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Studies on physico mechanical properties of ber cultivars

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Abstract

Ber is an important fruit crop in the arid regions of Asia and Africa. Some physical and mechanical properties of six ber cultivars namely Umran, Ilaichi, Gola, Mundia, Goma kirthi and Banarasi karka were determined. The geometrical mean diameter of fruits varied from 2.65 to 4.85 cm. The sphericity varied from 0.73 to 0.88 among cultivars and the fruits of Gola were more spherical than the fruits of other cultivars. The surface area, volume, average weight and firmness of Umran fruits were significantly higher, 74.04 cm^2, 89.90 cm^3, 56.66 g and 6.80 N, respectively than the other fruits. The cutting strength of Goma kirti fruits was found to be better than the fruits of other cultivars.

Key words: *Ber cultivars, physical, mechanical properties*

Introduction

Indian jujube or Ber *(Zizyphus mauritiana* L.) has moved from forest to commercial cultivation in warm arid regions of India, Pakistan, Bangladesh, Sri Lanka, central to southern Africa and in the northern part of Australia. The expansion mainly took place because of its hardy nature to withstand vagaries of nature and the commercial yield potential. Conventionally, ber is considered poor man's fruit but it is richer than apple in protein, phosphorus, calcium, carotene and vitamin C (Bakshi and Singh, 1974). India annually produces around 37,97,606 million tonnes fruits from an area of 61,279 ha (Sharma *et al.*, 2002). Fruits of ber are commonly used in Indian households as fresh fruit and also dehydrated for later use. Presently, about 90% of its production is consumed as fresh fruit. Although there seems to be a good potential for use of the fruit in the processing industry (Pareek, 2001), it has not been fully exploited to the extent it should have been exploited.

To explore the potential use of ber for processing, machines like grader, peeler, stone remover, etc. need to be designed for which, its physical properties must be known. Detailed studies on physical and mechanical properties of ber fruits have not been reported. Since the environmental factors influence the quality attributes, physical and mechanical properties of different cultivars may also differ depending upon maturing season. Thus, these studies were conducted to determine the physical and mechanical properties of matured ber fruits of different cultivars.

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Materials and methods

Matured fruits of six different cultivars viz., Umran, Ilachi, Banarasi karka, Mundia, Gola and Goma kirti were used for the experiments in this study. In the selected six cultivars, Mundia and Gola were of early maturity (January - February), Banarasi karka and Goma kirti were of mid season (February) and Umran and Ilaichi were late maturing cultivars (March - April) (Vashistha, 2001). The fruits were harvested from the orchard of Central Institute of Post Harvest Engineering and Technology, Abohar, during January- April, 2004. Damaged and other undesirable fruits were sorted out and healthy fruits were selected for the study. Twenty fruits were randomly selected from each cultivar and the average values were calculated. The geometry and the relative size of the ber fruit are shown in Fig 1. The parameters such as linear dimensions, size, sphericity, surface area, firmness and cutting strength were determined.

Determination of size and dimensions

The linear dimensions, length (L) and diameter (D) were measured using a vernier caliper (least count - 0.01 cm). The size was calculated using the linear dimensions and were expressed in terms of geometrical mean diameter. Aydin and Ozcan (2002) and Demir *et al.*, (2002) have measured the linear dimensions in a similar manner to determine the size of the fruits. The geometrical mean diameter (D_g) was calculated using the following formula (Mohsenin, 1970):

$$D_g = (LD^2)^{1/3} \quad (1)$$

Sphericity expresses the shape character of the solid

relative to that of a sphere of the same volume. It is an index of roundness. According to Jain and Bal (1997), the degree of sphericity (o) can be expressed as follows:

$$o = D_g/L \qquad (2)$$

The linear dimensions were used to calculate the volume (V) and surface area (S) of the fruit by using the following equations (Mohsenin, 1970):

$$V = \pi D^2 L/4 \qquad (3)$$
$$S = \pi D_g^2 \qquad (4)$$

Mass of single fruit

The individual mass of fruits were weighed using an electronic balance of accuracy 0.001 g, make - citizen, Blue beacon enviro pvt ltd., Chandigarh, India.

Determination of firmness and cutting strength

The firmness of the fresh fruits was measured using the Texture Analyzer (TA-Hdi, Stable Microsystems, UK) with the 2 mm diameter stainless steel probe. The operating conditions were, pre-test speed 1.5 mm/s, test speed, 0.50 mm/s and post-test speed of 10.0 mm/s. The maximum value recorded by the probe while passing through the fruits, in Newton (N), was given as firmness. The firmness was measured in two places of each sample and average value was calculated. The cutting strength was also determined using the Texture Analyser, with a knife edge probe with blade set. The operating conditions were kept as that of used during measurement of firmness.

Results and discussion

The inter-cultivar differences in physical properties of ber fruits are given in Table 1.

Fruit dimensions

The data shows that the difference in major dimension (length) and minor dimension (diameter) are less in some cultivars like Gola, Umran and Ilaichi. The geometrical mean diameter of the selected fruits varied from 2.65 cm to 4.85 cm. The late season cultivar of Umran is of bigger size and Ilaichi is the smallest fruit.

Sphericity, volume and surface area

The sphericity of the fruits varied from 0.73 to 0.88 . The fruit of the cultivars Gola, Illaichi and Umran has sphericity of more than 0.85, which shows that the fruits developed uniformly in both the axes. The fruits of Goma kirthi, Mundia and Banarasi karka developed more in lengthwise. These data will be useful in designing a ber grader. The surface area and average weight of Umran fruits were higher (74.04 cm^2 and 54.66 g) followed by Goma kirti cultivar. The volume of ber fruits calculated by equation 3 varied from 15.1 to 89.9 cm^3 for different cultivars.

Mass of single fruit

The average weight of fruits varied from 10 to 55g. The late season cultivar of Umran was found to be of bigger size having maximum weight. The early maturing cultivars of Gola and Mundia had less average weight than other cultivars, viz., Goma kirthi, Banarasi karka and Umran.

Firmness and cutting strength

The late season cultivar of Umran had the highest (6.80 N) firmness and the early season cultivar Gola had the lowest (2.9 N) firmness (Table 2). The firmness of middle and late season cultivars were higher than the early season varieties. The fruits of *Gola* and *Mundia* were softest among all the cultivars. The varied firmness of ber fruits maturing in different period may be due to its genetic character. The early maturing fruits may be susceptible to injuries while harvesting and grading since the strength was very less. It can be implied from the firmness that the middle and late season cultivar fruits can be transported for long distances with less damage. The ripening season of the fruits doesn't have any effect on the cutting strength (Table 2). The cutting strength varied from 28.2 to 59.3 N. The cutting strength of cultivars Goma kirthi, Umran and Mundia was high (45.8 - 59.3 N) when compared to other fruits.

Table 1. Physical properties of ber fruits

Sl. No.	Cultivar	Length (cm)	Diameter (cm)	Geo. Mean dia (cm)	Sphericity	Volume (cm^3)	Surface area (cm^2)	Average wt. (g)
1.	Gola	4.31 (±0.23)	3.55 (±0.10)	3.79 (±0.12)	0.88 (±0.03)	42.85 (±4.3)	45.23 (± 2.96)	27.78 (±2.85)
2.	Mundia	4.33 (± 0.29)	2.72 (±0.13)	3.17 (±0.16)	0.73 (± 0.02)	25.35 (±4.03)	31.73 (±3.26)	15.90 (±2.24)
3.	Goma kirti	5.72 (±0.36)	4.11 (±0.32)	4.58 (±0.25)	0.80 (±0.05)	76.14 (± 12.62)	66.14 (±7.28)	44.74 (±5.59)
4.	Banarasi karaka	5.76 (±0.25)	3.82 (±0.18)	4.38 (±0.18)	0.76 (±0.02)	66.10 (±8.50)	60.23 (±5.11)	40.69 (±4.85)
5.	Ilaichi	3.05 (±0.22)	2.48 (±0.27)	2.65 (±0.26)	0.87 (±0.02)	15.05 (±4.39)	22.32 (±4.34)	9.87 (±2.69)
6	Umran	5.67 (±0.32)	4.50 (±0.18)	4.85 (±0.09)	0.86 (±0.05)	89.90 (±4.77)	74.04 (±2.62)	54.66 (±2.44)

Values in parenthesis are standard deviations

Table 2. Mechanical properties of ber fruits

Sl. No.	Cultivar	Firmness (N)	Cutting strength (N)
1	Gola	2. 92 (±0.47)	33.0 (±6.50)
2	Mundia	3. 52 (±0.21)	45.8 (± 5.20)
3	Goma kirti	5.83 (±0.26)	59.3 (±3.60)
4	Banarasi karka	4. 60 (±0.53)	28. 2 (±4. 20)
5	Umran	6. 80 (±0.62)	57. 5 (±2. 00)

Values in parenthesis are standard deviations

From the study it is concluded that the late season cultivar of Umran was found to be of bigger size compared to other fruits while the average geometric mean diameter, surface area, volume, average weight and firmness of Umran fruit were 4.85 cm, 74.04 cm^2, 89.90 cm^3, 56.66 g and 6.80 N, respectively.The ripening season of ber fruits slightly influenced the firmness of the fruits. The early maturing fruits were found to be less firm than the late varieties. Since the firmness is high, the fruits of Umran, Goma kirti and Ilaichi can be used for transportation to longer distances and storage.

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