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Post-harvest handling, packaging and value addition protocols for mulberry

Mulberry fruits are renowned for their taste, rich nutraceuticals and several health advantages. It is a potential premium fruit for fresh consumption and value addition. The major obstacles for its commercial cultivation and marketing are high perishability and very short post-harvest life. Protocols have been standardized for harvesting, post-harvest handling and packaging for safe storage, transport and marketing of fresh fruits. In addition, juice extraction, bottling, beverages preparation and dehydration methods were also developed at ICAR-CIAH, Bikaner.

MULBERRY fruits are delicious with enormous nutritional and medicinal properties. *Morus alba* (white mulberry), *Morus nigra* (black mulberry) and *Morus rubra* (red mulberry) are commonly accepted worldwide species of mulberry. In India, mulberry is known as 'Kalpa Vruksha' since all parts of the plant are used for various purposes and its fruit is commonly named as *toot* and *shahtoot*. Mulberry fruits particularly black and red varieties are a powerhouse of nutrition and pharmaceutical compounds, offering an array of health benefits. They support renal health, reducing oxidative stress, rich in resveratrol, protect the skin from UV rays and combat hyperpigmentation. Vitamins viz. A, C, and E serves as anti-aging agents, zeaxanthin prevents retinal damage, significant amounts of vitamin K, calcium, and iron, strengthen bone tissues, reducing the risk of osteoporosis and arthritis. Additionally, mulberries are packed with antiviral, antibacterial properties, aiding in immunity.

In India, mulberry is being cultivated commercially for foliage production to provide feed for silk worm. However, now-a-days, mulberry fruits are emerging as an important commodity in the market considering their mouthwatering taste, nutraceutical significance and premium prices. ICAR-Central Institute for Arid Horticulture, Bikaner is spearheading systematic long term-research on mulberry for one decade that leads to development of two improved varieties, clonal propagation technique and production technology for commercial cultivation of mulberry under hot arid and semi-arid areas. Two varieties namely; Thar Harit (*Morus alba*) and Thar Lohit (*Morus nigra*) were developed and released for commercial cultivation. Thar Lohit is gaining popularity among farmers due to high yield, long, attractive deep-red colour, sweet-acidic fruits and short fruiting period escaping scorching summer in hot arid region. Recently farmers are showing interest in commercial cultivation of mulberry variety *Thar Lohit* for fruit yield purpose and systematic plantation are being established.

Mulberry fruits are one of the most fragile and perishable fruits prone to damage during harvesting, postharvest handling and marketing due to composite

Thar Lohit

Thar Harit

fruit type (sorosis), climacteric ripening behaviour, thin skin and soft texture. High fruit perishability is the main hinderance in expansion of area and production of mulberry. Sometime, whole produce gets perished if careful harvesting and post-harvest handling is not followed by the farmers. Therefore, ICAR-CIAH, Bikaner standardized complete protocol for harvesting, post-harvest handling, packaging, labelling and value addition of mulberry cv. *Thar Lohit* fruits.

Maturity indices: Mulberry fruits harvesting stage depends on the end use and market distance. If fruits are to be sold in distant market, then harvesting should be carried out when red colour appears on 20-50% fruit surface starting from distal end with TSS range from 19-20.5 °Brix (stage I). When fruits are to be sold in local market or consumed on same day, harvesting should be done when red colour occur on 80-100% fruit surface with TSS range of 21-23° Brix (Stage II).

Harvesting: Fruit maturity in mulberry is not synchronized therefore, 2-3 staggered manual harvesting is recommended. Ladders can be used for fruit harvesting from tall trees. Fruit can also be harvested by spreading a mat below the tree canopy thereafter gentle shaking of tree branches which ensure detachment of ripened fruits. Then fruits are collected in basket for further handling.

Post-harvest handling: Mulberry fruit is a composite fruit (Sorosis) contains several individual tiny fruitlets which are highly delicate and prone to damage. Therefore, sorting should be done immediately after harvesting of fruits and immature or over ripened fruits should be separated from desirable quality fruits. Fruit grading is not needed since *Thar Lohit* bear almost uniform size fruits. Fruit washing or hydro-cooling is not recommended because it damage fruit surface which leads to oozing of juice from tiny fruitlets which cause rotting and fungal growth. Air-cooling by desert cooler or any other means is recommended for removal of field heat.

Maturity stage I

Maturity stage II

On-farm packaging in plastic punnet boxes

On-farm packaging: To minimize fruits injury, it is advised to do packaging in orchard itself immediately after harvesting and sorting. Packaging boxes with required aeration were standardized for mulberry fruits at ICAR-CIAH, Bikaner. Plastic punnet and corrugated fibre board (CFB) boxes of 200-, 250- 300 and 500-gram capacity with 0.3% aeration is recommended for safe packaging, transport and marketing of mulberry fruits. During long distance transport, stacking of boxes must be carried out in such a way that fruits of bottom stack should not damage. For long distance transport, CFB boxes of 500 gram capacity with 0.3% ventilation (8 holes of 12 mm size) are preferred over plastic boxes to avoid fruits injury in bottom stacked boxes. Mulberry fruits can be marketed similarly to strawberry in retail shopping outlets at premium prices through packaging in plastic or CFB boxes and proper labelling.

Processing and value addition

Mulberry fruits hold immense potential for processing and value addition due to their high perishability and excellent nutraceutical value. A process has been standardized for mulberry juice extraction, bottling, RTS and squash preparation.

Juice extraction and value addition: Fully ripened fruits (colour changed to deep red or black) should be utilized for juice extraction. At domestic level juice is extracted through mecerating of fully ripened fruits followed by manually squeezing fruit slurry in muslin

Packaging in corrugated fibre boxes (CFB) and plastic punnet boxes

cloth while at industrial level, it can be extracted through hydraulic press. The extracted juice recommended to be filtered through double layer muslin cloth to seperate pomace. Through proper sterlization and bottling, juice can be stored for one month at room temperature and 8 months at 5°C without compromising sensory quality. Stored juice can be consumed directly, blended with other fruit juices, or used in the preparation of ready-to-serve beverages and squash.

Dehydration: Dehydrated black mulberry fruits (*Thar Lohit*) can be added as a nutritionally rich and high value commodity in dry fruit market. A process has been standardized for dehydration and packaging of black mulberry fruits. Fully ripened fruits are recmmended to be dried in the shade with proper ventilation for getting good quality and desirable colour dried product. Inferior colour and acridity was observed in dried product when drying was carried out at high temperature (more than 55°C). Packaging of dehydrated mulberry fruit is recommended in glass jars and food grade standy pouches.

CONCLUSION

Mulberry plants flourish in water-deficient and low-fertility sandy soils of arid and semi-arid environments. Varieties released by ICAR-CIAH, Bikaner, exhibit precocity, regularity, and yield high-quality fruits. By employing appropriate post-harvest techniques, consumer-oriented packaging, and strategic marketing of fresh mulberry fruits along with processing them into various value-added products can establish mulberry as a lucrative and low-input-cost fruit crop in arid and semi-arid areas.

Mulberry RTS and squash

Mulberry fresh fruit, dehydrated fruits and packaging of dry fruits

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