Journal of AgriSearch 1(4): 251-256
Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)
SHORT NOTE

Reducing Post-harvest Losses of Betel (*Piper betel* L.) Leaves by various Preservation Techniques

ADITYA MADAN*, NEHA BALAN[1] AND RAHUL DEB BARMA[1]

A. D. Patel Institute of Technology, New VallabhVidyangar, Anand, Gujarat (India)

ARTICLE INFO

Received on	: 28.07.2014
Revised received on	: 25.09.2014
Accepted on	: 12.10.2014
Published online	: 05.12.2014

ABSTRACT

Due to highly perishable nature, betel leaves undergo quick spoilage due to fungal infections and discoloration during storage and transportation. Post-harvest losses of betel leaves can be prevented if proper preservation techniques are followed. Right from the ancient techniques of solar drying and depetiolation to the modern methods of preservation including modern drying technologies, modifying surrounding atmosphere, advanced packaging technologies, etc., can prove to be beneficial in reducing post-harvest losses of betel leaves. Such wastage may also be reduced by extracting essential oils from the leaves which remains unsold in the market. This essential oil has reported of remarkable medicinal and aromatic properties which indicate a promising industrial future. If a well-coordinated effort by the farmers, traders, scientists, technologists and policy makers are made, it will not only help reduce the post-harvest losses of betel leaves but also boost the national economy and also generate huge employment opportunities for the people.

Keywords: Betel leaves, Preservation, Post-harvest loss, Essential oil

Piper betle L. (betel vine, Paan) an indigenous medicinal plant, has a folk reputation in the rural areas of India, a member of the *piperaceae* family. The plant is dioecious and shade loving perennial root climber. There are about 125 to 150 cultivars of betel vine in India (Verma *et al.*, 2004 and Guha, 2004).The significance of leaves has been explained in relation to every sphere of human life including social, cultural, religious and even day-to-day life, which is very much relevant even these days (Guha, 2006). For example, a well-prepared betel quid is still regarded as an excellent mouth freshener and mild vitalizer, routinely served on the social, cultural and religious occasions like marriage, *Puja* (religious festivals), *Sraddha* ceremony (religious function performed after cremation) etc. It is also used as a special item offered to the guests in order to show respect and for such traditional use of betel leaf in the Indian society, the leaf really stands alone without any parallel even today (Guha 1997; Mehrotra 1981). Betel leaves are traditionally used for chewing in their natural raw condition along with many other ingredients like sliced areca nut, slaked lime, coriander, aniseed, clove, cardamom, sweetener, coconut scrapings, ashes of diamond, pearl, gold and silver (Ayurvedic preparations), jelly, pepper mint, flavouring agent, fruit pulp etc. (CSIR, 1969 and Guha, 2006).

Fresh leaves of betel vine are consumed by 15-20 million people in India and the major contributor towards the production is West Bengal which is about 66% (Guha, 2006).The leaves possess a particular aroma with pungent and sharp taste. The demand for fresh *paan* leaves is not only limited to Nepal, Canada and Gulf countries but also there is tremendous demand from the European countries (Balasubramanian *et al.*, 2011). However, on the darker side, there is an alarming problem of post-harvest losses mainly during the transportation and

[1]Indian Institute of Crop Processing Technology, Thanjavur, Tamil Nadu (India)

***Corresponding author E-mail:** adityamadan800@gmail.com

storage. Owing to the perishable nature, it undergoes spoilage rapidly. Spoilage may occur due to some infectious diseases, pest attack or dehydration and discoloration (Johri *et al.,* 1984). The spoilage of betel leaves accounts for the post-harvest losses in the range of 35% to 75% (Rao and Narsimhan, 1997).

The wastage can be minimized by drying the leaves for further value addition. Attempts have been made to reduce the post harvest losses right from the ancient times (sun drying, curing) to the modern age techniques (Modern dryers, advanced packaging technologies, chemical treatments). Such wastage may also be reduced by extracting essential oils from the leaves which remains unsold in the market. This essential oil has reported of remarkable medicinal and aromatic properties which indicate a promising industrial future (Guha, 2006). Some of the medicinal properties of betel leaves are discussed in following sub-section.

In Ayurvedic medicines, there have been reports of usage of betel leaf for the treatments of various diseases. Traditionally, it is known to be useful for the treatment of various diseases like bad-breath, boils and abscesses, conjunctivitis, constipation, headache, hysteria, itches, mastitis, mastoiditis, leucorrhoea, otorrhoea, ringworm, swelling of gum, rheumatism, abrasion, cuts and injuries etc as folk medicine while the root is known for its female contraceptive effects (Chopra *et al.,* 1956 and Khanra, 1997).The extracted essential oil also possesses anti-fungal and anti-bacterial properties. This indicates that essential oil is the powerful inhibitor of pathogens causing cholera, typhoid, tuberculosis etc (CSIR, 1969). Betel leaves serves as a cheap source of medicine which is also easily available in the market. Mastication of betel leaves produces a sense of freshness, alertness, salivation, energetic feeling with enhanced mental and physical response of the human body (Guha, 2006). According to Khanra (1997), betel leaves have been reported to exhibit antioxidant, anti-inflammatory, immune-modulatory and antitumor activities. Owing to huge potential in the industrial market, on account of its medicinal benefits, it becomes the foremost duty of the country to preserve these. Some of the preservation techniques are reviewed in the following section.

The basic objective of drying is the removal of water to a certain level at which microbial spoilage, deterioration and chemical reactions are generally minimized (Krokida *et al.,* 2003). Since ages, solar drying of leaves has been practiced as an essential tool for preservation in various parts of the country. But, prolonged exposure to the solar radiation leads to negative changes in colour, flavour, texture, contamination from soil and other foreign matter (Adom *et al.* 1997 and Midilli 2001). Another method which is practiced is shade-drying, but the issue with such practice is that it is very time consuming. Because of these reasons, modern and well-equipped hot air dryers seems inevitable for drying to improve the quality of the final product (Doymaz and Pala 2002; Ertekin and Yaldiz, 2004).

There is very few research reported for the preservation of betel leaves through dehydration and hence modern drying should be promoted for beneficiary outcomes. The thin-layer drying experiments were performed in a pilot plant cross-flow tunnel dryer and cabinet dryer by Balasubramanian *et al.* (2011) for removing moisture from betel leaves. In this study it was reported that, drying time reduced considerably in cabinet dryer as compared to tunnel dryer. The drying characteristics of betel leaves in tunnel as well as cabinet dryer can be visualized (Fig.1).

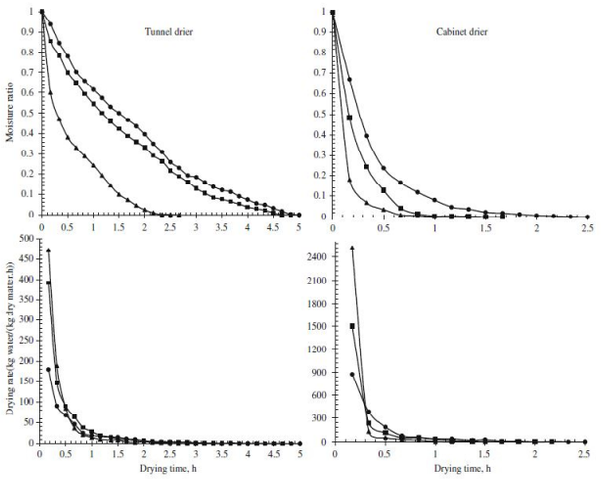

Fig.1. Drying characteristics of betel leaves at different temperatures (50ºC (●), 60ºC (■), 70ºC (▲) in tunnel and cabinet driers (Balasubramanian *et al.,* 2011)

The curing process for betel leaves was probably first invented at Varanasi, India where the techniques were traditionally used for making *Banarasi paan* (cured betel leaf). The green leaves are treated with smoke, high temperature and pressure for improving organoleptic qualities and ultimately the green leaves are converted to white or yellowish white colour leaves. Although, there is no standard method been reported for curing process of betel leaves, Betelvine Research Centre, Islampur under Bihar Agricultural University, Bhagalpur, Bihar (India) took initiation in the studied of curing of betelvine and constructed two *paan bhati* at the centre. It also facilitates the training to betel growers coming

from different parts of the state. The method of curing the betel leaves are alternate heating of 6 hours at 50-60 °C and cooling of 12 hours, two to three time following aeration of leaves by turning and stored under dark condition. It took 15-20 days for making complete white or yellowish from green betel leaves. In this process, the shelf life of betel leaves is extended up to one month and curing imparts softness and sweet taste in betel leaves (Dastane *et al.*, 1958).

Depetiolation is removal of the petioles from the leaves and thus, about 10-25% weight of leaves are reduced beside 10-40% reduction in length of leaves. It helps in delaying senescence (Mishra and Gaur, 1972). Post-harvest losses is minimizing since time memorial through depetiolation by betel growers. The time taken for 50 per cent of the experimental leaves to become brown halfway along the midrib (HMS_{50}) was used as an index of senescence rate. Effect of depetiolation at different days since leaf harvest on senescence can be visualized from Fig.2.

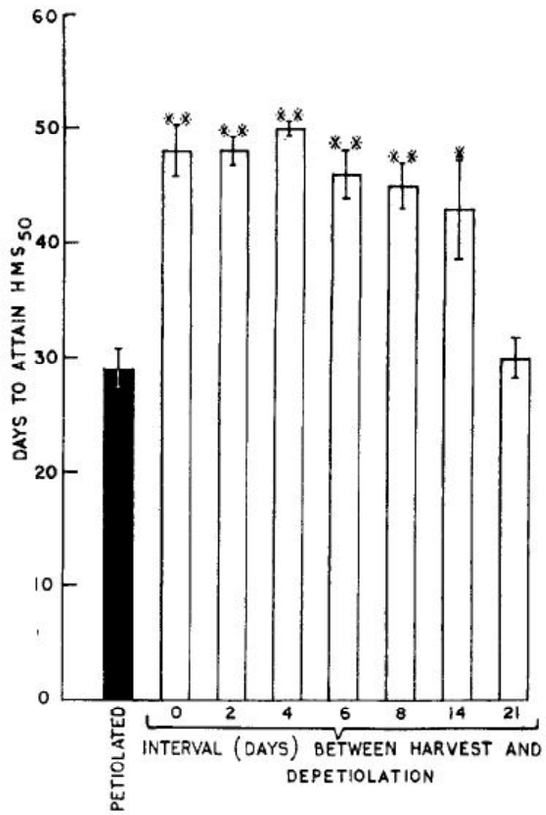

Fig. 2. Depetiolation at different days since leaf harvest on senescence.
Treatments with asterisk are statistically different (one asterisk at P = 0.05 and two asterisks at P = 0.01) from those without asterisk. Each histogram value is the average of 4 replicates. (*Source:* Mishra and Gaur, 1972).

Removal of midrib can also result in delay of senescence but when depetiolation was combined with partial or total removal of midrib, senescence was delayed to a greater extent than with depetiolation alone (Table 1).

Table 1: Effect of removal of midrib on betel leaf senescence

Treatment	Days to attain HMS_{50}
Complete	65.2_{a}
3 cm	61.8_{ab}
2 cm	60.6_{b}
1 cm	59.9_{c}
Petiolated	33.2_{d}

Means with the same letters are not significantly different at p=0.01
(*Source:* Mishra and Gaur, 1972)

It is a well-known fact that leaves of plants and trees respire which causes metabolic changes. When these respire, they release CO_2 and intake O_2 just similar to that of any other living organism. But, when the atmosphere surrounding the leaves is modified beneficially by changing the gaseous composition, it causes retention in the quality attributes of leaves and delay in the senescence process. Not much of the work has been reported in this area for betel leaves. Rai *et al.* (2010) stored betel leaves for 10 days at 20°C under modified atmosphere packaging (MAP) to assess the impact of differential in-pack gaseous atmospheres on the pigments and an antioxidant. Among different packaging treatments, the in-pack partial pressures of 2.5 kPa for O_2 and 6.2 kPa for CO_2, respectively, for the film packages containing 750 g of betel leaves, resulted in better retention of chlorophyll. Beta-carotene remained largely unaffected by the modifications in the surrounding atmosphere. If such more attempts are made for different combinations of gaseous composition, the quality retention and shelf-life of betel leaves can be improved to a larger extent.

Apart from drying, curing, depetiolation and beneficially modifying the surrounding atmosphere, few attempts are also being made to reduce wastage by bleaching of the leaves (Dastane 1958; Sengupta 1996), chemical treatments, manipulation of storage temperature, adopting better packaging materials and advance packaging techniques (Guha 2004, Rao and Narasimham, 1997).

Despite the knowledge of traditional and modern preservation methods, India is still facing the serious issue of post-harvest losses. Surplus leaves which remain unsold in the market can be utilized through extraction of essential oil. The constituents present in the oil may vary with the variety, soil and agro-climatic conditions followed to raise the crop like any other essential oil yielding crop (Sankar *et al.*, 1996; Sharma *et al.*, 1981). According to Khanra (1997), these constituents are the sources of the medicinal, aromatic, stimulant, tonic and various other useful properties found in the leaves. A wide range of products from betel leaf can be manufactured at industrial level and can be sold in the markets (Table 2).The industrial use of such range indicates promising future for betel leaves. As a raw material, it can be used for the manufacturing of number of commercial products. Therefore, for exploitation of the unique qualities of the crop, there is a tremendous requirement for research on developing new products from betel leaves and essential oil. This would definitely be helpful for minimizing the menace of post-harvest losses of the leaves. Unfortunately, there are very few reports available on the preservation of betel leaves and hence more of such research inputs are required in this area.

Table 2: Different products manufactured from betel leaves

Products manufactured from betel leaves on industrial scale
Tooth-pastes
Skin emollients
Tooth-powders
Paan masala
De-odourants
Mouth freshners
Facial creams
Anti-septic lotions
Cold drinks
Chocolates
Appetizers
Digestive agents
Tonics and medicines
Beauty and cosmetics products
Betel leaf essential oil

(*Source*: Guha, 2000)

The economic potentiality of the crop can be imagined by the fact that around 20 million people consume betel leaves in India on a regular basis (Jana, 1996). Presently betel vine is cultivated extensively in India in almost all the states barring Haryana, Punjab, Himachal Pradesh and Jammu & Kashmir. The extent of its cultivation in different major states is shown (Table 3). It can generate national employment by providing the livelihood to millions of the people engaged with this work. At present around 20 million workers derives their livelihood, partly or fully, right from the production till its consumption (Jana, 1995). In this way, the crop provides a National Income to the tune of Rs. 6000- 7000 million every year.

Table 3: Estimated area under Betel vine cultivation in major states

State	Area (ha)	Area (%)
Andhra Pradesh	2900	5.80
Tamil Nadu	5500	11.00
Karnataka	8700	17.40
Kerala	3300	6.60
Orissa	5000	10.84
Gujarat	200	0.40
Maharashtra	2700	5.40
Madhya Pradesh	1250	2.50
Rajasthan	50	0.10
Uttar Pradesh	2000	4.00
Bihar	3200	6.42
West Bengal	3000	6.00
Assam	3000	6.00
Others	9200	17.56
Total	50000	100.00

(*Source:* Balasubrahamanyam, 1994)

The betel farming industry, the report claims, supports about 400,000-500,000 agricultural families (Guha, 2006). Leaves worth about Rs. 30-40 million are exported to the countries like Bahrain, Canada, Great Britain, Hong Kong, Italy, Kuwait, Nepal, Pakistan, Saudi Arab and many other European countries (Jana, 1996; Singh *et al.*, 1990). This clearly indicates that this crop has a tremendous potentiality in earning the foreign exchange which will strengthen the nation in many ways. Though a "Betel leaf oil extractor" is been developed by IIT, Kharagpur, more of such research and technology inputs are required in this area.

Post-harvest losses of betel leaves (*Paan*) poses a serious threat for the country's economy. Post-harvest losses of betel leaves can be prevented if proper preservation techniques are followed. Right from the

ancient techniques of solar drying and depetiolation to the modern methods of preservation including modern drying technologies, modifying surrounding atmosphere, advanced packaging technologies, etc., can prove to be beneficial in reducing post-harvest losses of betel leaves. Some of the suggestions which might help reducing post-harvest losses of betel leaves are (1) More of the scientific research and technology inputs are required in post-harvest losses. (2) A well co-ordinated effort by the farmers, traders, scientists, technologists, administrators and policy makers will boost the national economy and generate huge employment opportunities for the people. (3) Waste and by-product utilization in the industries should be focused. (4) Government should take initiative in this area for funding various projects under competent scientists.

REFERENCES

Adom KK, Dzogbefia VP and Ellis WO. 1997. Combined effect of drying time and slice thickness on the solar drying of okra. *Journal of the Science of Food and Agriculture* **73** (3):315-320.

Balasubrahamanyam VR (Ed.). 1994. "Betel vine". National Botanical Research Institute, Lucknow 6-7.

Balasubramanian S, Sharma R, Gupta RK and Patil RT. 2011. Validation of drying models and rehydration characteristics of betel (*Piper betel* L.) leaves. *Journal of Food Science and Technology* **48** (6):685-691.

Chopra RN, Nayar SL and Chopra IC.1956.Glossary of Indian Medicinal Plants, 194. CSIR, New Delhi.

CSIR (Council of Scientific and Industrial Research).1969.The Wealth of India. CSIR, New Delhi 84-94.

Dastane NG, Patil RG and Chaugule BA. 1958. This business of bleaching betel leaves. *Indian Farming* **7**(10):10-12.

Doymaz I and Pala M. 2002.Hot-air drying characteristics of red pepper. *Journal of Food Engineering* **55** (4):331-335.

Ertekin C and Yaldiz O. 2004. Drying of eggplant and selection of a suitable thin layer drying model. *Journal of Food Engineering* **63** (3):349-359.

Guha P. 1997.Exploring Betel Leaves for Cottage Industry. Krishi, Khadya-O-Gramin Bikash Mela, Agricultural and Food Engineering Department, IIT, Kharagpur (Ed.) 15-19.

Guha P. 2000.Commercial exploitation of oil from betel leaves. Proceedings of Sixth Regional Workshop on Oil Seeds and Oils. IIT, Kharagpur (Ed.). Kharagpur, India 56-57.

Guha P. 2004. Development of technology for enhancing shelf life of betel leaves (*Piper betle* L.). Annual Report of All India Coordinated Research Project on Post Harvest Technology (ICAR). IIT, Kharagpur (Ed.).pp. 39-56. Food and Agricultural Engineering Department, IIT, Kharagpur, India (2004).

Guha P. 2006. Betel leaf: the neglected green gold of India. *Journal of Human Ecology* **19** (2): 87-93.

Jana BL. 1995. Gram Banglar Arthakari Phasal-Paan (In Bengali).Betel Leaf: A Cash Crop of Villages of Bengal. Asaboni, Flat 203, 184, B. B. Chatterji Road, Calcutta.

Jana BL. 1996. Improved technology for betel leaf cultivation. Seminar-cum-Workshop on Betel leaf Marketing.5-6 June. Midnapur (W. B.).

Johri JK, Chaurasia RS and Balasubrahmanyam VR. 1984. Status of betel vine pests and diseases in India. *Improvement of betel vine cultivation*, SD Khanduja and VR Balasubrahmanyam (eds), 13-24.

Khanra S. 1997. Betel Leaf Based Industry. *Nabanna Bharati* **30** (2):169.

Krokida MK, Karathanos VT, Maroulis ZB and Marinos-Kouris D. 2003. Drying kinetics of some vegetables. *Journal of Food engineering* **59** (4): 391-403.

Mehrotra RS. 1981 .Fungal diseases of betel vine and their control. Proceedings of Group Discussion on Improvement of Betel vine Cultivation. SD Khanduja and VR Balasubrahmanyam (Eds.).pp. 3-12 National Botanical Research Institute, Lucknow, India.

Midilli A. 2001. Determination of pistachio drying behaviour and conditions in a solar drying system. *International Journal of Energy Research* **25** (8):715-725.

Mishra SD. and Gaur BK. 1972. Control of senescence in betel leaves by depetiolation. *Experimental Gerontology* **7** (1):31-35.

Rai DR, Chourasiya VK, Jha SN and Wanjari OD. 2010. Effect of modified atmospheres on pigment and antioxidant retention of betel leaf (Piper betel L.). *Journal of Food Biochemistry*, **34** (5):905-915.

Rao MV and Narasimham B.1977.Prolonging storage life of betel leaves. *Indian Journal of Horticulture* **34** (2):175-182.

Sankar CR, Sridevi D and Babu MK. 1996.Studies on essential oil and oil constituents of betel vine cultivars. *The Andhra Agric. J.* **43** (1):24-26.

Sengupta K. 1996. Preservation of Betel Leaves. *Nabanna Bharati* **28** (12):580-582.

Sharma ML, Rawat AKS, Balasubrahmanyan VR and Singh A. 1981.Essential oil of betel leaf (*Piper betle*, L.) cv. Kapoori. Proceedings of Group Discussion on Improvement of Betelvine Cultivation. SD Khanduja and VR Balasubrahmanyam (Eds.). pp. 161-164. National Botanical Research Institute, Lucknow,

India.

Singh KK, Balasubrahmanyam VR and Kochhar VK. 1990. Effect of different packing methods, temperature conditions, treatment with chemicals on the senescence and storage behaviour of betel (*Piper betle* L.) leaves. *Journal of Plantation Crops* **18** (1): 23-28.

Verma A, Kumar N and Ranade SA. 2004. Genetic diversity amongst landraces of a dioeciousvegetatively propagated plant, betel vine (*Piper betle* L.). *Journal of Biosciences* **29** (3):319-328.

Correct Citation:

Madan A, Balan N and Barma RD. 2014. Reducing postharvest losses of betel (*Piper betel* L.) leaves by various preservation techniques. *Journal of AgriSearch* **1**(4): 251-256.