DEVELOPMENT OF VALUE ADDED PRODUCTS FROM HOME-GROWN LYCHEE

A THESIS

BY

MD. MAHAMUDUL HASAN TALUKDAR
Student No.: 1105027
Session: 2011-12
Semester: January – June, 2012

MASTER OF SCIENCE (MS)
IN
FOOD ENGINEERING AND TECHNOLOGY

DEPARTMENT OF FOOD ENGINEERING AND TECHNOLOGY

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

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Submitted to the Department of Food Engineering and Technology, Hajee Mohammad Danesh Science and Technology University, Dinajpur

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Approved as to the style and content by

(Prof. Dr. Md. Kamal Uddin Sarker)
Supervisor

(S. M. Kamrul Hasan)
Co-supervisor

(Prof. Dr. Md. Kamal Uddin Sarker)

Chairman of the Examination Committee
and

Chairman

DEPARTMENT OF FOOD ENGINEERING AND TECHNOLOGY

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

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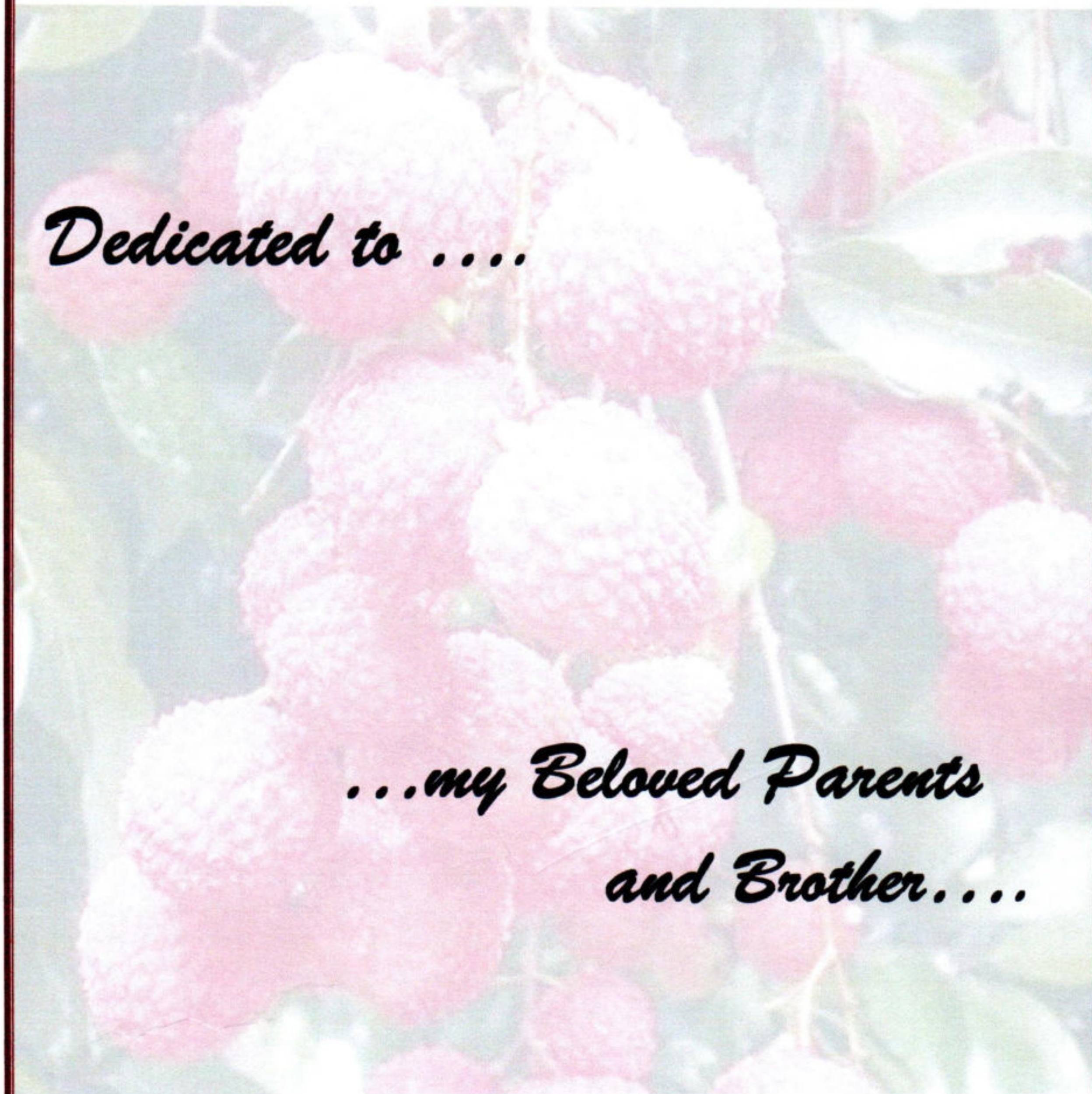

Dedicated to ....

...my Beloved Parents

and Brother....

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The Author

ABSTRACT

The experiment was concerned with developing of home-grown Lychee based different products, like squash and jelly to assess its prospect in respect to its marketability and food value. This thesis work was conducted in the laboratory of the Department of Food Engineering & Technology and Department of Food Processing & Preservation, Hajee Mohammad Danesh Science & Technology University (HSTU), Dinajpur. The fruits were collected from the local market and the pulp was extracted. Then the pulp was analyzed for proximate composition. The proximate analysis of lychee pulp showed 78.2% moisture, 17-18% TSS, 6.68% reducing sugar, 6.89% non-reducing sugar, 13.75% total sugar, 0.69% ash, 4.92 p^H, 0.327% acidity and 1.2 mg/100gm vitamin C. Total two types of products each with three (3) different formulations were prepared and packed in appropriate containers for storage studies. Products were stored at room temperatures (28°C) and changes during storage were observed at an interval of 30 days for a period of 6 months. A testing panel consisting 10 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 sample of squash, jelly was awarded the highest scores by the panelists; S-2 (Squash: TSS 40%, Juice 25%, Acidity 1.25%, KMS 250 mg/kg),E-2 (Jelly: TSS 67%, Pectin 1.0%, pH 3.2)respectively.

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ABBREVIATIONS

Cm	Centimeter
Gm	Gram
Kg	kilogram
GDP	Gross Domestic Product
LSD	Least Significant Difference
ANOVA	Analysis of Variance
DMRT	Duncan's Multiple Range Teat
KMS	Potassium Metabisulphate
CMC	Carboxy Methyl Cellulose
TSS	Total Soluble Solids
APHA	American Public Health Association
USDA	United State Department of Agriculture
FAO	Food and Agricultural Organization
WHO	World Health Organization
CFTRI	Central Food Research and Training Institute,India
BSTI	Bangladesh Standards and Tasting Institution
AOAC	Association of Analytical Chemistry
BBS	Bangladesh Bureau of Statistic

CHAPTER I

INTRODUCTION

The lychee (*Litchi chinensis*) belongs to the family Sapindaceae and sub-family Nepheleae. It is one of the most important sub-tropical evergreen fruit trees which grow well in Bangladesh. Another member of the sub-family 'Anshphal' (*Euphoria longana Lam.*) also grows in Bangladesh, mostly in backyards. It bears longan type but small sized fruits of little commercial value.

The sugar contents in different varieties ranges from 6.74-20.6% (Singh & Singh, 1964). Cabin (1954) also reported that the edible portion of lychee contained 74.5%, moisture 78.5%, citric acid 1.2%, ash 0.69% and sugar 13.57%.

The world production of lychee is estimated to be around 2.7 million tons mainly in Asia. The fruit is grown commercially in many subtropical areas in China and Southeast Asia such as Vietnam, Thailand and Taiwan. Other relatively small places also have favorable condition, for lychee growing including Israel, Australia, India, Parts of Africa, and at higher elevations in Mexico and Central and South America. The fruit is consumed mostly (about 60%) in fresh, drying and canned lychee are equally accounted for 20% each. The fresh fruit market dominates the trade, followed by dried and canned fruit. The main importing countries are the European Union, the United States, Hong Kong, Singapore, Japan and Canada. The main exporting countries are china, Taiwan, Thailand, Madagascar, South Africa, Australia and Mexico (most of it sent to California). The reasons included both short shelf-life and poor marketing systems. (Evans, *et al.*,2004).

China is the leading county in terms volume production followed by India, Taiwan, Thailand and Viet name (FAO, 2002). Current production covers approximately 600000 ha, over 60% of which has been developed in the past 10 years. India is the second largest lychee producer, averaging approximately 500,000 tons of lychee annually on 56000ha. The third largest lychee producer is Taiwan (FAO, 2002).

Other commercial producers are Indonesia, Australia, USA, New Zealand, South Africa, India and Bangladesh. In Bangladesh, lychee is grown in Dinajpur, Rangpur and Rajshahi district. The area under cultivation in 1998 was 4,750 hectares with 12,755 tones of total production (BBS, 1999).

A rich source of vitamin C litchi contains a fair amount of phosphorus, Calcium,Iron,Vitamin A and B . Litchi fruit 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 (Ahmad, 1956).

Processed lychee products are rarely available in our market and very little work has been done on processing of lychee in our country. Now Bangladesh use high technology, sophisticated machineries and equipment, skilled manpower and large capital investment for modern food processing industries as in developed countries. Therefore it is important to develop and use low level appropriate technology for processing and preservation of jelly, juice and squash made from lychee. Major constraints to the growth in supply of fruits in the country include post harvest losses due to inadequate packaging, transportation and storage and lack of familiarity with good post harvest processing.

Thus the scope of utilizing lychee remains bright in Bangladesh. Development of various value added products like jelly, juice and squash utilizing local producer is significantly important for expanding the country's ever growing food industries. In this study the prospect of using lychee fruit for the preparation of good quality squash and jelly with different composition along with their acceptability would be investigated.

On the basis of the above discussion, this study was under taken to achieve the following specific objectives:

- To prepare and analyzed squash and jelly.
- To asses the overall acceptability of the processed squash and jelly.
- To study shelf life in room temperature.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Many researchers worked in different countries investigated the formulations of different fruit based soft drink, juice, squash, nectar, jam, jelly etc. a little work has been done on the value addition or processing of lychee. The available information related to the present study is cited below:

The most important substrates in lychee fruit is its sugar content that ranges from 7 to 21 percent, 0.7 percent protein, 0.3 percent fat, 0.7 percent minerals (particularly Ca and P) were found in fresh fruit of lychee depending on variety and the weather in which lychee is grown. There is considerable content of some important vitamins such as Vit-C (64 mg/100g pulp), Vit-A, Vit-B1 and Vit-B2. The use of lychee is mainly as fresh fruit which accounted for 60 percent fresh, 20 percent canned and 20 percent dried fruit can also be processed into pickles, preserves, ice-cream, yoghurt, juice and wine (Christopher Menzel, 2002).

(Lopez-Lago, *et al.,* 1997) found that the physic-chemical properties of fruits from Costa Rica and Ivory Coast respectively were P^H 3.5 and 3.4; total acidity 0.682%; ash 0.27 and 0.36 % . Hormone treatment, sometimes applied to assist color development tended to develop only external color thus making fruits look ripe when they were not included oversized crowns and mould growth of the base, also fermented, off odor on the outside.

(Roy, *et al.,* 1997) observed that homogenization affects the viscosity, acceptability and storage properties of mango pulp and mango juice such as squash, nectar etc. he showed that storage at 4±1° C ensured maximum retention of chemical and sensory properties.

(Zurowietz, 1996) reported that the, relationship between subconscious sensory perceptions and product development in the beverage industry is discussed with particular reference to development of soft drinks and fruit juice. Aspects considered include evolutionary aspects of sensory perception; the physiology of olfaction; use of common sensory profiling for product development; advertising and psychological aspects of appeal to the senses; recommendations for providing taste/olfactory profiles for fruit juice and nectar; common profiling of other flavored products; and concept of global profiling.

(Khramitelna, 1994) observed that the mixed nectars were made from a fruit base of apple and citrus fruits (orange, lemon and grape fruit) bottled, sterilized and stored at 5, 10, 20 or 30° C for 6 months. Changes in furfural and color during storage were examined. Contents of Furfural increased with increasing storage temperature to give furfural content in apple and orange nectar of 0.08, 0.016, 0.66 and 1.95 mg/lit after 6 months at 5, 10, 20 and 30° C respectively. Storage at ≥20.6°C also resulted in unwanted color changes. It was concluded that the nectar should be stored at ≤ 10° C in order to preserve color and flavor.

(Bhasin, *et al.,* 1993) investigated that the geological characteristics of cold vs. hot break tomato juice were studied in two widely cultivated varieties namely Pb. Chuhara and Pb. Kesri relationship was observed between high pectin content and the nature of pectin. The predominant fraction of the juice was water soluble pectin. More of the highest molecular weight fraction was retained in the hot break juice than in controls as indicated by get filtration studies the methoxyl content of serum pectin in hot break juice was higher than in cold break. Other factors discussed are the difference in electrophoretic pattern of cold vs. hot break juice, and the effects of long-term storage on the electron profile and electrophoretic mobility RCTRI.

For fruit destined to overseas, sulfur dioxide fumigation is used (Zauberman, 1991).

Mid-term storage and transportation of lychee is mainly based on a cold chain system. Preservatives and film packaging could extend fruit cold storage and transportation life up to 30 to 40 days. Quick-frozen technology is commonly used in long term storage and transportation (Li, 1985), which prolongs storage life up to one or even more years.

(Efiuvwevwere, 1991) studied the effects of acidification and post process inoculation, using alternaria tenuis (a) common tomato contaminant), on change in chemical composition, physical quality and microbial stability of tomato juices were studied. Tomato juice was pasteurized (86° C for 10 min) and subjected to 3 different conditions, control and initial acidified non-inoculated (initial PH 4.0) with 17 terwis these were evaluated for chemical, physical and microbiological stability during ambient (29±2°C) storage for 58 days. Acidified non-inoculated and control samples showed appreciable increase in microbial population, attaining log 10, 7.5 and 6.9cfu/ml respectively.

(Furia, 1991) studied on the mixed fruit juice using various stabilizers ranging from 0.05 – 1.5% (wb) preferably 0.3 – 0.60% (wb) xanthan gum (based on total wt. of the mix). Water and other ingredients were incorporated such that the bled had a Brix value of ≥20 – 25. No refined sugar or corn sweetener was added. He found that juice mix could form a hard pack material at low temperature storage (0 - 18°C) for days and then be wormed to - 5 to -10°C to be scooped and eaten without the appearance of being too icy, coarse, crumbly or gummy but inhibiting a smooth, fine creamy texture and superior melt characteristics relative to soft pack.

(Guichard, 1991) investigated the composition of headspace, consistency, taste and flavor characteristics in jams made with different pectin. At usual concentration higher meth-oxy-late pectin induced an undesirable modification of typical flavor and intensity of flavor and taste; where as low meth-oxy-late pectin induced few alterations. A fixed concentration and molecular weight, a decrease in degree of esterifications, produced a significant decrease in consistency and noticeable modifications of the flavor perception but not taste alteration. Mechanical reduction of pectin molecular weight significantly modified only the consistency.

(Vasilenko, 1991) investigated that jellied sweets are made by mixing pectin with sugar preparing pectin sugar syrup, adding sodium lactate, a sugar containing component and an additive of vegetable origin, boiling of the syrup to 29 to 30% moisture content, forming the resultant mass, drying, sprinkling with sugar and cooling. To reduce the calorific value of the end product, the vegetable additive used in hydro-processed coca husks with particles of less than 30μm in greater than 92% of the resultant powder and is added during mixing at 1 to 3% of total weight of sugar in the product.

(Takada, *et al.,* 1990) investigated the production of tomato juice with a reduced level of green odor. Crushed tomatoes are heated to 60 – 65 °C at heating rate 7/4 °C/s, held at this temperature for 2 – 15 min heated further (40 to 85 °C) and processed into juice or used for recovery of natural tomato essence. The essence is recovered by collecting vapors containing aroma compounds, usually by flashing tomatoes in a vacuum tank, rectifying vapor and condensing the aroma components.

(Khorshied, *et al.,* 1989) observed that dried whey was used to make (1) jelly, to which was added fruit flavoring (mango, orange or strawberry or chocolate powder or (2) custard, flavored with vanilla or chocolate. Cooled samples of flavored jelly and custard were analyzed for TS, Protein, ash, fat, sucrose and lactose and PH values measured.

(Constenia, *et al.,* 1989) studied the effect of concentration and temperature on thermo physical properties of clarified apple juice and measured viscosity, specific heat and thermal conductivity under various conditions ranging from 20 to 90° C and 12 to 70° Brix. Experimental data were related to corresponding properties of water and compared with the behavior of sugar solutions. Results were used to derive mathematical models and correlation for predicting these properties as a function of both concentration and temperature.

(Soto-peralta, *et al.,* 1989) compared acid soluble and water soluble chitosans as fining agents for apple juice with conventional silica gel. Chitosans proved equally effective in reducing juice turbidity as control treatment.

Effect of chitosans on yield, titrable acidity, P^H, soluble solid and color of apple juice were evaluated by (Imeri, *et al*., 1988) retreatment with chitosan produced no effect on juice yield, but pH values and soluble solids were affected. Chitosan treatment also significantly reduced titrable acidity and color index.

Clarification of juice (maturely pH 6.8) extracted from Fuji apples, using a pectolytic enzyme preparation (0 – 0.007 %) and or P^H control (3.5 – 5.00) was studied by (kim, *et al.* 1989).It was reported that enzyme preparations increased clarity, effectiveness increasing with enzyme concentration. Juice adjusted to p^H 3.5 with malice acid gave the best clarity but was unacceptable because of its high acidity.

(Ahmed, 1988) reported that retention of ascorbic acid was higher and sensory quality characteristics were better in sulphite-treated (0.06 % potassium meta-bi-sulphite) citrus squash than preserved by benzoic acid. Storage of citrus squash in fluorescent light deteriorated its quality. Colored glass bottles proved better in retaining ascorbic acid and other quality indices in citrus squash than uncolored glass or PVC bottles.

(Siddique, *et al.,* 1987) reported that copper, lead, tin and zinc contents of canned and bottle jams, jelly, marmalade, fruit halves and fruit salads were estimated by atomic absorption spectrophotometer. Cu content was greatest in canned and bottled mixed fruit jam and lowest in pear halves, but all case below the world Health Organization (WHO) maximum permissible limit of 50 mg/kg. Pb content of fruit products packed in cans ranged from 7.5 to 9.67 mg/kg, values being lower for products packed in glass jars. However, Pb content of all samples tasted was above the WHO limit of 3 mg/kg. Sn content was greater in canned than bottled products but in every sample was below the WHO limit of 250mg/kg. Zn content varied widely from 14.25 in mango jam to 50.15 mg/kg in fruit salad. Again, canned products had a higher Zn content but all were within acceptable limits.

(Adisa, 1987) studied fresh fruit juice stored for 8 week in incubators at temperature of 5, 10, 15, 25 and 30° C and at the end of the storage period he determined the ascorbic acid content. He showed that a considerable amount of ascorbic acid was lost during the 8 week storage period.

(Kravchuk, *et al.,* 1986) studied the effect, of temperature, storage period and dry matter (DM) content on the keeping quality of concentrated apple juices stored at 10°C, 2°C and 20 to 25°C in light and dark for one year. They reported that storage at lower temperature in the dark retarded melanoidin formation and oxidation. Concentration of juice to 70% DM content proved feasible.

(Babsky, *et al.,* 1986) studied the effect of storage, on apple juice concentrate for a period of 111 days at 37 °C. The result showed that the storage caused an 87% loss in the total free amino acids, mostly due to decrease in gluta-mic acid, asparagines and aspartic acid.The formal titration methods was inadequate for determining the amino compounds involved in Maillard type reactions, sucrose was hydrolyzed under these conditions at a rate corresponding to a first order process. The reducing sugars increased at a rate determined by the inversion of sucrose. Reduction of organic acid was 9% while apparent phenolic compounds increased from 0.149 to 0.215 gm/100 gm. They observed maximum accumulation of hydro-oxy-methyl furfural after 100 days of storage.

(Sandhu and Bhatia, 1985) investigated the physic- chemical changes during preparation of fruit juice concentrate. It was found that deteriorate changes in quality *(i. e.)* inversion of sugars, losses of ascorbic acid and browning were more pronounced at higher concentrates in fruit juice.

(Freedomen, *et al.*, 1984) observed, that jellies prepared from strawberry, blackberry, apple and citrus juice and fortified with ascorbic acid at 75 mg/ 100 ml did produce lighter product and well- retained in jellies.

(Souza, *et al.*, 1984) studied about the mean fruit weight, pulp percentage, acidity, soluble solids content and brix; acidity ratio in fresh fruits. Total solids, acidity and the content of water and both reducing and non-reducing sugars in jelly made from them according to a standard recipe were determined. Felipe and Tau were identified as the best for fresh consumption locally, and Haden, Jasmin and Zill for export Uba made the best jelly, while for marmalade, juice and syrup production, Felipe and Zill were recommended by them.

(Anonymous, 1984) reported, that fruit juice is normally an acid food and does not support the growth of pathogens. He specified pasteurization time and temperature for these foods, which are as follows:

For, high acid foods. (*i.e.*)at low P^H foods.

Pasteurization will be done at 80°C for 30 Sec.

For cloudy juice pasteurization will be perform at 90 to 95°C for 30Sec.

(Parashakova, 1982) reported that fruit jelly manufactured with low sugar content preserved well the aroma and flavor of fresh fruit due to shorter heating time.

(Islam, 1981) the pulp was extracted from fully ripe and sound mangoes (variety: Gopalbogh). Pasteurized and stored in a deep freezer for further use. The mango pulp had the composition of T. S. S. 16.18%, acidity (citric acid) 0.4%, P^H 4.3 and vitamin C content 14 mg per 100gm. Three different formulations coded as "A" (pulp 5%, T. S. S. 10%, Acidity 0.1%, Sodium benzoate 0.05% and Carbon dioxide gas volume 3.0 unit), and "C" (pulp 10%, T. S. S. 15%, Acidity 0.2%, sodium Benzoate 0.05% and Carbon dioxide gas volume 3.0 unit) were selected for the preparation of carbonated beverage based on mango pulp.

(Anisworth, *et al.*, 1979) concluded that the strength of the gels is greatly reduced on processing. He also found that the network chains in the gels depend on the cross-link of its density.

(Fenericioglus and Gould, 1979) investigated that reconstituted tomato juice samples of 19 varieties. These reconstituted tomato juices were higher in ascorbic acid contents, pH and total acid percentage than single strength tomato juice samples. Color scores measured by hunter color and color difference meter or by Agtron E 5 did not differ much from single strength and reconstituted juice samples.

(Settee, *et al.,* 1978) reported that a ready to beverage could be prepared having pulp content 10% refracto-meter solids 20% and acidity 0.3%.

It has been reported by (Desrosier, 1977) that gel formation occurs only within a certain range of hydrogen-ion concentration, the optimum acidity figures for jellies being p^H 3. The gel strength falls slowly on decreasing and rapidly on increasing the p^H value. Beyond pH 3.4 no jelly formation occurs at the usual soluble solid range. The optimum concentration of sugar is about 67.5 %. It is, however possible to make jellies with high content of pectin and acid containing less than 60% sugar. Too high concentration of pectin necessary to from a gel depends largely on the quality of pectin. Only percent should be sufficient to produce a firm jelly.

(Desrosier, 1977) reported that the presence of small concentrates of sulfur-di-oxide in fruit juice might protect the fresh flavors. He also stated in the accomplishing the preservation of foods under various methods, the following principles are involved:

Preventation or dealy of microbial decomposition: by keeping out microorganisms; by removal of microorganisms, i.e. by filtration; by hindering the growth and activity of microorganisms *(i.e.)* by low temperature, dry anaerobic conditions or dry conditions; by killing the microorganisms (*i.e.*) by heating or radiation.

Prevention or delay of self decomposition: by destruction or inactivation of food enzyme (*i.e.)* by blanching; by prevention or delay of purely chemical reaction e. g. prevention or delay of oxidation by means of antioxidants; prevention of damage of insects, animals, mechanical cause etc.

(Words and Anrand, 1977) reported that ascorbic acid (vitamin C) was very susceptible to oxidation. Alkalis, iron and copper salts, heat, oxidative enzymes, air and light accelerated its destruction. It is readily preserved in acid media, but it disappeared rapidly when heated in neutral and alkaline media, certain enzymes destroyed ascorbic acid as a result.

(Parsi Ros, 1976) found that jam stored for 180 days at 29.4°C were found to be microbiologically safe and to have undergone negligible changes in Brix, P^H and organoleptic properties.

A few other workers also recommended the same ingredients for mango squash but with slight modification in the quantity used (Govt. of India, 1971). One and a half pound of sugar had been prescribed for every pound of mango pulp (Tandon, 1938). According to Indian specification (Daya Nand, 1975) a fruit squash should contain juice 25%, total soluble solids 40%, acidity (as anhydrous citric acid) 1.25% and the preservatives at the rate of 350ppm of sulfur-di-oxide and 500ppm of sodium benzoate.

BCSIR Laboratories in Rajshahi (Annual report 1979 – 75) investigated the compatibility of ripe mango juice in admixture with other fruit juice such as pineapple, lemon, guava etc. It has been observed that the mixed fruit juice had consumer appeal.

(Flaumenbaum and Shengeliya, 1974) reported that the taste of sweetened fruit juice depends upon the sugar/ juice/acid ratio. Maximum sugar content should be 18%, acidity 0.8 – 1.5% and the sugar acid ratio is 20 – 29 %.

(Central Food Technological Research Institute (CFTRI), 1972) proposed a recipe for the preparation of a mango squash as follows: mango pulp 1Kg, water 1kg, sugar 1Kg, citric acid 30gm, edible orange yellow color and potassium- meta – bisulphate (KMS) at the rate of 610mg per kg of finished product.

The method used for making apricot nectar may be briefly described as follows: soft ripe apricots are thoroughly washed and then passed over an inspection belt to eliminate damaged fruit and foreign matter. The fruit is steamed in a continuous steam cooker for approximately 5 min (Tressler and Joslyn, 1971).

(Hulme, 1971) in food industry fruit juice is defined as the liquid expressed by manual or mechanical means (pressure) from the edible portion of the fruit. Frequently the juice may be turbid, contain cellular components in colloidal suspension with variable amounts of finely divided tissue. It sometimes may contain oily or waxy material and carotenoed pigments.

(Hulme, 1971) stated that all juices are inherently unstable. Microorganisms already present on the fruit or gaining access to the product during processing rapidly attack them; they are also subject to enzymatic and non-enzymatic changes. It is thus essential to destroy the microorganisms at an early stage or to prevent their development. At the same time inactivating the enzyme activity will restrict the chemical change by heating or refrigeration.

(Anon, 1968) the sugar content of fruit juice or fruit decomposition to the sugar using microorganisms or enzymes, if undesirable by-products were obtained, e. g. alcohol and if the sugar has been removed by alcoholic fermentation, these by-products are subsequently removed. The alcohol-free fruit juice beverages obtained possess all the minerals and a least most of the vitamins of the original products but do not have their high calorific content or too sweet at taste.

(Eddy, *et al.,* 1967) the term “fruit nectar” is used by the industry to designate pulpy fruit juices blended with sugar-syrup and citric acid to produce a ready to drink beverage.

(Moyls, 1966) Guava nectar can be fortified with vitamin C at seven levels of concentration ranging from the original content to 300mg/100ml. the canned products are stored at room temperature and at 38°C than at room temperature regardless of concentration level. At the end of six months, the loss of vitamin C is less than 30% in samples stored at room temperature.

(Hamed, 1966) reported that sugar, vitamin and organic acid in mango juice were changed during storage. He also found that the levels of non-reducing sugar decrease and reducing sugar increased in all the preservation treatment employed, such as pasteurization at 85°C and addition of 0.7% sodium benzoate, 0.1% sorbic acid, 0.7% and 0.02% sulfur-di-oxide.

(Rangana and Bajaj, 1966) reported that Sulfur- di- oxide is widely used throughout the world principlally for treating food of plant origin. It is also used in the preservation of fruit juices, pulps, beverages and concentrates. The concentration of sulfur-di-oxide in the above mentioned food items might vary from 350 to 2000ppm. Soluble sulphite salts (e.g. KMS) are usually used in treating the acid food products.

Many fruit nectar contains not less than 50% pure juice, either single strength or reconstituted concentrate. Essences, vitamins, pectin, sugar and acid may be added (Rahaman, *et al.,* 1964).

(Desrosier, 1963) stated that preservation of fruits by manufacturing jam and jelly is a recognized practice throughout the world. Jam and jelly from pulp and juice respectively are prepared by adding sugar, pectin, citric acid after concentrating by evaporation to a point where microbial spoilage is prevented. The products are stored without hermetic sealing by covering with paraffin on the air surface.

A jelly is strictly defined as a semi-solid food made from not less than 45 parts of fruit juice ingredient to each 55 parts weight of sugar. This substrate is concentrated to not less than 65% soluble solids. Pectin and citric acid may be added covering the deficiencies that occur in the fruit itself.

In case of jam the fruit pulp is used in lieu of fruit juice.

The main four substances for jam or jelly are: pulp or juices, pectin, citric acid, sugar.

Papaya nectar can be made with approximately 10 parts of puree, 16.4 parts of water, 2.1 parts of sugar and citric acid sufficient to adjust the p^H 4 (Tressler, 1961).

Squash is non-carbonated fruit juice drink containing sugar, water and citric acid, sometimes gum –Arabic artificial color and flavor. In USA some canneries proposed a minimum juice content of 40 to 50 percent in the drink. The drink could be blended of two or more kinds of fruit juice (Tressler and Joslyn, 1961).

(Tressler, 1961) reported the photochemical decomposition of ascorbic acid in black current syrup. The decomposition of ascorbic acid was accompanied by a loss of color. It is assumed that the pigment of the juice may act as a protective agent for vitamin C or ascorbic acid.

(Joslyn, *et al.,* 1961) investigated the effect of length and temperature of storage period and relationship of oxygen, light; sugar, p^H and ascorbic acid with deteriorate changes in color of juices. Storage temperature and oxygen were the most specific for color injury of both juices and isolated pigments. Exposure to light caused little deterioration in color. Adjustment of acidity within the range of p^H 2 – 4.5 or addition of sugar had little effect on color retention in fruit juices during storage.

According to (Jacob, 1959) "Beverages" are characterized by the principle character. Firstly, they are liquid or are consumed in a liquid state. Secondly, they are generally used to quench the thirst. The major groups of beverages, which conform to these characteristics, are the carbonated non – alcoholic beverages and beverages such as fruit drinks and fruit juices. He also defined carbonated beverages as the drinks that are generally sweetened and flavored and sometimes are acidified and some times have salts and minerals added, that are artificially charged with carbon dioxide and that contain no alcohol.

Fruit flavored beverages could be classified into two broad categories, from the point of view of consumption, those containing fruit juice with or without pulp and fruit cells and other fruit flavored oils and those flavored with natural fruit oils.
Most members of the first group are citrus flavored beverages but other beverages in which fruit juice is commonly used are grape, apple, pineapple etc (Jacob, 1959).

(Cruess, 1958) observed that preservation of the flavor, aroma, color and vitamin content of fresh juice was dependent on the degree of destruction of enzymes or inhibition of their activity. Enzymes could be destroyed and their activity could be inhibited by pasteurization.

(Cruess, 1958) stated that fruit juices were most palatable when first expressed from the fresh and any treatment applied to preserve them resulted in more or less injury to quality. Fruits that were to be used for the preparation for juice should have well marked flavor and aroma. The juice should be prepared from sound fruit only. Even slight fermentation or mould growth spoils the flavor of the juice. Fruit that will be mould attacked will be vigorously washed. The crusher should be of such material that it does not react with the juice.

Guava nectar of 12 – 14 ° Brix consists of the acidity 0.17 – 0.20 % as citric acid and 15 – 25% guava juice (Tressler, 1948).

The hot fruit is run through a brushed equipped with 0.025 to 0.033 inch screen. The resulting puree is then passed through a steam heated tubular heat exchanger where it is brought to a temperature of 85 – 95 °C. The puree is sweetened with approximately 1.8 times its volume of 15 to 18° Brix sugar syrup and citric acid is adjusted so as to maintain a constant total solids acid ratio throughout the season. The resulting nectar is filled into plain cans, exhausted for approximately 6 minutes and sealed in No. 1 tall cans are processed for 15 minutes at 100°C; larger cans are given a longer process and then cooled with sprays of cold water (Tressler, 1948).

The peaches are thoroughly washed, halved, pitted and passed over an inspection belt to remove damaged fruit and foreign material. The peaches are halved and pitted in a flipper twist pitter. The peach halves are peeled in an up-down peeler by spraying with 1% sodium hydroxide solution at 100° C for 15 minutes. The peeled peach halves should be heated in a steam-jacked kettle or a continuous steam cooker to 80° C and run through a fruit disintegrator. The resulting puree is then run through a finisher with a 0.020 to 0.033 inch screen. A ton of fruit yields approximately 130 gal of puree. To each 100 gal of puree 63.5 gal of 30° Brix sucrose syrup should be added. The syrup may be prepared from three parts sucrose and one part dextrose. It may be necessary to add a small quantity of citric acid to adjust the p^H of the nectar 3.7 to 3.9. It is advisable to pass the finished nectars through a vacuum decorator prior to pasteurization. Then nectar is filled into the cans, closed at a temperature of 90°C inverted and given holding period of approximately 3 minutes prior to cooling (Tressler, 1948).

The pears at optimum ripeness level are washed and mechanically peeled and cored. The pear halves are heated to 85° C and held there for 3 minutes in a continuous stream. The hot fruit is passed through a continuous entrant fitted with a 0.033 inch screen. The hot puree is put through a brush type finisher fitted with 0.020 – 0.030 inch screen. The smooth puree is blended with sugar, citric acid and water to the desired consistency and solids. Usually it has a brix reading of 13° to 15° and pH value of 3.6 to 4.2. The product is flashed heated to 95°C or higher, inverted and given a holding period of 3 minutes prior to water cooling (Tressler, 1948).

(Phaff and Joslyn, 1947) stated that the action of pectin, sugar and acid in the formation of jellies could be accounted for by the Kruyt hypothesis of the stabilization of emulsions by hydration of change on the particales. Pectin is considered to be a negatively charged hydrophilic colloid, which is stabilized by a layer of water surrounding the individual micelles. Jelly formation occurs in ramifying aggregates of micelles in the presence of sugar, which acts as a dehydrating agent, and in the presence of hydrogen ions, which act to reduce the negative charge on the pectin.

During the process of boiling sucrose solutions in presence of acid, a hydrolysis occurs, in which reducing sugars are formed. Sucrose is converted into reducing sugars and the product is known as invert sugar. Invert sugar is useful in jelly manufacturing as crystallization of sucrose in the highly concentrated substrate is retarded or prevented.

(CFTRI, 1972) acid is necessary for the constituent of fruit jam and jelly. Juices that are deficient in acidity will make good jelly if citric acid is added, provided the proper proportions of pectin and sugar are present.

(CAC, 1976) For optimum jelly, total soluble solids content, pectin concentration and pH value should be 67%, 1% and 3.2% respectively.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted in the laboratories of the Department of Food Engineering and Technology, under the Faculty of Agro-Industrial and Food Process Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur during June 2011 to July 2012.

3.1 Materials

The indigenous lychee (*Litchi chinesis*) (used local variety name Bombai) and other raw materials were collected from the local market of Dinajpur. The major ingredients for the preparation of products were sugar, citric acid, pectin and KMS. These were used from the laboratory store.

3.2 Methods

3.2.1 Extraction of lychee pulp

The ripe and fresh lychee were washed thoroughly with potable water and then broken the upper layer of each lychee with maintaining hygienic condition. The extraction procedure of the pulp from the ripe fresh healthy lychee is shown in (Appendix – 1). Peel part of the lychee is discarded carefully from its seed. Water is added equal to the weight of the pulp and pH is adjusted by adding citric acid. The pulp prepared is kneaded and heated at 80°C for one minute. The material is sieved through stainless steal sieve and large part of the fibers is removed. The pulp thus obtained is treated with KMS and preserved by freezing or canning for future use.

Table 3.4 Ingredients used to manufacture 250 gm of lychee Jelly:

Sample	Ingredient				
	Juice/Pulp (gm)	Sugar (gm)	Citric Acid (gm)	Pectin (gm)	KMS (gm)
E-1	395.75	151.25	1.25	3.75	0.15
E-2	395.75	151.25	1.25	2.50	0.15
E-3	395.75	151.25	1.25	1.25	0.15

3.2.3 Processing of Lychee Squash

Fruit juice squash Consists essentially strained juice containing moderate quantities of fruit pulp to which cane sugar is added for sweetening. The materials required are Lychee Juice, sugar, Citric acid, potassium-meta bi-sulphit (KMS) as a source of SO_2, CMC, bottles, juice extractors; pasteurizers' etc. acid is used to lower the P^H which arrests the growth of microorganisms responsible for the spoilage of the product. Acid in combination with sugar also improves the taste of squash. Sulphur-di-oxide (SO_2) is used as preservative. In addition to act as preservative, SO_2 also helps to prevention of non-enzymatic browning. Presence of small concentration of SO_2 may help in protecting the fresh and delicate flavor of the squash. Usual specification of the squash is juice 25%, Total Soluble Solids (TSS) 40%, Acidity (Citric Acid) 1.25%, preservative at the rate of 350ppm of SO_2 in the final product. Sodium benzoate may be used at the rate of 1000ppm.

Steps to Prepare Squash

a) Processing of juice/pulp:

Pulp was prepared from the ripe and sound Lychee, strained, pasteurized, blended and analyzed for TSS, acidity and p^H value.

b) Weighing:

Various ingredients for the preparations of squashes (3 fold and 4 fold) were weighed by balance according to the calculations.

Shown in Appendix-2 (e.g. sugar, citric acid, juice, KMS and water)

c) Preparation of Syrup:

Required sugar and citric acid were mixed with required fresh water and then the mixture was boiled for about 3 to 5 min to prepare the syrup. The prepared syrup was filtrated through fine cloth.

d) Mixing:

The above mentioned syrup and required pulp were mixed thoroughly to obtain the desire squashes. The obtained squashes were heated to about 95°C for 3 minutes.

e) Cooling and Addition of Preservative (KMS):

The prepared squash were cooled down to about 28 to 30°C and then the measured amount of KMS was added thoroughly with each of the products by a blender.

f) Bottling:

The prepared squashes were poured into sterilized bottles through sterilized funnels keeping headspace about 2 cm. the bottles were corked and sealed tightly.

g) Labeling:

The sealed bottles were labeled by indicating the amount of ingredients, the name of the products, the name of the manufacturer, the number of the sample etc.

h) Storage:

The final products were in a dry and cool place for the next experiment.
Schematic diagram for manufacturing of lychee squash is shown in (Appendix – 4)

3.2.4 Processing of lychee jelly

Only a minimum quantity of water should be added to the pulp for extraction of pectin. If necessary, a second or even a third extraction may also be taken and mixed with the first extract. If large quantities of water used jelly will be weak and if too little water is used the extract will be difficult to clarify. The length boiling varies 20 to 60 minutes. The materials should be heated only long enough to soften it sufficiently to permit through extraction of pulp by pressing and to render it mushy.

Steam-jacked kettles are used for the extraction of pulp from the material for the preparation of jelly. Tilting kettle is generally preferred. Copper and tin injury the color of fruit if contact at the boiling point is prolonged. Stainless steel and aluminum are preferred for most fruits. Filter press is used for pressing out the juice. The press cake, May if desired be mixed with water in the kettle and heated a second time to obtain the remaining pectin. It may also be used as cattle feed. The juice should be cleared to yield an attractive clear jelly. Setting overnight in vessels 0.5 to 1.00 meter in depth can satisfactorily clear some fruit juice. Centrifuging is also employed for juice clarification. The juice and sugar are boiled to increase the concentration of sugar to the point where jelling will occur. Color, acid and pectin are incorporated just before the end point. Prolonged boiling results in loss of flavor, injury to color, and hydrolysis of the pectin, consequently it is a frequent cause of jelly failure. The boiling is continued until on cooling the product will from a jelly of a desired consistency. The end point is determined by a allowing the liquid to sheet from on a wooden paddle or spoon in sheets or forms jelly like sheets on its side, the boiling is considered to be complete. If the juice contains the proportions of sugar, acid and pectin, and boiling point of the liquid at the jellying point will normally be about 110°C. It has been noted that at 0.05 percent acidity (citric acid), 75 gm of sugar per 100gm of jelly is necessary to from jelly; while at 1.05 percent acidity; jelly can be formed when the finished product contains only 53.5gm of sugar per 100gm of jelly.

Jelly is usually packed at the boiling point or at about 95°C and sealed hot condition. Such procedure sterilizes the jelly glass and lead, and as the package is hermetically sealed, the product does not mold or ferment.

Schematic diagram for manufacturing of lychee jelly is shown in (Appendix – 5)

3.3 Chemical analysis of lychee pulp

Vacuum oven drying method described by Endel Karmas (1980) was used for determining moisture in lychee products where the temperature was maintained at 70°C at pressure 40 – 100mg of Hg. Temperature of drying was reduced because fruit sugars are mainly fructose which might be decomposed to great extent when heated to 100°C and may give a unrealistic of moisture content.

The acidity was determined by titration using standard sodium hydroxide solution and expressed as anhydrous citric acid and pH was measured by a pH meter. The ascorbic acid content in the products was estimated by Titrimetric method summarized by Rangana (1979) using 2 – 6 dichlorophenol dye and sugar by Lane and Eynen (1923) method. AOAC (1970) method was used to determine the ash content of the products.

3.3.1 Moisture Content

In crucible 5 gm sample was taken and placed in an oven at 80°C for 72 hours until constant weight attained. Present moisture content was calculated using following formula:

$$\% \, Moisture = \frac{I_W \;\; F_W}{I_W} \times 100$$

Where,

I_w = Initial weight of sample

F_w = Final weight of oven dried sample

3.3.2 Total Soluble solid (TSS)

Total soluble solids (TSS) were estimated by using Abbe Refractrometer by placing a drop of juice its prism. Present TSS was obtained from direct reading of the refractrometer.

3.3.3 Reducing Sugar

Standardization of Fehling's solution

10 ml of both Fehling's solution A and Fehling's solution B were mixed together in a beaker. 10 ml of mixed solution was pipette into a 250 ml conical flask and 25 ml distilled water was added to it. Standard sugar solution was taken in a burette. The conical flask containing mixed solution was heated on a hot plate. When the solution began to boil, three drops of methylene blue indicator solution was added to it. Mixed solution was titrated by standard sugar solution. The end point was indicated by de-colorization of the indicator. Fehling's factor was calculated by using the following formula:

$$Fehling's \; Factor = \frac{Titree \times 2.5}{1000}$$

Preparation of Sample

Mixed 25 ml juice and 100 ml distilled water in a volumetric flask at the same time add 2 ml neutral lead acetate solution and stand for 10 minutes. Add 5ml potassium oxalate solution and made a volume of 250ml. then filtrated and made the dilution.

Titration for Reducing Sugar

10ml of mixed Fehling's solution was taken in a flask and 25 ml of distilled water was added to it. Purified juice was taken in a burette. Conical flask containing mixed Fehling's solution was heated on a heater. Three drops of methylene blue indicator were added to the flask when boiling started and titrated with solution taken in the burette at the same time. The end point was indicated by de-colorization of indicator. Percent reducing sugar was calculated according to the following formula:

$$\%\ Reducing\ Sugar = \frac{F \times D \times 100}{T \times W \times 100}$$

Where,

F = Fehling's Factor

D = Dilution

T = Titre

W = Weight of Sample

3.3.4 Non-reducing sugar

15 ml of purified solution was taken in a conical flask. 15 ml of distilled water and 5 gm of citric acid were added to it. Then the conical flask was heated for 10 minutes for insertion of sucrose and finally cooled. The samples was then neutralizes by 1 N NaOH solution using phenolphthalein indicator. The volume was made up to 100ml with distilled water.

The mixed Fehling's solution was titrated using similar procedure followed as in the case of reducing sugar. The percent invert sugar is then calculated by the similar procedure as in the case of reducing sugar from which we got the percent non reducing sugar by using the following way:

% Non-reducing Sugar = % Invert Sugar - % Reducing Sugar

3.3.5 Total sugar

Total sugar can be calculated by using the following way:

% Total Sugar = % Reducing Sugar + % Non-reducing Sugar

3.3.6 Ash content

The inorganic residue remaining after destruction of organic matter is the ash content. The oven-dried sample was taken in a muffle furnace at 600°C for 4 hrs after pre-ashing at 200°C.The difference between oven dried matter and final weight represent the ash, which was expressed in percentage. It was calculated using the following formula:

$$\%\, Ash\ Content = \frac{F}{I} \times 100$$

Where,

F = Weight of ash

I = Initial weight of dry matter

3.3.7 p^H

p^H meter was used to determine the p^H by using the method described by Covenin (1984).

3.3.8 Acidity

20gm samples was taken in a blender machine and homogenized with distilled water. The blended materials were then filtrated and transferred to a 250 ml volumetric flask and the volume was made to the mark with distilled water. 5ml of solution was taken in a conical flask and titrated with 0.1 N NaOH solutions just below the end point, using phenolphthalein indicator. The titration was done for several times for accuracy:

$$\%\, Titrable\ acidity = \frac{T \times N \times V_1 \times E}{V_2 \times W \times 1000} \times 100$$

Where,

T = Titre

N = Normality of NaOH

V_1 = Volume of made up solution

E = Equivalent weight of acid

V_2 = Volume of Sample taken for estimation

W = Weight of Sample taken for estimation

3.3.9 Vitamin – C Content

The reagents used for the estimation of vitamin C were follows:

- Metaphosphoric Acid (3%)
- Standard Ascorbic Acid Solution
- Dye Solution

For Estimation of Vitamin C the following steps were followed:

Standardization of Dye Solution

5 ml standard ascorbic acid solution was taken in a conical flask and 5 ml meta-phosphoric acid was added to it and shaken. A micro burette was filled with dye solution. The mixed solution was titrated with dye using phenolphthalein as indicator solution to a pink colored end point, which persisted at least for 15 seconds. Dye factor (i.e. mg of ascorbic acid required to neutralize per ml of dye) was calculated using the following formula:

$$Dye\ factor = \frac{Ascorbic\ acid\ present\ in\ the\ solution\ titrated}{Titrated\ volume\ of\ the\ dye}$$

Preparation of Sample

20 gm of sample was taken and blended with 3% meta-phosphoric acid. Then it was filtrated and transferred into a volumetric flask made up to a volume of 150 ml.

Titration

10 ml of meta-phosphoric acid extracted sample was taken and titrated with standard dye solution, using phenolphthalein indicator to a pink colored end point which persisted at least for 15 seconds.

Vitamin – C content was calculated by using the following formula:

$$Vitamin\ C\ content\ (mg\ per\ 100\ gm\ sample) = \frac{T \times D \times V_1}{V_2 \times W} \times 100$$

Where,

T = Titre

D = Dye factor

V_1 = Volume of made up solution

V_2 = Aliquot of extract taken for estimation

W = Weight of Sample for estimation

3.4 Sensory evaluation

The consumer's acceptability of developed jelly and squash were evaluated by a taste-testing panel. The hedonic rating test was used to determine this acceptability. The panelists were selected from the teachers, students and lab attendant of the faculty of Agro- Industrial and Food Process Engineering, Hajee Mohammad Danesh science and Technology University, Dinajpur. Samples were served to the panelists and were asked to assign appropriate score for characteristics color, flavor, texture and overall acceptability of processed Lychee Jelly and Lychee Squash.

The scale was arranged such that:

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 Storage studies

Processed Lychee squash & jelly was stored at ambient temperature (27°C to 34°C) for a period of 6 months and quality parameters were assessed. During storage the changes in TSS, acidity, P^H, color, flavor, texture and vitamin C were observed. The analyses of the parameters were done according to standard analytical methods summarized by AOAC (1984) and Rangana (1994).

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to produce some value added product from indigenous lychee which would be economically profitable to our lychee cultivators and also help our food processing sector. Some value added product like lychee juice and lychee squash has a great demand in local and international market. The study also investigates the cost analysis of lychee jelly and lychee squash processing.

4.1 Composition of lychee pulp

After extraction of pulp, it was prepared for further processing of lychee product like squash and jelly and properly packed in appropriate containers. Then the samples were kept for microbiological and storage studies. The composition of fresh lychee pulps such as moisture, TSS, reducing sugar, non reducing sugar, total sugar, ash, pH, acidity and vitamin – C content is shown in Table 4.1

Table 4.1 Chemical Composition of Fresh Lychee Pulp

Components/Parameters	As in percentages (%)
Moisture	78.20
TSS	17.00
Reducing Sugar	6.68
Non-reducing Sugar	6.89
Total Sugar	13.75
Ash	0.69
p^H	4.92 (only value)
Acidity	0.327
Vitamin – C (mg/100g)	1.20

The above analyses are almost similar to the finding reported by Van Horn, 1936; Randhawa, 1945; Mustafa, 1961; Rehman et al., 1982; Sharma et al., 1990.

4.2 Composition of lychee products

Ascorbic acid content in lychee pulp was found to be very low (Table 4.1) compared to other juice fruits. It was further reduced in jellies prepared from lychee pulp because most of the ascorbic acid present in the pulp destroyed during long heating at high temperature. However, better retention of ascorbic acid in squash was observed (Table 4.2) because of mild heat treatment and also perhaps using potassium-meta bisulphate as preservative. Sing and Roy (1984) stated the acidity of lychee juice range from 0.31% - 0.40% which is lower than fresh lychee 0.327% pulp, it may be due variety, environment and maturity effect. This reducing was probably attributed due neutralizations of acid during inversion of sugars in juice and squashes and also resulted an increasing in reducing sugar content in jellies.

The average results are presented in Table 4.2

Table 4.2 Composition of Lychee Products (Average of three Formulations shown in Table 3.1)

Composition	Product	
	Squash	Jelly
Moisture (%)	40.00	28.23
Ash (%)	0.38	0.29
Acidity (%)	1.25	0.50
P^H	3.00	2.77
Reducing Sugar (%)	13.13	13.85
Non-reducing Sugar (%)	27.54	50.76
Total Sugar (%)	40.67	64.61
TSS (%)	40.00	67.15
Vitamin-C (mg/100g)	1.25	-

4.3 Storage studies of lychee products

Processed Lychee squash and jelly were stored at ambient temperature (27 to 34)°C for a period of 6 months and quality parameters were assessed. During storage the changes in TSS, acidity, p^H, color, flavor, texture/turbidity and vitamin C and visual fungal growth were observed. The analyses of the parameters were done according to standard analytical methods summarized by AOAC (1984) and Rangana, (1994). Results are presented in Table 4.3 and 4.4.

From storage studies of Lychee squashes at room temperature (Table 4.3), it is evident that it can be prepared in good condition with variation of adding a preservative and remaining other ingredients & parameters are same. If food color is added during processing, the attractive color remains up to 5 months. Squashes having moisture content 40% and other parameters same could be preserved up to 6 months or more.

Table 4.4 shows that Lychee jelly having normal TSS 67% and pectin 1.0% can be preserved up to 6 months in a good condition. Jelly prepared from Lychee pulp with 0.5% pectin become preserved up to 4 month.

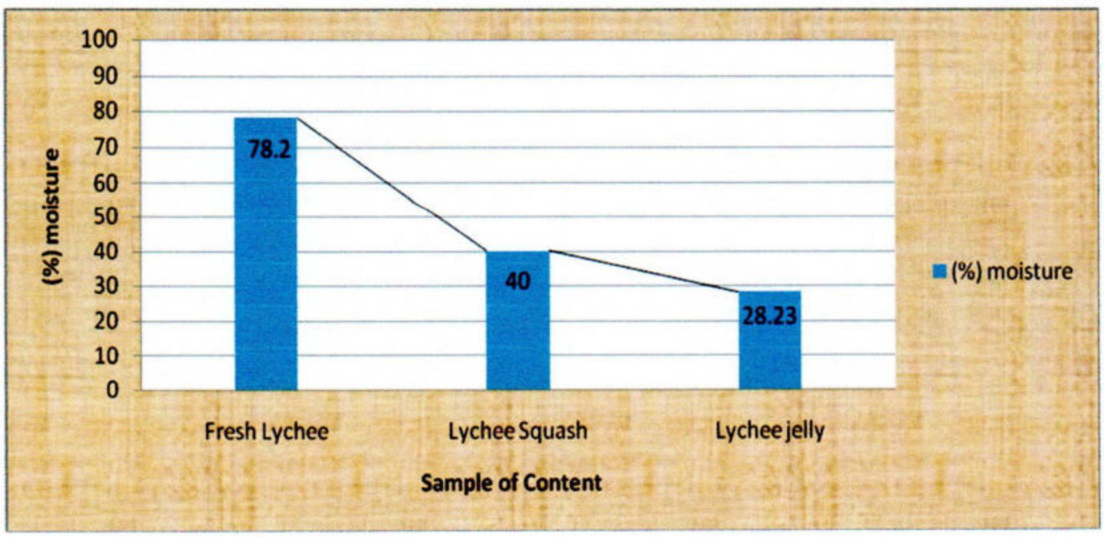

Fig. 4.1 Moisture Content (mc) reduced of fresh lychee after producing final lychee products.

Table 4.3 Storage studies of lychee squash

Storage (month)	Sample	Observations			TSS (%)	Acidity (%)	pH	Vitamin-C (mg/100gm)	Remark
		Color	Flavor	Turbidity					
0	S-1	Bright Whitish	Fresh	Clear	40.00	1.25	3.00	1.25	Good
	S-2	Bright Whitish	Fresh	Clear	40.00	1.25	3.00	1.25	Good
	S-3	Bright Whitish	Fresh	Clear	40.00	1.25	3.00	1.25	Good
1	S-1	Bright Whitish	Fresh	Clear	40.00	1.25	3.00	1.25	Good
	S-2	Bright Whitish	Fresh	Clear	40.00	1.25	3.00	1.25	Good
	S-3	Bright Whitish	Fresh	Clear	40.00	1.25	3.00	1.25	Good
2	S-1	Bright Whitish	Fresh	Clear	40.00	1.30	2.90	1.20	Good
	S-2	Bright Whitish	Fresh	Clear	40.00	1.28	2.95	1.15	Good
	S-3	Pasty	Fresh	Clear	40.00	1.28	2.95	1.15	Fair
3	S-1	Bright Whitish	Fresh	Clear	40.00	1.35	2.80	1.15	Good
	S-2	Bright Whitish	Fresh	Clear	40.00	1.32	2.83	1.15	Good
	S-3	Pasty	Off Flavor	Not Clear	40.00	1.30	2.90	1.15	Fair
4	S-1	Bright Whitish	Fresh	Clear	40.00	1.42	2.64	1.05	Good
	S-2	Bright Whitish	Fresh	Clear	40.00	1.36	2.75	1.10	Good
	S-3	Pasty	Off Flavor	Not Clear	40.00	1.35	2.81	1.08	Not Good
5	S-1	Bright Whitish	Fresh	Clear	40.00	1.47	2.54	1.00	Good
	S-2	Bright Whitish	Fresh	Clear	40.00	1.39	2.70	1.06	Good
	S-3	Pasty	Off Flavor	Not Clear	40.00	1.40	2.68	1.05	Not Good
6	S-1	Pasty	Off Flavor	Not Clear	40.00	1.53	2.41	1.00	Not Good
	S-2	Bright Whitish	Fresh	Clear	40.00	1.42	2.65	1.02	Fair
	S-3	Pasty	Off Flavor	Not Clear	40.00	1.46	2.60	1.00	Not Good

Table 4.4 Storage studies of Lychee Jelly

Storage (month)	Sample	Observations			TSS (%)	Acidity (%)	pH	Remark
		Color	Flavor	Turbidity				
0	E-1	Watery	Fresh	Clear	67.15	0.50	2.77	Good
	E-2	Watery	Fresh	Clear	67.15	0.50	2.77	Good
	E-3	Watery	Fresh	Clear	67.15	0.50	2.77	Good
1	E-1	Watery	Fresh	Clear	67.15	0.50	2.77	Good
	E-2	Watery	Fresh	Clear	67.15	0.50	2.77	Good
	E-3	Watery	Fresh	Clear	67.15	0.50	2.77	Good
2	E-1	Watery	Fresh	Clear	67.15	0.58	2.70	Good
	E-2	Watery	Fresh	Clear	67.15	0.58	2.70	Good
	E-3	Watery	Fresh	Clear	67.15	0.54	2.71	Good
3	E-1	Watery	Fresh	Clear	67.15	0.64	2.59	Good
	E-2	Watery	Fresh	Clear	67.15	0.62	2.60	Good
	E-3	Watery	Fresh	Clear	67.15	0.60	2.63	Good
4	E-1	Blush	Fresh	Not Clear	67.15	0.70	2.54	Fair
	E-2	Watery	Fresh	Clear	67.15	0.66	2.57	Good
	E-3	Watery	Fresh	Clear	67.15	0.60	2.64	Good
5	E-1	Blush	Off Flavor	Not Clear	67.15	0.72	2.51	Not Good
	E-2	Watery	Fresh	Clear	67.15	0.69	2.55	Good
	E-3	Watery	Fresh	Clear	67.15	0.66	2.58	Fair
6	E-1	Blush	Spoiled	Not Clear	67.15	0.80	2.41	Spoiled
	E-2	Watery	Fresh	Clear	67.15	0.70	2.53	Good
	E-3	Blush	Off Flavor	Not Clear	67.15	0.72	2.50	Not Good

4.4 Sensory evaluation

A panel of 10 judges tested the color, flavor, texture and overall acceptability of the Lychee products like squash and jelly manufactured with variable ingredients and mean scores are presented in Table 4.5 and Table 4.6.

4.4.1 Lychee squash

The samples of lychee squashes were subjected to sensory evaluation. Ten judges evaluated the color, flavor, texture and overall acceptability of three samples. S-1 treated by at the rate of 350 mg/kg of KMS and required amount of food color, S-2 was treated by same amount of preservative but not added color and S-3 was treated as without use of preservative and food color. The mean scores for color, texture, flavor and overall acceptability of different samples are presented in (table 4.5).

A two-way analysis of variance (Appendix 7) was carried out for color preferences and the results reveled that there were no significant ($p>0.01$) differences since the calculated F-value (2.835) was smaller than the tabulated F-value (6.013). So the samples are equally accepted. As shown in Table 4.5, there was no significant difference for color preference among the samples and S-1 secured the highest score of (7.8) out of 9. S-3 secured the second score with a little difference with S-2 as far as color in concerned.

Table 4.5 Duncan's Multiple Range Test (DMRT) for color, flavor, texture and overall acceptability of lychee squash.

Sample Code	Sensory Attributes			
	Color	Flavor	Texture	Overall Acceptability
S-1	7.8^{a}	6.4^{b}	7.1^{ab}	6.7^{ab}
S-2	7.2^{a}	7.4^{a}	7.3^{a}	7.3^{a}
S-3	7.1^{a}	7.1^{a}	6.2^{b}	6.2^{b}
LSD ($P<0.01$)	0.877	0.754	0.940	0.819

- Sample means having the same letter suffix do not differ at 1% ($p<0.01$) level of statistical significance.
- KMS at the rate of 350 mg/Kg and required amount of food color treated S-1; S-2 was treated by same amount of preservative but no added color and S-3 received any preservative and food color.

In case of flavor preference among the samples a two way analysis of variance (ANOVA). (Appendix 7) was carried out the results revealed that there was significant ($p<0.01$) differences in flavor acceptability since the calculated F-value (7.040) was greater than the tabulated F-value (6.013). The results (table 4.5) showed that S-2 was the most preferred one securing (7.4) and was equally acceptable as S-3 securing (7.1) while S-1 secured the lowest score (6.4) out of 9.

In case of texture preference among the samples a two way analysis of Variance (ANOVA). (Appendix 7) showed that there was no significant ($p<0.01$) difference in texture since the calculated F-value (5.905) was smaller than the tabulated F-value (6.013). The results showed (table 4.5) that there was significant difference for texture preferences among the samples and that S-2secured the highest score (7.3) out of 9. The second highest score (7.1) was given by S-2, while the lowest score is (6.2) is given S-3.

It was apparent from the results of the ANOVA (Appendix 7) that there was significant ($p<0.01$) differences in overall acceptability among the samples, since the calculated F-value (6.882) was greater than the tabulated F-value (6.013). This indicated that the samples are not equally accepted as far as overall acceptability is concerned (Table 4.5). The result showed that the highest score (7.3) and is equally acceptable as S-2 securing (6.7). S-3 however obtained the lowest score (6.2) as before.

4.4.2 Lychee Jelly

The samples of lychee jelly were subjected to sensory evaluation. 10 judges evaluated the color, flavor, texture and overall acceptability of three samples. Retaining all the ingredients equally but only using different percent of pectin. Three different samples were prepared where E-1 was prepared by 1.5% of pectin, E-2 was processed by 1.0% pectin and E-3 was processed by 0.5% pectin. The mean scores for color, texture, flavor and overall acceptability of different samples are presented in Table 4.6.

A two way of variance (Appendix 9) was carried out color preferences and the results revealed that there were no significant ($p>0.01$) differences in color acceptability since the calculated F-value (0.137) was smaller than the tabulated F-value (6.013). So the samples are equally accepted. The results showed in (table 4.6) that E-3 was the most preferred one followed by E-1 and E-2 in respect to color preferences. However, E-1 and E-2 were equally accepted at 0.01% level of statistical significance. It can also be noted that E-3 secured the highest score of 7.3 out of 9.

In case of flavor preference among the samples a two-way analysis of variance (ANOVA) (Appendix 9) was carried out and the results revealed that there was significant ($p<0.01$) differences in flavor acceptability since the calculated F-value (7.875) was greater than the tabulated F-value (6.013). The results showed in (table 4.6) that E-2 was most preferred one securing (7.7) while E-1 and E-3 secure (6.9) and (6.7) out of 9.

In case of texture preference among the samples a two –way Analysis of variance (ANOVA) (Appendix 9) showed that there was significant ($p<0.01$) difference in texture since the calculated F-value (8.186) was greater than the tabulated F-value (6.013). But the results showed in (table 4.6) that E-2 was most preferred one secure 7.7 out of 9.while the other two sample E-1 and E-3 secure (6.6) and (6.2) out of 9.

Table 4.6 Duncan's Multiple Range Test (DMRT) for color, flavor, texture and overall acceptability of Lychee jelly.

Sample Code	Sensory Attributes			
	Color	**Flavor**	**Texture**	**Overall Acceptability**
E-1	7.2^{a}	6.9^{b}	6.6^{b}	6.1^{b}
E-2	7.1^{a}	7.7^{a}	7.7^{a}	7.6^{a}
E-3	7.3^{a}	6.7^{b}	6.2^{b}	6.5^{b}
LSD (P<0.01)	1.053	0.736	1.058	0.975

- Sample means having the same letter suffix do not differ at 1% ($p<0.01$) level of statistical significance.
- E-1 was processed by 1.5% pectin, E-2 was processed by 1.0% pectin and E-3 was processed by 0.50% pectin.

It was apparent from the results of the ANOVA (Appendix 9) that there was significant ($p<0.01$) differences in overall acceptability of the samples, since the calculated F-value (9.639) was greater than the tabulated F-value (6.013). This indicated that the samples are not equally accepted as far as overall acceptability in concerned. It can be seen from (table 4.6) that E-2 had the best overall acceptability as compared to other samples. E-2 secured the highest score (7.6) out of 9 and other two sample E-3, E-1scored (6.5) and (6.1) respectively.

4.5 Cost analysis

In this case the experiment was done with lychee of which the cost of raw material was analyzed for squash and jelly. The cost analysis of squash and jelly production from lychee is shown in Table 4.7 and Table 4.8 respectively.

Table 4.7 Cost of 1 bottle (250gm) lychee Squash with Fixed Cost & Break-Even Point

No	Particulars	Amount in Tk.	
[A]	**Sales or Market price of fruit squash (250gm)**		75.00
[B]	**Variable cost**		48.00
	Lychee pulp/juice	5.00	
	Sugar	5.00	
	Citric acid/Vinegar	1.00	
	KMS (preservative)	1.00	
	Electricity	18.00	
	Labor	14.00	
	Packaging	4.00	
[C]	**Contribution [A]-[B]**		27.00
[D]	Total Fixed cost (40% of total cost)		19.00
[E]	**Total Cost [B]+[D]**		67.00
	Profit [A] - [E]		8.00
[P]	**Break-Even Point [D] / [C]**		70%

The cost per bottle (250 gm) of lychee squash is Tk. 67.00. But the cost per bottle of lychee squash will be lower when it was produced in large scale. The cost of production of lychee squash depends on market value of raw material, proper management and depending on the fixed cost.

Table 4.8 Cost of 1 bottle (250gm) lychee jelly with fixed cost & break-even point

No	Particulars	Amount in Tk.	
[A]	**Sales or Market price of fruit jelly (250gm)**		120.00
[B]	**Variable costs**		78.01
	Lychee pulp/juice	32.00	
	Sugar	8.76	
	Citric acid/Vinegar	0.25	
	KMS (preservative)	1.00	
	Electricity	18.00	
	Labor	14.00	
	Packaging	4.00	
[C]	**Contribution [A]-[B]**		41.99
[D]	**Total Fixed cost (40% of total variable cost)**		31.20
[E]	**Total Cost [B]+[D]**		109.21
	Profit [A] - [E]		11.00
[P]	**Break-Even Point [D] / [C]**		74.30%

The cost per bottle (250 gm) of lychee jelly is Tk. 109.00. But the cost per bottle of lychee jelly will be lower when it was produced in large scale. The cost of production of lychee jelly depends on market value of raw material, proper management and depending on the fixed cost.

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

The research work was accomplished in the laboratory of the Department of Food Processing & Preservation and the Department of Food Engineering &Technology under the faculty of Agro-Industrial and Food Process Engineering, during the period of June 2011 to July 2012, Hajee Mohammad Danesh Science and Technology University, Dinajpur, for the exploration of appropriate method.

The main purpose of this thesis was to developing lychee based different processed products like squash and jelly to evaluate its prospect in respect to marketability and food values the fruits. After collection the raw materials were analyzed and then squash and jelly were prepared. Later the processed lychee product was also chemically analyzed for proximate composition. Sensory evaluations of the products were done six months after quality attributes were found satisfactory by the taste panel. The acceptability of processed lychee Squash and lychee jelly were organoleptically evaluated by the panelist using 1-9 hedonic scale. The panelists were selected at University Campus of HSTU. The panelists tasted the products and assigned marks for color, flavor, texture and overall acceptability. The mean score for color, flavor, texture and overall acceptability showed that all samples of squash secured score within acceptable limit of ranking 'like slightly' to 'like very much'. The score of panel test indicated that among three samples, the S-2 sample is more acceptable. In the similar way the mean score for color, flavor, texture and overall acceptability showed that all samples of jelly secured score within acceptable limit of ranking 'like slightly' to 'like very much'. The score of panel test indicated that among three samples, the E-2 sample is more acceptable.

The proximate composition of fresh lychee was moister content 78.20%, TSS 17%, reducing sugar 6.68%, non reducing sugar 6.89%, Total sugar 13.75%, Ash 0.69%, P^H 4.92 and Vitamin C 1.20(mg/100g). The compositions of processed lychee product were depending on the processing media. The chemical analysis of the lychee squash showed that moister content was highly reduced in all the samples. The analysis also showed that acid content were substantially increased in all sample of squash thus pH value of the lychee squash is decreased. But the composition of Vitamin-C content fresh Lychee and lychee squash were found satisfactory. In the similar way the chemical analysis of the lychee jelly showed that moister content was reduced dramatically from 78.20% to 28.23%, this analysis also showed that acid content of lychee jelly reduced slightly; hence the p^H value is also increase very small percentage. Though in jelly processing high amount of heat is used during processing, so vitamin-C content decreased in all the sample of lychee jelly. Vitamin-C is lost by oxidation and heat following a first-order kinetics, which states that concentration has exponential relationship with time.

Storage studies were carried out for six months at room temperature (28°C-33°C) and samples were taken at an interval of 1 month. The samples were then observed for some parameters such as color, flavor, Turbidity etc. All the samples of squash & jelly become cloudy with passing of some time. It also revealed that one sample of squash out of three & one sample of jelly out three were found to be quite shelf stable up to six months. This study indicates a good prospect of processing of lychee squash and lychee jelly. In Bangladesh, lychee is a costly popular and major table fruit. It comes to market in the months of May-June when the market is full of other fresh fruits, particularly mango and jackfruit. But in spite of the availability of different types of fruit in the market the demand for fresh lychee is always very high due to its, flavor and color. The supply of lychee is insufficient and its availability is only for about 60 days. Though the retention time of fresh lychee is quiet low, in this research it was found that, a good quality value added product could be produced from this home-grown lychee. As this fruits has some special taste and nutritive value, it is assumed that it could fetch a good monetary value from the consumers. Though a partial price analysis was completed it was shown that lychee products are quiet profitable also with comparative to other fruit product. Processed lychee can be sold in off-season in both local and international market and earn foreign currency, which will enrich our national GDP.

This study indicates a bright prospect of processing of lychee for products of commercial value. We should encourage processing and preservation of lychee commercially in our country. Thus a large number of skilled, semi-skilled and even unskilled persons would be employed in the relevant industries, which will help to remove unemployment problem of our country. Further investigation is necessary to study the shelf life, economic and safety aspects of the products before commercial exploration.

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APPENDICES

APPENDICES

APPENDICES

Appendix 1 Flow-chart for extraction of pulp from lychee

Ripe fruit

⇩

Washing in fresh water

⇩

Removing the upper layer of fresh lychee

⇩

Separate the edible fleshy part or peel from its seed

⇩

Addition of water half to the weight of the pulp

⇩

Addition of citric acid (titratable acidity 0.5%, ph 4.3)

⇩

Kneading

⇩

Heating at 80°C for one minute

⇩

Passing through a pulping machine or stainless steel sieve of 20 mesh

(discard undesirable elements)

⇩

Lychee fruit pulp

⇩

Canning, freezing, preserves for further processing

Appendix 2 Ingredients required for preparing 250*gm* of Lychee Squash

Let,

250gm of Squash is to be prepared.

Specification required:

Juice/Pulp = 25%

TSS = 40%

Acidity = 1.25%

SO_2 = 350 ppm (in the from of KMS)

Suppose acidity of the pulp = 0.327%

And

TSS of the pulp = 17%

Pulp required $= \frac{25}{100} \times 100 - 62.5gm$

Acid present $= \frac{0.327}{100} \times 62.5 = 0.204gm$

Acid required $= \frac{1.25}{100} \times 250 = 3.13\ gm$

Acid to be added = (3.13 – 0.204) *gm* = 2.9*gm*

TSS present $= \frac{17}{100} \times 62.5 = 3.50\ gm$

TSS required $= \frac{40}{100} \times 250 = 100gm$

KMS required $= \frac{350}{1000000} \times \frac{222}{128} \times 250 = 0.15gm$

Sugar to be added = TSS required – (TSS Present + Acid to be added + KMS required)

= 100 – (10.63+ 2.9 + 0.15) *gm*

= 100 – 13.68 *gm*

= 86.32 *gm*

Therefore water to be added = 250*gm* – (juice+ additional sugar + acid to be added + KMS to be added) gm

$= 250\ gm - (62.5 + 86.32 + 2.9 + 0.15)\ gm$

$= 250\ gm - 151.87\ gm$

$= 98.13\ gm$

Appendix 3 Ingredients required for preparing 250 gm of Lychee Jelly

Let,
Total pulp to be used = 395.75 *gm*

(Because in jelly manufacturing the pulp contain is reduced almost ¼ of its original weight after cooking)

Total sugar to be used = 151.25 *gm*

Then the approximate jelly production is almost = 151.25 + (395/4) = 250 *gm*

TSS present in the pulp = $\frac{17}{100} \times 395 = 67.15\ gm$

Total TSS = 151.25 + 67.15 = 218.4 *gm*

For (sample E-1) pectin required = $\frac{1.5}{100} \times 250 = 3.75\ gm$

For (sample E-2) pectin required = $\frac{1}{100} \times 250 = 2.50\ gm$

For (sample E-3) pectin required = $\frac{0.5}{100} \times 250\ gm = 1.25\ gm$

Citric acid required = $\frac{0.50}{100} \times 250\ gm = 1.25\ gm$

KMS required = $\frac{222}{1000000} \times \frac{350}{128} \times 250\ gm = 0.15\ gm$

Appendix 4 Schematic diagram for manufacturing of Lychee Squash

Ripe Lychee

⇩

Washing

⇩

Removing Upper Layer & Seed from Lychee Peel

⇩

Pulping

⇩

Mixing
(Addition of sugar syrup)

⇩

Passed Through Finisher
(with addition of Preservatives)

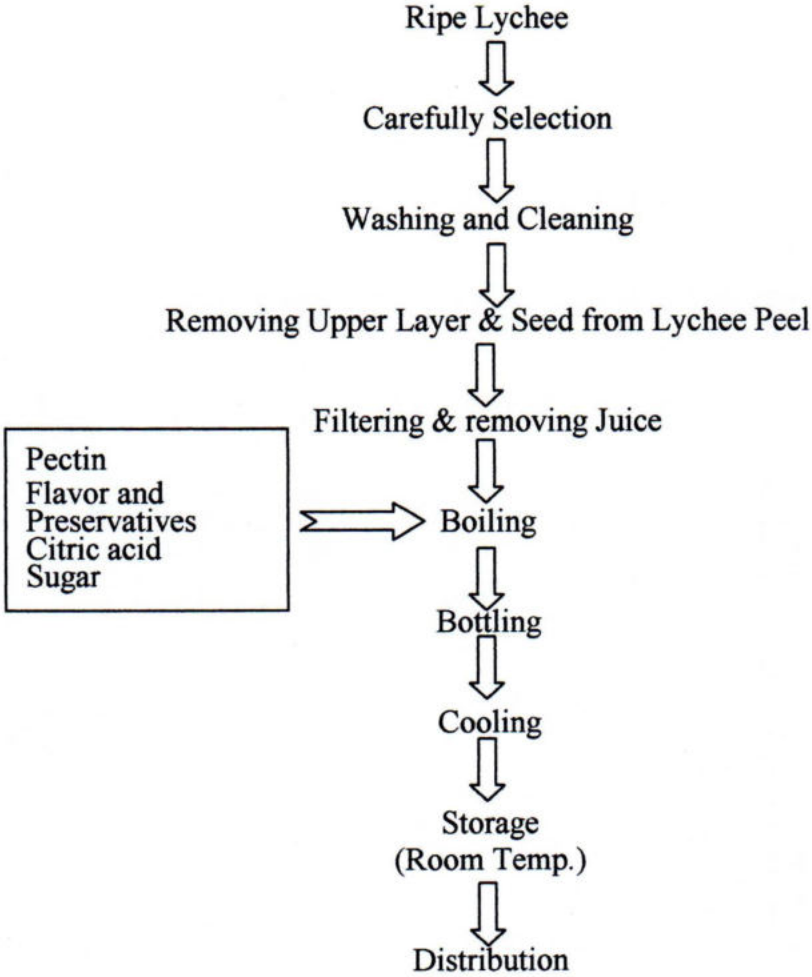
⇩

Filling in Sterilized Bottles
Sealed, Washed in warm water

⇩

Lychee Squash

Appendix 5 Schematic diagram for manufacturing of Lychee Jelly



Appendix 6 Rating Score for Color, Flavor, Texture and Overall Acceptability of Lychee Squash

Judge	Color			Flavor			Texture			Overall Acceptability		
	S-1	S-2	S-3	S-1	S-2	S-3	S-1	S-2	S-3	S-1	S-2	S-3
1	8	7	8	6	8	7	7	8	7	7	8	7
2	9	8	7	7	7	7	7	8	7	7	8	7
3	8	6	6	5	6	5	5	7	6	5	7	7
4	8	8	8	6	8	7	8	8	8	7	8	6
5	7	6	7	6	7	7	7	7	6	6	7	6
6	9	8	7	7	9	9	7	8	5	7	8	7
7	7	8	8	6	8	6	7	6	5	6	6	5
8	7	8	7	7	7	8	8	6	6	7	6	5
9	8	7	6	7	7	8	7	8	6	7	8	6
10	7	6	7	7	7	7	8	7	6	8	7	6
Total	78	72	71	64	74	71	71	73	62	67	73	62
Means	7.8	7.2	7.1	6.4	7.4	7.1	7.1	7.3	6.2	6.7	7.3	6.2

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 and
1 = Dislike extremely

Appendix 7 ANOVA (Analysis of Variance) for Color, Flavor, Texture and Overall Acceptability of Lychee Squash

Parameters		Degree of Freedom	Sum of Squares	Mean Squares	F Value		Probability	Co-efficient of Variation (%)
					Calculated	Tabulated		
Color	Product	2	2.867	1.433	2.825	6.013	0.086	9.67
	Judges	9	8.967	0.996	1.964	3.597	0.107	
	Error	18	9.133	0.507				
	Total	29	20.967					
Flavor	Product	2	5.267	2.633	7.040	6.013	0.006	8.78
	Judges	9	14.967	1.663	4.446	3.597	0.004	
	Error	18	6.733	0.374				
	Total	29	26.967					
Texture	Product	2	6.867	3.433	5.905	6.013	0.011	11.11
	Judges	9	10.133	1.126	1.936	3.597	0.111	
	Error	18	10.467	0.581				
	Total	29	27.467					
Overall Acceptability	Product	2	6.067	3.033	6.882	6.013	0.006	9.86
	Judges	9	9.867	1.096	2.487	3.597	0.048	
	Error	18	7.933	0.441				
	Total	29	23.867					

Appendix 8 Rating Score for Color, Flavor, Texture and Overall Acceptability of Lychee Jelly

Judge	Color			Flavor			Texture			Overall Acceptability		
	E-1	E-2	E-3	E-1	E-2	E-3	E-1	E-2	E-3	E-1	E-2	E-3
1	7	8	8	6	8	5	7	8	7	7	8	6
2	8	7	8	8	8	7	7	8	6	5	8	7
3	6	6	5	5	6	6	5	6	7	6	8	5
4	8	8	8	8	9	8	7	9	7	7	8	6
5	6	7	8	6	7	6	7	7	6	6	7	6
6	8	7	6	8	9	8	7	9	6	7	8	7
7	8	8	6	6	7	7	7	7	7	7	7	7
8	8	7	8	7	7	7	6	7	3	5	7	6
9	7	6	8	7	8	7	6	8	7	6	7	8
10	6	7	8	8	8	6	7	8	6	5	8	7
Total	72	71	73	69	77	67	66	77	62	61	76	65
Means	7.2	7.1	7.3	6.9	7.7	6.7	6.6	7.7	6.2	6.1	7.6	6.5

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 and
1 = Dislike extremely

Appendix 9 ANOVA (Analysis of Variance) for Color, Flavor, Texture and Overall Acceptability of Lychee Jelly

Parameters		Degree of Freedom	Sum of Squares	Mean Squares	F Value		Probability	Co-efficient of Variation (%)
					Calculated	Tabulated		
Color	Product	2	2.867	1.433	2.825	6.013	0.086	9.67
	Judges	9	8.967	0.996	1.964	3.597	0.107	
	Error	18	9.133	0.507				
	Total	29	20.967					
Flavor	Product	2	5.267	2.633	7.040	6.013	0.006	8.78
	Judges	9	14.967	1.663	4.446	3.597	0.004	
	Error	18	6.733	0.374				
	Total	29	26.967					
Texture	Product	2	6.867	3.433	5.905	6.013	0.011	11.11
	Judges	9	10.133	1.126	1.936	3.597	0.111	
	Error	18	10.467	0.581				
	Total	29	27.467					
Overall Acceptability	Product	2	6.067	3.033	6.882	6.013	0.006	9.86
	Judges	9	9.867	1.096	2.487	3.597	0.048	
	Error	18	7.933	0.441				
	Total	29	23.867					

Appendix 10 Format for the taste testing of different food sample by Hedonic Rating Test (1-9)

TASTE TESTING OF ---

Name of Taster: --- Date: -----------------

Product: ---

HEDONIC RATING TEST OF -- (1-9)

Please taste the sample and give numerical score ranging from (1-9) in the appropriate space.

Property	Sample Identity		
	S-1 or E-1	S-2 or E-2	S-3 or E-3
Color			
Flavor			
Texture			
Overall Acceptability			

Hedonic scale used:

Like extremely = 9

Like very much = 8

Like moderately = 7

Like slightly = 6

Neither like nor dislike = 5

Dislike slightly = 4

Dislike moderately = 3

Dislike very much = 2

Dislike extremely = 1

Signatur