RESEARCH ARTICLE

DEVELOPMENT OF LYCHEE PULPY DRINKS AND QUALITY ASSESSMENT DURING STORAGE

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ARTICLE DETAILS

ABSTRACT

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The experiment was concerned with developing of Lychee pulpy drinks to assess its prospect in respect to its marketability and food value. The fruits were collected and the pulp was extracted. Then the pulp was analyzed for proximate composition. Lychee pulpy drinks were prepared, analyzed the changes of TSS (Total soluble solid), acidity, pH, viscosity and gas volume and compared with carbonated lychee pulpy drinks and carbonated lychee drinks. Products were stored at room temperatures in PET (polyethylene terephthalate) bottles and changes during storage were observed at an interval of 1 month for a period of 7 months. A testing panel consisting 14 panelists studied the acceptability of the samples. The consumer's preferences were measured by statistical analysis of the scores obtained from the response of the panel. Among the samples the following lychee pulpy drink was awarded the highest scores by the panelists.

KEYWORDS

Lychee, Pulpy drinks, Sensory analysis, Acceptability, Carbonated pulpy drinks.

1. INTRODUCTION

Lychee (*Litchi chinensis*) is a sweet, flavorful and nourishing fruit that belongs to the family Sapindaceae and sub-family Nephelaeae. It grows well in Bangladesh which is one among the foremost important tropical and sub-tropical evergreen fruit trees. The main lychee planting areas all everywhere the world are China, India, Thailand, Vietnam, South Africa, Australia, USA and also the Malagasy Republic, etc. (Menzel et al., 1988). The overall lychee planting areas in China are 600,000 hectares and yields about 1.4 million tons annually, covering over almost 70% of the world's total output. Guangdong, Guangxi, Fujian, Hainan and Taiwan are the most produce provinces in China (Chen et al., 2006). India is that the second largest lychee producer, averaging approximately 500,000 plenty of lychees annually on 56000ha. The third largest lychee producer is Taiwan (FAO, 2002).

Lychee contains a rich in vitamin C with a fair amount of phosphorus, Calcium, Iron, Vitamin A and B. It also contains 15.9% seed, 9.6% pericarp, 74.5% edible portion, 78.2% moisture, 1.2% acid, 0.97% oil, 0.94% protein, 0.69% ash, 6.89% free reducing sugars, 6.68% hydrolysable sugars and 13.75% total sugars (Ahmed et al., 1988). Because of its attractive color, unique flavor, delicious taste, and bright red pericarp, lychee has been widely accepted by consumers. Apart from being consumed freshly, lychee fruit is also processed into drinks, juice, canned lychee and dried fruits.

But up to now, a very limited aspect of scientific research is carried out about lychee for the reason of its restricted planting areas. To reduce postharvest pericarp browning and pulpy decaying most of the research carried out on lychee focuses on planting techniques and fruit preservation methods (Dong et al., 2004; Jiang et al., 2004; Jiang et al., 2000; Olesen et al., 2004; Paull et al., 1998). Because of high moisture content and soft texture of litchi shelf life is very short and thus is processed for drinks production commercially.

Many people suffering from malnutrition due to inadequate and imbalance diet. The daily per capita fruit requirement is about 250-300g but the availability may not be enough due to various reasons. There are many synthetic drinks available in the market which contains water, acidulants, flavorings, food colors, preservatives etc as major ingredient (Ashurst et al., 1998). Different vitamins and minerals are found in fruit based drink. The consumer's behavior influenced 13.79% by healthy factor as they attracted on fruit based drink (Jaisam et al., 2008). The market for nutritional drinks is expected to expand further due to the trend toward lifestyle diseases (McCoy et al., 2005). Fruit based drinks contains fruit juice or mixture of fruits juices balancing sweetness and acidity which is free from alcohol. They are flavored by the use of natural or artificial materials, are frequently colored, and often contain an amount of fruit juice, fruit pulp or other natural ingredients. The predominant ingredient is water – often ignored and frequently maligned. The sweetness and other characteristics enhance the enjoyment of consumption and make the products more appealing to consumers. But lychee drinks are low-acid

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food with an approximate pH of 4.5-5.0, so it has a higher risk of microbial contamination. Some yeast and bacteria grow quickly in litchi drink, which can cause spoilage and produce undesirable organoleptic changes in products (Li et al., 2012). Therefore, lychee drinks should undergo some type of preservation to ensure product quality and safety.

Development of various value added products like jelly, juice, squash, and drinks utilizing local producer is significantly important for expanding the country's ever growing food industries. In the current research an attempt was carried out to the prospect of using lychee fruit for developing the good quality lychee drinks along with their acceptability would be investigated.

1.1 Objectives

1. To develop and analyze lychee drinks.
2. To assess the overall acceptability of the processed lychee drinks.
3. To study shelf life and quality of the lychee drinks.

2. MATERIALS AND METHODS

The experiment was conducted in the laboratory of AST Beverage LTD during the period of July-December, 2019.

2.1 Materials

2.1.1 Sample Collection

The mature lychee pulp was collected from China.

2.1.2 Chemicals, Solvents and Ingredients

Chemicals and reagents used in the study were used from laboratory stock. Sugar, Preservatives and other ingredients were collected from local market. Chemicals and solvents used in the study were of analytical reagent grade and water was distilled. Plastic (PET) Bottle was used as the packaging materials.

2.1.3 Apparatus Required

Blender, Filter cloth, Measuring cylinder, Pipette, Oven, Weight balance, Beaker, Volumetric flask

2.2 Methods

The experiment was examined with new recipe for developing lychee pulpy drink and kept sample checked for its stability. Three samples Lychee pulpy drinks (T₁), carbonated lychee pulpy drinks (T₂) and carbonated lychee drinks (T₃) were prepared for this research.

2.2.1 Lychee Drinks Preparation

Chemicals & Ingredients

Ingredients	Quantity (%)	For 1 Litre
Lychee pulp	1.145%	11.45 gm
Sugar	13.296%	132.96 gm
Anhydrous citric acid - (sour test)	0.1895%	1.895 gm
Sodium Benzoate	0.013%	0.13 gm
Sodium Citrate	0.063%	0.63 gm
Natural Cloudifier	0.12%	1.2 gm
Lychee Flavour- (Aromatic)	0.112%	1.12 gm
CMC	0.06%	0.6 gm
Potassium Sorbet	0.0025%	0.025 gm

2.2.2 Syrup Preparation

At first sugar was weighted and mixed with CMC powder then dissolved into hot water and then pasteurized at 85 °C for 30 minutes. At a time lychee pulp was pasteurized. After that pasteurized syrup & pulp were ready for mixing.

2.2.3 Juice Mixing

Syrup was taken into blending machine and pasteurized lychee pulp was added into it. After mixing all raw chemicals (Citric Acid, Sodium Citrate, Sodium Benzoate, Cloudifier, Potassium sorbet & Flavor) were weighted

and added into this mixer. Blender was used for mixing all chemical properly. Then the mixer was transferred to volumetric flask to added water to adjust its volume. Then water was added for final mix. Homogenization or mixing was done. After homogenization, pasteurization was done at 85 °C for 15 minutes. After filling in bottle, capping and sealing were done.

Figure 1: Flow chart of lychee pulpy drinks

Figure 2: Flow Chart of carbonated lychee pulpy drinks

Figure 3: Flow chart of carbonated lychee drinks

2.3 Proximate Analysis

Proximate chemical composition represents the gross content of important chemical constituents- TSS, Acidity, pH, Viscosity, Torque test, Microbial count.

2.3.1 Determination of Acidity

Acidity was determined using titration following the studies methods (Jacobi et al., 2001; Rangana et al., 1977).

2.3.2 Determination of pH

The pH means the negative logarithm of hydrogen ion concentration in a solution. The pH of the selected samples was determined by the conventional procedure by a pH meter.

2.3.3 Determination of Viscosity

A Visco meter was used to determine the viscosity of lychee drinks.

2.3.4 Determination of Total Soluble Solids (TSS)

Two drops of prepared drinks was taken in a refractometer (Model no. HI 96801, ROMANIA) plate and the total soluble solids of the drinks were read directly from the refractometer.

2.3.5 Torque Test of PET Bottle

A torque tester was used to determine the torque of PET bottle.

2.3.6 Microbiological Count

2.3.6.1 Determination of Total Viable Bacteria

For total viable count of microorganism present in the samples lychee drinks, Standard pour plate method was followed according to the method described in "Recommended method for the microbiological examination of food" (Ali et al., 2008).

Preparation of Media

Nutrient agar was used for total viable count. All necessary ingredients were measured and mixed in a conical flask. The conical flask was heated for proper mixing. In the time of heating, the mixture was rotted with the glass rod. When the mixture was properly mixed, the mouth of the conical flask was blocked with cotton plug and covered with aluminum foil. Then the conical flask with media was placed in autoclave for sterilization (Temperature: 121°C, Pressure: 14.5 psi and time: 15 mins.).

Incubation and Colony Count

After autoclaved the media was allow to cool in 40°C. About 20ml of media was poured in petridish and properly homogenized by clockwise & anticlockwise and allowed to solidify. After solidification the plate was incubate at 37°C in inverted position for 24-48 hours. After incubation colony was counted by colony counter. Laminar air flow was used to maintain aseptic condition.

Colonies were counted with the aid of a magnifying glass and finally the total number of bacteria per gram of sample was calculated by the following equation:

Colony count (per ml) = Number of colonies (per plate) × Reciprocal of the dilution.

CFU/ml= (no. of colony × dilution factor)/ sample taken (ml)

2.3.6.2 Determination of Total Yeast and Mold Count

Potato dextrose agar (PDA) was used for total yeast and mold count. After incubation colony was counted by colony counter and calculated by equation (same as section 2.3.6.1)

2.3.6.3 Determination of Total Coli form Count

Pour Plate Method was used to determine the coli form bacteria. MacConkey agar was used for total coliform count. After incubation colony

was counted by colony counter and calculated by equation (same as section 2.3.6.1).

2.4 Sensory Evaluation of Lychee Drinks

The sensory evaluation of three types of lychee drinks were evaluated for color, flavor, taste and overall acceptability parameters by 10 tasters. The panelists were selected from the employees of AST Beverage Ltd. For evaluation lychee drinks were given to 14 panelist and randomly coded sample. They were asked to rate the given sample a 9 point hedonic scale with ratings of: 9 = Like extremely, 8 = Like very much, 7 = Like moderately, 6 = Like slightly, 5 = Neither like or unlike, 4 = Dislike slightly, 3 = Dislike moderately, 2 = Dislike very much, 1 = Dislike extremely. The results were evaluated by Analysis of Variance and Duncan's Multiple Range Test (DMRT) procedures of SPSS.

2.5 Studies on Storage Stability of Prepared Lychee Drinks

Processed three samples were stored at room temperature in PET bottle, shelf life of lychee drinks were assessed by objective and subjective tests at different time intervals. The pH, acidity, TSS, viscosity, color, flavor, texture, gas volume, torque test, microbial count and fungal growth were observed up to 7 months.

2.6 Statistical Analysis

Data were analyzed using statistical software SPSS a single factor analysis of variance was carried out. Significant difference was estimated using Duncan Multiple Range Tests (DMRT). Differences were considered to be significant at ≤ 0.05 .

3. RESULTS AND DISCUSSION

The lychee drinks are perishable and subjected to quick deterioration during storage. The present study was undertaken to assess the shelf life during storage at room temperature.

3.1 Proximate Composition of Lychee Drinks

The lychee drinks were analyzed for pH, acidity, brix, viscosity and gas volume properties. The approximate composition of lychee concentrate (alcohol free) showed in the table 1.

Table 1: Approximate Composition of Lychee Concentrate	
Parameter	Amount
°Brix	64.11
Acidity	1.23%
pH	3.55

3.2 Changes of Lychee Drinks during Various Storage Periods

3.2.1 Changes of pH during Storage

The pH of the examined for the sample of lychee pulpy drinks, carbonated lychee drinks and carbonated lychee pulpy drinks ranged from 3.31 to 3.18, 3.54 to 3.40 and 3.40 to 3.21 respectively shown in Figure 4. The pH decreased as the number of days of storage increased, indicating acidity in lychee drinks. The use of sodium benzoate, potassium sorbate as preservatives significantly influenced the pH of lychee drinks. The pH of samples was decreased gradually after 7 months storage shown in Figure 4. However, after 7 months storage, the pH of lychee drinks preserved using potassium sorbate, Na-benzoate slightly decreased. The slight reduction in pH, observed in sample T₁ (lychee pulpy drinks), T₂ (carbonated lychee pulpy drinks) and T₃ (carbonated lychee drinks) due to the biochemical degradation of sugars by colonizing microorganisms resulting in the production of acids. The work is similar to (Ajibola et al., 2009; Makanjuola et al., 2013; Shah Nawaz et al., 2013). They reported a decrease in pH with increasing storage periods in fruit drinks. A study reported that pH values decreased from 4.02 to 3.41 in amla-grape blend juice during storage (Mishra et al., 2012). High acid and low pH may be due to production of acetic acid and lactic acid during storage.

Figure 4: Changes of pH during storage of 0 days to 7 months

3.2.2 Changes of TSS during Storage

The total soluble solids of chemically preserved lychee pulpy drinks (T_1), carbonated lychee pulpy drinks (T_2) and carbonated lychee drinks (T_3) ranged from 13.8-14.1 °Brix, 13.5-13.7 °Brix and 13.0-13.3 °Brix respectively. The total soluble solids of samples T_1 , T_2 and T_3 were 13.8°Brix, 13.5° Brix, 13.0 °Brix in the preparation day. After 7 months storage the total soluble solids of samples T_1 , T_2 and T_3 increased to respectively 14.1°Brix, 13.7 °Brix and 13.3 ° Brix shown in Figure 5. These results are in agreement with the results obtained by a research during preservation of grape juice stored at room temperature for one month preserved with sodium benzoate and potassium sorbate (Zeb et al., 2009). Similar results were also obtained by a recent study who worked on the storage of apple and apricot blended juice at refrigeration temperature for three months (Hussain et al., 2011). Increase in soluble solids may be due to break down of polysaccharides into monosaccharide and oligosaccharides while decrease may be due to fermentation of sugars into ethyl alcohol, carbon dioxide and water (Deka et al., 2001).

Figure 5: Changes of TSS during storage of 0 days to 7 months

3.2.3 Changes of Titrable Acidity (TA%) during Storage

The titrable acidity (TA) of lychee pulpy drinks (T_1), carbonated lychee pulpy drinks (T_2) and carbonated lychee drinks (T_3) ranged from 0.192-0.209%, 0.201- 0.218% and 0.235- 0.248% respectively. The TA slightly increased as number of months of storage increased for the three samples. The increase in the TA of the drinks might be due to fermentation activities by colonizing microorganisms (Nwachukwu et al., 2014). In the preparation day, the titrable acidity of samples T_1 , T_2 and T_3 were respectively 0.192%, 0.201%, 0.235%. After 7 months storage the total

solids of samples T_1 , T_2 and T_3 were slightly increased respectively to 0.209%, 0.218%, 0.248% shown in Figure 6. This might be due to the high solubility index of sodium benzoate in water. This is in conformity with the report of who evaluated the effect of different chemical preservatives on storage characteristics of bitter melon (Kaur and Aggarwal, 2014). A study reported that acidity increased from 0.25-0.36% during storage of cucumber-basil juice (Wadikar et al., 2010).

Figure 6: Changes of TA% during storage of 0 days to 7 months

3.2.4 Changes of Gas volume During Storage

The gas volume of carbonated lychee pulpy drinks and carbonated lychee drinks were ranged from 1.8 psi to 0.8 psi and 3.4 psi to 1.8 psi. The gas volume was decreased gradually for the T_2 and T_3 sample shown in Figure 7. During storage after 7 months gas volume of T_2 sample was decreased to 0.8 psi and T_3 was 1.8 psi. Gas volume was decreased gradually due to the micro leak in the cap of PET bottle.

Figure 7: Changes of gas volume during storage 0 days to 7 months

3.3 Storage Studies

Three treatments of were stored at room temperature. The color, flavor, taste was observed during the storage period of seven months at room temperature (Table 2). There was no change in color, flavor and texture change up to 15 days of storage, then slightly changed. There was no fungal growth occurred up to four months for sample T_1 , T_2 and T_3 . Lychee pulpy drinks (T_1) were seems to be more stable as after 6 months of storage. Carbonated lychee drinks (T_3) was slightly pungent after 4 months storage and carbonated lychee pulpy drinks (T_2) was changed after 5 months storage. After 5 months of storage, color and flavor were slightly changed for T_2 .

Table 2: Organoleptic evaluation of prepared lychee drinks stored during 0 to 7 months at room temperature

Storage Period	Sample	Color	Flavor	Texture
00	1. Lychee Pulpy Drink	Natural	Natural	Uniform
	2. Carbonated Lychee Pulpy Drink	Natural	Natural	Uniform
	3. Carbonated Lychee Drink	Natural	Natural	Uniform
1 Month	1. Lychee Pulpy Drink	No change	No off flavor	Uniform
	2. Carbonated Lychee Pulpy Drink	No change	No off flavor	Uniform
	3. Carbonated Lychee Drink	No change	No off flavor	Uniform
2 months	1. Lychee Pulpy Drink	No change	No off flavor	Uniform
	2. Carbonated Lychee Pulpy Drink	No change	No off flavor	Uniform
	3. Carbonated Lychee Drink	No change	No off flavor	Uniform
3 months	1. Lychee Pulpy Drink	No change	No off flavor	Uniform
	2. Carbonated Lychee Pulpy Drink	No change	No off flavor	Uniform
	3. Carbonated Lychee Drink	No change	No off flavor	Uniform
4 months	1. Lychee Pulpy Drink	No change	No off flavor	Uniform
	2. Carbonated Lychee Pulpy Drink	No change	No off flavor	Uniform
	3. Carbonated Lychee Drink	No change	No off flavor	Uniform
5 months	1. Lychee Pulpy Drink	No change	No off flavor	Uniform
	2. Carbonated Lychee Pulpy Drink	No change	No off flavor	Uniform
	3. Carbonated Lychee Drink	Slightly fade	Slightly Pungent	Uniform
6 months	1. Lychee Pulpy Drink	No change	No off flavor	Uniform
	2. Carbonated Lychee Pulpy Drink	Slightly fade	Slightly Pungent	Uniform
	3. Carbonated Lychee Drink	Slightly fade	Slightly Pungent	Uniform
7 months	1. Lychee Pulpy Drink	Slightly fade	Slightly Pungent	Slightly sediment
	2. Carbonated Lychee Pulpy Drink	Slightly fade	Slightly Pungent	Slightly sediment
	3. Carbonated Lychee Drink	Slightly fade	Slightly Pungent	Uniform

3.4 Microbial Load Calculation

Microbiological activity, its multiplication and load were calculated (Table) during 7 months of storage period for the three samples. This study was performed by Colony count method and nutrient Agar media, PDA and Macconkey agar were used for the total plate count (TPC), fungal count (FU), and coli form count were shown in Table 3, 4 and 5. After 48 hour of incubation colonies were counted. The total viable bacteria

present in lychee pulpy drinks were not uniform. In all the samples, the yeast, mold and coli form did not form any colony during 6 month of storage. After 7 months of storage yeast and mold start to form colony. In nutrient agar (NA) the presence of total bacteria was about 2/ml to 10/ml during 6 months storage period for the lychee pulpy drinks (T₁). Total viable bacterial count of the sample T₂ increased from 0 to 18/ ml after 6 months of storage at room temperature. Total viable bacterial count of the sample T₃ increased from 0 to 16/ml after 6 months of storage at room temperature. From the above results, it is clear that the total viable bacteria count increased with the increase of storage period. Sample T₁ contain less viable bacteria compare to other samples. The fungi were not present the three samples after 6 months of storage.

Table 3: Microbial count for lychee pulpy drinks during storage of 0 days to 7 months

Parameters	Microbiological Count		
Days	TPC (CFU/ml)	Yeast/Mold (CFU/ml)	Coliform (CFU/ml)
Initial	2	0	0
30 days	3	0	0
60 days	5	0	0
90 days	6	0	0
120 days	9	0	0
150 days	10	0	0
180 days	10	0	0
210 days	12	0	0

Table 4: Microbial count for carbonated lychee pulpy drinks during storage of 0 days to 7 months

Parameters	Microbiological Count		
Days	TPC (CFU/ml)	Yeast/Mold (CFU/ml)	Coliform (CFU/ml)
Initial	0	0	0
30 days	1	0	0
60 days	3	0	0
90 days	6	0	0
120 days	10	0	0
150 days	14	0	0
180 days	18	0	0
210 days	21	1	0

Table 5: Microbial count for carbonated lychee drinks during storage of 0 days to 7 months

Parameters	Microbiological Count		
Days	TPC (CFU/ml)	Yeast/Mold (CFU/ml)	Coliform (CFU/ml)
Initial	0	0	0
30 days	2	0	0
60 days	4	0	0
90 days	7	0	0
120 days	11	0	0
150 days	15	0	0
180 days	16	0	0
210 days	20	1	0

3.5 Sensory Evaluation

A panel of 14 judges (production officer and QC officer of AST beverage LTD) tested the color, flavor, taste and overall acceptability of lychee pulpy drinks (T₁), carbonated lychee pulpy drinks (T₂) and carbonated lychee drinks (T₃). The mean scores for color, flavor, taste and overall acceptability for the samples of T₁, T₂ and T₃ are presented in Table 6.

Table 6: Mean score for color, flavor and taste and overall acceptability of lychee drinks

Treatment	Sensory Attribute			
Sample	Color	Flavor	Taste	Overall Acceptability
T ₁ (lychee pulpy drinks)	8.0714 ^a	8.2143 ^a	8.1429 ^a	8.000 ^a
T ₂ (carbonated lychee pulpy drinks)	7.0714 ^b	6.8571 ^c	6.7143 ^c	6.9286 ^c
T ₃ (carbonated lychee drinks)	6.5714 ^c	6.3571 ^c	6.000 ^c	6.2857 ^c

a, b, c superscript indicates respectively the higher, medium and lower value. The test values along the different column carrying different superscripts are significantly different ($p < 0.05$).

Hedonic scale used: 9 = Like extremely; 8 = Like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much; 1 = Dislike extremely.

3.5.1 Color

A one way analysis of variance ANOVA (Appendix 1.1 and Appendix 1.1.1) was carried out for color preference and results revealed that there was significant ($P < 0.05$) difference in color acceptability among the lychee drinks. The results of DMRT (Appendix 1.1.2) showed that there was significant difference for color difference among the three samples T₁, T₂ and T₃ (Table 6). In case of color preference among the sample, the sample T₁ was more acceptable than sample T₂ and T₃. Sample T₁ secured the highest score 8.0714 and ranked as "Like very much". Sample T₂ ranked as "Like moderately" and T₃ are ranked as "Like slightly" securing score 7.0714 and 6.5714, respectively.

3.5.2 Flavor

A one way analysis of variance ANOVA (Appendix 1.2 and Appendix 1.2.1) was carried out for flavor preference and results revealed that there was significant ($P < 0.05$) difference in color acceptability among the lychee drinks. The results of DMRT (Appendix 1.2.2) showed that there was significant difference for flavor difference among the three samples T₁, T₂ and T₃ (Table 6). In case of flavor preference among the Sample, the Sample T₁ was more acceptable than Sample T₂ and T₃. Sample T₁ secured the highest score 8.2143 and ranked as "Like very much". Sample T₂ ranked as "Like slightly" and T₃ are ranked as "Like slightly" securing score 6.8571 and 6.3571, respectively.

3.5.3 Taste

A one way analysis of variance ANOVA (Appendix 1.3 and Appendix 1.3.1) was carried out for taste preference and results revealed that there was significant ($P < 0.05$) difference in taste acceptability among the lychee drinks. The results of DMRT (Appendix 1.3.2) showed that there was significant difference for taste difference among the three samples T₁, T₂ and T₃ (Table 6). In case of taste preference among the Sample, the Sample T₁ was more acceptable than Sample T₂ and T₃. Sample T₁ secured the highest score 8.1429 and ranked as "Like very much". Sample T₂ ranked as "Like slightly" and T₃ are ranked as "Like slightly" securing score 6.7143 and 6.000, respectively.

3.5.4 Overall Acceptability

It was apparent from the results of the ANOVA (Appendix 1.4 and Appendix 1.4.1), that there was significant ($p < 0.05$) difference in overall acceptability of the sample tested as the calculated F (29.705) greater than the tabulated F value (2.960). This indicates that so far as overall acceptability is concern the samples were not equally acceptable. Significant difference exist when $F(\text{Calculated}) > F(\text{Tabulated})$. It can be seen from Table 6 that the sample T₁ is the most acceptable product receiving 8.000 out of 9.0 compared to the other sample and ranked as "Like very much". Sample T₃ securing 6.2857 ranked as "Like slightly".

However T₂ securing 6.9286 ranked as "Like slightly".

Lychee drinks T₁ containing lychee pulp without CO₂ secured the highest score for color, flavor, taste and overall acceptability among the other samples and was closely followed by T₂ carbonated lychee pulpy drinks after 6 month storage. So, sample T₁ lychee pulpy drinks may be regarded as the best drinks among the samples.

4. SUMMARY AND CONCLUSION

To assess the physico-chemical properties and the shelf life of prepared lychee drinks, three samples namely, T₁, T₂ and T₃ were considered for this study. Sample T₁, T₂ and T₃ was lychee pulpy drinks, carbonated lychee pulpy drinks and carbonated lychee drinks respectively. The shelf life and consumer's acceptability of the prepared lychee drinks were studied. The lychee drinks were stored at room temperature for 7 months.

The physical and chemical analysis (TSS, acidity, pH, viscosity and gas volume) of the prepared lychee drinks for sample T₁, T₂, T₃ were done immediately after preparation i.e. 0th day. The changes of TSS, acidity, pH, viscosity and gas volume were found at an interval 0, 1, 2, 3, 4, 5, 6 7 months of storage period. On the day of preparation, the Sample T₁ contained pH 3.31, TSS 13.8%, acidity 0.192%. Sample T₂ contained pH 3.40, 13.5% TSS, 0.201% acidity. Sample T₃ contained 3.54 pH, 13% TSS, 0.235% acidity. After 6 months storage the Sample T₁ contained pH 3.20, TSS 14.0%, acidity 0.206%. Sample T₂ contained pH 3.25, TSS 13.6%, acidity 0.214%. Sample T₃ contained pH 3.43, TSS 13.2%, acidity 0.245%. Negligible Change in physical and chemical constituents was observed in the prepared lychee drinks throughout the 6 months of storage period.

The statistical analysis of the score response by the taste-testing panelists on the sensory attributes of drinks revealed that color, flavor, taste and overall acceptability of the differently drinks were significantly ($p < 0.05$) different. It was found that color, flavor, taste and overall acceptability of drinks of sample T₁ (lychee pulpy drinks) was more acceptable than other treatments.

Immediately after preparation of lychee drinks, total number of viable count was zero. It also showed that after 6 months intervals revealed that total colony increased slightly with the increase of storage period which was in consumable level for human. After 6 months storage, number of total bacteria was less in lychee pulpy drinks compare to other samples. After 7 months sedimentation problem occurs in the samples. This may be due to improper capping, coarse homogenization etc.

The study demonstrated that the lychee pulpy drink was effective to maintain the edible quality during six months of storage at room temperature. Lychee pulpy drink was effective against microbial growth to prevent spoilage.

The experimental finding concludes that, it is possible to prepare lychee pulpy drinks in Bangladesh those can be preserved for long time. The lychee pulpy drink with preservatives sodium benzoate, potassium sorbate and hot filled in PET bottle can be easily preserved for six months in room temperature without any spoilage and less taste, color and flavor. The drinks preparation is a simple technique for preservation and suitable for cottage and small scale enterprises.

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Appendices

Appendix 1.1

Rating score for color of Lychee Drink

No. of Panelists	Sample T ₁ (Lychee Pulpy Drink)	Sample T ₂ (Carbonated Lychee Pulpy Drink)	Sample T ₃ (Carbonated Lychee Drink)
1	8	7	6
2	9	7	7
3	8	7	8
4	8	7	6
5	8	8	7
6	7	8	7
7	8	6	6
8	9	7	7
9	8	7	6
10	7	7	6
11	9	8	6
12	8	7	6
13	8	6	7
14	8	7	7

Hedonic scale used: 9 = like extremely; 8 = like very much; 7 = like moderately; 6 = like slightly; 5 = neither like nor dislike; 4 = dislike slightly; 3 = dislike moderately; 2 = dislike very much; 1 = dislike extremely.

Appendix 1.1.1

ANOVA (Analysis of variance) for color of Lychee Drink

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16.333	2	8.167	20.836	.000
Within Groups	15.286	39	.392		
Total	31.619	41			

Appendix 1.1.2

DMRT (Duncan's Multiple Range test) test for color of Lychee Drink

Color				
Duncan ^a				
Sample	N	Subset for alpha = 0.05		
		1	2	3
3.00	14	6.5714		
2.00	14		7.0714	
1.00	14			8.0714
Sig.		1.000	1.000	1.000
Means for groups in homogeneous subsets are displayed.				
a. Uses Harmonic Mean Sample Size = 14.000.				

Appendix 1.1.3

Duncan's Multiple Range Test (DMRT) for color, P<0.05

Treatment code	Original order of means	Treatment Code	Ranked order of means
T ₁	8.0714 ^a	T ₁	8.0714 ^a
T ₂	7.0714 ^b	T ₂	7.0714 ^b
T ₃	6.514 ^c	T ₃	6.514 ^c

Appendix 1.2

Rating score for flavor of Lychee Drink

No. of Panelists	Sample T ₁ (Lychee Pulpy Drink)	Sample T ₂ (Carbonated Lychee Pulpy Drink)	Sample T ₃ (Carbonated Lychee Drink)
1	8	7	6
2	9	7	7
3	8	8	7
4	8	6	7
5	9	7	7
6	8	7	7
7	8	6	6
8	8	7	5
9	7	7	7
10	9	7	6
11	8	7	6
12	8	7	6
13	8	7	6
14	9	6	6

Hedonic scale used: 9 = like extremely; 8 = like very much; 7 = like moderately; 6 = like slightly; 5 = neither like nor dislike; 4 = dislike slightly; 3 = dislike moderately; 2 = dislike very much; 1 = dislike extremely.

Appendix 1.2.1

ANOVA (Analysis of variance) for flavor of Lychee Drinks

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	25.857	2	12.929	37.952	.000
Within Groups	13.286	39	.341		
Total	39.143	41			

Appendix 1.2.2

DMRT (Duncan's Multiple Range test) test for flavor of Lychee Drinks

Flavor				
Duncan ^a				
Sample	N	Subset for alpha = 0.05		
		1	2	3
3.00	14	6.3571		
2.00	14		6.8571	
1.00	14			8.2143
Sig.		1.000	1.000	1.000
Means for groups in homogeneous subsets are displayed.				
a. Uses Harmonic Mean Sample Size = 14.000.				

Appendix 1.2.3

Duncan's Multiple Range Test (DMRT) for flavor, P<0.05

Treatment code	Original order of means	Treatment Code	Ranked order of means
T ₁	8.2143 ^a	T ₁	8.2143 ^a
T ₂	6.8571 ^c	T ₂	6.8571 ^c
T ₃	6.3571 ^c	T ₃	6.3571 ^c

Appendix 1.3

Rating score for taste of Lychee Drinks

No. of Panelists	Sample T ₁ (Lychee Pulpy Drink)	Sample T ₂ (Carbonated Lychee Pulpy Drink)	Sample T ₃ (Carbonated Lychee Drink)
1	9	7	7
2	8	7	7
3	9	6	7
4	8	7	7
5	8	6	6
6	8	7	7
7	8	7	5
8	8	7	5
9	8	7	5
10	9	7	6
11	8	7	5
12	8	7	6
13	8	6	5
14	7	6	6

Hedonic scale used: 9 = like extremely; 8 = like very much; 7 = like moderately; 6 = like slightly; 5 = neither like nor dislike; 4 = dislike slightly; 3 = dislike moderately; 2 = dislike very much; 1 = dislike extremely.

Appendix 1.3.1

ANOVA (Analysis of variance) for taste of Lychee Drinks

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	33.333	2	16.667	39.224	.000
Within Groups	16.571	39	.425		
Total	49.905	41			

Appendix 1.3.2

DMRT (Duncan's Multiple Range test) test for taste of Lychee Drinks

Taste				
Duncan ^a				
Sample	N	Subset for alpha = 0.05		
		1	2	3
3.00	14	6.0000		
2.00	14		6.7143	
1.00	14			8.1429
Sig.		1.000	1.000	1.000
Means for groups in homogeneous subsets are displayed.				
a. Uses Harmonic Mean Sample Size = 14.000.				

Appendix 1.3.4

Duncan's Multiple Range Test (DMRT) for taste, P<0.05

Treatment code	Original order of means	Treatment Code	Ranked order of means
T ₁	8.1429 ^a	T ₁	8.1429 ^a
T ₂	6.714 ^c	T ₂	6.714 ^c
T ₃	6.000 ^c	T ₃	6.000 ^c

Appendix 1.4

Rating score for overall acceptability of Lychee Drink

No. of Panelists	Sample T ₁ (Lychee Pulpy Drink)	Sample T ₂ (Carbonated Lychee Pulpy Drink)	Sample T ₃ (Carbonated Lychee Drink)
1	8	8	7
2	8	7	7
3	9	7	7
4	8	7	7
5	8	7	7
6	8	7	7
7	8	6	6
8	9	7	6
9	8	7	6
10	8	7	5
11	7	7	6
12	7	7	6
13	8	7	6
14	8	6	5

Appendix 1.4.1

ANOVA (Analysis of variance) for overall acceptability of Lychee Drink

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	21.000	2	10.500	29.705	.000
Within Groups	13.786	39	.353		
Total	34.786	41			

Appendix 1.4.2

DMRT (Duncan's Multiple Range test) test for overall acceptability of Lychee Drink

Overall acceptability				
Duncan ^a				
Sample	N	Subset for alpha = 0.05		
		1	2	3
3.00	14	6.2857		
2.00	14		6.9286	
1.00	14			8.0000
Sig.		1.000	1.000	1.000
Means for groups in homogeneous subsets are displayed.				
a. Uses Harmonic Mean Sample Size = 14.000.				

Appendix 1.4.3

Duncan's Multiple Range Test (DMRT) for overall acceptability, P<0.05

Treatment code	Original order of means	Treatment Code	Ranked order of means
T ₁	8.0000 ^a	T ₁	8.0000 ^a
T ₂	6.9286 ^c	T ₂	6.9286 ^c
T ₃	6.2857 ^c	T ₃	6.2857 ^c

Appendix 1.5

Changes of pH during storage of 0 days to 6 months

Days	Lychee pulpy drink	carbonated lychee drink	carbonated lychee pulpy drink
0 days	3.31	3.54	3.40
30 days	3.3	3.53	3.39
60 days	3.29	3.52	3.37
90 days	3.29	3.50	3.35
120 days	3.27	3.48	3.32
150 days	3.24	3.46	3.29
180 days	3.20	3.43	3.25
210 days	3.18	3.40	3.21

Appendix 1.6

Changes of TSS during storage of 0 days to 6 months

Days	Lychee pulpy drink	carbonated lychee drink	carbonated lychee pulpy drink
0 days	13.8	13.00	13.50
30 days	13.90	13.05	13.51
60 days	13.90	13.10	13.52
90 days	13.90	13.15	13.53
120 days	14.0	13.2	13.6
150 days	14.00	13.20	13.62
180 days	14.0	13.2	13.6
210 days	14.1	13.3	13.7

Appendix 1.6

Changes of Titratable acidity during storage of 0 days to 6 months

Days	Lychee pulpy drink	carbonated lychee drink	carbonated lychee pulpy drink
0 days	0.192	0.235	0.201
30 days	0.193	0.236	0.202
60 days	0.195	0.238	0.204
90 days	0.198	0.24	0.206
120 days	0.2	0.241	0.209
150 days	0.203	0.243	0.211
180 days	0.206	0.245	0.214
210 days	0.209	0.248	0.218

Appendix 1.7

Changes of gas volume during storage of 0 days to 6 months

Days	carbonated lychee drink	carbonated lychee pulpy drink
Initial	3.4	1.8
30 days	3.3	1.7
60 days	3.1	1.6
90 days	2.9	1.5
120 days	2.7	1.3
150 days	2.4	1.1
180 days	2.1	1
210 days	1.8	0.8