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ORIGINAL ARTICLE

Effect of pectinase treatment and concentration of litchi juice on quality characteristics of litchi juice

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Abstract Litchi (*Litchi chinensis* L) juice concentrate was prepared from pulp extracted from ripe fruits. Clarification of litchi pulp was optimized using pectinase at different concentrations. Litchi pulp treated with pectinase enzyme facilitated the removal of insoluble solids and extraction of juice. Vacuum concentration of clarified juice was carried out in a pilot scale turbafilm vacuum evaporator to obtain litchi juice concentrate with total soluble solids of 60°Brix. The litchi juice concentrate contained 49.9% total sugars, 47% reducing sugars, 32.7 mg/100 g ascorbic acid and its titratable acidity was 0.73%. The litchi juice concentrate was stored at –20°C for 6 months and analyzed at regular intervals for changes in quality. No significant changes in the composition of juice concentrate was observed during storage except tannin content and non-enzymatic browning which increased during storage. Single strength litchi juice reconstituted from juice concentrate was highly acceptable sensorily during 6 months storage.

Keywords Litchi · Pectinase · Litchi juice concentrate · Vacuum concentration · Quality · Storage stability

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Introduction

Litchi (*Litchi chinensis* L) is a tropical fruit grown in Northern part of India especially in the Muzaffarpur district of Bihar. Production of litchi fruits in India was estimated to be 3.68 million tonnes during the year 2004–2005 (NHB 2006). The fruits are available during a short season of 2 months. The shelf-life of litchi fruit is 4–6 days at room temperature (25–32°C). The fruits are mainly consumed as fresh and to some extent they are processed into canned litchi, litchi beverage and litchi squash, by processing industries located near the growing regions.

Quality and discoloration of litchi juice from 4 litchi cultivars 'Desi', 'Calcutta', 'Rose scented' and 'Late Bedana' was reported by Jain et al. (1988) and squash prepared from 'Calcutta' cultivar was found to be stable during 9 months storage whereas squash from cultivar 'Late Bedana' developed pink discoloration within 3 months storage at 28–39°C. The evaluation of 4 litchi cultivars grown in Uttar Pradesh, India indicated that 'Rose scented' variety had highest soluble solids (19°Brix), titrable acidity (0.25%), reducing sugar (9.2%) and total sugars (12.6%) (Tripathi et al. 1987). Litchi pulp heated to 85°C and added with 500 ppm SO_2 and 1% citric acid could be stored for 6 months at 25–35°C and 12 months at 4–5°C (Sethi 1985).

Processing of litchi fruits into juice concentrate during the season results in the reduction of bulk and the concentrate can be used for the formulation of single strength juice and other blended beverages during off season. Preservation of fruit juice in single strength form is expensive due to its high volume thereby increasing packaging, storage and transportation cost. Concentration of fruit juice results in reducing the bulk, which in turn reduces the packaging, transportation and storage costs. It also enables economic utilization of perishable fruits during peak season. Therefore, there is a need to process litchi into value added juice concentrate for preservation. The main objective of the present investigation was to study the effect of pectinase

treatment of litchi pulp on juice quality, processing the enzyme clarified litchi juice into juice concentrate and to evaluate its storage stability.

Material and methods

Freshly harvested litchi (*Litchi chinensis* L) fruits of 'Shahi' cultivar were procured from Muzaffarpur region of Bihar, India. The fruits were packed in ventilated corrugated fiber board boxes and transported by air to Mysore. The fruits were sorted and washed. Fruit weight, length, diameter, pulp, peel, seed content and visual colour of randomly selected litchi fruits were recorded.

Hunter colour values were measured using color measuring system, (Model UV–2100, Shimadzu, Japan). The colour values were expressed as L, a, b, where L = lightness, a (+) = redness, a (–) = greenness, b (+) = yellowness and b (–) = blueness. The total soluble solids (TSS) of the pulp were determined using a digital refractometer (Model RX 5000, ATAGO, Japan). pH was measured using digital pH meter (Model APX 175 Control Dynamics Ltd. Bangalore, India).

Moisture was determined by weighing 5–10 g of the sample in a metal dish and drying for 6 h at 70±1°C under pressure of ≤100 mm Hg (13.3 Kpa). Titratable acidity was determined by titrating known quantity of sample against 0.1 N NaOH and expressed as %citric acid. Reducing and total sugars were determined by inversion method. Ascorbic acid was determined by 2,6-dichlorophenol indophenol titration based on the reduction of ascorbic acid by the dye in the pH range of 1 to 3.5. Tannin content was determined by spectrophotometric (Model – GBC-10 Cintra, USA) method based on the measurement of blue colour formed by the reduction of phosphotungstomolybdic acid by tannin like compounds in alkaline solution (AOAC 2000). Five g of litchi juice concentrate were soaked in 100 ml of 65% ethanol (v/v) overnight and the extract was filtered through Whatman Nr 41 filter paper. The optical density of the filtrate was measured at 420 nm in a spectrophotometer and expressed as absorbance to determine non-enzymatic browning (NEB) (Askar and Treptow 1993).

Extraction of litchi pulp: Litchi fruits (25 kg) were peeled and passed through an extractor fitted with a sieve having a pore diameter of 0.79 mm to separate the seeds and pulp. Litchi pulp thus obtained was used for enzyme treatment studies.

Pectinase treatment of litchi pulp: Commercial pectinase enzyme used for clarification was obtained from M/s Biocon India Ltd, Bangalore, India. The activity of the enzyme used was 3592 units/ml. Litchi pulp was heated to 40°C in a stainless steel steam jacketed kettle to which was added commercial pectinase enzyme at concentrations of 100, 200, 300, 400 and 500 ppm and incubated at 40°C for 2 h.

Clarity of enzyme clarified litchi juice: Enzyme treated litchi juice was pasteurized at 80°C and passed through a separator (Model TA-05-00-1-5, Westfalia USA). Transmittance of the clarified juice obtained was measured at 660 nm in a UV- visible spectrophotometer.

Litchi juice concentration: The clarified litchi juice was concentrated in a Turbafilm evaporator (Model 04012, Votator divison, Chemetron Corporation, Louisville, Kentucky, USA). The clarified litchi juice was evaporated at 47°C and vacuum of 610 mm of Hg. Litchi juice was passed 3 times through the evaporator to obtain juice concentrate with TSS of 60°Brix. Chemical changes of litchi juice concentrate obtained after each pass from the evaporator were determined.

Storage of litchi juice concentrate: Litchi juice concentrate was packed in low density polyethylene pouches of 100 micron thickness and sealed. The sealed pouches were frozen at –40°C in a blast freezer and stored at –20°C in a deep freezer. The concentrate samples were analyzed periodically during storage for 6 months.

Reconstitution of litchi concentrate into single strength litchi juice: The stored litchi juice concentrate was reconstituted into single strength litchi juice with TSS of 16°Brix by blending with water and evaluated for sensory quality.

Sensory analysis: The samples were assessed for colour, flavour, texture and overall quality by a 15 – member trained panel, on a 10-point scale, where 1–2 = poor, 3–4 = fair, 5–6=good, 7–8= very good, and 9–10= excellent. Samples receiving an overall quality score of 7 and above were considered acceptable and those receiving below 7 were considered unacceptable. The sensory data was subjected to two way analysis of variance and the difference between the means was analyzed by Duncans multiple range test (Askar and Treptow 1993).

Statistical analysis: Analysis was carried out in 3 replicates (Microsoft Excel 2000). The sensory data was analyzed by 2-way analysis of variance and the significance of the data is reported (Steel and Torrie 1980).

Results and discussion

Physical characteristics: There were variations in the length (3.0–3.9 cm), weight (10.2–20.2 g) and diameter (2.3–3.4 cm) of the litchi fruit. The seed and peel contents were 16.0 and 20.0 % (w/w) of whole fruit, respectively. Litchi fruit has a pulp content of 64% which renders it suitable for processing into juice and juice concentrate. The Hunter colour values of the surface colour of litchi fruit peel indicated that the peel had reddish yellow colour.

Composition: Moisture comprised the main component of fruit. Reducing sugars comprised about 72% of the total sugars (Table 1). The ascorbic acid content was 18 mg/100 g. Litchi pulp also contained polyphenol compounds (tannins) which could be responsible for the discoloration of the pulp during processing and storage. Tripathi et al. (1987) evaluated different litchi cultivars for the compositional characteristics and reported similar findings.

Effect of enzyme clarification of litchi pulp: Pectinase treatment of litchi pulp facilitated the removal of insoluble solids and yielded clarified litchi juice. The clarity of centrifuged litchi juice increased with an increase in enzyme concentration (Fig. 1). This could be due to the breakdown of pectic substances. Among the different concentrations used for the optimization of pectinase, the litchi pulp added with 500 ppm of pectinase resulted in maximum transmittance of 80% at 660 nm. Hence the same enzyme concentration was used throughout the study. Litchi juice clarified with 500 ppm enzyme had TSS of 16.4°Brix. Wu et al. (2001) reported that litchi juice treated with bentonite (0.2 g/l) and chitosan (0.3 g/l) for 4 h resulted in lowest turbidity. The desired clarity could be obtained by pectinase (500 ppm) treatment alone in the present study.

Table 1 Hunter colour of peel and chemical composition of litchi fruit pulp

Hunter color of peel (n=10) L	24.33 ± 0.47
a	13.7 ± 0.33
b	7.56 ± 0.42
Litchi pulp composition and colour (n=3)	
Moisture, %	82.1± 1.1
TSS, °Brix	16.3 ± 0.23
Titrable acidity, %	0.17 ± 0.01
pH	5.04 ± 0.04
Reducing sugars, %	8.5 ± 0.75
Total sugars, %	11.8 ± 0.64
Ascorbic acid, mg/100g	17.6 ± 0.5
Tannins, %	0.06 ± 0.02
NEB (at 420 nm)	0.14 ± 0.002
Hunter colour values L	48.9 ± 0.21
a	–2.3 ± 0.06
b	5.3± 0.04

TSS= Total soluble solids, NEB = Non enzymatic browning

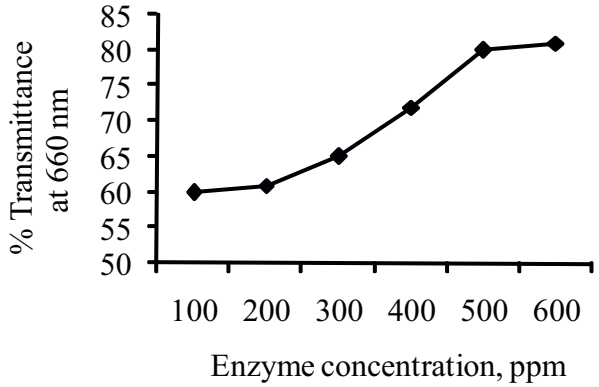

Fig. 1 Effect of pectinase treatment on the clarification of litchi juice

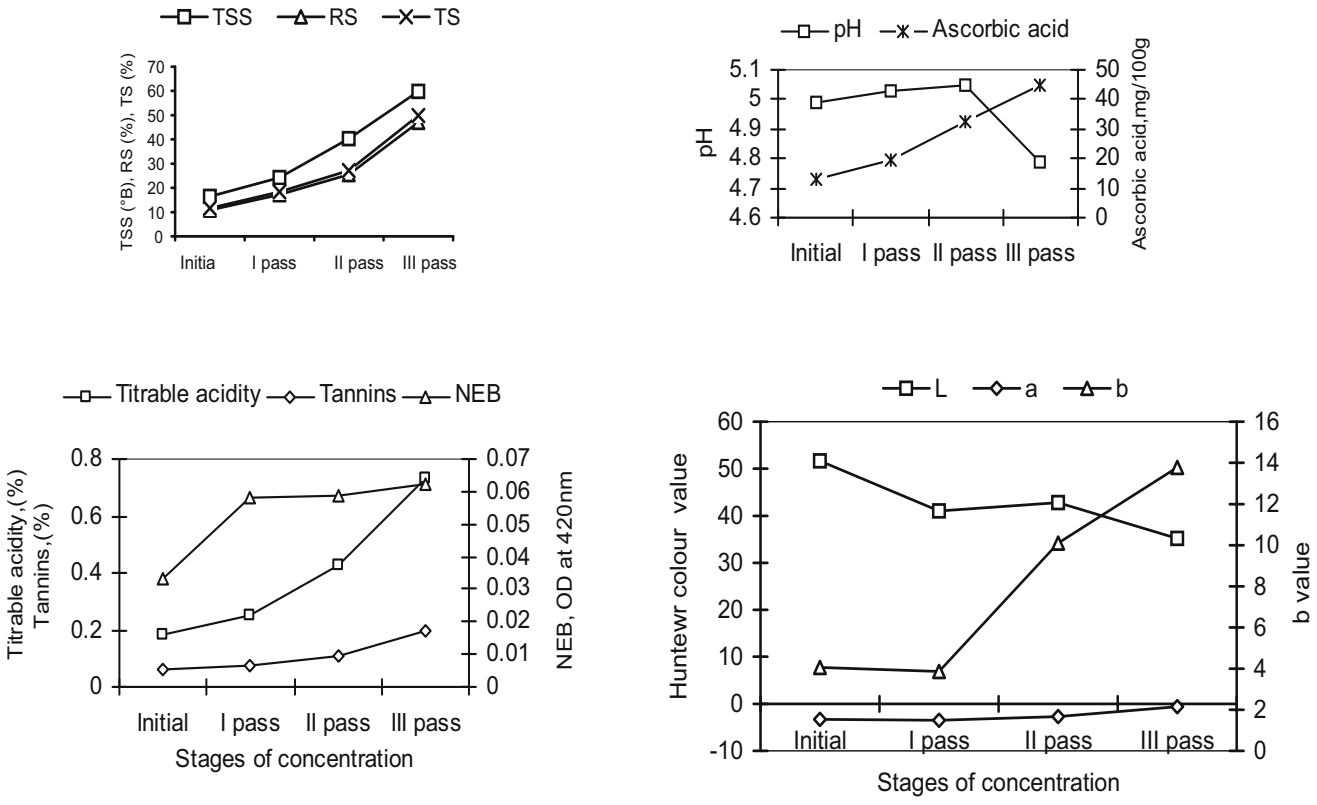

Fig. 2 Changes in physical and chemical characteristics in litchi juice during concentration (n=3), RS= Reducing sugars, TS: Total sugars, TSS,NEB: See Table 1

Table 2 Changes in quality characteristics of litchi juice concentrate during storage (–20°C)

	Storage period, months			
	Initial	2	4	6
Physico-chemical (n=3)				
TSS,°B	59.6 ± 0.22	60.4 ± 0.26	60.8 ± 0.54	60.7 ± 0.26
Titrable acidity, %	0.73 ± 0.02	0.73 ± 0.01	0.74 ± 0.01	0.74 ± 0.01
pH	4.79 ± 0.01	4.78 ± 0.01	4.79 ± 0.01	4.77 ± 0.01
Reducing sugars, %	47.1 ± 1.20	47.5 ± 1.10	47.2 ± 1.50	47.6 ± 1.70
Total sugar , %	49.7 ± 1.80	49.7 ± 1.50	49.7 ± 1.26	49.4 ± 1.16
Ascorbic acid, mg/100g	32.6 ± 0.50	32.4 ± 0.45	31.5 ± 0.75	29.5 ± 0.65
Tannins, %	0.19 ± 0.01[a]	0.22 ± 0.01[b]	0.24 ± 0.01[bc]	0.24 ± 0.01[c]
NEB (at 420 nm)	0.06 ± 0.001[a]	0.06 ± 0.002[a]	0.07 ± 0.001[a]	0.09 ± 0.002[b]
Hunter colour values L	35.2 ± 0.22	33.1 ± 0.30	32.2 ± 0.12	31.8 ± 0.25
a	–0.58 ± 0.05	–0.98 ± 0.04	1.06 ± 0.05	1.32 ± 0.06
b	13.78 ± 0.10	13.69 ± 0.09	13.61 ± 0.07	13.54 ± 0.08
Sensory quality (n=15 panelists)				
Colour	8.3	8.1	8.1	8.1
Flavour	8.3	8.2	8.1	8.0
Taste	8.5	8.3	8.2	8.1
Overall quality	8.4	8.2	8.2	8.1

Means in the same row with different superscripts are significantly different ($p \leq 0.05$) and changes on other parameters during storage are marginal ($p \leq 0.05$). TSS, NEB: See Table 1

The ascorbic acid content of clarified juice decreased to 11.8 mg/100 g as compared to that of litchi pulp (17.6 mg/100 g), which could be due to the oxidation of ascorbic acid during the clarification.

Effect of vacuum concentration on the composition of litchi juice: Enzyme clarified litchi juice contained TSS of 16.4°Brix which increased to 24.2, 40.3 and 59.8°Brix after 1st, 2nd and 3rd pass in the evaporator, respectively as also total (TS) and reducing (RS) sugars (Fig. 2). Titrable acidity and ascorbic acid content increased and pH of litchi juice concentrate decreased (Fig. 2) due to the removal of water during concentration. Tannin content and NEB of litchi juice concentrate increased marginally during concentration (Fig. 2). Hunter L (lightness) and a (redness) decreased while b (yellowness) increased during the concentration of litchi juice indicating the darkening of colour (Fig. 2). Harsimrat and Dhawan (2003) reported that vacuum concentration of clarified guava juice resulted in a superior product quality in terms of tannin, total sugars content and retention of ascorbic acid.

Effect of storage on composition of litchi juice concentrate: No significant ($p \geq 0.05$) changes were observed in TSS, total and reducing sugars, pH, ascorbic acid and Hunter colour values during storage (Table 2), non-enzymatic browning and tannin content increased ($p \leq 0.05$) at the end of 6 months of storage (Table 2). Galeb et al. (2002) observed much higher levels of NEB in cantaloupe juice concentrate stored at 25°C for 4 months, which could be attributed to the higher pH of cantaloupe juice and high temperature of storage. Similar trend of storage effect on pineapple juice concentrate was reported by Sandhu et al. (1985).

Sensory quality of single strength litchi juice prepared from litchi juice concentrate: Sensory colour, flavour, taste and overall quality decreased from 8.3–8.5 to 8.0–8.1 (Table 2) during storage and the single strength litchi juice prepared from litchi juice concentrate stored for 6 months was sensorily acceptable.

Conclusions

Litchi fruits which are available for short season of 3 months could be used for the production of juice concentrate which can reduce packaging, transportation and storage costs. Pectinase treatment and subsequent clarification of litchi juice facilitated vacuum concentration of litchi juice concentrate. The litchi juice concentrate was found to retain the nutrients and sensory quality during storage for 6 months at –20°C. Litchi juice concentrate reconstituted into single strength juice was having acceptable sensory quality characteristics.

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