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STORAGE STABILITY OF LITCHI JUICE AND JELLY: CHANGES IN BIOCHEMICAL, PHYSIOCHEMICAL, AND MINERAL NUTRIENT

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ABSTRACT

Litchi (*Litchi chinensis* Sonn.) is an underutilized fruit under the Sapindaceae family. Still now, there is very limited research available regarding processing of this fruit into value added products. The aim of this study was preparation of Litchi juice and jelly and preserve them as well as the assessment of their biochemical properties. The selected litchi variety for the study was China-3 (Kathali) which was procured from the local market at Kalitola in Dinajpur Sadar, Bangladesh. The experiment was executed in the Department of Agricultural Chemistry Laboratory and Preservation laboratory, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The Litchi fruits were carefully selected to ensure optimum maturity because its pectin content depends on maturity. Juice and jelly were prepared with five different treatments and the best one type of each juice and jelly were selected by sensory test with a panel of 20 testers. The study allows to preserve juice and jelly for 120 days and check their shelf-life through biochemical analyses. Analyses were done in 0-day, 15th day, 30th day, 60th day, and 120th day. According to compositional analysis, juice had higher concentrations of moisture, sodium, potassium, calcium, sulfur, magnesium, reducing sugar, vitamin C, proteins, TSS, total sugar and non-reducing sugar, while having lower concentrations of fat, ash, pH, phosphorous, vitamin A, beta carotene, acidity and total phenol. On the other hand, jelly had higher concentrations of moisture, reducing sugar, vitamin C, non-reducing sugar, protein, TSS, total sugar, calcium, magnesium, sodium, potassium and sulfur, while having lower pH value, vitamin A, beta carotene, total phenol, phosphorous, ash, fat, and acidity. Overall findings showed that juice made from T_2 sample and jelly made from T_3 sample were more acceptable than those of other samples and might be marketed for public consumption and could be preserved for 120 days or more.

Keywords: Litchi (*Litchi chinensis* Sonn.); Value-added products; Fruit processing; Biochemical properties; Sensory evaluation; Shelf-life

1 INTRODUCTION

Litchi (*Litchi chinensis* Sonn.*)* is a subtropic fruit mature primarily in Southeast Asia [1]. Litchis possess a high level of industrial worth on the international market and area unit vital for the economies of the countries [2]. Litchi is valued for its characteristics balance of sweetness and acidity, exceptional aroma and high helpful nutritive worth [3]. Litchi may be a non-climacteric fruit [4] and it decays in no time once harvest. It involves market throughout May and June once the market is jam-packed with different contemporary fruits, mainly mango and jackfruit. However, despite the supply of various styles of fruit within the market, the demand for contemporary Litchi is usually terribly high because of its exclusive style, flavor, and hue. Litchi contains 0.7% protein, 0.3% fat, 0.7% minerals (particularly Ca and P) and square measure cheap sources of vitamins C (64 mg/100 g pulp), A, B1 and B2 [5]. Another study has shown that Litchi is a superb source of antioxidant (40-90 mg/100 g) [6]. It additionally contains 21.6 g/100 g of total sugar [7], 0.37g/100g titratable acidity (as citric acid) [8], 43 aroma volatile compounds [9] and 0.8 mg/g total synthetic resin compounds [10]. The polyphenolic compounds and pro-anthocyanidins found in litchi are literally even a lot more powerful than antioxidants in equilibrating free radicals and defending the body from varied diseases and affliction. The litchi incorporates a limited postharvest self-life thanks to natural covering desiccation and browning [11] and fruit surface cracking [12]. The skin rupturing of litchi fruits reveals the plant part to ambient conditions and offers entry to flora pathogens leading to fast decay. Thus, litchi has limited postharvest duration or storage life [11]. Litchi juice and jelly are obtained from the edible aril of litchi ripe fruits. Litchi juice and jelly are generally characterized by a translucent appearance, floral aroma, refreshing flavor and high moisture content. During Storage Litchi juice and jelly may undergo different types of biochemical, physiochemical and mineral nutrient changes. However, the specific objectives of this research were to prepare Litchi juice and jelly and store them for 120 days and evaluate their biochemical, physiochemical, and mineral nutrient changes; and to keep Litchi fruit products available throughout the year in the market.

2 MATERIALS AND METHODS

Research was conducted in the Department of Food Processing and Preservations laboratory, and chemical analysis was done in the Department of Agricultural Chemistry's laboratory, both at Hajee Mohammad Danesh Science and Technology University in Dinajpur.

2.1 Materials

Litchi (*Litchi chinensis* Sonn.*)* fruits were collected from a local market at Dinajpur Sadar Upazila in Bangladesh. Fruits were chosen according to approximate uniform size, shape, color, and free form damage.

2.2 Preparation of Litchi juice

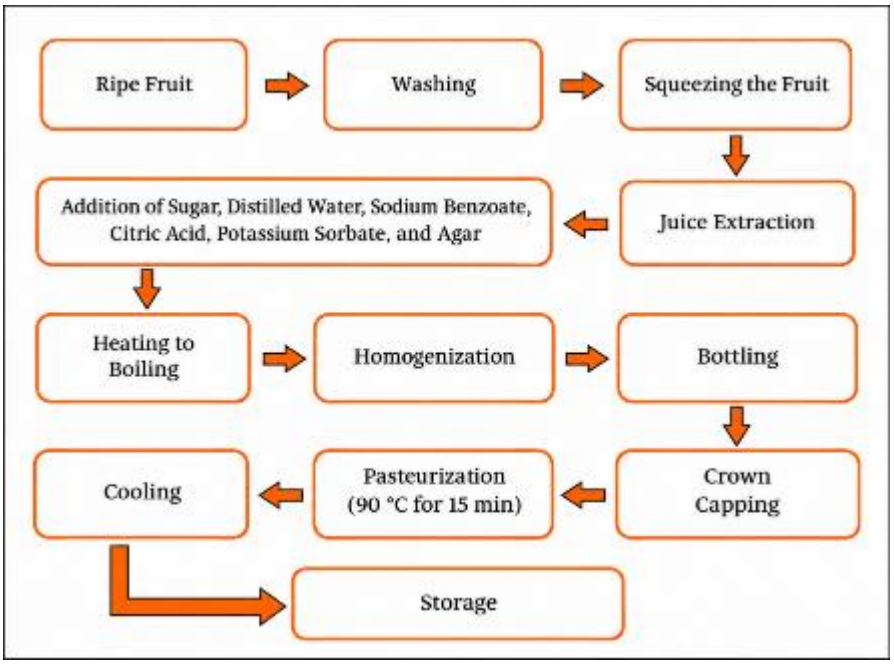
At first freshly ripen Litchi was collected in a basket. Then washed it thoroughly into the distilled water. After Squeezing the fruit in a pot, then add sugar, distilled water, sodium benzoate, citric acid, garlic powder, clove powder, cinnamon powder and agar. Then the pot was heated for boiling. When boiling started, then in the meantime we measured the total soluble solid content in the refractometer (TSS meter). When the total soluble solid content reached 16, we stopped the boiling process. After that process bottling was done in the sterilized bottle. And pasteurization (90 °C) for 15 min. Then cooling and storage was done.



Figure 1: Litchi juice samples



Figure 2: Litchi juice (best sample)



Flow chart 1: Juice (Litchi) preparation

Table 1: Different types of Litchi juice sample preparation

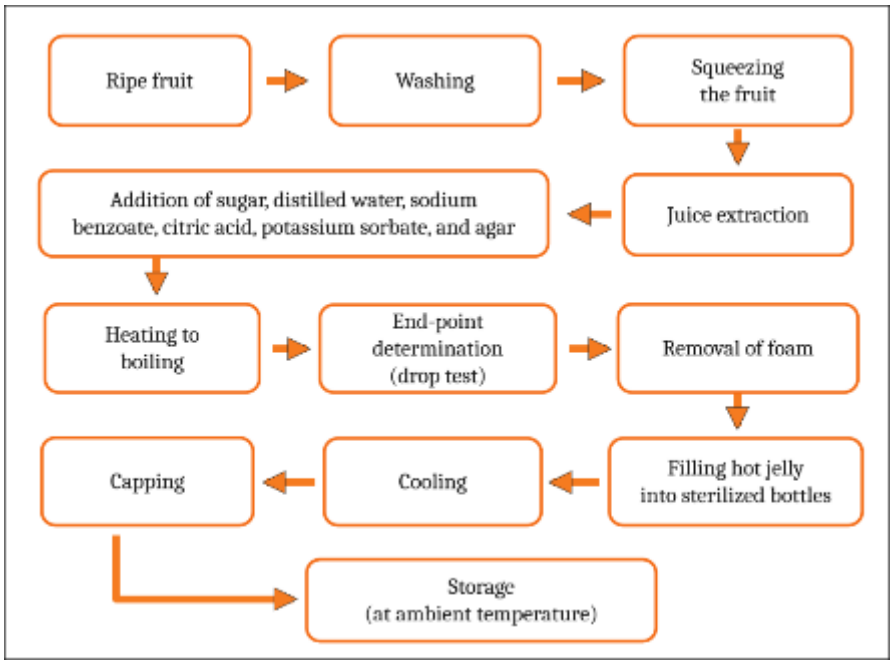
Sample name	Litchi Juice (ml)	Water (ml)	Citric acid (g)	Agar (g)	Sodium benzoate (g)	Sugar (g)	Garlic (g)	Clove (g)	Cinnamon (g)	Total volume (ml)	Prepared Juice (ml)
T_1	140	110	1.25	0.5	0.05	8	0.08	0.08	0.08	250	200
T_2	160	90	1.25	0.5	0.05	7	0.03	0.03	0.03	250	200
T_3	200	50	1.25	0.5	0.05	6.5	0.05	0.05	0.05	250	200
T_4	225	25	1.25	0.5	0.05	5.5	0.07	0.07	0.07	250	200
T_5	250	0	1.25	0.5	0.05	5	0.4	0.04	0.04	250	200

2.2.1 Sensory analysis of different types of Litchi juice samples

Twenty skilled panelists reviewed the prepared juice sensory qualities such as color, taste, flavor and overall acceptability. The CV% and LSD score for sensory evaluation of juice was given in Table 3. The outcome showed that various juice samples varied significantly regarding color, taste, flavor, and overall acceptability. Overall findings showed that juice made from T3 was more acceptable than the other samples.

2.3 Preparation of Litchi jelly

At first freshly ripen Litchi was collected in a basket. Then washed it thoroughly into the distilled water. After squeezing the fruit in a pot, then addition of sugar, distilled water, sodium benzoate, citric acid, garlic powder, clove powder, cinnamon powder and agar. Then the pot was heated for boiling. When boiling was started, then in the meantime we measured the TSS content in the refractometer (TSS meter). When the TSS content was reached 81.9 then we stopped the boiling process. And the liquid was formed in a thicken jelly. Then we removed the foam from the tops if any have. After that process bottling was done in the sterilized bottle. Then cooling and storage was done.



Flow chart 2: Jelly (Litchi) preparation



Figure 3: Litchi jelly samples



Figure 4: Litchi jelly (best sample)

Table 2: Different types of Litchi jelly sample preparation

Sample name	Litchi Juice (ml)	Water (ml)	Citric acid (g)	Agar (g)	Sodium benzoate (g)	Sugar (g)	Garlic (g)	Clove (g)	Cinnamon (g)	Total Volume (ml)	Prepared jelly weight (g)
T_1	300	300	2.85	2.85	0.25	165	0.10	0.10	0.10	600	300
T_2	350	250	2.85	2.85	0.25	192	0.19	0.19	0.19	600	300
T_3	400	200	2.85	2.85	0.25	220	0.16	0.16	0.16	600	300
T_4	440	160	2.85	2.85	0.25	245	0.15	0.15	0.15	600	300
T_5	500	100	2.85	2.85	0.25	275	0.18	0.18	0.18	600	300

2.3.1 Sensory analysis of different types of Litchi jelly samples

Twenty skilled panelists reviewed the prepared jelly sensory qualities such as color, taste, flavor and overall acceptability. CV% and LSD score for sensory evaluation of jelly were given in Table 3. The outcome showed that various

jelly samples varied significantly regarding color, taste, flavor, and overall acceptability. Overall findings showed that jelly made from T_3 was more acceptable than the other samples.

2.3.2 Physicochemical and biochemical analyses

The selected juice (T2) and jelly (T3) were analyzed on days 0, 15, 30, 60, and 120. Moisture was determined by vacuum-oven drying at 65 °C and ash by incineration at 550 °C [13]. Total soluble solids (TSS) were measured using a calibrated refractometer and expressed as °Brix [14]. The pH was measured with a calibrated pH meter and titratable acidity was determined by titration with 0.1 N NaOH using phenolphthalein as the indicator [15, 16]. Crude fat was determined by Soxhlet extraction with petroleum ether (boiling range 60-80 °C). Protein was determined by the Kjeldahl method using a nitrogen-to-protein conversion factor of 6.25 [16]. Vitamin C was measured by dye titration. Beta-carotene and vitamin A were determined after acetone-hexane extraction from absorbance at 663, 505 and 453 nm [17]. Total and reducing sugars were determined by Fehling titration [16]. Non-reducing sugar content was calculated from the difference between total and reducing sugars using a conversion factor of 0.95 and expressed as a percentage [16]. Total phenolics were measured by the Folin-Ciocalteu assay with gallic acid as the standard and expressed as mg gallic acid equivalents per 100 g [18]. Total flavonoid content was determined by the aluminum chloride colorimetric method using sodium nitrite and sodium hydroxide, with absorbance measured at 510 nm and results expressed as mg rutin equivalents per 100 g [18]. Calcium and magnesium were determined by EDTA titration, sodium and potassium by flame emission spectrophotometry and phosphorus spectrophotometrically at 660 nm [19]. Sulfur content was determined by the barium chloride turbidimetric method following oxidation of sulfur to sulfate, with the resulting barium sulfate suspension measured spectrophotometrically [20].

2.3.3 Statistical analysis

Data were analyzed by one-way analysis of variance (ANOVA), followed by Duncan's Multiple Range Test (DMRT) for mean separation using SPSS. Results are presented as means from three replications with the reported measures of dispersion.

3 RESULTS AND DISCUSSION

3.1 Sensory analysis: color, flavor, taste, and overall acceptability

Color is an essential element in determining a product's acceptability and has a great influence on how well it does with the market. The highest color T_2 juice (7.50), and sample T_3 jelly (7.8) was excellence. In case of guava, it is precise that the role of composition of guava extract to carrot juice ratio and storage periods on color score was significant [21]. The sensory analysis of juice and jelly for taste (ANOVA) demonstrated that there was significance variation among the samples. The sample T_2 juice (7.40) and sample T_3 jelly (7.7) were excellent.

Table 3: Sensory characteristics of prepared juice and jelly

Product	Treatments	T_1	T_2	T_3	T_4	T_5
Juice	Color	5.90	7.50	5.60	4.40	6.50
	Flavor	5.90	7.40	5.60	4.70	5.90
	Taste	6.70	8.50	6.20	5.50	5.80
	Overall acceptability	6.30	7.94	6.00	5.00	5.90
	LSD	0.86	1.12	0.67	3.18	0.50
	CV%	6.18	6.40	5.13	8.29	5.31
Jelly	Color	6.6	5.9	7.8	6.4	5.2
	Flavor	6.3	6.6	7.7	6.9	5.7
	Taste	6.6	5.7	8.5	6.2	5.4
	Overall acceptability	6.7	6.1	8.2	6.3	5.8
	LSD	0.21	0.45	0.37	0.35	0.32
	CV%	2.77	6.50	3.97	4.81	4.54

Taste is a main factor in any product's acceptability and has the greatest influence on a product's success on the market. ANOVA results from the sensory analysis of juice and jelly for taste indicated that there were significant differences among the samples. The sample T_2 juice (8.50) and sample T_3 jelly (8.50) were excellent. The critical variable in organoleptic estimation is overall acceptability, which involves a wide range of implications. The sample T_2 juice (7.94) and sample T_3 jelly (8.2) were highly acceptable. In case of, Guava jelly with prominent taste and aroma by incorporating it with red grape cultivars which was detected to be highly acceptable [22].

3.2 Physicochemical, Nutritional and Biochemical constituents of best selected Litchi juice (T_2) during storage period

3.2.1 Moisture, total soluble solid (°Brix), pH, titrable acidity, ash, fat and protein

Juice's moisture content as a percentage is affected by Litchi maturity and tropical region. According to Table 4, the lowest moisture content value (30.22%) was on 15th day, and the highest value (91.62%) was on the 120th day. The moisture content was in 0, 60th and 120th days were 82.26%, 30.23% and 30.25% respectively. Most fruits and juices of fruits are consisted of 70 to 90% water [23]. The maximum content of moisture of these fruit juices provides great influence on energy compactness (amount of energy in a given weight of food (kcal/g)) as water adds significant weight to the food without adding energy and this may give the consumers a better appetite suppression without increased their energy consumption [24]. Content of total soluble solid (°Brix) of Litchi juice showed significant variation. The total soluble solid (°Brix) content was detected for Litchi juice reported varied from 8.97 to 66.66. The maximum value 66.66 was found both on the 60th day and minimum value 8.97 was found on the 120th day. Results of this research were revealed that the pH varies in the samples. The pH in 0-day, 15th, 60th and 120th days were 3.64, 3.88, 3.87, 3.86, 3.48, respectively. The highest pH value was obtained (3.88) in 15th day and the lowest pH value (3.48) was recorded in 120 days. Multiple researchers have documented fruit and vegetable juices with various pH values. Tomato juice has been recorded to contain a pH range of 3.7-4.5 by Frazier and Westhoff [25]. Akusu et al. [26] detected that juice of pineapple has a pH value of 3.97. Adubofuor et al. [27] reported a range of 4.82-4.99 for cocktail juices, Ndife et al. [28] observed a range of 3.23-4.08 for different brands of orange juices.

This study's acidity varied from 1.03% to 2.39%. The results reveal that the highest acidity value (2.39%) was in 120th day, while the lowest value (1.03%) was in 15th, 30th and 60 day (Table 4). There is an agreement with the outcomes of Harnanan et al. [29] and recommended that 0.4 percent acidity was ideal and suitable for served beverage. The ash content of Litchi juice showed the value was significant. The ash content was detected for Litchi juice ranged from 0.18% to 0.45%. The largest value (0.45%) was found both on 15th and 30th day, and minimum value (0.18%) was found on 120th day.

Table 4: Physicochemical and proximate composition of best selected Litchi juice (T_2) during storage period

Treatment	%Moisture	Total Soluble Solid (°Brix)	pH	%Acidity	%Ash	%Fat	%Protein
0 day	82.26 ^{b}	17.50^{b}	3.640^{b}	1.07 ^{b}	0.37^{b}	0.01 ^{c}	1.16 ^{b}
15th day	30.22 ^{c}	66.65^{a}	3.88 ^{a}	1.03^{b}	0.45^{a}	0.03^{a}	1.28 ^{a}
30th day	30.23 ^{c}	66.65 ^{a}	3.87 ^{a}	1.03 ^{b}	0.45^{a}	0.03^{a}	1.29 ^{a}
60th day	30.25 ^{c}	66.66 ^{a}	3.86 ^{a}	1.03 ^{b}	0.44^{a}	0.03^{a}	1.27 ^{a}
120th day	91.62 ^{a}	8.97 ^{c}	3.48 ^{c}	2.39 ^{a}	0.18^{c}	1.33 ^{b}	1.38^{a}
Mean	52.91	45.29	3.75	1.31	0.37	0.02	1.28
LSD	0.38	0.34	0.03	0.02	0.01	2.79	0.03
CV%	0.89	0.91	0.86	2.33	3.57	1.77	2.80

Note: Means within a column followed by different superscript letters differ significantly according to DMRT ($p < 0.05$). LSD = least significant difference; CV = coefficient of variation.

The fat content in 0-day, 15th, 30th, 60th and 120th days were 0.01%, 0.03%, 0.03%, 0.03% and 1.33%, respectively. The highest amount of fat was 1.33% found in 120th day and the lowest amount of fat was 0.01% found in 0 day. There was no significant difference among the treatments. The protein content in 0-day, 15th, 30th, 60th and 120th days were 1.16%, 1.28%, 1.29%, 1.27% and 1.38%, respectively. The highest amount of protein was 1.38% and the lowest amount of protein was 1.16%. There was no significant difference among the treatments.

3.2.2 Reducing sugar, non-reducing sugar, total sugar, Vitamin C, β-carotene, Vitamin A, total phenol and total flavonoid

The highest value for reducing sugar was observed (52.91%) on the 15th day and the lowest value (4.20%) was recorded on the 120th day. The higher sugar concentration, the less water supported by the acidity of the substrate. The non-reducing sugar was detected for Litchi juice noted from 2.36% to 20.93%. The highest value of non-reducing sugar was 20.93% obtained on the 60th day and the lowest value (2.36%) obtained on the 120th day. The percentage of total sugar also depends on the stage of ripening. According to the research, total sugar in 0-day, 15th, 30th, 60th and 120th days were 16.22%, 73.81%, 73.78%, 73.83% and 6.59%, respectively. Vitamin C was found for Litchi juice that ranged from 7.42 mg/100g to 14.20 mg/100g. The largest value of vitamin C is 14.20 mg/100g obtained on 60th day and lowest value 7.42 mg/100g obtained in 0 day (Table 5).

Table 5: Biochemical constituents of best selected Litchi Juice (T_2) during storage period

Treatment	%Reducing sugar	%Non-reducing sugar	%Total sugar	Vit. C mg/100g	β-Carotene mg/100g	Vitamin-A mg/100g	Total phenol mg/100g	Total Flavonoid mg/100g
0 day	12.86 b	3.36 b	16.22b	7.42 b	0.79b	1.32 b	4.61b	1.25 c
15th day	52.91 a	20.91 a	73.81a	14.19a	0.65b	1.09b	8.19a	3.71 a
30th day	52.90 a	20.88 a	73.78a	14.19a	0.65b	1.09b	8.20 a	3.71 a
60th day	52.87 a	20.93 a	73.83a	14.20a	0.68b	1.10b	8.18a	3.71 a
120th day	4.20 c	2.36 c	6.59 c	7.49b	1.32a	2.20 a	4.29c	3.11 b
Mean	35.15	13.69	48.85	11.50	0.81	1.36	6.70	3.10
LSD	0.25	0.09	6.59	0.13	0.08	0.13	8.43	0.05
CV%	0.88	0.80	0.83	1.33	11.59	11.67	0.15	1.73

Note: Means within a column followed by different superscript letters differ significantly according to DMRT ($p < 0.05$). LSD = least significant difference; CV = coefficient of variation.

The β-carotene in 0-day, 15th, 30th, 60th and 120th days were 0.79 mg/100g, 0.65 mg/100g, 0.65 mg/100g, 0.68 mg/100g and 1.32 mg/100g, respectively. The highest amount of β-carotene was 1.32 mg/100g and the lowest amount of β-carotene was 0.65 mg/100g. Vitamin A was found for Litchi juice reported ranged from 1.09 mg/100g to 2.20 mg/100g. The highest value of vitamin A was 2.20 mg/100g obtained on the 120th day and the lowest value 1.09 mg/100g obtained both on the 15th and 30th day. The total phenol was found for Litchi juice reported ranged from 4.29 mg/100g to 8.20 mg/100g. The highest value of non-reducing sugar was 8.20 mg/100g obtained on the 30th day and lowest value 4.29 mg/100g obtained in 120th day. The total flavonoid was found for Litchi juice varied from 1.25 mg/100g to 3.71 mg/100g. The highest value of flavonoids is 3.71 mg/100g obtained on 15th, 30th, 60th day and lowest value 1.25 mg/100g obtained in 0 day.

3.2.3 Mineral constituents of litchi juice

The Ca content in 0-day, 15th, 30th, 60th and 120th days were 24.02 mg/100g, 34.07 mg/100g, 34.17 mg/100g, 34.27 mg/100g and 44.92 mg/100g, respectively. The maximum content of Ca was 44.92 mg/100g and the lowest content of Ca was 24.02 mg/100g. The Mg content in 0-day, 15th, 30th, 60th and 120th days were 16.19 mg/100g, 24.11 mg/100g, 24.13 mg/100g, 24.12 mg/100g and 36.32 mg/100g, respectively. The maximum content of Mg was 36.32 mg/100g and lowest content of Mg was 16.19 mg/100g. Results of this research expressed that the Na varies in the samples. The Na content in 0-day, 15th, 30th, 60th and 120th days were 16.65 mg/100g, 21.25 mg/100g, 21.25 mg/100g, 21.26 mg/100g and 18.68 mg/100g, respectively. The highest Na content value was 21.26 mg/100g obtained on the 60th day and the lowest Na value 16.65 mg/100g was recorded in 0 day. The K content in 0-day, 15th, 30th, 60th and 120th days were 49.95 mg/100g, 67.31 mg/100g, 67.35 mg/100g, 67.30 mg/100g and 52.92 mg/100g, respectively. The highest K content value was 67.35 mg/100g obtained in 30th day and the lowest K value 49.95 mg/100g was recorded in 0 day (Table 6).

The highest S content value was 11.29 mg/100g obtained on the 30th day and the lowest S value 4.56 mg/100g was recorded in day 0. Results of this research were exposed that the P varies in the samples. The P content in 0-day, 15th, 30th, 60th and 120th days were 6.62 mg/100g, 13.54 mg/100g, 13.54 mg/100g, 13.54 mg/100g, and 15.38 mg/100g respectively. The maximum P content value was 15.38 mg/100g obtained in 120th day and the lowest P value 6.62 mg/100g was recorded in 0 day.

Table 6: Mineral constituents of best selected Litchi juice (T_2) during storage period

Treatment	Ca (mg/100g)	Mg (mg/100g)	Na (mg/100g)	K (mg/100g)	S (mg/100g)	P (mg/100g)
0 day	24.02 ^{c}	16.19 ^{c}	16.65 ^{c}	49.95 ^{c}	4.56 ^{b}	6.62 ^{c}
15th day	34.07 ^{b}	24.11 ^{b}	21.25 ^{a}	67.31 ^{a}	11.28 ^{a}	13.54 ^{b}
30th day	34.17 ^{b}	24.13 ^{b}	21.25 ^{a}	67.35 ^{a}	11.29 ^{a}	13.54 ^{b}
60th day	34.27 ^{b}	24.12 ^{b}	21.26 ^{a}	67.30 ^{a}	11.28 ^{a}	13.54 ^{b}
120th day	44.92 ^{a}	36.32 ^{a}	18.68 ^{b}	52.92 ^{b}	4.62 ^{b}	15.38 ^{a}
Mean	34.23	24.96	19.82	60.95	8.61	12.52
LSD	0.25	0.19	0.12	0.37	0.37	0.03
CV%	0.88	0.92	0.77	0.75	5.37	0.32

Note: Means within a column followed by different superscript letters differ significantly according to DMRT ($p < 0.05$). LSD = least significant difference; CV = coefficient of variation.

3.3 Physicochemical, nutritional and biochemical constituents of best selected Litchi jelly (T_3) during storage period

3.3.1 Moisture, total soluble solid (°Brix), pH, titrable acidity, ash, fat and protein

Jelly's moisture content as a percentage is affected by Litchi maturity and tropical region. According to Table 7, the lowest moisture content value (30.21%) was at 60th day and the highest value (37.41%) was in 0 day. Singh and Chandra [30] reported that moisture content in guava jelly is almost (27%). The total soluble solid (°Brix) content of Litchi jelly showed significant variation. The total soluble solid (°Brix) content was detected for Litchi jelly stated ranged from 60.20 to 66.66. The maximum value of 66.66 was found on 60th day and minimum value of 60.20 was found on 0 day. The pH in 0-day, 15th, 30th, 60th and 120th days were 3.69, 3.88, 3.88, 3.88, 3.89, respectively. The highest pH value was (3.89) obtained in 120th day and the lowest pH value (3.69) was recorded on day 0. In case of guava, there is an agreement with the outcomes of Singh and Chandra [30] who have reported that the pH of guava jam was (3.61 to 4.15). The pH value also depends on ripening stage of guava.

This study's acidity varied from (0.87% to 1.12%). Table 7 revealed that on the 120th day, the highest acidity value was 1.12%, while in 0 day, the lowest value was 0.87%. The ash content of Litchi jelly ranged from 0.39% to 0.58%. The maximum value 0.58% was found in 120th day and the minimum value 0.39% was found on the 0 day. The fat content in 0-day, 15th, 30th, 60th and 120th days were 0.02%, 0.03%, 0.03%, 0.04%, 0.12%, respectively. The highest amount of fat was 0.12% found in 120th day and the lowest amount of fat was 0.02% found in 0 day. There was no significant difference between the treatments.

Table 7: Physicochemical and proximate composition of best selected Litchi jelly (T_2) during storage period

Treatment	%Moisture	Total soluble solid (°Brix)	pH	% Acidity	%Ash	%Fat	%Protein
0 day	37.41 ^{a}	60.20 ^{c}	3.69 ^{b}	0.87 ^{c}	0.39 ^{c}	0.02 ^{c}	1.25 ^{b}
15th day	30.25 ^{c}	66.65 ^{a}	3.88 ^{a}	1.02 ^{b}	0.44 ^{b}	0.03 ^{b}	1.28 ^{b}
30th day	30.22 ^{c}	66.65 ^{a}	3.88 ^{a}	1.02 ^{b}	0.44 ^{b}	0.03 ^{b}	1.28 ^{b}
60th day	30.21 ^{c}	66.66 ^{a}	3.88 ^{a}	1.02 ^{b}	0.44 ^{b}	0.04 ^{b}	1.28 ^{b}
120th day	32.84 ^{b}	65.76 ^{b}	3.89 ^{a}	1.12 ^{a}	0.58 ^{a}	0.12 ^{a}	1.51 ^{a}
Mean	32.18	65.18	3.84	1.01	0.46	0.05	1.32
LSD	0.18	0.37	0.02	0.01	0.01	3.63	0.03
CV%	0.69	0.71	0.80	2.35	3.62	9.38	2.63

Note: Means within a column followed by different superscript letters differ significantly according to DMRT ($p < 0.05$). LSD = least significant difference; CV = coefficient of variation.

The protein amount in 0-day, 15th, 30th, 60th and 120th days were 1.25%, 1.28%, 1.28%, 1.28% and 1.51%, respectively. The highest amount of protein was 1.51%, and the lowest amount of protein was 1.25%.

3.3.2 Reducing sugar, non-reducing sugar, total sugar, Vitamin C, β-carotene, Vitamin A, total phenol and total flavonoid

The percentage of reducing sugar depends on the stage of ripening. The reducing sugar amount in 0-day, 15th, 30th, 60th and 120th days were 53.21%, 52.91%, 52.90%, 52.89% and 36.30%, respectively. The maximum reducing sugar (53.21%) was found in 0 day, whereas the lowest reducing sugar was observed (36.30%) on the 120th day. The percentage of non-reducing sugar also depends on the stage of ripening. The non-reducing sugar amount in 0-day, 15th, 30th, 60th and 120th days were 19.60%, 20.91%, 20.90%, 20.92% and 4.84%, respectively. The maximum non-reducing sugar (20.92%) was found on the 60th day, whereas the minimum reducing sugar was detected (4.84%) on the 120th day. In this study, the total sugar in 0-day, 15th, 30th, 60th and 120th days were 72.81%, 73.81%, 73.83%, 73.78% and 41.15%, respectively. Vitamin C was found for Litchi jelly varied from 12.20 mg/100g to 18.51 mg/100g. The highest value of vitamin C was 18.51 mg/100g obtained on the 120th day and the lowest value 12.20 mg/100g obtained in 0 day (Table 8).

Table 8: Biochemical parameters of best selected Litchi jelly (T_3) during storage period

Treatment	%Reducing sugar	%Non-reducing sugar	%Total sugar	Vit. C mg/100g	β-Carotene mg/100g	Vitamin-A mg/100g	Total phenol mg/100g	Total Flavonoid mg/100g
0 day	53.21 a	19.60 b	72.81 a	12.20 c	0.63 b	1.05 b	6.37 c	2.99 b
15th day	52.91 a	20.91 a	73.81 a	14.19 b	0.65 b	1.09 b	8.19 a	3.71 a
30th day	52.90 a	20.90 a	73.83 a	14.18 b	0.65 b	1.09 b	8.20 a	3.71 a
60th day	52.89 a	20.92 a	73.78 a	14.19 b	0.65 b	1.09 b	8.18 a	3.71 a
120th day	36.30 b	4.84 c	41.15 b	18.51 a	1.77 a	2.95 a	8.04 b	2.90 b
Mean	49.64	17.43	67.07	14.65	0.87	1.45	7.79	3.41
LSD	0.33	0.11	0.42	0.20	0.03	0.04	0.03	0.04
%CV	0.81	0.76	0.77	1.63	4.00	3.86	0.48	1.52

Note: Means within a column followed by different superscript letters differ significantly according to DMRT ($p < 0.05$). LSD = least significant difference; CV = coefficient of variation.

The β-carotene in 0-day, 15th, 30th, 60th and 120th days were 0.63 mg/100g, 0.65 mg/100g, 0.65 mg/100g/100g 0.65 mg/100g and 1.77 mg/100g, respectively. The maximum amount of β-carotene was 1.77 mg/100g and the lowest amount of β-Carotene was 0.63 mg/100g. The Vitamin A in 0-day, 15th, 30th, 60th and 120th days were 1.05 mg/100g, 1.09 mg/100g, 1.09 mg/100g, 1.09 mg/100g, and 2.95 mg/100g, respectively. The highest amount of Vitamin A was 2.95 mg/100g and the lowest amount of Vitamin A was 1.05 mg/100g.

The total phenol was found for Litchi jelly reported from 6.37 mg/100g to 8.20 mg/100g. The highest value of total phenol was 8.20 mg/100g obtained in 30th day and the lowest value 6.37 mg/100g obtained in 0 day. The total flavonoid was found for Litchi jelly reported varied between 2.90 mg/100g to 3.71 mg/100g. The highest value of flavonoid 3.71 mg/100g obtained on 15th, 30th and 60th days, and lowest value 2.90 mg/100g obtained on 120th day.

3.3.3 Mineral constituents of Litchi jelly

The Ca content in 0-day, 15th, 30th, 60th and 120th days were 29.80mg/100g, 34.17 mg/100g, 34.07 mg/100g 34.09 mg/100g and 59.64 mg/100g, respectively. The highest Ca content was 59.64 mg/100g and the lowest content of Ca was 29.80mg/100g. The Mg content in 0-day, 15th, 30th, 60th and 120th days were 21.08 mg/100g, 24.11 mg/100g, 24.13 mg/100g and 24.12 mg /100g, 60.28 mg/100g, respectively. The maximum Mg content was 60.28 mg/100g and the lowest content of Mg was 21.08 mg/100g. The Na content in 0-day, 15th, 30th, 60th and 120th days were 18.59 mg/100g, 21.23 mg/100g, 21.25 mg/100g 21.24 mg/100g/100g and 31.00 mg/100g, respectively. The highest Na content value was 31.00 mg/100g obtained in 120th day and the lowest Na value 18.59 mg/100g was recorded in 0 day (Table 9).

The K content in 0-day, 15th, 30th, 60th and 120th days were 55.76 mg/100g, 67.35 mg/100g, 67.32 mg/100g, 67.30 mg/100g and 74.40 mg/100g, respectively. The highest K content value was 74.40 mg/100g obtained in 120th day and the lowest K value, 55.76 mg/100g was recorded in 0 day.

Table 9: Mineral elements of the best selected Litchi jelly (T_3) during storage period

Treatment	Ca (mg/100g)	Mg (mg/100g)	Na (mg/100g)	K (mg/100g)	S (mg/100g)	P (mg/100g)
0 day	29.80 ^{c}	21.08 ^{c}	18.59 ^{c}	55.76 ^{c}	10.06 ^{b}	11.95 ^{d}
15th day	34.17 ^{b}	24.11 ^{b}	21.23 ^{b}	67.35 ^{b}	11.28 ^{a}	13.54 ^{c}
30th day	34.07 ^{b}	24.13 ^{b}	21.25 ^{b}	67.32 ^{b}	11.28 ^{a}	14.19 ^{b}
60th day	34.09 ^{b}	24.12^{b}	21.24 ^{b}	67.30 ^{b}	11.28 ^{a}	14.19 ^{b}
120th day	59.64 ^{a}	60.28 ^{a}	31.00 ^{a}	74.40 ^{a}	10.07 ^{b}	18.05 ^{a}
Mean	38.33	30.73	22.67	66.41	10.79	14.38
LSD	0.34	0.25	0.21	0.64	0.23	0.12
%CV	1.10	1.01	1.15	1.19	2.64	1.09

Note: Means within a column followed by different superscript letters differ significantly according to DMRT ($p < 0.05$). LSD = least significant difference; CV = coefficient of variation.

The S content in 0-day, 15th, 30th, 60th and 120th days were 10.06 mg/100g, 11.28 mg/100g, 11.28 mg/100g, 11.28 mg/100g and 10.07 mg/100g, respectively. The P content in 0-day, 15th, 30th, 60th and 120th days were 11.95 mg/100g, 13.54 mg/100g, 14.19 mg/100g, 14.19 mg/100g and 18.05 mg/100g respectively. The highest P content value was 18.05 mg/100g obtained in 120th day and the lowest P value 11.95 mg/100g was recorded in 0 day.

4 CONCLUSION

Litchi juice and Litchi jelly were prepared from the Litchi fruits collected from the local market-Kalitola, Dinajpur. Sugar, citric acid, sodium benzoate, potassium sorbet etc. and other necessary experimental materials were obtained from the laboratory stock. Juice and jelly from Litchi were examined for sensory attributes by a panel of 20 testers. The outcome showed that the juice and jelly samples varied significantly regarding color, taste, flavor, and overall acceptability. Juice made from T_2 sample and jelly made from T_3 sample were more acceptable than those of other samples. On the basis of these above results, it can be determined that there is no more significant difference from 0 to 120 days in various parameters like pH, fat%, acidity%, vitamin C, total phenol etc. Litchi juice and jelly were suitable to store for 120 days and might be marketed for public consumption.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

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