Plant Archives Vol. 25, No. 1, 2025 pp. 551-556 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.084

EVALUATION OF FRUIT MORPHOLOGY OF INDIGENOUS BER (*ZIZIPHUS MAURITIANA* LAMK.) AT BEMETARA DISTRICT OF CHHATTISGARH, INDIA

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(Date of Receiving-18-11-2024; Date of Acceptance-19-01-2025)

ABSTRACT

The investigation was conducted during 2022–23 and 2023–24 to study the morphological characteristics of indigenous Ber (*Ziziphus mauritiana* Lamk.) in various villages of the Bemetara district, Chhattisgarh. The morphological characterization focused on tree characteristics, with a total of 40 indigenous Ber trees surveyed and evaluated across different locations within the district. The study employed a linear mixed-effect model, using data collected from four random branches per tree to ensure a representative assessment. focused on fruit characteristics recording observations on fruit maturity group, bearing habit bunching, fruit shape apex, mature fruit shape, mature fruit colour, pulp texture, stone shape apex and stone shape.

The study focused on observing and characterizing the indigenous Ber fruit in their wild forms, noting significant variations in their morphological attributes. The primary objectives were to thoroughly document and analyze these indigenous Ber trees to understand their potential and diversity better.

Results revealed that in tree character on fruit maturity group (early maturity group- 30 and mid maturity group- 10), bearing habit bunching (bunching present- 6 and bunching absent- 34), fruit shape apex (flat shape- 16, round shape-14 and pointed shape-10), mature fruit shape (oblong- 9, oval-10, ovate-5, oblate-1, round-14 and falcate-1), mature fruit colour (yellow-11, greenish yellow- 7 and chocolate brown-22), pulp texture (soft-18, medium-13 and hard- 9), stone shape apex (acute-28 and obtuse- 12) and stone shape (oblong-19, oval-11, spindle-6, club-3 and falcate-1). These observations highlight the diversity within the indigenous Ber fruit population, with variations in fruit maturity, fruit shape, fruit colour, stone shape apex, and stone shape.

Key words : Ber, Evaluation, Morphology, Indigenous, *Ziziphus mauritiana.*

Introduction

The Indian jujube commonly known as Ber (*Ziziphus mauritiana* Lamk.) is one of the ancient and indigenous fruit of India. It belongs to the Family Rhamnaceae. The tree is an example of extremely drought hardy species, which can be grown in dry land areas and on degraded, eroded, gravely, saline and sodic wasteland. It is a dominant component of the natural vegetation in the Indian "Thar desert" and thrives well under a maximum annual temperature of 35-42°C and the minimum temperature of 4-12°C. The plant can tolerate temperatures as high as 49-50°C and as low as -2°C. However, growth and development of the plant is affected at both the extremes (Awasthi *et al*., 2007).

Ziziphus jujube, commonly known as Ber, Chinese date, or Chinese apple is a remarkable fruit with a rich history of cultivation and consumption. Native to a region stretching from India to China, Ber belongs to the Rhamnaceae family and is cherished for its sweet flavor, versatility, and numerous health benefits. Ber is highly valued for its nutritional content, being a good source of vitamins, minerals, and antioxidants. Its adaptability allows it to thrive in diverse growing conditions, making it a staple fruit in many regions. Ber can be enjoyed fresh or used

in jams, jellies and traditional medicines. Its use in Ayurvedic and other traditional healing practices highlights its role beyond nutrition, addressing ailments ranging from digestion issues to skin health. While Ber has deep roots in Indian agriculture, its cultivation has spread globally, including regions in Iran, Syria, Australia, the USA, France, Italy, Spain, and various African countries. This global reach underscores its economic and agricultural significance. In India, Ber is widely cultivated, particularly in Uttar Pradesh, where districts like Varanasi, Mirzapur, Sonbhadra, Jaunpur, Aligarh, Ayodhya, Agra and Raebareli are prominent producers. These areas benefit from Ber's adaptability and contribute significantly to local agricultural economies. Though sometimes perceived as a "poor man's fruit," this notion varies by region, and Ber's growing recognition for its health benefits and taste continues to enhance its reputation. Ber's resilience to harsh growing conditions and its wide-ranging uses make it a valuable crop in addressing food security and nutrition challenges. Its expanding cultivation area reflects its increasing global appeal and economic importance.

Ber (*Ziziphus*) has a rich genetic diversity due to natural cross-fertilization and self-incompatibility (Bhargava *et al.*, 2005). There hasn't been a significant effort to classify and characterize these genotypes based on vegetative and leaf traits. While many Ber cultivars have been identified, none of them possess all the desired attributes. The present study aims to categorize and characterize the morphological traits of Ber leaves genotypes to facilitate variety evaluation and proper identification. In essence, the underscores the importance of research and development efforts to create improved Ber varieties that meet various criteria for quality and resilience.

The evaluation of germplasm serves as a crucial initial step in any crop improvement program. It provides foundational information on the traits and potential of the germplasm, enabling breeders to make informed decisions before advancing to the next stages of breeding. Understanding the interrelationships among quantitative traits of economic importance, such as yield, quality, and other agronomic characteristics, is essential for improving complex traits through selection (Meena *et al*., 2019).

Materials and Methods

The experimental material consists of 40 indigenous Ber trees, that were identified from different locations of the Bemetara, Berala, Navagaon and Saja blocks in Bemetara district of Chhattisgarh under study. The experiment was conducted in Linear mixed effect statistical model design with inclusion of four different soil types. These indigenous Ber trees were morphologically characterized for their tree and leaf parameters which involves the observations of fruit maturity group, bearing habit bunching, fruit shape apex, mature fruit shape, mature fruit colour, pulp texture, stone shape apex and stone shape as per the key descriptor of *Ziziphus mauritiana*, Food and Agriculture Organization of the United Nations.

Results and Discussion

Fruit maturity group

Fruit maturity group of all forty indigenous Ber trees classified into three categories *viz.*, early, mid and late (Table 1). Among the 40 indigenous Ber trees, 30 indigenous Ber trees recorded early (Tree-2, Tree-3, Tree-4, Tree-6, Tree-7, Tree-8, Tree-9, Tree-10, Tree-12, Tree-13, Tree-14, Tree-15, Tree-16, Tree-18, Tree-19, Tree-20, Tree- 21, Tree-23, Tree- 24, Tree-25, Tree-27, Tree-28, Tree-29, Tree-30, Tree-31, Tree-32, Tree-34, Tree-35, Tree-37 and Tree-39) whereas, remaining 10 indigenous Ber trees had recorded mid group (Tree-1, Tree-5, Tree-11, Tree-17, Tree-22, Tree- 26, Tree-33, Tree-36, Tree-38 and Tree-40).

The largest proportion of fruit maturity group was noticed in early group with 75.00 percent and lowest in late group with 25.00 percent (Fig. 1).

Numerous researchers have studied Ber and documented the occurrence of variation in fruit maturity group (Kamble *et al.*, 2023 and Rai *et al.*, 2023).

Bearing habit bunching

Bearing habit bunching was classified into two categories *viz.*, absent and present (Table 1). Among the 40 indigenous Ber, 34 indigenous Ber tree observed absent (Tree-1, Tree-2, Tree-3, Tree-4, Tree-6, Tree-7, Tree-8, Tree-9, Tree-10, Tree-11, Tree-12, Tree-13, Tree-15, Tree-16, Tree-17, Tree-18, Tree-19, Tree-20, Tree-21, Tree-22, Tree-23, Tree-24, Tree-25, Tree-26, Tree-27, Tree-28, Tree-29, Tree-32, Tree-34, Tree-35, Tree-37, Tree-38, Tree-39 and Tree-40) while the 6 indigenous Ber tree had bunching (Tree-5, Tree-14, Tree-30, Tree-31, Tree-33 and Tree-36).

The highest number of indigenous Ber tree were belong to non- bunching with 85 percent followed by lowest proportion bunching present with (15 percent) (Fig. 1). Several researches have noted variations in the morphological fruit bunching of Ber Godi *et al.* (2015) and Kamble *et al.* (2023).

Fruit shape apex

Fruit shape apex was classified into three categories *viz.*, flat, round and pointed (Table 1). Among the 40

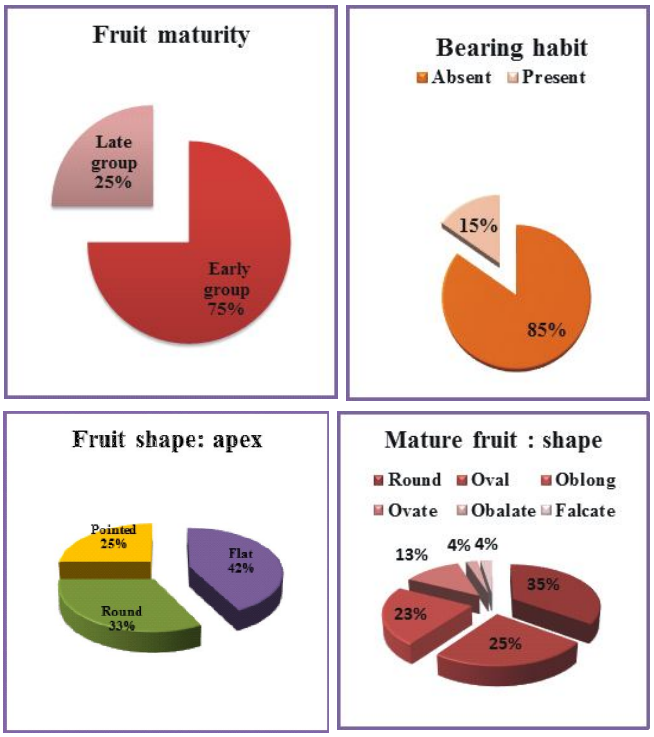

Fig. 1 : Morphological characters of fruits parameters of various indigenous Ber.

indigenous Ber recorded 16 Ber tree was flat shape fruit apex (Tree-4, Tree-7, Tree-8, Tree-12, Tree-13, Tree-16, Tree-19, Tree-20, Tree-23, Tree-24, Tree-25, Tree-26, Tree-30, Tree-31, Tree-38 and Tree-39) followed by Ber 14 Ber tree round shaped apex (Tree-1, Tree-2, Tree-3, Tree-6, Tree-9, Tree-10, Tree-11, Tree-14, Tree-15, Tree-17, Tree-27, Tree-34, Tree-35 and Tree-40) and 10 Ber tree was pointed shape fruit apex (Tree-5, Tree-18, Tree-21, Tree-22, Tree-28, Tree-29, Tree-32, Tree-33, Tree-36 and Tree-38).

The maximum number of indigenous Ber were belongs to flat shape fruit apex was noticed in flat shape with 42.50 percent followed by round shaped (32.50 percent) and lowest proportion in pointed shape with 25.00 percent (Fig. 1). Similar results were also noted by Godi *et al.* (2015), Akter and Rahman (2020) and Kumar and Tripathi (2024) in Ber.

Mature fruit shape

Mature fruit shape for forty indigenous Ber trees was classified into six categories *viz.*, oblong, oval, ovate, oblate, round and falcate (Table 1). Among the 40 indigenous, 9 indigenous Ber trees recorded oblong (Tree-1, Tree-3, Tree-6, Tree-9, Tree-10, Tree-14, Tree-15, Tree-17 and Tree-28), 10 indigenous Ber trees had recorded oval (Tree-2, Tree-11, Tree-13, Tree-19, Tree-21, Tree-24, Tree-34, Tree-35, Tree-38 and Tree-40), 5 indigenous Ber trees had recorded ovate (Tree-18, Tree-22, Tree-29, Tree-32 and Tree-36), 1 indigenous Ber trees recorded oblate (Tree-5), while 14 indigenous Ber trees recorded round (Tree-4, Tree-7, Tree-8, Tree-12, Tree-16, Tree-20, Tree-23, Tree-25, Tree-26, Tree-27, Tree-31, Tree-32, Tree-38 and Tree-40 and remaining 1 indigenous

Table 1 : Morphological characters of Ber fruits (Pooled analysis).

Indigenous Ber trees	Fruit maturity group	Bearing habit	Fruit shape apex	Mature fruit shape
Tree-1	Mid	Absent	Round	Oblong
Tree-2	Early	Absent	Round	Oval
Tree-3	Early	Absent	Round	Oblong
Tree-4	Early	Absent	Flat	Round
Tree-5	Mid	Present (2-3)	Pointed	Oblate
Tree-6	Early	Absent	Round	Oblong
Tree-7	Early	Absent	Flat	Round
Tree-8	Early	Absent	Flat	Round
Tree-9	Early	Absent	Round	Oblong
Tree-10	Early	Absent	Round	Oblong
Tree-11	Mid	Absent	Round	Oval
Tree-12	Early	Absent	Flat	Round
Tree-13	Early	Absent	Flat	Oval
Tree-14	Early	Present (2-3)	Round	Oblong
Tree-15	Early	Absent	Round	Oblong
Tree-16	Early	Absent	Flat	Round
Tree-17	Mid	Absent	Round	Oblong
Tree-18	Early	Absent	Pointed	Ovate
Tree-19	Early	Absent	Flat	Oval
Tree-20	Early	Absent	Flat	Round
Tree-21	Early	Absent	Pointed	Oval
Tree-22	Mid	Absent	Pointed	Ovate
Tree-23	Early	Absent	Flat	Round
Tree-24	Early	Absent	Flat	Oval
Tree-25	Early	Absent	Flat	Round
Tree-26	Mid	Absent	Flat	Round
Tree-27	Early	Absent	Round	Round
Tree-28	Early	Absent	Pointed	Oblong
Tree-29	Early	Absent	Pointed	Ovate
Tree-30	Early	Present (3-4)	Flat	Round
Tree-31	Early	Present (2-3)	Flat	Round
Tree-32	Early	Absent	Pointed	Ovate
Tree-33	Mid	Present (2-3)	Pointed	Falcate
Tree-34	Early	Absent	Round	Oval
Tree-35	Early	Absent	Round	Oval
Tree-36	Mid	Present (2-3)	Pointed	Ovate
Tree-37	Early	Absent	Pointed	Oval
Tree-38	Mid	Absent	Flat	Round
Tree-39	Early	Absent	Flat	Round
Tree-40	Mid	Absent	Round	Oval

Ber trees recorded falcate (Tree-33).

The largest proportion of fruit shape was noticed in round group with 35 percent followed by oval (25 percent), oblong group with 22.50 percent, ovate group with 12.50 percent and smallest in obalate group and falcate group with 2.5 percent and 2.5 percent (Fig. 1). Similar results were also recorded by Kamble *et al*. (2023) and Nikmatullah *et al.* (2023) in Ber.

Mature fruit colour

Mature fruit colour for forty indigenous Ber trees was classified into three categories *viz.*, yellow, greenish yellow and chocolate brown (Table 2). Among the 40 indigenous Ber trees, 11 indigenous Ber trees recorded yellow (Tree-2, Tree-4, Tree-6, Tree-7, Tree-13, Tree-14, Tree-20, Tree-27, Tree-28, Tree-34 and Tree-38), 7 indigenous Ber trees had recorded greenish yellow (Tree-8, Tree-9, Tree-10, Tree-11 Tree-24, Tree-32 and Tree-37) and remaining 22 indigenous Ber trees recorded chocolate brown (Tree-1, Tree-3, Tree-5, Tree-12, Tree-15, Tree-16, Tree-17, Tree-18, Tree-19, Tree-21, Tree-22, Tree-23, Tree-25, Tree-26, Tree-29, Tree-30, Tree-31, Tree-33, Tree-35, Tree-36, Tree-39 and Tree-40).

The largest proportion of fruit color was noticed in chocolate brown group with 57.50 percent followed by yellow (25 percent) and smallest in greenish yellow group with 17.50 percent (Fig. 2).

Uddin *et al*. (2021) observed the fruit colors of Ber named with species *i.e.*, *Ziziphus nummularia*, yellow-red and red-brown in 29 percent genotypes. Brown in 24 percent genotypes. Red in 18 percent genotype while Yellow in 20 percent genotypes. Similar results were also obtained by Kamble *et al.* (2023) in Ber.

Pulp texture

Pulp texture of forty indigenous Ber trees was classified into three categories *viz.*, soft, medium and hard (Table 2). Among the 40 indigenous Ber trees, 18 indigenous Ber trees recorded soft (Tree-1, Tree-3, Tree-4, Tree-11, Tree-13, Tree-14, Tree-15, Tree-16, Tree-19, Tree-21, Tree-26, Tree-27, Tree-29, Tree-30, Tree-33, Tree-34, Tree-37 and Tree-39), whereas, 13 indigenous Ber trees had recorded medium (Tree-2, Tree-6, Tree-8, Tree-10, Tree-17, Tree-18, Tree-20, Tree-22, Tree-24, Tree-28, Tree-31, Tree-35 and Tree-40) and remaining 9 indigenous Ber trees recorded hard (Tree-5, Tree-7, Tree-9, Tree-12, Tree-23, Tree-25, Tree-32, Tree-36 and Tree-36).

The largest proportion of pulp texture was noticed in soft with 45 percent followed by medium (32.50 percent) and smallest in hard with 22.50 percent (Fig. 2).

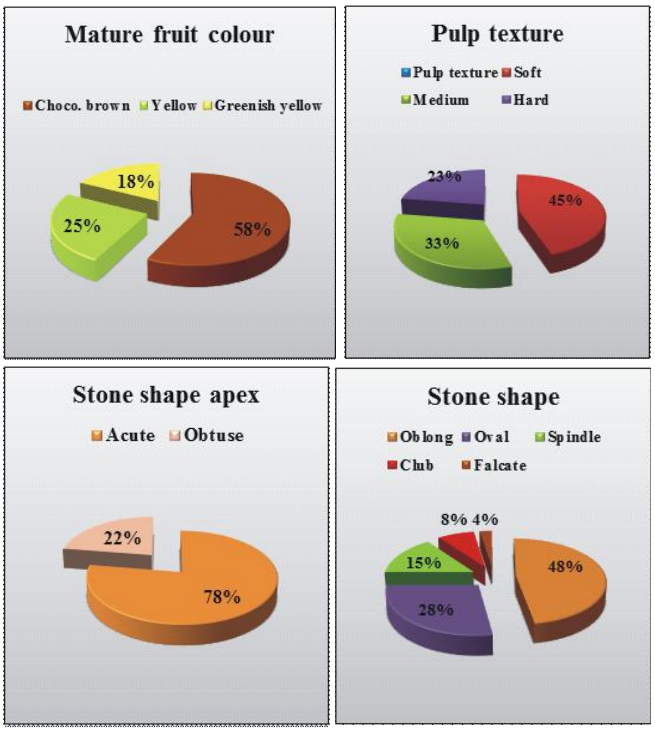

Fig. 2 : Morphological characters of fruits, pulp and seed parameters of various indigenous Ber.

Godi *et al.* (2015) studied the various Ber genotypes and noted the following pulp textures: Kala Gola and Chameli had as of texture and Kopargaon Selection had Granular texture while all others had medium texture. Similar results were also obtained by Kumar and Tripathi, (2024) in Ber.

Stone shape apex

Stone shape apex of forty indigenous Ber trees was classified into three categories *viz.*, acute and obtuse (Table 2). Among the 40 indigenous Ber trees, 28 indigenous Ber trees recorded acute (Tree-2, Tree-3, Tree-4, Tree-5, Tree-6, Tree-7, Tree-9, Tree-10, Tree-12, Tree-13, Tree-14, Tree-15, Tree-17, Tree-18, Tree-20, Tree-21, Tree-22, Tree-25, Tree-26, Tree-27, Tree-28, Tree-29, Tree-30, Tree-31, Tree-33, Tree-37, Tree-39 and Tree-40) and 12 indigenous Ber trees recorded obtuse (Tree-1, Tree-8, Tree-11, Tree-16, Tree-19, Tree-23, Tree-24, Tree-32, Tree-34, Tree-35, Tree-36 and Tree-38).

The largest proportion of stone shape: apex was noticed in acute with 77.50 percent followed by obtuse (22.50 percent) (Fig. 2). Godi *et al.* (2015) and Kumar and Tripathi, (2024) found similar inferences in Ber.

Stone shape

Stone shape of forty indigenous Ber trees was classified into five categories *viz.*, oblong, oval, spindle, club and falcate (Table 2). Among the 40 indigenous Ber

Table 2 : Morphological characters of fruits and seeds (Pooled analysis).

Indigenous Ber trees	Mature fruit colour	Pulp texture	Stone shape apex	Stone shape
Tree-1	Chocolate Brown	Soft	Obtuse	Oblong
Tree-2	Yellow	Medium	Acute	Oblong
Tree-3	Chocolate Brown	Soft	Acute	Oblong
Tree-4	Yellow	Soft	Acute	Club
Tree-5	Chocolate Brown	Hard	Acute	Spindle
Tree-6	Yellow	Medium	Acute	Oblong
Tree-7	Yellow	Hard	Acute	Oblong
Tree-8	Greenish Yellow	Medium	Obtuse	Oval
Tree-9	Greenish Yellow	Hard	Acute	Spindle
Tree-10	Greenish Yellow	Medium	Acute	Oblong
Tree-11	Greenish Yellow	Soft	Obtuse	Oval
Tree-12	Chocolate Brown	Hard	Acute	Spindle
Tree-13	Yellow	Soft	Acute	Oblong
Tree-14	Yellow	Soft	Acute	Club
Tree-15	Chocolate Brown	Soft	Acute	Spindle
Tree-16	Chocolate Brown	Soft	Obtuse	Oval
Tree-17	Chocolate Brown	Medium	Acute	Oblong
Tree-18	Chocolate Brown	Medium	Acute	Oblong
Tree-19	Chocolate Brown	Soft	Obtuse	Oval
Tree-20	Yellow	Medium	Acute	Oblong
Tree-21	Chocolate Brown	Soft	Acute	Oblong
Tree-22	Chocolate Brown	Medium	Acute	Oblong
Tree-23	Chocolate Brown	Hard	Obtuse	Oval
Tree-24	Greenish Yellow	Medium	Obtuse	Oval
Tree-25	Chocolate Brown	Hard	Acute	Oblong

Table 2 continued...

Table 2 continued...

Indigenous Ber trees	Mature fruit colour	Pulp texture	Stone shape apex	Stone shape
Tree-26	Chocolate Brown	Soft	Acute	Oblong
Tree-27	Yellow	Soft	Acute	Oblong
Tree-28	Yellow	Medium	Acute	Club
Tree-29	Chocolate Brown	Soft	Acute	Oblong
Tree-30	Chocolate Brown	Soft	Acute	Oval
Tree-31	Chocolate Brown	Medium	Acute	Oblong
Tree-32	Greenish Yellow	Hard	Obtuse	Oval
Tree-33	Chocolate Brown	Soft	Acute	Falcate
Tree-34	Yellow	Soft	Obtuse	Oval
Tree-35	Chocolate Brown	Medium	Obtuse	Oblong
Tree-36	Chocolate Brown	Hard	Obtuse	Oval
Tree-37	Greenish Yellow	Soft	Acute	Spindle
Tree-38	Yellow	Hard	Obtuse	Oval
Tree-39	Chocolate Brown	Soft	Acute	Oblong
Tree-40	Chocolate Brown	Medium	Acute	Spindle

trees, 19 indigenous Ber trees recorded oblong (Tree-1, Tree-2, Tree-3, Tree-6, Tree-7, Tree-10, Tree-13, Tree-17, Tree-18, Tree-20, Tree-21, Tree-22, Tree-25, Tree-26, Tree-27, Tree-29, Tree-31, Tree-35 and Tree-39), whereas, 11 indigenous Ber trees recorded oval (Tree-8, Tree-11, Tree-16, Tree-19, Tree-23, Tree-24, Tree-30, Tree-32, Tree-34, Tree-36 and Tree-38), 6 indigenous Ber trees recorded spindle (Tree-5, Tree-9, Tree-12, Tree-15, Tree-37 and Tree-40), 3 indigenous Ber trees recorded club (Tree-4, Tree-14 and Tree-28) and remaining 1 indigenous Ber trees recorded falcate (Tree-33).

The maximum number of indigenous Ber tree were found in oblong with 47.50 percent, followed by oval with 27.50 percent, spindle with 15 percent, club with 7.5 percent while indigenous Ber with falcate with 2.5 percent (Fig. 2).

Raja (2004) recorded the stone shape of various Ber genotypes. He found oblong oval shape in Genotype G-4 and elliptical shape found in Genotype G-7. In the rest of

the genotypes grooved stone surface was noted. Akhter and Rahman (2020) found similar inferences in Ber.

Conclusion

The study mentioned focused on the analysis of various qualitative characteristics of fruits in different indigenous Ber (*Ziziphus mauritiana* Lamk). The research revealed significant variations in several aspects of fruit morphology, which can be used to distinguish between different indigenous Ber of this fruit crop. In this study found that the mature fruit shapes varied significantly among different indigenous Ber. Some had oblong leaves, while others had oval to oblong or obovate leaves. The apex of the fruit was flate shape, round and pointed shapes. The stone apex had rounded apexes, while others had obtuse ones. The study measured various characteristics related to fruits, including maturity, shape and color and stone apex and stone shape. The findings of this study indicate that *Ziziphus mauritiana* has a wide range of variations in its indigenous Ber, making it a potential fruit crop for arid regions. The fruit morphological characteristics were shown to be indigenous Ber and associated with variations fruits, including maturity, shape and color and stone apex and stone shape. These characteristics can serve as a reliable basis for identifying and distinguishing between different indigenous Ber *Ziziphus mauritiana*. This information is valuable for growers and researchers involved in the cultivation and breeding of this fruit crop.

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