PRESENT STATUS OF BER PRODUCTION AND FUTURE THRUSTS IN INDIA- A REVIEW

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ABSTRACT

The ber (Zizyphus mauritiana) is an important fruit crop for arid and semi arid regions in tropical and sub tropical regions. Its origin is India. It is known for its ability to withstand adverse conditions. It is truly a desert apple of Thar Desert. It can be processed to prepare murabba, pulps, jam and beverage. Z. mauritiana cultivated in the tropical and subtropical regions of Indian regions. The commercial method of vegetative propagation is by budding. The best method widely adopted is shield budding (T or I budding). Success in micro propagation of ber in vitro from stem explants of mature tree was reported. Leguminous crops are preferred as intercrop. Ber fruits followed a double sigmoid growth curve. Fruits having a specific gravity of <1 were considered to be ready to harvest. Powdery mildew is the most serious disease of ber and causes heavy losses.

Keywords: Ber, Importance, Species, Varieties and Future planning.

The ber (Zizyphus mauritiana) is an important fruit crop for arid and semi arid regions in tropical and sub tropical regions. It belongs to the family Rhamnaceae. It is mainly grown in India and other countries in central Asia, China and Taiwan. It is more associated with the Indian culture since ancient times. It is cultivated widely for its resistance to grow in drought and other diversified soil and climatic conditions. Its origin is in India. It is a hardy tree that copes with extremes temperature and thrives under rather dry conditions. Fruit quality is best under hot, sunny and dry conditions, but there should be a rainy season to support growth and flowering, leaving enough soil moisture to carry the fruit to maturity. Commercial cultivation usually extends upto 1000 m above sea level. It is known for its ability to withstand adverse conditions, such as salinity, drought and waterlogging. It has also been mentioned in holy books like Ramayana and Mahabharata. In view of the recent development in production technology of this crop, the cultivation of ber crop is becoming increasing popular in many parts of India. It is an ideal fruit tree for arid and semi arid regions of the country. The Rajasthan, Haryana, U.P, Gujarat, M.P, Bihar, Maharashtra A.P and T.N. It occupied an area of 8.7 Lac ha with an annual production of 8.9 lac tones in India. Present work is an effort to view the present status of ber production and future thrusts in India.

Botanic description: It is a spiny evergreen shrub or tree upto 15m high, with trunk 40 cm or more in diameter, spreading crown, stipular spines and many drooping branches. It grows vigorously and has a rapidly developing tap root. The leaves are about 2.5 to 3.2 cm long and 1.8 to 3.8cm wide having fine tooth at margin. The flowers are borne or the current season growth in leaf axil, the inflorescence is cymose, each cyme containing 15-28 flowers. The flowers are pale white pentamarous, stamens attached to petals. Stigma becomes receptive at the time of anthesis and remains receptive 12 hrs after anthesis. It is a cross pollinated crop, the main pollinator being Physiophora sp. Most of the cultivars are self compatible but some times due to lack of pollinators, the fruit set is poor. Application of GA, NAA at different concentrations (10-50 ppm) were found to be effective for increasing fruit set. The fruit is berry with single stone. The shape of the fruit may vary from round to oblong, ovate, oval with skin smooth or rough, glossy, thin but tough. Fruits are...
first green turning yellow as they ripen. The fully mature fruit is entirely red, soft juicy with wrinkled skin and has pleasant aroma. The styler end of the fruit may be round, flat with depression, obliquely beaked, pointed and bluntly tapering depending on the cultivar. Stem end may be grooved or smooth. Weight of the fruit varies from 20 to 50g.

**Nutritive and medicinal value:** Although, the Ber is called as poor man’s fruit, it is nutritious and delicious and is usually eaten fresh. Chattopadhyay (2007) reported that fruit contain 80-100 mg of ascorbic acid per 100g of pulp, 5.4-10.5g of sugar with TSS of 12-18º Brix, protein (0.8 g), energy (24.76 KJ), carbohydrate (17g), Thiamine (Vit.B1) (0.02-0.024 mg), Riboflavin(Vit.B2) (0.02-0.038 mg), Niacin (Vit.B3) (0.7-0.873 mg), Calcium (25.6 mg), Iron (0.76-1.8 mg), Phosphorus (26.8mg). Fruits are also eaten dried, candied. It can be processed to prepare murabba, pulps, jam and beverage. Raja, (1985) observed a maximum TSS of 20% in cv. Illaichi.

Besides fruit, different parts of plant like root, bark, leaves, flowers, seeds etc. are used in Ayurvedic and yunani medicines for treatment of diarrhoea, ulcer, billousness, indigestion, cough, headache, bleeding of gums, asthma etc. It is also blood purifier and appetizer.

**Crop improvement**

**(a) Genetic diversity:** The original home of *Zizyphus mauritiana* is India, while China is the home of *Zizyphus vulgaria*. The ber belongs to the genus Zizyphus having more than 600 species of which 18-20 are native of India. Singh and Arora, (1978) listed eight species having edible fruits found in different parts of India. The Z. apetala, Z. funiculosa and Z. incurva occur in north eastern hills. Z.mauritiana and Z. nummularia all over the dry regions particularly in North West India and U.P. Z. oenoplia and Z. rugosa particularly in central and eastern India and Z. vulgaris grows naturally in the North Western Himalayas. Z. rupicola is found in central and Eastern India and Z. xylocarpus in M.P. and Peninsular region as reported by (Pareek, 1988). Z. mauritiana is the most important fruit species being cultivated in the tropical and subtropical regions of India. Fruits of Z. nummularia and Z. rotundifolia are edible and the latter is used as rootstock. Although Z. nummularia and reported by (Vashishtha, 1982), Z. rotundifolia forms a tree even if it is headed back whereas Z. nummularia forms a bush.

**(b) Germplasm Conservation:** Several ber germplasm including species,cultivars have also been collected at different stations in the country and are being maintained in the field gene bank centres of CIAH, Bikaner; NBPG, Jodhpur; MPKV, Rahuri; CSSHAU,Hisar; CAZRI Jodhpur, G.AU S.K Nagar. At CIAH, Bikaner highest collections (338) have been made in the National Field Repository.

**(c) Improvement approach:** A large number of cultivars are cultivated in India. Attempts were made by Vashishtha and Pareek, 1989 in formulating keys to identify ber cultivars based on vegetative and fruit characters. As cross pollination is a rule in ber, it gave natural hybrids with wide genetic base. This wide genetic base was further augmeneted by polyploidy and thus creating large variability. Very little attempts have been made in cultivar improvement through hybridization. However, the germplasm has been screened at various research institutes and universities to identify location specific cultivars. Vashistha and Pareek (1983 ) attempted reciprocal crosses of Seb, Gola, Sanaur 2, Katha and Umran.

**(d) Variety Improvement:** In ber there is superior several quality cultivars with high yields recommended for commercial cultivation. More than 80 cultivars were evaluated for their suitability to grow under varying rainfall conditions (150-500mm) at CAZRI Jodhpur as reported by (Pareek and Vashishtha, 1983). Cultivars Seb, Gola and Mundia have been recommended for growing under rainfall conditions in regions having as low as an average rainfall of 150 mm because of their short period of fruit growth. Cultivar Gola is earliest in fruit ripening (end of December) followed by Seb and Mundia three week later. Umran is a late ripening cultivar, therefore, not suitable for rainfed areas having less than 500mm rainfall. The commercial cultivars grown in different states of India are presented in table.
### Some of varieties are described here under:

**Gola:** This is an early variety and very popular in Delhi, Haryana and other adjoining areas. The fruit is ovate to round in shape and size of fruit is medium. It develops greenish to golden yellow colour at ripening stage. The quality of fruit is excellent. The average fruit weight varies from 15-20g, yields upto 85 kg/tree.

**Seb:** Tree spreading, leaves ovate to ovate oblong in shape. Fruit round, resembling crab-apple. Fruit light pinkish yellow with occasional specks at maturity, skin slightly rough. Yield upto 85 kg/tree.

**Selected Safeda:** This early variety is popularly grown in Haryana and Punjab. The fruit is almost round in shape and medium in size. The fruit is sweet, fleshy and develops golden yellow to greenish yellow colour at ripening stage. The average weight of fruit varies from 25-30g. The variety is resistant to powdery mildew.

**Kaithli:** Mid season variety and popularly grown in Punjab & Haryana. The shape of fruit is oval to oblong and medium in size. The fruit on its maturity develops greenish yellow to golden yellow colour. The weight of the fruit varies from 25-30g, sweet to taste and thin skinned. Yields upto 125 kg/tree.

**Sannaur:** This mid season variety is popular in Punjab and Haryana. The fruit is oval to oblate in shape and medium in size. The fruit on its maturity or ripening stage develops golden yellow colour. The yield of this variety is good and keeping quality is appreciable. The fruits can stand long distance transport and is also resistant to fruit flies. Yields upto 200 kg/tree.

**Meharun:** This mid season variety is famous in Gujarat. The fruit is ovate to oval in shape and medium in size. The fruit reaches light yellow to greenish yellow colour on maturity. The average weight of fruit ranges from 20-25g and the variety is resistant to fruit flies.

**Banarasi Kadaka:** This is very popular mid season variety of Uttar Pradesh. The fruit is oblong to long in shape and large in size. The average weight of fruit is 40-50g and it develops light yellow to yellow colour on maturity. Yields upto 125 kg/tree.

**Umran:** This is a late season variety and famous in Punjab & Haryana. The fruits are oval to elliptical in shape and large in size. The weight of the fruit varies from 35-40g. The fruits on its maturity or ripening stage develops golden yellow colour. The yield of this variety is good and keeping quality is appreciable. The fruits can stand long distance transport and is also resistant to fruit flies. Yields upto 200 kg/tree.

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*Navjot et al. (2007) recorded fruit yield was in Muria murhera (60.8 kg/tree) followed by Umran (59.8 kg/tree). The fruit weight was maximum in Umran (27.3 gm). Fruit length and fruit breadth varied from 3.3 to 5.5 and 2.2 to 3.6 cm. Pulp: stone ratio was maximum in Umran. The TSS ranged from 14.3 to 19.2 per cent among various varieties. The maximum TSS (19.2%) and the minimum acidity (0.25%) were recorded in Chhuhara. The acidity was maximum (0.788%) in Katha Phal. Dalal et al. (2008) found that fruit firmness, TSS, acidity and ascorbic acid content were 5.90-12.33 kg/cm², 12.10- 17.03° Brix, 0.19-1.37% and 46.65-106.52 mg/100 g fruit pulp, respectively. The fruit firmness value was lowest for Akhrota (5.90) and highest in Umran (12.33). Ilaiachi, Umran, Chhuvara, Murhara and Sanori Nos.1, 3 and 5 had the highest TSS content (17.16%), whereas Govindgarh Special, Hybrid, Triloki No.1, Narma and Thornless had the lowest (12.13%). Desi was characterized by the highest level of acidity (1.37%); Umran, Kaithali and ZG-3 showed the lowest levels of acidity*
(0.19%). Kathaphal, Chinese, Laddu and Sanori No. 3 also registered high levels of acidity (0.683-0.406%). The ascorbic acid content was highest in Sanori No.1, Ililaichi Jhajjar and Umran (102.07-106.52 mg/100 g pulp), and lowest in Desi (46.56 mg/100 g pulp), followed by Hsangtasao, Akhrota, Laddu, Chinese, Collar and Narma.

**Soil and Climate:** The ber is peculiar for its ability to grow on wide range of soils. It can grow successfully even under unfavorable climatic conditions. It can grow well up to a height of 100m above sea level. Plants can tolerate pH > 9 and soil or water salinity to a limited extent. Studies at central soil salinity research Institute, Karnal, India have revealed that ber can also be grown satisfactorily in alkali soils characterized by High pH and sodicity. In such soils, it was suggested to mix 5 kg gypsum per pit followed by flooding about one week before planting. However, sandy loam soils with neutral or slightly alkaline reaction make good growth of ber plants. Normally ber prefers drier climate for good quality of fruits but it can also be grown well under tropical and subtropical zones of the country. Ber is highly drought tolerant. The trees can withstand to extreme high temperatures. Some of the species of ber are also found growing in foot hills of temperate regions. However temperature below freezing point is injurious to fruits as well as to the young plants. The areas receiving annual rainfall of 400-650mm are ideal for its cultivation.

**Propagation:** Old plantations in India are seedling trees, which bear fruits of inferior quality and of wide variability. The vegetative propagation has overcome this problem. The commercial method of vegetative propagation is by budding. Other methods like cuttings have been tried and their success recorded.

**Cuttings:** Shen *et al.*, (1992) also reported that treatment of green wood cuttings of jujube with 250-500ppm IBA, 250-500 ppm NAA resulted in 85% rooting in sand and high percentage of survival.

**Budding:** It has been found to be the best method of ber propagation. Different type of budding e.g. T budding, ring, patch and forkerst budding etc. have been tried but the best method which is widely adopted is shield budding (T or I budding) as observed by (Pareek, 1978). The ring budding is cumbersome, as it requires equal freshness and thickness of stock and scion. *Z. nummularia* is slow in growth and if used as rootstock, forms an inverted bottle incompatibility. There is a danger of breaking at bud union where wind velocity is high. Therefore, the most widely used rootstock is *Z. rotundifolia* locally known as Bordi. The time of budding depends mainly on temperature, humidity and availability of budding material. According to (Pareek, 1983) the best time for budding in Western Rajasthan is in July. Singh *et al.* (2004) revealed that the total investment is very high (Rs. 35,476.05), but a net profit of Rs 32 023.95 can be earned provided there is a guaranteed sale of plants at a reasonable price of Rs. 10 per budling. On a per acre basis, a net profit of Rs. 262 483.60 can be obtained by raising ber budlings. Ghosh (2009) found that the cultivars ‘Ililaichi’ and ‘Gola’ showed the best compatibility with the local rootstock as it resulted in 100% success with maximum in budling growth while ‘Banarasi Karaka’ gave lowest of 70%. The study indicated that the budded scion of Banarasi Karaka performed best in open condition than under shade-net. Results indicated that the month of May, June and September were the best for in situ budding as it showed cent percent success with maximum plant growth while for polybags grown seedlings in the nursery, May and June were best months with 75 to 85% success.

**Rootstocks:** *Zizyphus mauritiana* cv. Umran was budded on 12 rootstocks (Five *Z. mauritiana* accessions obtained from different regions of India, Chinese, *Z. jujuba*, Argentinian *Z. zoaziroo*, Indian *Z. Xylopyrus* and four accessions of *Zizyphus nummularia* from different regions of India as reported by (Bal *et al.*, 1997). Umran on *Zizyphus mauritiana* rootstock was the most vigorous and produced the highest yields of fruits (Cumulative yield was 115-146 kg/tree).

**Raising of seedlings:** Mankar *et al.* (1997) found that soaking extracted seeds for 24 hrs in water promoted early germination, good vegetative growth and higher percentage germination compared with control (sowing whole seeds). Cracked seeds exhibited better germination than control seeds, but were not as good as water treated seeds. By conventional method, it used to take about 13 months to raise budded plants. While planting, high mortality was observed in the field because of the damage caused to the tap root, which had gone deep.
Seedlings are raised in situ, but these may be raised in polythene bags also. Seedling raised in polythene bags are budded and thereafter transplanted to desired place. The seedlings are budded when 90 days old in July and seedlings are ready for planting a month earlier.

**Top working**: Top working in wild jujube (Z. nummularia) by T budding of cv Gola was reported by Yadav, 1991.

**Micropropagation**: Toxin resistant cell lines against *Fusarium oxysporum* and *Colletotrichum* species were also developed in Z. rotundifolia rootstock as observed by Raj Bhansali, 1999. The proliferated shoots were subsequently transferred for rooting, but no root initiation occurred in any treatments. Instead, callus originated at the base of each shoot. In leaf explants, high callussing was obtained on medium supplemented with 0.25 mg IBA/litre and 2.5 mg BA/litre. Callus obtained from both the explants was transferred to shoot regeneration medium after 40 days, but no shoot differentiation occurred, though calluses maintained a high rate of growth. Singh et al. (2010) found that shoot tip explant was found to be better than nodal and internodal explants. The plant growth regulator BAP (2.0 mg/l), NAA (0.1 mg/l) and GA$_3$ (0.1 mg/l) were judged best for shoot proliferation considering sprouting percentage, number of shoots, shoot length and leaf area. IBA (2.0 mg/l) resulted in best treatment for root induction percent, root regeneration, days to root initiation, root number and root length; 2,4-D (2.0 mg/l) proved to be best for callus initiation and root induction from callus. BAP (2.0 mg/l), NAA (0.1 mg/l) and GA$_3$ (0.1 mg/l) were found to be best treatment.

**Planting**: The planting of ber in India is done in square system. The spacing adopted is 6x6m in rainfed areas and 7x3m and 8x8m in irrigated orchards for larger canopy. In Punjab and Haryana, the best time of planting ber is Feb-March or in the monsoon during July to September.

**Irrigation**: Water conservation is an important aspect of fruit production under rainfed condition in arid areas. For establishment of young seedling in the field, a double walled pot known as Jaltripiti has found to save 75 percent irrigation water as observed by (Gupta et al. 1991). The plant is planted in the inner pot (hollow at both the ends) and the water is filled in the outer pot (sealed at the bottom). Since the pot is made of clay, water seeps through the wall of inner pot and thus available to the plants. The growth of plants grown in Jaltripiti was better than those planted directly in the pit. Ber plants have deep tap root system and Xerophytic nature and once it gets established, needs little care and irrigation. The harvesting of fruits is over by April and plants become dormant in May-June and shed their leaves. They do not need irrigation during the fruit maturation. Harvesting and dormancy of plants from March to June. Ber trees need irrigation from November to February for better fruit development.

**Training and Pruning**: Training of ber trees is essential during first 2-3yrs to build up a strong frame work. To develop a strong frame work, it is necessary to train the trees right from the nursery stage. The young plants transplanted in the field should be supported with bamboo stake to avoid damage of the bud union and to support main stem. If proper training of the ber is not done, it will attain a bushy and spreading form with long slender branches. More than one shoot emerge from the base of the stem causing overcrowding of branches and provide a condition suitable for the harboring of pests and diseases. Such trees are short lived and poor in productivity. Flowering and fruting in ber takes place on current season growth. The pruning is normally completed during mid to end of May (before the beginning of the growth season). The severity of pruning in irrigated orchards improved the fruit quality as observed by Bisla et al., 1991. Singh et al. (2004) found that fruit yield was recorded appreciably higher from plants pruned on 15th April and mean average yield was 180.3 kg per tree in cv. Sanaur 2. Early pruning advanced the date of flowering. The ber trees are deciduous and are in dormancy during May and June and level of reserve metabolites such as carbohydrates, starch and sugars is higher during this phase of dormancy. Pruning during this period can lead to more growth, higher fruit set, and greater yield. Any deviation from the time of pruning, phase of dormancy results in lower yield and poor quality fruits. Kumar et al 2002 observed that secondary branches of ber trees were pruned at 20 cm (light), 40 cm (medium) and 60-cm (severe) length. Severely pruned trees produced significantly lower fruit yields than the light pruned plants.
**Manuring and fertilization:** Mahendra et al. (2009) observed that maximum plant height, spread, trunk girth, fruit set and fruit retention was recorded with the soil application of recommended FYM + 100% NPK + Azotobacter + PSB closely followed by recommended FYM + 75% NPK + Azotobacter + PSB. The maximum improvement of soil nutrient status viz., organic carbon, N, P, K, Ca, Mg and minimum soil pH and EC with the soil application of FYM + 100% NPK + Azotobacter + PSB which was at par with FYM + 75% NPK + Azotobacter + PSB treatment, during both the years of experimentation. Hari-Dayal et al. (2010) observed that the nitrogen content was significantly influenced with the application of N in orchard soil. P, K and Zn content also increased but the results were not significant. The soil phosphorus was significantly influenced by the application of P, but it had no significant effect on N, K and Zn. The foliar application of zinc sulfate did not significantly influence the N, P, K and Zn content of soil. The yield of ber increased significantly with the application of N, P, and Zn sulfate.

**Weed control:** Bajwa et al., (1993) reported that all the weed control treatments i.e. Diuron, Glyphosate and Paraquat at 3-4 kg/ha decreased weed populations from untreated control values of 14.44-16.41 plants/m² to 5.15-11.14 plants and increased crop yields from control values of 12.82 q/ha to 135-150 q/ha.

**Intercropping:** After planting ber plants, 4 to 5 years are required to cover the interspace between the trees. The interspace between the rows of plants can be utilized for growing intercrops. Generally, leguminous crops are preferred as intercrop as they enrich the soil in addition to some income. The effect of intercropping in ber cv. Seb with different crops (Cluster beans cv. Maru, Moong bean cv. S-8 and Sesame cv. TC-25) during kharif season was studied by Singh, 1997. He reported that initial fruit yield in the intercropped orchard increased 3 times (14.8 kg/tree) compared with the control (5.2 kg/tree). Intercropping in a newly planted ber orchard had no adverse effects on plant growth for upto 5 years. Under irrigated hot arid ecosystem Saroj et al. (2003) reported that ber + cluster bean-mustard is a compatible combination with respect to sustainable yield, optimum returns, multiple outputs and improvement of site conditions.

**Rejuvenation of old orchards:** Pandey (1999 b) reported that a 30-year-old ber orchard of cultivars, Banarasi Karaka, Pewandi and Local Kanpur were rejuvenated by heading back to a height of 180 cm above ground level on 25 May, 1991. Weeds were controlled and manure and fertilizers were applied. Ber plants responded well to this treatment. The number of primary and secondary shoots was highest in cv. Local. The length and thickness of primary shoots were also greatest in this cultivar. Flowering started in Local on 14th September, in Banarasi Karaka on 20th September and in Pewandi on 24th September. Average leaf area was greatest in Pewandi (34.53 cm²) followed by Banarasi Karaka (29.30 cm²) and Local (13.05 cm²).

**Flowering, floral biology and fruit set:** The time of flowering varies in different parts of India and different regions in other countries and it is influenced by climatic conditions. The life of individual flower is very short and in an inflorescence many flowers remain unpollinated during their receptive periods. Flowering occurred about 21 days from early bud development and length of flowering ranged from 57 to 75 days, depending on cultivar. The mode and time of anthesis was also cultivar specific. Anther dehiscence started about 2 h after anthesis and continued for 2-4 h. Peak receptivity of the stigma appeared to be just as the flower opened.

**Fruit growth and development:** Extensive investigations have been carried out for the physical and biochemical changes in growth and development of ber fruits. Ber fruits followed a double sigmoid growth curve. Fruits having a specific gravity of <1 were considered to be ready to harvest; organolpetic tests assisted in judging maturity. Angamuthu et al. (2004) observed that maximum fruit set was obtained with Ilaichi as polleniser. Low fruit set was recorded in Tikdi. Fruit set increased with the application of IAA at 100 ppm but decreased with IAA at 200 ppm. IAA also removed cross incompatibility, as IAA-treated Tikdi and Ilaichi set fruits in crosses with Gola and Banarasi. IAA treatment increased fruit retention and decreased fruit drop in all crosses.
**Pests**

**Fruit fly:** Fruit fly is the most serious pest of ber. Infestation of fruit fly starts in September with the beginning of fruit set. The adult female lays eggs by inserting its oviposition in the growing fruits. After 2 to 5 days, larvae come out and feed on the pulp. Infested fruits become deformed, rotting may take place and a large number of affected fruits drop down.

**Bark eating caterpillar:** The caterpillar eats away the bark of the tree and severe damage reduces the yield. To control the pest, the exposed holes should be painted with 10 ml monocrotophos. Application of mixture of one litre kerosene oil and 100 g soap in 19 litres water has also been found effective.

**Hairy caterpillar:** The caterpillars feed on leaves in initial stages. The old caterpillars also feed on fruits and tender shoots and damage the trees. The caterpillars can be controlled with 0.05 percent methyl parathion.

**Diseases**

**Powdery mildew (Oidium sp.):** Powdery mildew is the most serious disease of ber and causes heavy losses as reported by Bose et al (2002). The disease appears during Oct.-Nov. when the temperature goes low and weather is humid (cloudy). Initially white spots of fungus appear on the leaves, fruits etc. In case of severe infestation the powdery mass spreads all over the surface of leaves and fruits. The fruits drop prematurely or become sunken. This results in reduction in yield.

**Sooty mould or black spot (Isariopsis sp.):** The symptoms of this disease are the appearance of black spots on the lower surface of the leaves and in advanced stages the lower surface may be curved by sooty mould and the leaves may drop down as reported by Bose et al (2002).

**Harvesting and yield:** Ber plants start fruiting after first year of plantation in budded plants while seedling plants take 3-4 years to come to fruiting. However, commercial production starts from third year onwards, hence the first year fruiting should not be allowed. The fruits of ber do not mature after harvesting. It is therefore, essential to harvest the fruits at an optimum stage of maturity. Usually, the maturity is judged by external colour of fruits, specific gravity, climatic conditions and management practices. Though harvesting is difficult in ber due to spiny nature of plants but the fruits are picked manually. Harvesting of fruits by shaking of branches is also adopted. Repeated harvesting is required. The yield potential of ber plant varies with the agro-climatic conditions. In rainfed areas an average yield per plant (more than five years age) ranges from 10 kg with 125 mm rainfall to 52 kg with 850 mm rainfall. However, in irrigated situations (with 4-5 irrigation) an average yield of 150-300 kg per plant (30-60 t ha-1) can be obtained depending upon cultivar and location.

**Ripening and storage:** The ber fruits can be stored about one week at room temperature and about three weeks in perforated poly bags under cold storage. Bhasker et al. (2006) found that in a 20 days storage period the combinations of 1% and 2% Ca with polyethylene bag under zero energy cool chamber were found effective in maintaining better quality of the fruit throughout the storage period in term of retention of acidity, ascorbic acid and total sugar. Singh et al (2008) observed that the treatment with calcium nitrate (1.5%) and kept in the PPE (perforated polyethylene) bag was most efficient to retain fruit quality. This treatment recorded 21.3 and 10.8% PLW in Gola and Goma Kirti, respectively. Calcium nitrate (1.5%) + PPE bag also recorded least spoilage loss in both cultivars. The cultivars had 5 and 9 days, while the untreated control had 3 and 5 days economic life for Gola and Goma Kirti, respectively, under ambient conditions. Randhawa et al. (2009) observed that physiological loss in weight increased and fruit firmness decreased during storage. The sensory rating increased up to 10 days in all the treatments, except control but subsequently it decreased during storage. The rate of increase in PME activity was faster up to 10 days in untreated fruits while treated fruits showed slower rise in PME activity up to 20 days and declined afterwards. Fruits can be stored up to 20 days by pre-harvest spray of CaCl₂ (2%) and GA₃ (60ppm) treatment, with minimum loss in quality. Vithlani and Patel (2010) found that titratable acidity, Flavonoid content, Flavonol content, DPPH radical scavenging capacity and ABTS radical scavenging capacity increased significantly in jujube wine and vinegar as compared to fresh jujube juice. While pH, total carbohydrate content, total phenol content and ferric reducing
antioxidant power decreased significantly in jujube wine and vinegar as compared to fresh jujube juice. Alcohol content of vinegar and flavonol content of wine also significantly decreased. Major part of acids was volatile whereas, non-volatile acids were present in negligible amounts. Results indicated that jujube vinegar has high amount of antioxidant compounds and antioxidant capacity and hence can be defined as functional vinegar.

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