**Evaluation of physical parameters of different ber *(ziziphus mauritiana l.*) Varieties under sub-tropical conditions of punjab, India**

**Abstract**

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| The ber (*Ziziphus mauritiana* Lamk.) is one of the ancient and common fruits indigenous to India. It grows in tropical, sub-tropical and arid regions of the world. The present study was undertaken on “Evaluation of ber (*Ziziphus mauritiana* Lamk.) varieties under sub-tropical conditions of Punjab” at laboratory of Sri Guru Granth Sahib World University, Fatehgarh Sahib during the year 2022. The fruit samples were collected from the ber orchard Patiala. Eight cultivars (Umran, Sanaur-2, Wallaiti, Kaithli, Sanaur-5, Dandan, Gola and Chhuhara) were selected for physical analysis. The experiment was laid out in Randomized Block Design with three replications. All physical fruit characters such as fruit size, weight and colour showed significant differences amongst ber cultivars. The late season cultivar Umran was found to be superior in physical characters [fruit length (4.99); fruit breadth (3.36 cm); fruit weight (25.73) and pulp (93.66 %)] followed by Sanaur-2. The specific gravity of fruits of all ber varieties were less than. one at maturity and were ripened. The palatability rating was noted highest i.e.8.05 out of 9.00 in cv. Sanaur-2 followed by in cv. Gola (8.00) and rated as very much desirable.  |

**Key words**: ***Ber, Fruit size, Palatability rating, Sanaur-2, Vitamin C***

**Introduction**

The ber or Indian jujube (*Ziziphus mauritiana* Lamk.) is one of the ancient and common fruit indigenous to India (Rai and Gupta, 1999). Ber belongs to Bukthorn family Rhamnaceae. It is tertraploid (2n=48) in nature. Ber fruit grows in tropical, sub-tropical, and arid regions of the world (Pareek, 2001). In India, ber occupies 54,000 ha area. The states under ber cultivation are Maharashtra, Gujarat, Madhya Pradesh, Punjab, Haryana, Rajasthan, Bihar, Karnataka, Andhra Pradesh, Tamil Nadu, West Bengal, and Assam. It is an important fourth fruit crop of Punjab after kinnow, mango, and guava. The area under Punjab is 1278 ha with a production of 22083 MT. The districts of Sangrur, Patiala, Mansa, Bathinda, Fazilka, and Barnala are the most famous for ber cultivation (Anonymous, 2021).

The ber is highly paying and rich in food value, particularly in ascorbic acid and protein (Bal and Mann, 1978). Nutritionally ripe fruits are richer than apple in calcium, protein, phosphorus and vitamins (Mukhtar et al 2004). The pulp of ber fruit contains 13.0 to 20.0 percent total soluble solids (TSS %) and 0.20 to 0.80 per cent acidity at the full ripening stage. However, it is the richest source of the vitamin - C (120mg/100g) next to aonla and 12 to 18 per cent of sugars. Therefore, it is even better than the vitamin - C content of the juice of sweet oranges. Ber fruit has a high nutritive value and is a rich source of provitamin A, vitamin C and B complex (Tiwari and Banafar 1995). Galactose, fructose, and glucose are the major sugars found in ber fruit (Muchuweti et al 2005).

There are nearly 125 cultivars of ber in India, which are most popular for their several uses because of their different physical and biochemical characteristics, physical characters. The size of ber fruits was maximum in late season cultivar Umran (4.9 cm) closely followed by Sanaur-2 (4.4 cm). Moreover, Gupta (1977) studied 40 cultivars of ber at Bahadurgarh, Punjab, and found that the Umran and Sanaur-2 have recommended for commercial cultivation because of their large size fruit with the highest pulp content. Choudhary et al (2017) conducted an experiment on comparative performance of ber genotypes under semi-arid conditions of Rajasthan and revealed that the maximum fruit breadth of 2.88 cm in cv. Gola. However, the minimum fruit breadth of 1.52 cm was recorded in cv. Sukhawani. Bal and Boora (2016) evaluated 52 varieties of ber for several vegetative and physical characteristics. The fruit size and weight were observed greatest in cv. Umran (4.9×3.4 cm) followed by cv. sanaur- 2 (4.4×3.1 cm). Naseem et al (2019) worked on 60 ber cultivars and reported variations among different varieties for fruit length, fruit weight and vast morphological characters. Gupta et al (2004) studied that the color of fruits at full maturity was golden yellow in the Umran, Illaichi, and Gola group of fruits. They found light green with coffee color patches in Kathaphal and Desi 3, however yellow to golden yellow with coffee color patches on Desi 1 variety. Saran (2005) reported that cultivars of ber showed several colour such as, green yellow, coffee color, deep golden etc while cvs. Dandan and Thornless both were at full maturity were greenish-yellow in color. Brindza et al (2011) reported that the average weight of stones is in the range of 0.90- 0.24 g, length from 14.35- 0.58 mm, and width 8.32-0.34 mm and significantly differences have been found in stones, shapes, and colors. The highest pulp to stone ratio was observed in Umran (23.60) followed by Muria Murhera and the minimum in Katha Phal. The highest pulp to the stone ratio of 23.10 was reported in Umran (Godi et al 2016). Kumar et al (2018) carried out an experiment on physicochemical and nutritive evaluation of five minor fruit germplasm/varieties i.e Anola, Ber (Karaka and Umran), Jackfruit and Kaitha and reported that the specific gravity was higher in ber cv. Umran (0.99 %) followed by ber cv. Karaka (0.98 %).Kumar et al (2022) studied eight different varieties of ber under Saurashtra region of Gujarat and they recorded variation in palatability rating on the basis of colour, texture and general appearance. The 15 cultivar seb had maximum acceptability (8.12) but the minimum acceptability was observed (6.07) in Umran. So, an attempt has been made in the present study to critically evaluate the cultivars to judge which variety is better regarding the characteristics such as color, shape, size, mesocarp, sugars, acid etc.

**MATERIALS AND METHODS**

The present investigation was carried out in the laboratory of Faculty of Agriculture, Sri Guru Granth Sahib World University, Fatehgarh Sahib (Punjab). The fruit samples were collected of the different ber varieties grown at ber orchard near Patiala city during the month of March to April in the fruiting season of 2022. The orchard is situated at 300 21‟45.9” North latitude and 760 28‟14.76” East longitude at an elevation of 263 Meters (862.86 Feet) above mean sea level. The research on physical characters was analyzed in the laboratory of Faculty of Agriculture, Sri Guru Granth Sahib World University (Fatehgarh Sahib). The experimental area comes under sub-tropical climate. It receives approximately 489.4 mm annual rainfall. Major part of the rain is received from July to September. The area is having irregular rainfall pattern. The experiment was conducted from the mid-March to April (8 March to 7 April) and maximum temperature ranges between 28.40 c to 400 c but the minimum temperature falls between 100 to 150 c. Eight ber cultivars (Umran, Sanaur-2, Wallaiti, Kaithli, Sanaur-5, Dandan, Gola and Chhuhara) having space of 7.5x7.5 m selected for study from full grown trees in the ber orchard near Patiala city. These plants were given uniform cultural practices as per PAU recommendations. Experiment was laid down in randomized block design having three replications.

**Table 1** **sampling details of different ber varieties as follows:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Varieties** | **Gola** | **Wallaiti** | **Sanaur-2** | **Kaithli** | **Dandan** | **Umran** | **Sanaur-5** | **Chhuhara** |
| **Season** | Early | Early | Mid | Mid | Mid | Late | Late | Late |
| **Picking** | 8/3/22 | 10/3/22 | 17/3/22 | 21/3/22 | 24/3/22 | 4/4/22 | 4/4/22 | 6/4/22 |
| **Physical parameters** | 8/3/22 | 10/3/22 | 17/3/22 | 21/3/22 | 24/3/22 | 4/4/22 | 4/4/22 | 6/4/22 |

As per sampling,the size of ten randomly selected fruits and stones from each experimental tree was recorded in terms of length and breadth with the help of a measuring scale and expressed in centimeters. Both the length and breadth of the fruits were taken separately. The average value of fruit length and breadth were expressed in centimeters (cm). The selected fruits and stone were weighed on an electronic weighing machine and the average weight was expressed in grams per fruit (g/fruit) and grams per fruit (g/stone). The skin colour of ber fruits were recorded by matching the fruits with Royal Horticultural Color Chart (Wilson, 1938). The pulp of the fruit was separated from stone and the pulp of each fruit was weighed separately on electric balance. From the weight of pulp and the weight of fruit, the percentage of pulp was calculated as per the formula given below:

$$Pulp Percentage (\%)=\frac{Weight of pulp}{Weight of Fruit}X100$$

Pulp stone ratio was calculated from the fresh weight of pulp divided by stone weight.Texture of fruit pulp was observed at maturity and varieties were grouped into firm, semi-firm, semi-soft and soft. Specific gravity of fruits was measured with water displacement method as per the formula given below:

$$Specific gravity=\frac{Weight of pulp}{Weight of Fruit}X100$$

The organoleptic rating of the fruits was assessed on the basis of Hedonic score. Pulp texture was recorded at the fruit maturity and fruits were grouped as soft, medium and firm.

**RESULTS AND DISCUSSION**

It was undertaken to identify various physical characteristics of ber varieties. The observations of the experiment calculated and results are provided as below in Tables 2 to 4.

The results in show that the maximum fruit length of 4.99 cm was recorded in late bearing cultivar Umran which was significantly higher than Wallaiti (4.06 cm), Dandan (4.05 cm), Sanaur-5 (4.03 cm), Kaithli (3.76 cm), Chhuhara (3.24 cm) and Gola (3.06 cm) However, the fruit length in mid-season variety Sanaur-2 (4.54 cm) was non- significant with Umran. The lowest fruit length was to the tune of 3.06 cm was recorded in early ripening variety Gola (Table 2).

Similarly, the fruit breadth in cultivar Umran was recorded maximum (3.36 cm) followed by in Sanaur-2 (3.24 cm) and were statistically non-significant with each other but The results further revealed was significantly higher than rest of the other cultivars studied.More or less similar results on the evaluation of ber varieties have been reported under sub-tropical conditions of Punjab by Bal (1981) and Bal and Boora (2014). The highest fruit weight of 25.73 g was recorded in late bearing cultivar Umran which was significantly higher than all other varieties. The fruit weight in Sanaur-2 and Sanaur-5 is above 20 g but it is significantly less than Umran. However, the fruit weight in early variety “Gola” (11.73 g) was non-significant with Wallaiti and Dandan. The lowest fruit weight was to the tune of 9.10 g was recorded in late ripening cultivar Chhuhara. Inpresent study, the fruits of Umran were recorded maximum in weight followed by Sanaur-2. Similarly, Singh and Jindal (1980) also reported that the Umran variety had

**Table 2 Fruit size (length and breadth), fruit weight and fruit colour of different ber varieties**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Varieties** | **Fruit length (cm)** | **Fruit breadth (cm)** | **Fruit weight** **(g)** | **Fruit colour****(HCC)/ Visual** |
| **Umran** | 4.99a | 3.36a | 25.73a | Y4A (Deep Golden Yellow) |
| **Sanaur -2** | 4.54b | 3.24b | 23.43b | YG150C (Light Yellow) |
| **Wallaiti** | 4.06c | 2.88d | 10.97d | Y2B (Light Golden Yellow) |
| **Kaithli** | 3.76c | 2.21f | 9.30ef | YG150B (Light yellow) |
| **Sanaur -5** | 4.03c | 3.04c | 21.07c | YG150B (Light yellow) |
| **Dandan** | 4.05c | 2.52e | 10.50de | G149B (Greenish yellow) |
| **Gola** | 3.06d | 2.78d | 11.73d | Y2B (Light golden yellow) |
| **Chhuhara** | 3.24d | 2.24f | 9.10f | Y22A (Golden yellow) |
| **SE (±)** | 0.12 | 0.04 | 0.46 | **-** |
| **CD @ 5%** | 0.38 | 0.12 | 1.39 | **-** |

Means with the same letters are not significant

 maximum fruit weight as compared to rest of the varieties (Table 2).

The late season cultivar Umran attained deep golden yellow (Y4A) colour at full maturity and mid bearing variety Sanaur-2 (YG150C), Sanaur-5 (YG150B) and Kaithli (YG150B) had light yellow colour at full maturity. Golden yellow and deep golden yellow colour in ber varieties at maturity is more appealing to the consumers and such ber fruits fetch higher premium in the market (Bal, 2018). Similarly, Bal and Singh (1978) also reported that the late mature variety Umran fruits were green in colour and it changed to golden yellow at full ripening (Table 2). The data revealed that Umran produced the longest stone of 2.63 cm. The stone length was 2.53 cm in early cultivar Wallaiti but it was significantly less than Umran. Stone length in Wallaiti was observed statistically non- significant with cv. Dandan (2.48 cm) and resulted significantly more than rest of the other varieties i.e. 2.39 cm; 2.28 cm; 2.12 cm and 1.83 cm in Sanaur-2, Sanaur-5, Kaithli and Gola, respectively. The lowest stone length of 1.73 cm was recorded in cultivar Chhuhara. The present study was also in agreement with the results of Nehra *et al* (1984) who reported that the length of stone increased according to the size of fruit and the stone length was highest. Similar results were also obtained by Brindza *et al* (2011) in their study .The stone breadth was recorded maximum (0.99 cm) in Sanaur-2 closely followed by in Sanaur-5 (0.93 cm). It is significantly higher compared to all other varieties. The minimum stone breadth of 0.74 cm was observed in Kaithli variety.

The present investigation is also in accordance with the results of Singh and Misra (2012). They studied on twenty-four genotypes of ber and reported maximum stone breadth in cultivar sanaur-3. The maximum stone weight of 1.90 cm was recorded in cultivar Sanaur-2 which was significantly higher than Umran (1.57 g) and Sanaur -5 (1.47 g) but stone weight was noted non-significant between Umran and Sanaur-2. However, the cultivars Chhuhara, Gola and Dandan had 1.07, 1.03 and 0.95 g stone weight.

Kaithli which is significantly less in weight as compared to all other varieties under investigation. More or less similar results on the evaluation of ber varieties with regard to stone weight were reported by Ghosh and Methew (2005) and Brindza *et al* (2011. It is evident from the Table 4 that the maximum pulp percentage (93.66 %) produced by cv. Umran which was non-significant with the Gola (93.17 %), Sanaur-2(91.69 %), Wallaiti (91.57 %) and Dandan (90.88 %) and significantly higher with the Chhuhara (88.93 %), Sanaur-5 (81.20 %) and Kaithli (81.01%). The lowest pulp percentage (81.01 %) was observed in cv. Chadha *et al* (1972) studied thirty-five ber varieties at FRS Bhadurgarh and reported that the cultivar Umran is a late season variety had a maximum pulp percentage, which was 96 per cent pulp.Cultivar Umran produced the highest pulp/stone ratio of 15.50 which was highly significant from the other varieties i.e., Kaithli (13.08), Sanaur-5 (11.67), Sanaur-2 (11.64), Gola (10.59), Wallaiti (10.39) and Dandan (9.68), respectively. However, the cv. Chhuhara produced significantly the lowest pulp/stone ratio of 7.05 as compared to other ber varieties under study.The results obtained in present investigation are in agreement with the results obtained by Tomar and Singh (1987) who observed that the pulp/stone ratio was highest in cv. Umran (19.93) which was highly significant from the other cultivars. Wallaiti cultivar produced the highest specific gravity of 0.91 which was non-significant with the Dandan (0.90), Gola (0.90) and Umran (0.89) and significantly higher than the Sanaur-2 (0.87), Chhuhara (0.86) and Sanaur-5 (0.84), respectively. However, the cv. Kaithli produced the minimum specific gravity of 0.83. These results are also in line with those reported in ber by Marimuthe and Thirumaran (2003).

**Table 3 Stone length, stone breadth and stone weight of different ber varieties**

|  |  |  |  |
| --- | --- | --- | --- |
| **Varieties** | **Stone length** **(cm)** | **Stone breadth** **(cm)** | **Stone weight** **(g)** |
| **Umran** | 2.63a | 0.84c | 1.57b |
| **Sanaur-2** | 2.39c | 0.99a | 1.90a |
| **Wallaiti** | 2.53b | 0.82c | 0.97c |
| **Kaithli** | 2.12e | 0.74d | 0.58d |
| **Sanaur -5** | 2.28d | 0.93b | 1.47b |
| **Dandan** | 2.48bc | 0.76d | 0.95c |
| **Gola** | 1.83f | 0.83c | 1.03c |
| **Chhuhara** | 1.73g | 0.75d | 1.07c |
| **SE (±)** | 0.03 | 0.01 | 0.05 |
| **CD @ 5%** | 0.09 | 0.04 | 0.15 |

The perusal of data on palatability rating indicated that the highest rating value of 8.05 out of 9.00 was observed in cv. Sanaur-2 and having better in taste/flavor and general appearance, thus categorized as very much desirable. It was followed by the cv. Gola (8.00) and had also rated under same scale because its general appearance is very good and attarctive colour. The palatability rating above 7.00 out of 9.00 was recorded in Wallaiti (7.70), Umran (7.50), Sanaur-5 (7.35), Dandan (7.25) and Kaithli (7.05) and rated moderately desirable. The minimum palatability rating among the varieties was observed in cv. Chhuhara

**Table 4 Pulp percentage, pulp/stone ratio and specific gravity of different ber varieties**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Varieties**  | **Pulp percentage** | **Pulp/stone ratio** | **Pulp texture** | **Specific gravity** **(g/cc)** | **Palatability rating (9)** |
| **Umran** | 93.66a | 15.50a | Firm | 0.89ab | 7.50c |
| **Sanaur -2** | 91.69ab | 11.64be | Semisoft | 0.87bc | 8.05a |
| **Wallaiti** | 91.57ab | 10.39cd | Soft | 0.91a | 7.70b |
| **Kaithli** | 81.01c | 13.08b | Semisoft | 0.83c | 7.05e |
| **Sanaur -5** | 81.20c | 11.67bc | Semisoft | 0.84c | 7.35cd |
| **Dandan** | 90.88ab | 9.68d | Semisoft | 0.90ab | 7.25d |
| **Gola** | 93.17ab | 10.59cd | Soft | 0.90ab | 8.00a |
| **Chhuhara** | 88.93b | 7.05e | Semisoft | 0.86bc | 6.15f |
| **SE (±)** | 1.25 | 0.60 | - | 0.01 |  0.12 |
| **CD @ 5%** | 3.80 | 1.82 | - | 0.04 |  0.36 |

(6.15) and thus it was rated slightly less desirable.The variation in organoleptic rating in ber fruits of different varieties was recorded by Pareek (2001) and Nissi and Joshi (2016).

**CONCLUSION:**

A wide range of variability was observed among the eight cultivars of ber. The late season cultivar Umran was found to be superior on account of fruit size and weight followed by Sanaur-2. All ber varieties attained greenish yellow to light yellow colour but Umran attained deep golden yellow colour at full maturity. Umran, Gola, Sanaur-2, Wallaiti and Dandan are having pulp above 90 per cent and considered superior from marketing point of view. The cultivar wallaiti is having soft texture fruit pulp which is good for old people. Based on palatability rating overall higher acceptance was recorded in cultivar Sanaur-2 and Gola. It was concluded that Umran is the best commercial variety on the basis of fruit size and colour development at peak maturity. On the other hand, keeping fruit quality and consumer acceptance into consideration, Sanaur-2 holds promise and can be rated best as kitchen/home gardening variety.

**Disclaimer (Artificial intelligence)**

Option 1:

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.

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