A STUDY ON THE PROCESSING AND PRESERVATION OF FRUIT CANDY FROM PINEAPPLE

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THESIS

BY

ALIF KADIRA
Student no. 1205050
Session: 2012-2013
Semester: January-June/2013

MASTER OF SCIENCE
IN
FOOD PROCESSING AND PRESERVATION

DEPARTMENT OF FOOD PROCESSING AND PRESERVATION

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY
UNIVERSITY, DINAJPUR-5200

JUNE, 2013

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Submitted to the

Department of Food Processing and Preservation
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DEDICATED

TO
MY

BELOVED
PARENTS

ABSTRACT

Good quality pineapple is grown in Bangladesh in a reasonable quantity but processing and preservation is not so satisfactory. This work explored some ways to preserve pineapple in the form of candy. Pineapple under study contained moisture content 86.55%; acidity 0.79%; pH 3.50, fat 0.20%, fibre1.20%, vitamin C 21 mg/100gm, 0.60% protein. Two types of candies were prepared using pineapple pulp and crushed pulp. Three samples of candy from pulp were made using 100 gm pulp and 10 gm vinegar varying sugar as 50%, 70%, 90% to that of pulp. Three samples of candies were made from crushed pulp using 100 gm crushed pulp, 6 gm milk powder and 2% vanilla essence varying sugar as 50%,70% and 90% to that of crushed pulp. The fresh pineapple was cut into cubes. Pineapple cubes were cooked by dipping syrup then washing by clean water and dried in cabinet dryer at 20-22hrs at 40° C then packaged in low density polyethylene and glass bottle. Another processing method is the crushed pineapple were cooked with different sugar percentages and added milk powder and vanilla essence and the mixture was cut and shaped in desired pieces and packaged. Six samples prepared were named as A, B, C, X, Y and Z respectively. The sample B (100 gm pulp, 70% sugar, 10% vinegar) secured highest score for overall acceptability and ranked as like very much. Vitamin C and moisture content were analysed in storage condition. Vitamin C decreased as the storage period increased. Pineapple candies showed no remarkable change during 90 days as well after the day of preparation in both storage and different packaging conditions. After 90 days slight change in color and flavor was observed in the samples of low density polyethylene package. The best quality of candy was achieved when stored in glass bottle at storage temperature is (3-5°C).

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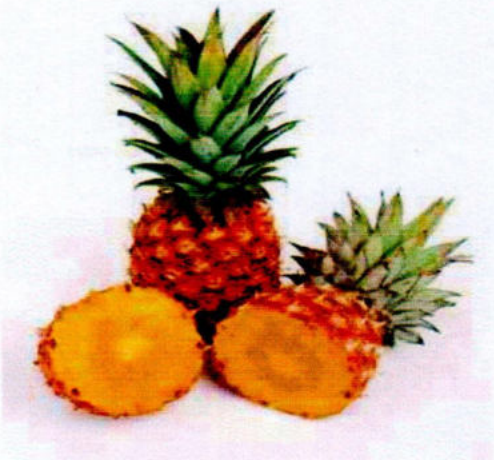
June, 2013 *The Author*

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION



CHAPTER I

INTRODUCTION

Fruits are natures wonderful medicines packed with vitamins, minerals, antioxidants and many phyto-nutrients. Pineapples are nutritionally packed members of the Bromeliaceae family. It contains packed form of vitamin C and fiber important for the immune and digestive systems. Pineapple has anti-inflammatory effects (Joy and Abraham, 2013).

Pineapple *(Ananas comosus)* is one of the important fruits grown in Bangladesh. This is highly perishable fruit require processing for preservation. This fruit is much liked and popular in all over the world.

Pineapple *(Ananas comosus)* is one of the popular and delicious fruit in Bangladesh. It is very much favored for its attractive flavor, color, taste and nutritive value. Pineapple is named for its resemblance to the pine Cone. Pineapples are consumed or served fresh, cooked, juiced and can be preserved.

The world production of pineapple shows a steady increase over the years much of the increase due to the expansion of pineapple industry in the developing countries of Far East, Africa and Latin America (Bose, 1990).

Pineapple is one of the major seasonal fruits in Bangladesh. Its cultivation is confined within a limited area such as Madhupur, Chittagong Hill Tracts and Sylhet only. The statistical data show that about 13,850 hectares of land is under pineapple cultivation in Bangladesh with an annual production of 14,8857 tons and the average yield of pineapple is 10.75 tons per hectare (BBS, 1997).

Pineapple contains vitamins A, B, C, calcium, protein, carbohydrate, iron, carotene etc. The fresh pineapple fruits and juice contain the protein digesting enzyme bromeline (Collins, 1968).

One cup of fresh pineapple contains 82 calories. These calories come primarily from carbohydrates, of which there is 13.52g of carbohydrate in 100 g of pineapple. Like all fruits, pineapple does contain sugar. Pineapple is a combination of glucose and fructose. Hundred gram of pineapple also contains 1.40g of fiber (USDA, 2009).

The most popular processing products from pineapple in the world market are canned pineapple. But today various products are prepared from pineapple.

Candy is a sweet food prepared from fruits by impregnating them with sugar syrup followed by draining of excessive syrup and then drying the product to a self-stable state (Dar *et al.* 2011)

Candy is a confection made with crystallized sugar. Crystallization of sugar formed by boiling down sugar syrup. To encrust in or coat with sugar, specifically to cook (as fruit or fruit peel) in a heavy syrup until glazed.

Candied fruit is made by soaking fresh fruit pieces in sugar syrup, then heating the mixture until all the fruit's original water content is replaced with sugar.

The popularity of pineapple is increasing day by day for its nutritive value and possible diversified use in making different palatable foods. Pineapple can be eaten either raw or processed form. The processed pineapple products are jam and jellies, pickles and chutneys, sauce and ketchup, salad, halua, candy etc. which will definitely help to solve the food and nutritional scarcity among the population. Since the pineapple has a high value of nutrition and the availability of pineapple is for limited period (as it is a seasonal fruit and the shelf life pineapple is also very limited), so it is very important to make the availability of this nutritious fruit throughout the year.

The inadequate and improper post-harvest handling, processing and preservation facilities of the fruit often form a glut during the season and a substantial quantity is wasted every year. The prevention of the losses of the seasonal surplus of the fruit by processing and preservation techniques at farmer's level and as well as industrial scale should therefore be warranted.

For processing pineapple fruits into value added products candy is highly acceptable product. Food preparation and processing can be defined as any change that is made to a food to alter its eating quality or shelf life.

Intermediate moisture food (IMF) have been attracting wide spread attention in recent times. They are eminently more suited for combat rations of as compared to fully dehydrated or canned foods. Intermediate moisture foods which are partially dehydrated foods with moisture content in the intermediate range, *i.e.*, 20 to 50 %, stabilized by using suitable additives so as to keep water activity low at safe levels (0.6-0.85) from the view point of microbiological spoilage (Jayarman and Gupta, 1978).

The examples of IMF are jam, jelly, halua, morobba, candy, smoked fish etc. IMF products increase solid content as well as calories. The sugar and solid would act as preservatives.

Nowadays raw fruits are allergic to the children. But fruits are beneficial to health and acts as healing agent of the body. Processed products are so much popular to the children. If we supply the fruits as processed form then they will get proper nutrition.

On the basis of the information so far accumulated, the present study has been undertaken with the following objectives:

i. To develop candy from fresh pineapple.

ii. Chemical analysis of the fresh and developed pineapple product.

iii. To asses the acceptability (sensory attributes) of the processed product.

iv. To asses the shelf-life of the processed product.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Pineapples are native to southern Brazil and Paraguay, as these are areas where their wild relatives occur. Pineapples were domesticated by Indians, and they were carried through South and Central America to Mexico from West Indies, before the onset of Europeans.

The pineapple can be found in Thailand, the Philippines, United States (Hawaii), Mexico, Ivory Coast, South Africa, Malaysia, Kenya, Taiwan, Australia, and other countries.

It wasn't until the 19th century that the Spanish introduced the pineapple to Zimbabwe, the Philippines and Hawaii. As part of the most successful commercial pineapple enterprises, the companies Dole and Del Monte started growing pineapple on the Hawaiian Island Oahu in 1901 and 1917 respectively, to be joined by the Maui Pineapple Company (on the island of Maui) in 1909.

Chemical composition of pineapple per 100 gm (USDA, 2009)

Parameter	**Fresh pineapple**
Carbohydrate	13.12
Protein	0.54
Fat	0.12
Fiber	1.4
Energy	209 Kj (50Kcal)

Mohammed and Wickhom (1995) observed biochemical changes and sensory evaluation in pineapple during storage at refrigerated and non refrigerated temperatures. They studied recently harvested pineapple cv. Deltada fruits stored at 10, 20 or 30°C and 65-80% RH for up to 12 days. During that storage time they were assessed for quality parameters (weight loss, shell and flesh color, firmness, decay, TSS, pH acidity, sugars and, vitamin C contents, flesh translucency and taste score) at 4 days interval. The best results were obtained in the 10°C treatment in which all fruits were decay free after 12 days. This treatment resulted in 15.9 and 25.1% more marketable fruits than at 20°C and 30°C treatments, respectively. Significant correlations were found between taste test

scores, decay free fruits and flesh translucency, but not between taste test scores and pH, sugars content, vitamin content or acidity.

Achinewhu and Hart (1994) studied the effect of processing and storage on the ascorbic acid (vitamin C) content of 4 pineapple varieties grown in the Rives State of Nigeria. They estimated ascorbic acid content of the juice of the varieties before and after storage of whole pineapple, and processing and storage of the juice for 2 months. They found that ascorbic acid of fresh juice ranged from 22.5 to 33.5 mg/100 g sample, while after storage of whole pineapple at 30°C to 32°C for 2 weeks. Ascorbic acid was reduced to between 59 and 65% of the fresh juice. They also found that processing the juice by pasteurization reduced ascorbic acid to between 28 and 46% while storage in plastic bottles for 2 months further reduced the ascorbic acid content to between 10 and 21 %.

Barua *et al.* (1987) studied biochemical changes during storage of pineapple fruits in relation to time of harvest at 130, 140, 145, 150 and 155 days after flowering (DAF) were sampled after 2, 7 and 14 days of storage at room temperature. They reported that fruit acidity was lowest in fruits harvested 140 DAF and stored for 7 days. They also reported that TSS did not change appreciably during storage. Ascorbic acid content increased initially but then decreased with storage time.

Botrel *et al.* (1993) conducted an experiment of the effect of fruit weight on internal browning and quality in pineapple cv. Smooth Cayenne. They used fruits in 6 weight grades (700-899, 900-1009, 1100-1299, 1300-1499, 1500-1799 and 1800-2300 g) either at 25°C and 75% RH over 7 days or at 5°C and 90% RH over 15 days before assessed for the indices studied. They found that larger fruit (1500-1799 and 1800-2300 g) were more susceptible than smaller ones to internal browning and TSS content also was highest. They also found that ripe fruits held at 5°C had lower amounts of TSS.

Bartolome *et al.* (1995) conducted an experiment on morphological characteristics, chemical composition and sensory analysis of Red Spanish and Smooth Cayenne cultivars. They studied some physical (weight, size, shape, texture and colour), physico-chemical (pH, titratable acidity and soluble solids), chemical (soluble sugars and organic acids) and biological (total dietary fibre, peroxidase activity and soluble protein) characteristics and sensory attributes (appearance, flavour, odour, colour, firmness and acceptability) of pineapple fruits in Red Spanish and imported Smooth Cayenne cultivars. They found significant difference between size, shape and colour and also between other

objective (lightness, green colour, total acidity, soluble solids, total dietary fibre, peroxidase activity, fructose and glucose) and subjective (color) measurements. They also found that values of texture, fibre content and soluble solids: acid ratios were lower in Red Spanish, while peroxidsase activity and soluble protein were higher. Taste panelists preferred appearance, colour and firmness of the Red Spanish pineapples slice.

Anonymous (1960) reported the composition of pineapple, moisture content (75%); reducing sugar (3.06%); non-reducing sugar (6.88%); total sugar (19.94%); ascorbic acid (8.76 mg/100 g); ash (0.56%); acidity (0.64%); pH (2.57%); T.S.S. (13%).

Sen *et al.* (1980) reported that the pineapple fruit is a good source of vitamin A and B and rich in vitamin C. It contains an enzyme, bromelin and pineapple leaf is a good source of chlorophyll. They also found that pineapple fruits contain moisture 85%, sugar 13%, protein 0.6% and vitamin C 63 mg/ 100 gm.

Remarkable works on analysis of pineapple- composition was done throughout the world. The composition of pineapple according to FAO (1972) reported that moisture content (87%); Kcal (47%); Ca (17 mg): Fe (0.3 mg); vitamin A (18 mg); vitamin C (22 mg); ash (0.41%); fibre (1.5g) and fat (0.3%).

Akinyele *et al.* (1990) conducted an experiment to observe nutrient losses during and after processing of pineapple and orange. They analysed ascorbic acid, pH, total titratable acidity, total solids, ash and contents of calcium, magnesium, sodium and potassium of various products of pineapple and oranges. They estimated sugars in the samples quantitatively and qualitatively and stored the samples of pasteurized pineapple pieces, and pasteurized orange juice at room temperature for 3 months followed by chemical analyses. They observed the considerable reduction of ascorbic acid of fresh juice with processing and storage and also observed that both the pasteurized and unpasteurized orange juices were acidic and the pineapple products were less acidic. They showed that the total solids, ash and the selected minerals were present in appreciable amount in the fruit products and were not significantly affected by processing and storage. They showed that pasteurized pineapple juice and pieces contained glucose, fructose and sucrose in appreciable amounts while pasteurized orange juice contained only glucose and fructose with traces of maltose but no sucrose.

Ahmed (1995) conducted an experiment to develop certain processing techniques to preserve the pineapple juice. He suggested that the juice can be preserved by can or bottle and may happily be consumed as drink for its delicious taste and characteristic flavors. His research was mainly conducted to preserve pineapple juice by bottling, reuse bottle, little or no syrup or additive and processing at water bath temperature will certainly result in a low cost processed product. The juice was preserved by various heat treatments with or without KMS (preservative) in different types of containers. He found that the products developed by combined heat treatment and chemical preservative had retained significantly better colour than those developed by heat treatment alone. However, all the products were found equally acceptable in so far as taste and general acceptability are concerned.

Desrosier (1963) stated that in the acid food groupings troublesome organisms are aciduric bacteria of no specific heat resistant qualities. Bacteria, yeasts and moulds are the troublesome organisms. But their heat resistance is generally low. In this group, the enzymes present in food may be heat resistant. Nearly all enzymes are irreversibly destroyed in a few minutes by heating to 79.5°C. The food containing pH<4.5 can be processed in bottling as the lower limit of pH for the growth of an important food poisoning thermophilic *clostridium botulinum is* 4.5.

Rangana and Bajaj (1966) reported that SO_2 is widely used throughout the world principally in treating food of plant origin. It is used in the preservation of fruit juices, pulps, beverages and concentrates. Concentration used may very from 350 to 2000 ppm soluble salts (e.g. K.M.S.) are usually used in treating fruits and vegetable products. The activity is higher at pH below 4.0.

Askar (1998) investigated the importance and characteristics of tropical fruits. He discussed the properties of tropical fruits and their significance within the overall fruit and fruit juice industry. Aspects considered included: fruit production and consumption; the importance of quality management for successful production of tropical fruit products (Juices, nectars etc); importance of correct harvesting time; compositional aspects; and nutritional and health benefits associated with tropical fruits.

Fraziar and Westheff (1978) described the activity of microorganisms on pH scale as follows:

Moulds	: pH 1.5-8.5
Yeast	: pH 2.5-8.0
Bacteria	: pH>4.0

Fruits usually have pH 4.2 thus bacteria are not main spoilage organism in this case, yeast and mould are most troublesome ones. Most fermentative yeasts are favored by a pH of about 4.0 to 4.5 as in fruit juice. Most bacteria are favored by pH near neutrality. Moulds are aerobic and the majorities are favored by an acid pH. The growths of most yeast are favored within pH 4 to 4.5. They grow best under aerobic conditions, but the fermentative types can grow slowly anaerobically. Yeast is specially important in spoilage of syrup, juices etc. Mould can grow with least available moisture than yeast and bacteria.

Islam and Uddin (1985) studied the development of shelf-stable pineapple products by mechanical dehydration, sun drying and osmotic dehydration. Sugar syrup of different concentrations was used to study their effectiveness as an agent of osmotic dehydration and higher rate of dehydration observed, with higher concentration of syrup. Studies on the influence of time and syrup-fruit ratio showed that 6 hour contact time and 4:1 syrup fruit ratio would be optimum.

Ponting *et al.* (1996) observed the requirement that the osmotic solute should be of pleasant flavor (itself) as well as it should be nontoxic. Several carbohydrates have been extensively tested as osmotic solutes. They observed little difference in the rate of osmotic dehydration for sucrose or invert syrup when used at the same concentration and at the same temperature. It was shown that 50% of the water of fruit pieces could be removed by mixing with dry sucrose or by immersion in concentrated solution (65-75% solids) of sucrose or invert sugars.

Ramamurthey *et al.* (1970) dissociated osmotic dehydration step prior to drying. After cutting the fruits into pieces of suitable size, the pieces were dipped in 0.25% sodium metabisulphate solution for 10-15 min. at room temperature, soaked in 70% sugar syrup at 50°C for 2 hrs and after washing, dried at (60±2)°C for 8 hrs, at 736 mm vacuum and immediately packed. They reported that the final products contained 3% moisture and was comparable in quality of freeze products.

Islam and Flink (1982) showed that the time required for drying to a moisture content is lower from osmosed sample (even through drying rate is lower). This behavior was attributed to the higher solid content (up to 3 to 4 times higher) with which the product information on process scales up. Hope and Vitale (1972) used 67% (W/W) sucrose solution for osmotic concentration of banana and ripe mango, and 25% *(WN)* sodium chloride for raw mango. The authors also studied the effect of syrup concentration, re-circulation rate, temperature and time on the rate of osmosis dehydration using salt and sugar solution (both single and binary mixture) for concentration apple slice prior to freeze drying. They also determined the kinetics of water loss and solute gain during osmosis.

Azuara *et al.* (1992) expressed "dehydration as a process that has been proposed for the production of intermediate moisture foods as a preliminary stage to air drying, pasteurization or freezing. The rate of water loss during osmotic dehydration increase with (1) increasing concentration of solute in osmotic solution. (2) Immersion time, (3) Temperature (4). The ratio of osmotic solution in food stuff (5). The exposed surface area and (6) Low pressure in the system.

Intermediate moisture foods (IMF) which are practically dehydrated foods with moisture content in the intermediate range i.e. 20 to 50 percent, stabilized by using additives so as to keep water activity low at safe levels (0.6-0.85) from the stand point of microbial spoilage, have attracted attention of many workers recently. The principle behind the development of such foods is that one need not dehydrate foods below percent moisture levels (water activity>0.6) dictated by microbial stability. There will be substantial reduction in drying and reconstitution time and better retention of original flavour and texture compared to conventional hot air dried or heat processed (canned) foods, if the food is dehydrated to an intermediate moisture level. The IMF will have the additional advantages of processing sufficient moisture to provide the necessary plastic mouth feel to enable the food to be ready to be ready to eat and the product can kept for long time without refrigeration or thermal processing in any hermetically sealed container (Jayarman *et al.* 1974).

Uddin M.B. (1991) conducted studies for preparing preserves and candies from pineapples, mango, watermelon, papaya and carrot. Fruits and vegetables cubes were treated with preservatives and firming agents, blanched and pricked before processing to

preserve that mango and pineapple preserves were of excellent quality while those prepared from watermelon and papaya was categorized as "good product". The preserves and candies were shelf stable up to 12 months at ambient temperature (23-38°C).

Hiremath *et al.* (2012) conducted studies for sapota candy.Sapota candy was prepared with initial steeping in different concentration of syrup (40,50 and 60 degree brix) with or without citric acid with or without blanching.the mean maximum scores for color and appearance,taste,flavor and overall acceptability was recorded in the candy prepared with inial syrup strength of 60 degree brix with 1% citric acid,whereas maximum score for texture was observed in candy with initial syrup strength of 40 degree brix with 1% citric acid with or without blanching.

Shankar *et al.* (2010) studied effect of pretreatment method on the qualitative and organoleptic attributes of pineapple candy during storage. On the basis of the investigation, it was cocluded that better quality candy can be obtained by steeping of the fruit pieces in 2% lime solution and blanching with erythrosine color followed by syruping so as to maintain 78^0 brix TSS. Ratio of 1:0.587 was obtained by pineapple candy. Pineapple candy can be stored for 60 days with good retention of organoleptic quality and market value.

Burhan and Swamy (1981) investigated the prospect of processing preserves and candies from watermelon ring. They analyzed the proximate composition of watermelon. The white ring portion was cut into 1" × 1" × 1" cubes and processed to preserves and candies. Products were of good quality and shelf-stable at ambient temperature.

Candied fruit is usually coated with a thin transparent layer of heavy syrup containing cane sugar 3 parts, corn syrup 1 part and water 2 parts that dried to a more or less firm texture. The mixture was cooled to boiling point of about 236 to 238°F. This was cool to about 200°F and then candied fruit is dipped in it by wire dipping spoon. It is drained on screen and then dried for short time at 120°F. On cooling the coating would be reasonably free of stickiness. Candied fruit had been coated fairly satisfactorily by dipping in 1.1-1.5 percent solution and drying at 120°F for 2 hours. The coating was not only glossy but nevertheless is fairly attractive. It was not sticky (Cruess, 1958).

Genta *et al.* (2002) studied on the production and acceptance of a soy candy. In Tucuman (Argentina) a registered trade marked soy food is manufactured. The industrial residue

named "okara" has standard protein content. A candy (nougat) with okara, peanut, glucose, hydrogenated oil, sugar and natural essences was produced. Modifying the okara and peanut contents, three samples were prepared: A (18.3% okara and 27.4% peanut); B (27.4% and 18.3%) and C (36.6% and 9.1%), with the other components remained constant. The nougat was given to persons of both sexes and of different ages. The nonparametric Friedman test was used to evaluate the acceptance and preference. It concludes: (1) samples with lower okara content have a higher acceptance; (2) the acceptance of A differs significantly with regard to taste and texture from B and C; (3) C differs of A and B with regard to the acceptance. The production of this candy would increase the available vegetable proteins for human consumption and would increase the output of soyabean products factories.

Yousif (2001) studied on suitability of some date cultivars for candy making. The suitability of 9 date cultivars (Barni, Bkerah, Khnazi, Khudri, Kusbah, Ruzeiz, Sefri, Shagra and Sullag) for candy making was studied. Date candy was prepared by mixing 40, 50 and 60% date paste; 30, 25 and 20% roasted groundnut; and 30, 25 and 20% dessicated coconut, and homogenizing by passing through a meat grinder. The paste was shaped manually and either kept plain or coated with melted chocolate chips. The ratio 60/40 date paste/nuts with chocolate coating achieved the best scores, and candy made from Ruzeiz and Sullag dates were the best of 9 cultivars tested. Date candy from these cultivars was preferred to import Mars and had high nutritive value. The candy could not be stored for more than 8 weeks at room temperature (25.5 degrees C) and storage at 10-15 degrees C is recommended.

Yousif *et al.* (1987) used date paste as a replacement for caramel on sugar paste in candy bars or chocolate coated; They had good acceptability and could be stored for more than 5 months at 5^0 C ,second quality dates can be used in plain and chocolate-coated date bars, which can be stored for up to 6 months at 25 degree celcius.

Sawate *et al.* (2005) studied on effect of syruping and drying methods on quality of papaya-candy. Studies on effect of method of syruping (cold and hot) and drying (shed, sun and cabinet) on organoleptic properties and chemical composition of papaya (variety Taiwan-786) candy were conducted. Also the effect of syruping time on TSS of papaya candy was investigated to standardize the syruping sugar concentration. The syruping time for 60-70 degrees. Papaya candy prepared by cold syruping method and 6-7 days for

cold syruping method resulted in sparkling red color with glossiness to the candy compared to dull dark red colored candy of hot syruping method. The ascorbic acid (Vitamin C) content of cold syruping candy was found to be more i.e. 25.02 to 22.1 mg 100 g-1, whereas in hot syruping candy, vitamin C was 21.32 to 17.24 mg 100 g-l. The synergistic effect of combination-cold syruping and cabinet type of drying resulted in mostly acceptable papaya candy with strong support of sensory attributes such as color, flavor, texture and taste. The results showed that the method of syruping had significantly influenced the quality of papaya candy. The overall acceptability of cold syruping candy dried by cabinet drier gave a better quality product.

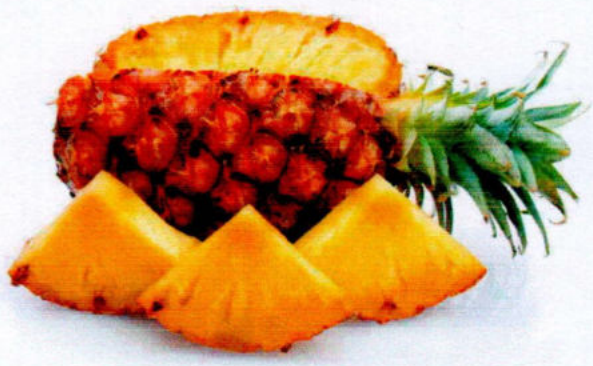
Dar *et al.* (2011) conducted that the effect of calcium chloride, citric acid and storage period on physico-chemical characteristics of cherry candy. Cherry cultivar Misri was used for making candy. Pitting of fruit was done manually and KMS (0.2%) was added for bleaching. The samples were concentrated subsequently till desired TSS of 70 degree brix was attained. The samples were dried in cabinet dryer at 80± 20^0 C till const. moisture was attained. The product was packed in polythene pouches and stored under ambient storage conditions. Results revealed that there was gradual increase in reducing sugar (%), total sugars (%) during storage while as moisture content (%) decreased. The product developed was found economically profitable and viable for commercial production.

Godoy *et al.* (2005) studied of crystallized fruits and preserves elaborated with different citric albedos. In this work, the physicochemical and sensorial properties of different citric albedos processed in the form of fruit preserves and of dried crystallized products were evaluated. The fruit preserves presented significantly different pH values, total soluble solids, and vitamin C. In the crystallized products, significant differences were noted in the contents of total soluble solids, total titratable acidity, and vitamin C. During the preference test, both the fruit preserves and crystallized products registered high average values. Among the studied species, the albedos of Citrus karna obtained better scores in the sensorial tests for fruit preserves and crystallized products. Drying time was also shorter. The maintenance of the albedos for 4 days in NaCl solution was not enough for naringina removal; the process should either be prolonged or revised. Fermentation as pretreatment for the peels can confer softer texture to the crystallized products.

Rekha-Lande (2003) investigated on the physio-chemical attributes of the bar candy. Investigations on bar candy were undertaken with respect to the standardization of the process, varietal evaluation (Gola, Mehrun, Nagpuri, Sanaur, Kadaka and Umran), consumer acceptability, nutritive value and shelf life. The sensory scores (color, taste, texture and flavor) revealed that candy prepared by the slow method had higher acceptability, as compared to those prepared by the quick method. Score for varieties and quality attributes (color, taste, texture and flavor) at different intervals showed a decreasing trend with storage life: However, candy prepared by the quick and slow method had good quality and remained acceptable for 120 and for 240 days of storage. Bar candy stored at frozen conditions was significantly better than those stored at room temperature for 180 days.

CHAPTER III

MATERIALS AND METHODS



CHAPTER III

MATERIALS AND METHODS

The experiment was conducted to develop pineapple candy from pineapple and the experiment was performed in the laboratory of the Department of Food Processing and Preservation, Hajee Mohammad Danesh Science and Technology University, Dinajpur.

3.1 Materials used

Mature Pineapple (variety- Honey queen) was collected from local market of Dinajpur. Chemicals and reagents used in the study were used from laboratory stock. Other ingredients were collected from local market. Chemicals and solvents used in the study were of analytical reagent grade and water was distilled. Low density polythene bags and glass bottles were used as the packaging materials.

3.2 Methods

A number of experiments were carried out in order to accomplish the objectives proposed to achieve the goal of this study. The experiments were divided into some major sections:

a) Collection of pineapple.

b) Processing of candy from pineapple.

c) Chemical analysis of pineapple and pineapple candies.

d) Sensory quality and shelf life of pineapple candies were also determined.

Table 3.1: Basic formulation of Pineapple Candy on 100 g pulp basis of total ingredient

Ingredients	Treatments					
	A	B	C	X	Y	Z
Pineapple Pulp	100gm	100gm	100gm	100gm	100gm	100gm
Sugar	50%	70%	90%	50%	70%	90%
Vinegar	10%	10%	10%	-----	---	-----
Vanilla				2%	2%	2%
Milk powder				6%	6%	6%

3.3 Preparation of pineapple candy (from pulp)

Mature Pineapple was collected from the local market. Washed the pineapple in running potable water and separated edible portion from non edible portion by knives. The edible portion was cut into 1 × 1×1.5 cm cubes. The cubes were dipped in 1% calcium chloride + 0.25% potassium metabisulphide solution for 24 hours. After 24 hrs the cubes were washed properly with fresh water. Sugar syrup was made on the basis of varying sugar percentages (50%, 70% and 90%) and syrup to fruit ratio was 4:1. The sugar syrup subsequently till desired TSS of (50^0, 70^0 & 90^0) brix. Cubes were dipped in syrup and cooked up to 30 minutes. White vinegar was mixed at the rate of 10% to the syrup. Cubes were kept overnight and then washed with water to remove adhering syrup. Then cubes were spread on tray and dried in a cabinet dryer at 40^0C for 20-22 hrs. After cooling cubes were rolled over sugar and packaged in glass bottle and low density polyethylene bag and stored in room temperature (25-30^0C) and refrigeration temperature (3-5^0C).

3.3.1 Flow chart of pineapple candy: (From pulp)

Fresh Pineapple was washed and separated edible portion from non-edible portion by knives. Removed eyes and core.

↓

Cut into cubes

↓

Dipped in 1% calcium chloride & 0.25% potassium metabisulphide

↓

At the end of 24 hours, the cubes were washed properly with fresh water

↓

Prepared the syrup varying sugar percentages

↓

Cubes were dipped in syrup and cooked up to 30 minutes at 100^0C

↓

White vinegar was mixed at the rate of 10% of the syrup. Soaked in the syrup over night

↓

Cubes were washed with water to remove adhering syrup

↓

Cubes were spread on tray and dried in a cabinet dryer at 40^0C for 22 hrs.

↓

Left for cooling

↓

Rolled over sugar

↓

Packaging

↓

Storage

Fig: 3.3.1 Flow chart of pineapple candy (from pulp)

3.4 Preparation of pineapple candy (from crushed pulp)

Mature Pineapple were collected from the local market, washed the pineapple in running potable water and separated edible portion from non edible portion by knives and cut into cubes. The cubes were crushed and mixed with different percentages of sugar. The mixture was cooked until becomes golden brown color. Milk powder and vanilla essence were added and spreaded. The product was then left for cooling and made desired shape of candies. The prepared candies were packaged and stored.

3.4.1 Flow diagram of Pineapple Candy: (From crushed pulp)

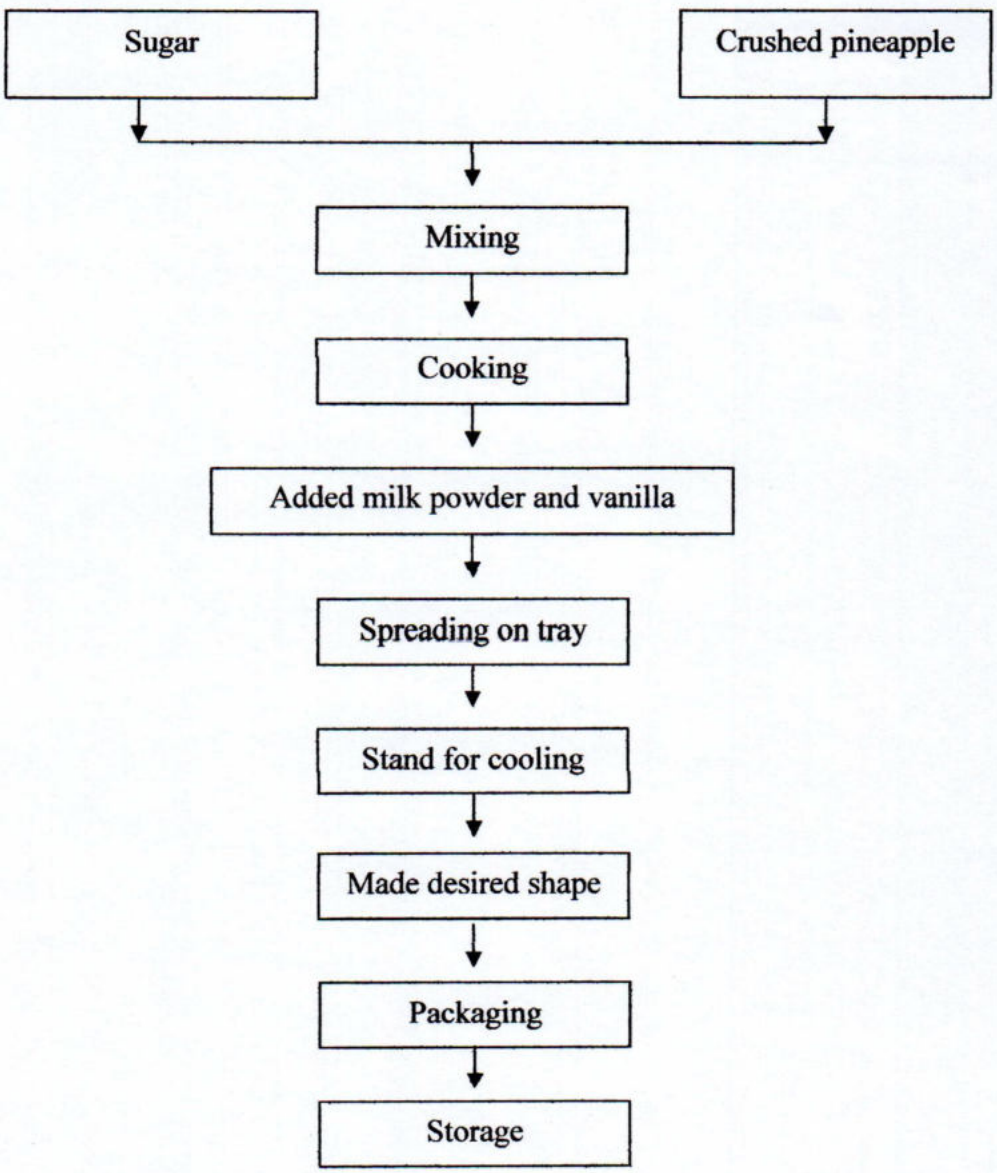


Fig: 3.4.1 Flow diagram of Pineapple Candy: (From crushed pulp)

3.5 Proximate analysis

Proximate chemical composition represents the gross content of important chemical constituents e.g.; moisture, protein, fat, ash, fibre, vitamin C, acidity, pH. The study of the proximate composition serves as an important base to study the nutritive quality of pineapple and pineapple candy.

3.5.1 Determination of Moisture content

The moisture content of the pineapple and pineapple candy samples were determined in accordance to moisture measurement by AOAC (1984) method.

Procedure

At first, 5 gm of sample was taken. The weights of previously dried (1hr at 100 ^{O}C) empty crucible were taken and 5 g of samples were placed in each. Then the crucibles with samples were dried in an air oven at 100-105^{O}C for 24 hrs or more till constant weight. After drying the crucibles were removed from the oven and cooled in desiccators. The crucibles were removed from desiccator and weighed soon after reaching room temperature. The losses in weight were taken as the moisture loss of the samples. From these weights the percent of moisture in the samples were calculated as follows:

$$\% \text{ moisture} = \frac{\text{Loss of weight}}{\text{Weight of sample}}$$

3.5.2 Determination of Ash

Total ash content of pineapple and pineapple candy were determined adopting AOAC method (1984)

Procedure

Two gram of each sample was weighed and taken in dry, clean porcelain dishes. Hot air oven method was applied to remove the moisture. Then the samples were burnt on an electrical heater. This was done to avoid the loss of sample in the muffle furnace under higher temperature. Then the samples were transferred into the muffle furnace and burnt at 550^{0}C temperature for 4-6 hours and ignited until light gray ash resulted (or to constant weight). The samples were then cooled in desiccators and weighed. The ash content was expressed as:

$$\% \text{ ash} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$

3.5.3 Determination of Fat

AOAC method (1984) was used to determine crude fat content of pineapple and pineapple candy.

Procedure

The dried sample remaining after moisture determination was transferred into a thimble and plugged the top of the thimble with fat free cotton. The thimble was dropped into the fat extraction tube of a Soxhlet apparatus. The bottom of the extraction tube was attached to a Soxhlet flask. Approximately 75 ml or more of anhydrous ether was poured into the flask. The top of the fat extraction tube was attached to the condenser. The sample was extracted for 16 hr. or longer on a water bath at 70 to 80^0C. The water bath was regulated so that the ether which volatilized was condensed and dropped continuously upon the sample without any appreciable loss.

At the end of the extraction period, the thimble was removed from the apparatus and most of the ether was distilled off by allowing it to collect in the Soxhlet tube. The ether was poured off when the tube was nearly full. When the ether was reached to a small volume, it was poured into a small, dry (previously weighed) beaker through a small funnel containing plug cotton. The flask was rinsed and filtered thoroughly using ether. The ether was evaporated on a steam bath at low heat, it was then dried at 100^0C for 1 hour, cooled and weighed. The difference in the weights was the ether- soluble material present in the sample. The percent of crude fat was expressed as follows:

$$\% \text{ Crude fat} = \frac{\text{Weight of the ether soluble material}}{\text{Weight of sample}} \times 100$$

3.5.4 Determination of protein content

Protein content of pineapple and pineapple candies were determined by Modified Kjeldahl method of Ranganna (1998).

Principle

Protein content can be measured by estimating the nitrogen content of the material and then multiplying the nitrogen value by 6.25. This is referred to as crude protein content, since the non-protein (NPN) present in the materials was taken into consideration in the present investigation. The estimation of nitrogen was made by modified Kjeldahl method of Ranganna (1998), which depends on the fact that organic nitrogen, when digested with concentrated sulphuric acid (H_2SO_4). In the presence of a catalyst, is converted into ammonium sulphate $(NH_4)_2SO_4$. Alkali is added to the sample to convert ammonium (NH_4^+) to ammonia (NH_3). The ammonia is steam distilled into a receiver flask containing boric acid and titrated with a standard acid solution. This determines % of N that is multiplied by 6.25 to give the value of crude protein.

Digestion Mixture

Potassium sulphate (K_2SO_4) and dehydrated copper sulphate ($CuSO_4.5H_2O$) in a ratio of 5g: 1g were powdered with mortar and pestle and mixed well. Concentrated HCl was used for titration.

Sodium hydroxide (40%)

Sodium hydroxide (NaOH) 40 gm was dissolved in distilled water and the volume was made up to 100 ml.

Receiver Solution

Ten gram of boric acid was added in 500 ml deionized water in a one liter volumetric flask, heated it gently until the boric acid was dissolved. An amount of 0.02 g bromo cresol green was dissolved with 4 ml ethanol (C_2H_5OH) in a separate beaker. An amount of 0.014g methyl red was dissolved with 4 ml ethanol (C_2H_5OH) in another beaker. Some bromocresol green and methyl red solution mixture was than transferred into that volumetric flask and 0.5 ml 1N NaOH was added when the total volume was made 1000 ml with deionized water.

Procedure

The Kjeldahl method consists of the following steps:

a) Digestion of the sample

b) Distillation

c) Titration

Digestion of the sample

The 10 gm sample (pineapple and pineapple candies) was taken in weighing paper and measured accurately. This sample was poured into a 100 ml clean and dry Kjeldahl flask, to which 10 gm of Digestion Mixture and 25 ml of concentrated HCl were added. To avoid frothing and bumping 2-5 glass beads was placed inside the flask. A blank was carried with all reagents except sample material for the comparison. The flask was then heated in a Fume hood Digestion chamber at 400°C until the solution became colorless. At the end of digestion period, the flasks were cooled and diluted with 100 ml distilled water. A small piece of litmus paper was placed in the solution and the reaction was found to be acidic.

Distillation

The distilling set of Kjeldahl apparatus was thoroughly washed with distilled water before starting the distillation. In a measuring cylinder 60 ml of 40% NaOH was taken and it was carefully poured down the side of the Kjeldahl flask. The mouth of the flask was closed with a stopper containing connective tube, which was ultimately connected to the ammonia-receiving flask containing 25 ml receiver solution.

The mixture was boiled at such a rate that water and ammonia distilled over at a steady moderate rate. The heating was not too slow so that the receiver solution might be sucked into the Kjeldahl flask and not to fast so that the distilling ammonia did not escape the receiver solution without absorption.

Titration

The ammonia absorbed in the receiving flask containing receiver solution was titrated with 0.1 N HCl. Similarly a reagent blank was distilled and titrated.

Calculation

Protein content of the sample on the percentage basis was calculated by the following formula:

$$\%\ \text{of protein (g)} = \frac{(c-b)\times 14\times d\times 6.25}{a}\times 100$$

Where,

a = sample weight (g)

b = volume of the sodium hydroxide required for the back titration

c = volume of sodium hydroxide required for the back and to neutralize 20 ml of 0.1 N H_2SO_4 (for blank)

d = Normality of NaOH used for titration.

The conversion factor of nitrogen to protein is 6.25 and atomic weight of nitrogen is 14.

3.5.5 Determination of Crude fibre

Crude fibre of pineapple and pineapple candies were determined by the method Henneberg *et al.* (1864).

Reagents:

0.255 N H_2SO_4 Solution: conc. H_2SO_4 (3.54 ml) added in distilled water and volume made up to 500 ml.

0.313 N NaOH Solution: NaOH (6.26 g) dissolved in distilled water and volume made up to 500 ml.

Procedure:

Moisture and fat free sample was taken in 500 ml beaker. 0.255 N H_2SO_4 (200 ml) added in a beaker and boiled for 30 mins, keep volume constant by addition of distilled water at frequent intervals. At the end of this period the mixture was filtered through a muslin cloth and the residue washed with hot water till free from acid. The material then transferred to the same beaker and 0.313 N boiling NaOH (200 ml) was added after boiling for 30 mins (keeping the volume constant as before). The mixture was filtered through muslin cloth; the residue was washed with hot water till free from alkali followed by washing with some alcohol and diethyl ether. It was then transferred into a crucible, dried overnight at 105 ° c in an oven and weight. Then the crucible was heated in a muffle

furnace of 600 ° c for 3-5 hours. Cooled and weighted again. The differences in the weights represented the weight of crude fibre.

Calculation:

$$\%\text{Crude fibre} = \frac{100 - (\text{Moisture} + \text{fat}) \text{ x weight of fibre}}{\text{Weight of sample taken (moisture and fat free)}}$$

3.5.6 Determination of Beta-carotene

Reagents:

Acetone, anhydrous sodium sulphate, petroleum ether.

Procedure

Five gm of sample (pineapple candy) was taken add in 10-15 ml acetone, adding a few crystals anhydrous sodium sulphate. Decant the supernatant into a beaker. Repeat the process twice and transfer the combined supernatant to a separatory funnel, add 10-15 ml petroleum ether and mix thoroughly. Two layers will separate out on standing. Discard the lower layer and collected upper layer in a 100 ml volumetric flask, make up the volume to 00 ml with petroleum ether and record optical density at 452 nm using petroleum ether as blank (Srivastava, 2003).

Calculation:

$$\beta\text{ - carotene } (\mu g /100 \text{ gm}) = \frac{\text{O. D} \times 13.9 \times 104 \times 100}{\text{Weight of sample} \times 560 \times 1000}$$

$$\text{Vitamin A (I.U)} = \frac{\text{beta - carotene } (\mu g /100 \text{ gm})}{0.6}$$

3.5.7 Vitamin C (Ascorbic acid)

Ascorbic acid of pineapple and pineapple candies were determined following the method of Ranganna (1998). The dye 2, 6- Dichloro phenol endophenol is blue in alkaline solution is reduced to light red color by an ascorbic acid at pH range of 1- 3.5.

Standardization of Dye

Five milliliter of standard ascorbic acid solution was taken in a 150 ml conical flask and 5 ml of HPO_3 was then added. A micro burette was filled with dye. The ascorbic acid

solution was titrated with the dye to a pink color, which persist for 15 seconds. Dye factor (i.e. mg of ascorbic acid required to neutralize per ml of dye) determined by using the following formula:

$$\text{Dye factor} = \frac{\text{Ascorbic acid present in the solution titrated}}{\text{Titer (Volume of dye)}}$$

Preparation of samples

Ten gram of the (pineapple and pineapple candy) sample was taken, diluted up to 100 ml with 3% HPO_3 and then filtered. 10 ml of the aliquot was taken in a 150 ml conical flask. 1 ml of 40% formaldehyde and 0.1 ml of HCl were added to it and kept for 10 minutes. This was titrated with the standard dye to a light pink colour (end point), which persists for 15 seconds.

Calculation

$$\text{mg of ascorbic acid per 100 ml} = \frac{\text{Titre} \times \text{Day factor} \times \text{Vol. made up} \times 100}{\text{Aliquot of extract} \times \text{wt. or vol. of the sample}}$$

3.5.8 Determination of titratable acidity:

The titratable acidity content of pineapple was determined by Ranganna (1998) method.

Reagents:

i) NaOH solution 0 .1 N (4g NaOH in one liter distilled water)

ii) Phenolphthalein indicator with 100% solution in ethanol (acid sample neutralizes NaOH and showed faint pink color at the end point).

Procedure:

In a 50 ml beaker, 2-4 g pineapple were taken and diluted with distilled water up to the mark of 50 ml of volumetric flask. Then the samples were taken into 250ml Erlenmeyer flask and 0.1N NaOH drop wise added to the burette until the desired end point faint where pink color was observed.

The same procedure was followed in case of all samples.

Calculation:

$$\% \text{ Acidity} = \frac{\text{titre value} \times 0.1 \times 64 \times 100}{\text{Sample volume} \times 1000}$$

3.6 Sensory evaluation of pineapple candy

The sensory evaluations of six types of pineapple candy were evaluated for color, flavor, taste, texture and overall acceptability parameters by 10 testers. The panelists were selected from the teachers, students and employees of the Department of Food Processing and Preservation, Hajee Mohammad Danesh Science and Technology University, Dinajpur. For evaluation, six types of pineapple candies were given to 10 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 Statistical Analysis System (SAS, 1985).

3.7 Storage studies of pineapple candy

Processed pineapple was stored at room temperature (25-30°C) and refrigerated temperature (3 to 5°C). Shelf life of Pineapple candy was assessed by objective and subjective tests at different time intervals. The, color, flavor, texture and fungal growth was observed for 3 months.

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULT AND DISCUSSION

Pineapple candy is an intermediate moisture food prepared from pineapple. The candy was studied for its acceptability with different ingredients and shelf life at room temperature (25-30°C) and at refrigeration temperature (3-5°C). The acceptability and shelf life were evaluated through organoleptic procedure along with chemical analysis. The consequences obtained are discussed in this chapter.

4.1: Chemical composition of fresh pineapple

Fresh pineapple was analyzed for its chemical composition.

Table 4.1: Chemical composition of fresh pineapple

Table 4.1 shows the composition of fresh pineapple that moisture-86.55%, protein-0.60%, fat- 0.20%, ash-0.46%, fibre-1.20%, pH-3.50, acidity-0.79%, vitamin C- 21mg/100g.

Parameter	Fresh pineapple
Moisture	86.55%
Protein	0.60%
Fat	0.20%
Ash	0.46 %
Fibre	1.20%
pH	3.50
Acidity	0.79%
Vit-C	21mg/100g

This study is nearly in agreement with the findings of Anonymous (1960) reported that the pineapple contain moisture-75%, vitamin c-8.76mg/100g, ash-0.56%, acidity-0.64%, pH-2.57.

4.2 Chemical composition of pineapple candy

The pineapple candy prepared from pineapple pulp and crushed pulps were analyzed for moisture, ash, protein, fat, fibre, vitamin A, vitamin C.

Table 4.2: Chemical composition of pineapple candy

Composition	Treatments					
	A	B	C	X	Y	Z
Moisture (%)	21.80	20.60	19.80	6.45	6.25	6.15
Ash (%)	0.844	0.846	0.847	0.706	0.716	0.724
Protein (%)	1.48	1.42	1.45	1.88	1.67	1.67
Fat (%)	0.21	0.21	0.21	.44	.42	.42
Fibre (gm)	1.508	1.513	1.53	1.12	1.14	1.12
Vitamin A (IU)	2.89	2.25	2.14	0.31	0.12	0.07
Vitamin C mg/100gm	13.76	13.76	13.56	11.05	10.76	9.32

According to the formulation, pineapple candy was prepared by mixing different ingredients. After preparation of pineapple candy the chemical composition of the product was determined. The chemical composition and different chemical attributes of pineapple and pineapple candy is shown in Table 4.2.

It was observed that the moisture content of the fresh pineapple was higher than the pineapple candy. It is due to heat treatment and high sugar concentration. The moisture content of the different pineapple candy samples A,B,C were different from sample X,Y,Z. This difference could be due to cooking method difference.

The fat content of the pineapple candy of sample A,B,C were lower from sample X,Y,Z due to incorporation of milk powder.

Ash content of the different candies was not different from each other due to reduction of moisture content as a result of processing.

Vitamin C content of pineapple candy was lower than the fresh pineapple due to processing. Vitamin C is known to be unstable as temperature increases because when heated the food, ascorbic acid oxidised to dehydroascorbic acid (Rui, 2002).

Chemical composition of pineapple candy was determined during the storage period. The change in vitamin C determines with time during the storage period is shown in Table 4.3.

Table 4.3: Changes of vitamin C during storage period.

Storage Condition	Packaging materials	Storage time(days)	Vitamin C (mg/100gm)
Refrigeration temperature (3-5°C)	Glass bottle	Processing day	13.76
		30	11.01
		60	8.97
		90	7.18
Refrigeration temperature (3-5°C)	Polyethylene bag	Processing day	13.76
		30	9.64
		60	5.79
		90	4.06
Room Temperature ($25-30^0$)	Glass Bottle	Processing day	13.76
		30	10.40
		60	9.18
		90	3.52
Room Temperature ($25-30^0$)	Polyethylene bag	Processing day	13.76
		30	8.06
		60	3.06
		90	1.85