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A CASE STUDY

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Reducing post harvest losses of litchi by processing

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SUMMARY :

Litchi (*Litchi chinensis* Sonn.) is a subtropical crop, non-climacteric and drupe or stone fruit. It is conical, heart shaped or spherical with a thick leathery, indehiscent pericarp at maturity. Litchi is known for its pleasant flavour and juicy pulp (aril) with attractive red colour pericarp. It is also an excellent source of vitamins and minerals. India with annual production of 483.3 thousand metric tons from an area of 74.4 thousand hectares, is the second largest producer of litchi next to China. Litchi fruit has great commercial potential in the domestic as well as global markets. It is very delicate fruit and highly perishable in nature. Under ambient conditions, it looses upto 7-11 per cent weight within one day after harvest due to water losses. The attractive bright red colour turns to unpleasant brown colour within 24-48 hours which drastically reduces marketability of fruit. Thus, these are considered as the major causes of post harvest losses of litchi. The browned or fresh litchi has tremendous potential in the processing industry as it may be utilized for extracting certain chemicals of industrial importance or may also be converted into value added food products. Certain free and glycosidically-bound volatile compounds that produce strong litchi-like fruity aroma can be extracted from litchi fruit. Innovative and value added products like cordial, squash, nectar, burfee, chutney, dehydrated litchi, pulp, osmo-syrup, wine and juice can be prepared from litchi. Litchi seeds can also be used for production of sesquiterpene glucosides, cyclopropyl-containing fatty acid glucoside and some antioxidants. The dried litchi peel after grinding and thermally activation can be used for removal of acid blue 25 dye from aqueous solutions which helps in treating industrial effluents containing dyes.

KEY WORDS : Reducing, Post harvest Losses, Litchi, Processing

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Litchi (*Litchi chinensis* Sonn.) is a subtropical crop that originated in South-East Asia and has great demand in the international trade. It belongs to the family *Sapindaceae* that covers around 2000 genus and 150 genera (Pandey and Sharma, 1989). Litchi fruit is a non-climacteric drupe or stone fruit (Holocroft and Mitcham, 1996) with bright red attractive pericarp surrounding white aril (Nakasone and Paull, 1998). Litchi is known for its pleasant flavour and juicy pulp (aril). It is also an excellent source of vitamins and minerals

(Chadha, 2001). The daily vitamin C requirement of an average adult can be met only by consuming 14-17 litchis (Wall, 2006). Besides, the fruit is also medicinally known for treatment of diseases like dyspepsia and smallpox. India with annual production of 580.1 thousand metric tones from an area of 82.7 thousand hectares, is the second largest producer of litchi next to China. In Uttarakhand, litchi is grown in Dehradun, Pithauragarh, Nainital and U.S. Nagar districts with an annual production of 17.97 thousand metric tones from an area of 3.46 thousand hectares (NHB, 2011).

Litchi is a very delicate fruit and highly perishable in nature, with an average moisture content of 84.3 per cent (Singh *et al*., 1963). The shelf-life of litchi is never more than 24-72 hours at ambient conditions (Kumar, 2000). The attractive bright red colour may be lost within 24-48 hours and under ambient conditions, it looses upto 7-11 per cent weight within one day after harvest (Wu *et al*., 1997). This causes desiccation and produces microcracks in the pericarp (Underhill and Critchley, 1993). Desiccation during post harvest handling accompanied by loss of red colour due to enzymatic action which initiates the browning process and pericarp browning has posed a major problem in its storage, transport and marketing. Postharvest loss of litchi is estimated to be 20 to 30 per cent of the harvested fruit, even as high as 50 per cent prior to consumption. Losses are also considerable due to the decay caused by infection of micro-organisms.Recent studies concentrated on delaying pericarp browning or aril decay of harvest litchi fruits are summarized in Table 1. The chemical treatments are not sufficient to reduce the post harvest losses and have several disadvantages which include high cost, SO_2 fumigation intensified micro-cracking of the pericarp, presence of chemical residue in fruit, etc.Vapor heat treatment causes loss of membrane integrity, electrolyte leakage, PPO activation, pH fluctuation and pericarp browning in susceptible cultivars (Wong *et al*., 1991). Desiccation and browning of skin may not affect the fruit but greatly reduce the commercial value of litchi in domestic and western markets (Snowdon, 1990), nevertheless the arils still remain fit for consumption. Such fruit may be converted into value added products with the purview that huge economic losses occurring to growers may be minimized. The processing potential of litchi is reviewed as under.

Value added products from litchi aril :

Juice :

This is the natural fruit juice pressed out of the fruit and remains unaltered in its composition during preparation and preservation. Zeng *et al*. (2008) reported that litchi juice contained 161.4 g/l total sugar; 2.2 g/l total acids and 354.12 mg/l vitamin C. Majumdar *et al*. (2009) developed cucumber-litchi-lemon mix juice and found that juice was acceptable upto 6 months at room temperature with 74 per cent loss of vitamin C. Vijayanad *et al*. (2010) studied the effects of pectinase treatment and concentration of litchi juice on quality characteristics of juice. They found that pectinase enzyme facilitated the removal of insoluble solids extraction from juice. Guo *et al*. (2011) used high-pressure carbon dioxide (HPCD) for inactivation of microbes in litchi juice and reported that 5 log reduction in yeasts and molds while aerobic micro-organisms were inactivated by employing 8 MPa pressure for 2 min. HPCD treatment had less influence on the quality parameters than HTST treatment.

Ready-to-serve beverage (*RTS*) :

It is beverage that should contain at least 10 per cent juice and 10 per cent total soluble solids (TSS). Litchi juice can be successfully utilized in production of RTS containing 10-12 per cent juice, 10-12 per cent TSS and 0.3 per cent citric acid. The sulfited and in-bottle pasteurized beverage has reasonable shelf-life. The product is served without dilution.

Nectar :

It is a fruit beverage which contains at least 20 per cent fruit juice/pulp, 15 per cent TSS and about 0.3 per cent acid. It is not diluted before serving. Litchi juice alone or in combination with other fruits can be used to produce nectar. Chakraborty *et al*. (2010) developed mixed fruit nectar containing litchi and jamun juice (1:3) and invert syrup made up of sugar, citric acid and water.

Squash :

It is a fruit beverage containing at least 25 per cent fruit juice/pulp and 40 per cent TSS. It is diluted before serving. Litchi squash has a characteristic taste and flavour. It is prepared from litchi containing 25 per cent juice, 40 per cent TSS, 0.3 per cent citric acid and 0.1 per cent potassium metabisulphite (KMS) (Arya and Rastogi, 1993; Singh, 1996 and Lal *et al*., 2010).

Table 1 : Treatments to reduce postharvest losses of litchi

Sr. No.	Treatments	Effects	References
1.	SO_2	Reduces browning	Jiang *et al*., 2002;
		Reduces aril decay caused by infection of micro-organisms such as *Peronophythora lithci, Penicillium, Colletotrichum.*	Jiang *et al*., 2001
2.	ClO_2	Control *Colletotrichum* spore germination (at concentration of 20 mg/l)	Wu *et al*., 2011
		Control pericarp browning	
		Increases shelf-life	
3.	Polyamines with fungicides	Reduces ethylene production	Jiang and Chen, 1995
		Reduces peroxidase (POD) activity	
		Assists to retain membrane integrity	
4.	Glutathione with citric acid	Reduces browning by inhibition of Polyphenol oxidase (PPO)	Jiang and Fu, 1997
5.	HCl (1%)	Assists to retain colour by inhibiting the PPO	Jiang *et al*., 2004;
		Minimizes pericarp damage	
		Maintain high anthocyanin content by stabilizing pH change and inhibiting anthocyanase activity in litchi	Zauberman *et al*., 1991
6.	Chitosan	Delays changes in contents of anthocyanin.	Zhang and Quantick, 1997
		Reduces PPO and POD activity, thereby reduces severity of browning under low temperature storage (4°C) @ 1% level.	Sivakumar *et al*., 2005
		Chitosan @ 0.1% level reduces microbial decay due to anti-microbial properties.	
		2% chitosan coating soon after cold storage extend shelf-life for 12 h at 25°C.	Jiang *et al*., 2005
7.	Vapor heat treatment	At 45°C core temperature for 42 min maintain quality of 'Tai So' and 'Wai Chee' litchi cultivars at 5°C for 4 weeks, retaining appearance and increasing disease control.	Jacobi *et al*.,1993
8.	Hot water brushing	Hot water brushing followed by HCl and prochloraz dip treatments, maintain uniform red colour and excellent eating quality in terms of taste and flavour during storage for at least 35 days.	Lichter *et al*., 2000.
		Hot water brushing at 25°C for 20 sec reduces or inhibit PPO activity in pericarp.	Wong *et al*., 1991
		In susceptible cultivars, 'Kwai May Pink', vapor heat treatment causes a loss of membrane integrity, electrolyte leakage, PPO activation, pH fluctuation and pericarp browning.	
9.	Gamma Irradiation	Irradiation treatment showed differential responses with respect to cultivar and dosage.	Ilangantileke *et al*., 1993
		Irradiation upto 1 kGy in combination with low temperature storage maintain market quality of thai litchi by reducing loss of red pericarp colour and decay but not retained overall fruit quality during prolonged cold storage.	
10.	Biocontrol agents	*Bacillus subtilis* is effective in controlling postharvest decay in litchi when kept at 5°C.	Korsten *et al*., 1993.
		Antagonist effect as the antibiotic action of a cyclic polypeptide, iturin A was effective in controlling fruit decay for a storage period of 30 days at 5°C.	Jiang *et al*., 2001.
11.	Modified atmospheric storage	Reduces or prevent browning by maintaining a higher RH around the fruit inside the sealed plastic film, which prevents water loss due to transpiration, loss of membrane integrity, loss of electrolyte leakage and increased PPO activity.	Kader 1994; Lemmer and Kruger 2000;
		Control post harvest decay due to high CO_2 (>10%) or low O_2.	Persis *et al*., 2000
12.	Controlled atmospheric storage	Litchi fruit under controlled atmosphere (3-5% CO_2 and 3-5% O_2) at 90% RH and 1°C showed good browning control, while retaining fruit quality upto 30 days.	Jiang and Fu, 1999.
		Litchi cv. 'HUAIZHI' stored in pure O_2 (100% O_2 and 0% CO_2) for 6 days at 28°C reduced pericarp browning because pure O_2 inhibited the activities of PPO and anthocyanase involved in the enzymatic browning mechanism.	Duan *et al*., 2004

Chakraborty *et al*. (2010) prepared mixed fruit squash containing litchi and jamun (2:3) with addition of sugar syrup, citric acid, water and 0.1 per cent KMS.

Cordial :

It is a sparkling clear, sweetened fruit juice from which pulp and other insoluble substances have been completely removed. It contains at least 25 per cent juice, and 30 per cent TSS (Total Soluble Solids). Cordial is usually prepared from citrus fruits. Chakraborty *et al*. (2010) developed litchi cordial. Filtered juice containing 0.12 per cent KMS was preserved in a large sized glass container for 15 days storage so as to allow the suspended material settle down; clear juice was siphoned and mixed with sugar syrup.

Wine :

It is an alcoholic beverage, prepared by fermenting different fruit juices by using yeast (Saccharomyces cerevisiae). Zeng *et al*. (2008) prepared litchi wine and found that young litchi wine contained highly dried extract (25.6 g/l), low volatile acid (0.36 g/l) and low higher alcohols (0.048 g/l). Total, 33 kinds of aroma compounds were also identified in litchi wine by liquid-liquid extraction and gas chromatography and mass spectrometry (GC/MS) analysis. The total amino acid content in litchi wine (784.1 mg/l) was similar to that in grape wine (700-1300 mg/l) while SO_2 content (Free State) was always below 10 ppm. Singh and Kaur (2009) also prepared wine from litchi juice. They suggested that fermentable sugar (85.20%), titratable acidity (4.25% citric acid) and yeast Saccharomyces cerevisiae MTCC 178 with inoculums level of 10 per cent (v/v) at 25^0C produced light amber colored product with natural aroma of litchi wine which contained 11.60 per cent (v/v) ethanol, 92 mg/l total esters, 124 mg/l total aldehydes and 0.78 per cent (v/v) titrable acidity.

Canned litchi :

Canning/ Appertization is a process of preservation of various food stuffs including fruits and vegetables whole or in pieces, in sugar syrup or brine by heat processing them in hermetically sealed containers. Litchi is canned in the form of arils and sugar syrup (40 ^{0}Brix) containing 0.5 per cent citric acid is used. The sealed plain cans are thermally processed at 82^0C for 25 to 30 min depending upon the size of can. Prompt cooling is required after thermal processing so as to prevent development of pink colour in the product (Arya and Rastogi, 1993 and Lal *et al*., 2010).

Chutney :

It is a product prepared by cooking the fruit pulp with added salt, sugar, spices and vinegar to suitable consistency. According to FPO fruit chutney should have 40 per cent fruit part and minimum 50 per cent TSS. Chakraborty *et al*. (2010) prepared litchi-jamun blended chutney after pulp extraction and straining of juice by heating on low fire. Spices, sugar, salt and vinegar were added during heating.

Cheese :

Fruit cheese is a product prepared by boiling the fruit pulp with sufficient quantity of sugar, acid and pectin with small amount of butter and salt. It contains 68 per cent TSS. Chakraborty *et al*. (2010) developed litchi cheese. The hot cheese was poured on a greased container and allowed to set by spreading. After cooling, the slab was cut into small pieces and wrapped in moisture proof paper.

Osmo air-dried litchi :

It is a product prepared by steeping the peeled/unpeeled fruit as such or in large pieces in75 ^{0}Brix sugar syrup for whole night and then drying at 50^0C. Litchi arils can be partially dried by steeping in sugar syrup and osmosed tissues are dried at 50-60^0 C for 4-5 hours to get the raisin like product.

Burfee :

It is a sweet confectionary made by cooking condensed milk and sugar until it solidifies. Sometime it is flavored with different fruits like cashews (kaaju burfee) and pista (pista burfee) etc. Litchi burfee was prepared from litchi pulp cooked with skim milk powder, sugar and cardamom powder to the desired consistency (Chakraborty *et al.*, 2010).

Volatile compounds :

Some free and glycosidically-bound volatile compounds including 1 ester, 14 alcohols, 2 aldehydes, 4 acids, 2 ketones and 2 terpenes were isolated and separated by Chyau *et al.* (2003) from fresh clear litchi juice using an Amberlite XAD-2 as adsorbent in column

chromatography .

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