid, reducing sugar, *Diospyros melanoxylon* Roxb

1. Introduction
Kendu is a common name from coromandel, the coast of southeastern India. Locally it is known as temburini or by its hindi name tendu. In Odisha, Jharkhand and Assam, it is known as Kendu. Its scientific name is *Diospyros melanoxylon* Roxb. It belongs to *Ebenaceae* family and Diospyros species. It is considered to be minor forest produce (MFP) in India. In several South Asian nations and in some parts of India such as Bihar, Madhya Pradesh, Chhattisgarh, West Bengal, Odisha, and Jharkhand, the fruits are periodically available in significant quantities from May to June (Panda *et al*., 2020) [6].
Kendu is a rich source of antioxidants, β-carotene, phenols, as antioxidants, alkaloids, essential oil, flavonoids, saponin, tannin and terpenoids. Kendu fruit is also beneficial for stomach problems. The dried fruit powder is used to treat urinary, skin, and blood problems as a carminative and astringent agent. Leaves are used as a styptic, as well as a laxative and carminative remedy for scabies and old wounds (Hmar *et al*., 2017) [3]. In traditional medicine, the fruits are frequently used to make anti-inflammatory and antipyretic medications (Panda *et al*., 2020) [6]. However, most fruits are wasted due to a lack of suitable processing procedures and consumer understanding of their nutritional elements, forcing them to be used in an inefficient manner. Some value-added products which are been prepared from the fruit are jam, jelly, nectar, bars, fruit juice, cordial, wine, pickles (Hmar *et al*., 2017) [3] (Info, 2021) [4].
The fruit is often pale orange and dark yellow in colour, and it is quite tender. Tendu is a naturally occurring fruit that matures between the months of March and April. It has a round structure, a length and breadth of 25 to 30 mm per fruit, and a maximum weight of 13 to 15 grammes per fruit. Maximum fruit weight is 15–18 g. The most important characteristic of this fruit is that it is inexpensive and readily available in local markets and tribal regions. This fruit, which sells for roughly 10-15 Rs/Kg and is a good source of carbohydrates, vitamin A, and C, is also found in forested areas, therefore it is completely organic fruit and processed preserved juice. Tendu ripen during the months of March and June. Fruit is round or oval in shape (Chandrashikha *et al*., 2021) [2]. Kendu fruits are gathered by tribal members in the summer, and the fruit pulp is dried for use as food in the winter. When fully mature, the fruit has a nice and sweet flavour. The Kendu fruit's potential as food, however, has not been thoroughly explored (Info, 2021) [4]. As Kendu fruit is available in various regions of the country each region fruit has its different taste size and properties according to the climatic conditions in particular region as well as the variety differs in each part, so this study has examined different properties of the fruit between two different regions Kendu fruit (Parija *et al*., 1999) [8].

2.Materials and Methods

2.1. Raw material collection

Kendu fruits were procured from local market of Chandrapur city of Maharashtra and from Jharkhand state of India and were transported to Lovely Professional University, Punjab for research purpose. Fresh ripened fruits were sorted and thoroughly cleaned to remove dirt. Selected fruits were stored in deep freezer at -18 ℃ to -20 ℃ to prevent damage till further use. Fruits were further used for extraction of juice assisted with enzyme treatment namely cellulase and pectinase.

2.2. Extraction of Kendu pulp

For pulp extraction, peel and seeds of fruits were removed and pulp was obtained. Pulp was further homogenized using mixer grinder (Sujata mixer) for 3 min at 10000 rpm. Extracted pulp was of high viscosity so to reduce its viscosity distilled water was added for dilution at the proportion of 1:1 (w/v), as it will enhance juice recovery and enzyme activity. Pulp was strained using muslin cloth for obtaining diluted pulp. The control sample was taken to be the 1:1 (w/v) pulp without any enzyme addition (Panda *et al*., 2021) [7].

2.3. Enzymatic extraction of juice

For each experiment, different pectinase (0.00-0.4 g) and cellulase (0.01-0.4 g) enzyme doses per 100 g of pulp were utilised. Based on the results of the preliminary experiment, the maximum and minimum limits of the enzyme concentration were established. According to the results of the preliminary experiment performed, neither the enzyme's higher concentration (>0.4 g) nor its lower concentration (0.01 g) had a significant impact on the juice yield. The enzymes were homogenously mixed and kept in a hot water bath according to the experimental combinations at different temperatures for a predetermined period of time. The enzyme-treated kendu pulp was filtered through muslin cloth to produce a clear juice (Abdullah *et al*., 2021) [1] (Pradhan *et al*., 2020) [9].

2.4. Quality evaluation enzymatically assisted Kendu juice

Different properties such as juice yield, pH, clarity of juice, TA (titratable acidity), TSS (total soluble solids), Antioxidant (DPPH), TPC (total phenolic content), TFC (total flavonoid content), reducing sugar of the juice were determined as follows.

2.4.1. Juice yield

The juice yield, which was calculated as the amount of kendu juice recovered from a measured amount of kendu pulp, was expressed as a percentage using the equation below.

$$\text{Yield (\%)} = \frac{\text{Clear juice recovered (ml)}}{\text{pulp quantity (ml)}} \times 100$$

Where, Pulp Quantity = Weight of Kendu pulp + Volume of water added

2.4.2. pH

pH of samples was measured using digital pH meter.

2.4.3. Titratable acidity (TA)

Using the titration method and a 0.1 N sodium hydroxide solution, the titratable acidity (TA) of kendu juice was determined. The titration process was continued until the colour turned pink. For this, phenolphthalein indicator was used. The citric acid equivalent (%) was used to express the titratable acidity.

2.4.4. Total soluble solids (TSS)

Using a benchtop digital refractometer, the Total Soluble Solids (TSS) of Kendu juice were measured. In terms of ºBrix units, the results for TSS were expressed.

2.4.5. Total Phenolic content (TPC)

The Folin-Ciocalteu (FC) technique described by (Hmar *et al*., 2017) [3] was used for determination of Total Phenols. To 100 µl of sample 1 ml of FC reagent was added and stirred for 1 min. A 2 ml of 7.5% (w/v) sodium carbonate solution was added and incubated in at room temperature for 30 min. Absorbance was measured at 765 nm and results were represented as mg gallic acid equivalents (mg GAE/ml).

2.4.6. Total Flavonoid content (TFC)

The total flavonoid content was determined by the method explained by (Kochadai *et al*., 2022) [5]. Briefly 200 µl of the sample and 1 ml of sodium nitrate solution was added. After incubation for 5 min 300 µl of aluminium chloride (10% w/v) was added, and after 6 min incubation 1 ml of 1 M sodium hydroxide solution was added. Absorbance was measured at 510 nm against the blank and the results were expressed as quercetin equivalents (mg QE/ml)

2.4.7. Antioxidant (DPPH)

The antioxidant property of the fruit was determined by the DPPH(2,2-diphenyl-1-picrylhydrazyl) method. For analysis of antioxidant content 0.9 ml of methanol was taken with 0.1 ml of sample and finally 3 ml of DPPH solution was added to it and kept in dark for further process. Absorbance was measured at 517nm against the blank and the results were expressed in % RSA (Radical Scavenging Activity).

2.4.8. Reducing sugar (RS)

Reducing sugar was determined using di-Nitrosalicylic solution (DNS) method. Samples were initially diluted in ratio 1:50 and from it 2 ml of sample was used for the test. 1.5 ml DNS was added to sample then heated to 80 ℃ for 10 min and then absorbance was measured at 510nm. Blank was prepared with DNS and used as reference. Standard curve was prepared using glucose (0.1-0.5 mg/ml).

3.Result and Discussion

Analysis was performed on the enzyme extracted juices from Maharashtra and Jharkhand and its results were observed.

3.1. Juice yield

The juice yield of fruit increased after enzyme treatment as enzymes in breakdown of fibers of fruits. Kendu's cell wall is mostly made of pectin. The protopectin releases water soluble pectin, which causes the fruit pulp to be juiced (Panda *et al*., 2021) [7]. The juice yield of kendu of Jharkhand was obtained 62% while for Maharashtra fruits it was 59%. It might be due to different environment, harvest time and storage conditions.

3.2. pH

pH of the Jharkhand Kendu fruit was found out to be 4.46 and for Maharashtra it was 4.26. There was no measure difference observed in pH of both the fruits. Hmar *et al*., 2021 [10]

reported fruit pH 5.47.

3.3. Titratable acidity (TA)
Titratable acidity of fruit from Maharashtra was 0.63% CAE and 0.71% CAE for Jharkhand fruits. The titratable acidity provides a better prediction of the impact of acid on the flavor of the food than pH.

3.4. Total soluble solid
TSS for fruits from Maharashtra and Jharkhand was observed to be 7.23^{o}brix and 9.2 ^{o}brix respectively. The change in TSS might be due to different environment, harvest time and storage conditions.

3.5. Total Phenolic content (TPC)
The phenolic content of fruits from Maharashtra was observed 0.465 mg GAE/ml and for Jharkhand fruits it was 0.512 mg GAE/ml. The change in phenolic content might be due to different environment, harvest time and storage conditions.

3.6. Total Flavonoid content (TFC)
The flavonoid content of Maharashtra and Jharkhand fruits was 0.133 mg QE/ml and 0.219 mg QE/ml respectively. The change in flavonoid might be due to different environment, harvest time and storage conditions.

3.7. Antioxidant (DPPH)
The DPPH inhibition activity for Maharashtra and Jharkhand fruits was observed to be 61.13% and 67.62% respectively. Similar results were observed by Hmar *et al*., 2021 [10].

3.8. Reducing sugar (RS)
The reducing sugar for fruits of Maharashtra was 1.048 mg/ml and for Jharkhand fruits was observed to be 2.24 mg/ml. The change in reducing sugar might be due to different environment, harvest time and storage conditions.

4. Conclusion
For further processing and value addition of Kendu fruit, physico-chemical factors such total soluble solids (TSS), acidity, pH, antioxidant, phenol, and flavonoid are crucial. To determine the quality of Kendu fruits, a number of physico-chemical factors must be combined. The physiochemical characteristics of fruits from Maharashtra and Jharkhand did not significantly differ. The change could be the result of the harvest season, storage conditions, or environmental variables. It is necessary to conduct additional research on the physical, chemical, textural, nutritional, and interaction between the many kinds and maturation levels of kendu fruits in order to develop methods and equipment for the collection, transportation, storage, and processing of fresh kendu fruits.

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