DEVELOPMENT OF AN ICE APPLE (*BORASSUS FLABELLIFER)* JELLY WITH NATURAL SWEETENER AND DETERMINE ITS QUALITY PARAMETER

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Roll no.: 0121/03

Registration no.: 985

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Master of Science in Applied Human Nutrition and Dietetics

Department of Applied Food Science and Nutrition

Faculty of Food Science and Technology

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Authorization

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This is to certify that we have examined the above Master's thesis and have found

That is complete and satisfactory in all respects and all revisions required by the thesis examination committee have been made

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PLAGIARISM VERIFICATION

Title of the Thesis: Development of an ice apple (*Borassus flabellifer*) jelly with natural sweetener and determine its quality parameter.

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DEDICATED TO MY

BELOVED FAMILY

&RESPECTED TEACHERS

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The Author

August, 2023

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Abbreviation

% : percentage

& : and

^{0}B : degree brix

^{0}C : degree celsius

µg : microgram

ABTS : 2,2-azinobis-3-ethylbenzthiazolin-6-sultonic acid

ANOVA : analysis of variance

AOAC : association of official analytical chemists

cfu : colony forming unit

CHO : carbohydrate

DPPH : 2,2-diphenyl-1-picrylhydrazyl

et al : et alii/ et aliae/et alia

etc. : et cetera

g : gram

Ibs. : pounds

Kcal : kilocalorie

Kg : kilogram

L. : linn

m : meter

mg : milligram

ml : milliliter

N : normality

Nm : nanometer

PPM : parts per million

QE : quercetin equivalents

SD : standard deviation

SPSS : statistical package for social science

TSS : total soluble solids

Abstract

The *Borassus flabellifer*, often known as the Ice Apple fruit or the palm fruit, has a taste similar to coconut water and a texture resembling lychee. It is a delightful exotic summer delicacy. It is a popular fruit in our country. However, very few studies are available regarding this. Development of jelly from this fruit is a different fruit commodity. The motto of this study to make a unique jelly using ice apple as mother ingredients while altering different type of sweetener instead of sugar. Total four formulations have been used using different concentration of sweetener; honey (50%and 33%) date (50% and 33%). A control sample was made using 50% sugars. The ice apple jelly with 33% honey had earned the greatest sensory acceptance rating of 8.80±0.42 out of five jelly formulations. The vitamin C and mineral contents were also found 25.22mg/100 and 2.75mg respectively which were acceptable than the other samples and proved its soundness nutritionally. However, crude fibre amount was recorded 1.11% that is relatively lower than the another sample. The energy content was found 284.5kcal/100g. The total viable count was found to be within an acceptable range after 15 days of storage at a cold temperature (8±2º C), and fungal activity was not seen. The high concentration of exceptional phytochemicals may therefore qualify it as a functional food.

Keywords: ice apple, pectin, Jelly, honey, date, Sensory properties

CHAPTER 1: INTRODUCTION

1.1 General Feature:

The demand for nutrient-rich, finely flavoured, and aesthetically appealing natural foods with high therapeutic value can be met in large part by tropical fruits, which are now underutilized (Ravani & Joshi, 2014). Fruits were among the first foods that humans are known to have eaten in the distant past. Fresh, dried, or processed fruits have always been a cornerstone of the human diet (Wani et al., 2013). Traditional cultures have used less well-known, underutilised fruits like palmyra palm as a staple diet and for therapeutic purposes. Since these fruits are the main source of dietary fibre for the underprivileged, they are crucial in combating the malnutrition issue.

In tropical areas, palm trees frequently dominate the countryside (Mogea et al., 1991). They have been supplying the majority of human needs in the tropics for ages. *Borassus flabellifer*, sometimes known as taal, is one of the principal sugar-yielding plant species (Mogea et al., 1991) among the 3000 multipurpose palms of the tropics and Subtropics. Bangladesh has it as well. A less well-known tropical fruit of the palmyra palm tree is the ice apple. It is easily accessible throughout the sweltering summer months. It is a member of the Arecaceae family and is referred to by the scientific name *Borassus flabellifer*. When ripe, ice apple fruit is spherical and appears deep brown to black. It is a fruit that resembles a coconut and has a luscious mass of white fibre covered in orange or yellow flesh. The mature ice apple pulp is eaten straight from the wiry fruit fibre.

The Palmyra palm has countless medical use for all of its sections. According to legend, the herb can treat gonorrhoea, diarrhoea, and biliousness. Young roots are anthelmintic and diuretic, and a decoction is used to treat several respiratory conditions. Heartburn, an enlarged spleen, and liver are treated with spadix ash. Both charcoal derived from the bark and the decoction of the bark with salt are used as mouthwashes and dentifrices. As a tonic, diuretic, stimulant, laxative, anti-phlegmatic, and amebicide, flower stem sap is highly valued. This sap is used to make sugar, which is used to treat coughs and other respiratory complaints as well as to combat poisoning. All types of ulcers are wrapped with fresh toddy that has been heated to encourage fermentation. The mature fruit's pulp soothes dermatitis. Its fruit

is a type of drupe that is big, fibrous, and often has 3 to 5 nutlike sections. When the fruit is tender, each of these portions contains a seed. The seeds have a delicate, sweet, sticky flesh inside them that is slightly liquid (Arunachalam et al., 2011).

In order to raise the total soluble solids (TSS) content of fruits to > 65%, fruits are cooked with sugar (with or without the addition of pectin and acid) to produce jelly, a food product with intermediate moisture (semi-solid).Jelly is a method of preserving fruit because its high sugar content inhibits the growth of bacteria, yeast and moulds as well as other types of spoilage. This means that it is possible to keep the fruit's nutritional value while still producing pleasant goods.(Ashaye & Adeleke, 2009).

To increase the output and clarity of fruit and vegetable juices, pectic enzymes like pectin methylesterase and polygalacturonase are frequently used in conjunction with amylases and cellulases. With the elimination of negatively charged pectin deposits on particulate matter, which ultimately leads to the coagulation of turbidity-causing materials, pectinase treatment can reduce the turbidity/cloudiness of fresh fruit juices.

The hydrocolloid that is most frequently utilized in processed fruits is pectin. The primary food type that uses higher levels of pectin is jams and jellies. Higher plants include a type of complex hetero polysaccharides called pectin in their cell walls, where they serve as a hydrating agent and a cement for the cellulose network (Mualikrishna & Tharanathan, 1994).

Sweeteners hold the moisture in fruits that harmful microorganisms need. Insufficient sugar can cause yeast and mold to thrive while preventing gelling. Sugar aids in jelling and acts as a preservative.

Acidulants are acids that are either added as food processing additives or exist naturally in fruits and vegetables. In the process of processing fruit, acidulants serve a number of purposes, the most important of which are acidifier, pH regulator, preservative and curing agent, flavouring agent, chelating agent, buffering agent, gelling/coagulating agent, and antioxidant synergist. Because every acid has a different combination of physical and chemical characteristics, the selection should be based on the attributes needed (Watase & Nishinari, 1993).

Citric, lactic, malic, and other organic acids are used to reduce the pH to 4.6 or below during the canning process. Due to its inclusion, microorganism sporulation and growth can be inhibited at lower temperatures and for shorter processing times

without compromising the final product's flavour, colour, or texture (Rajashekhara et al., 2000).

Therefore, tartaric acid is recommended for grapes, malic acid for apples, and citric acid for the majority of fruits. When mixing or substituting the used acids, the product should be checked both before and after storage because taste stability cannot always be foreseen. The ideal acidity for jams and jellies is around pH 3, which is within a certain range of hydrogen ion concentration where gel formation occurs.

1.2 Aims and Objective:

General Objective: The purpose of this study is to create an ice apple jelly and compare its nutritive value using different type of sweetener.

Specific Objectives:

- To determine nutritive value of ice apple jelly.
- To make analysis of mineral content of ice apple jelly after using different type of sweetener.
- To determine the overall acceptability of the developed products.

CHAPTER 2: REVIEW OF LITERATURE

2.1 Overview of Ice apple

In Bangladesh, the Asian palmyra or Asian palm is referred to as Tal/Taal. Borassus flabellifer is its scientific name. It's a member of the Arecaceae family. It also goes by several names in English. It is also referred to in English as the Ice apple, Toddy palm, Sugar palm, and Cambodian palm.

A sturdy tree, the Asian Palmyra Palm (Tal/Taal) can grow to a height of 30 m, live for 100 years or longer, and have a canopy of leaves that spans three metres in width. Young Palmyra palms (Tal/Taal) grow slowly at first then quickly as they get older. Large palm trees like the palmyra palm (Tal/Taal), which can occasionally reach heights of 30 metres, are found around the world. Up to 20 years may pass before the first harvest. Male and female trees are located apart. To obtain a sweet sap, male and female inflorescences are tapped.

Fruits develop in groups. The fruits are spherical, and the tops are green while the bottoms are dark-brown. When it ripens, the colour transforms to a dark-yellow. Fruits range in size from 13 to 20 cm. Three jelly seed sockets with pale-white translucent flesh, similar to that of the lychee but with a milder flavour and no pit that may be eaten, are found inside the fruits when they are sliced open. The taste of the flesh is pleasant. A thin, brownish-yellow skin covers the fruit's gelatinous portion. Fruits are manually gathered**.**

2.2 Plant description

The Ice Apple is a sizable, single-stemmed, evergreen tree with a base circumference of 1.7 meters and a height range of 20 to 30 metres. The leaves of ice apple trees are enormous, healthy-looking fans that are 1-2 m long, folded along the midrib, and have 20–25 leaves per tree. The tint of the leaves is a greyish green. The leaves are composed of 30 to 40 linear-lanceolate segments that culminate in rounded segments. Ice apples are gobbled on every level. Male and female flowers are always produced on two distinct plants. The flowers are tiny and appear as light yellow clusters; they have white petals that resemble inflorescences. The fruits are once more sub glubose and in clusters. Typically, a tree may yield between 50 and 300 fruits. The fruit is 4-8 inches in diameter, and when ripe is black, greenish white and black. Each fruit contains 1-3 seeds, each enclosed within a woody endocarp. A tree typically produces

50 to 300 fruits per year. When ripe, the 4–8-inch-diameter fruit is black, greenish white, and black. Each fruit has one to three seeds that are each protected by a woody endocarp.

2.3 Origin and distribution of Ice apple

Native to both Africa and India, the tal palm is widespread along the coasts of Sri Lanka, Burma, and many of the country's more arid regions (Ariyasena et al., 2001). It is naturally found growing from the Persian Gulf to the Cambodian-Vietnamese border, and it is also occasionally found being farmed in other warm places like Hawaii and southern Florida (Morton, 1988). This palm is planted across the remainder of Bangladesh in wastelands, along ails (field boundaries), or along pond banks. Its economic potential isn't, however, fully realized.

2.4 Utilization and economic importance of ice apple

Immature endosperm:

When the endosperm is still a liquid, mushy, delicious, gelatinous mass in the Palmyra fruits, a sizeable but indeterminate portion of the fruits are harvested. Fruit bunches are plucked from the trees and sold at roadside booths, open-air markets, and other places. There are three seeds in the normal Palmyra fruit, however some varieties have less. The fruit's top is cut off with a machete until the endosperms are exposed and their covering is just barely penetrated. The substance, "nunggu," is then extracted with a spoon or by being sucked out. After the frmt is harvested, immature endosperm degrades quickly. Each seed of nunggu, referred to as a "eye," is sold separately. Studies reported that palmyra fruit pulp which is regarded as a waste product, appeared to be best used as an alcoholic fermentation base, with the possibility of using the carotenoids (by-product) as a food (Ariyasena et al., 2001).

Mesocarp pulp:

The fibrous, yellowish mesocarp pulp of the mature Palmyra fruit is sweet and rich. Although it can be eaten directly from the source, it is most frequently cooked, sun dried, or baked before consumption, usually after being combined with sugar. The pulp can also be turned into a paste and added to other foods. When estimating the components of mature fruit, Davis (1986) discovered that the edible mesocarp (excluding the fibre) made up more than 51% of the total weight.

Anti-inflammatory and antioxidant activities are found in palm fruit. Due to the presence of a high concentration of crude flavonoids, saponins, and phenolic substances, antioxidant activity may have been induced (Gupta et al., 2018). In addition to being used as aperients and to aid in digestion, the fruits are cooling down, help in bowel movements, antibacterial, and relaxing (Rajendran et al., 2008).

For people who are trying to lose weight, ice palm fruit is a good option. Malnutrition in both children and adults is also avoided by it. Ascorbic acid, a natural vitamin, has been discovered to be present in this tree (Vengaiah et al., 2013).

Sap:

The most economically useful product of Palmyra is the sweet sap that is collected by tapping the inflorescences. The sap, known in Tamil as "neera" or "pathaneer," can be consumed directly or let to ferment into wine or palm toddy.

Palm sugar:

Jaggery, a type of palm sugar, can be made by crystallising palmyra sap after it has been cooked down to a syrup. Advertising that indicates palm sugar is healthier than other types of sugar is used to sell it as a sweetener.

The palmyra palm in Tamil Nadu is used to produce cordage, rough weaving and palming fibre, brush fibre, and other materials.

Rough weaving and platting fiber:

A strong, coarse fibre of exceptional quality known as "akam" or "'ahanla" is produced by the petiole's adaxlal region. It should be noted that the term "naar" is used to refer to any fibre obtained from the petiole. The fibre is separated from the petiole and split into strands with a constant width. The most significant application for akam is cot weaving. The flat, sturdy, resilient fibre provides an airy bed that is comfortable and popular in tropical climates. These customary cots have a frame made entirely of Palmyra wood and are weaved. This fibre is also used to make sturdy baskets. Palmyra leaves provide excellent-quality plaiting fibre. Numerous exquisite woven baskets, boxes, handbags, caps, and other items are produced in Tamil Nadu for domestic and export markets.

Brush fiber:

The leaf base's bifurcation area yields the most valuable fibre output commercially. The raw fibre is referred to as "kora," while the leaf base is called "pathal." A

thorough investigation into the palmyra fibre export market has been conducted (Davis & Johnson, 1987).

2.5 Nutritional properties of ice apple:

Its fruit is a type of drupe that is big, fibrous, and often has 3 to 5 nutlike sections. When the fruit is tender, each of these portions contains a seed. The seeds have a delicious, soft, sticky pulp that is slightly liquid-filled. The soft pulp progressively becomes harder and a fibrous kernel forms. Subrahmanyan et al. were the first to note the presence of galactomannan in the soft kernel of the palm tree (Subrahmanyan et al., 1956) and demonstrate that it was made up of galactose (27.64–28.06%) and mannose (78.32%). Recently Pathberiya and Jansz (On et al., 2005) investigated the carotenoids in palmyrah fruit pulp from mannar for their in vitro antioxidant capacity. They also showed how the free sugars and polysaccharides in the kernel behaved. Although low in fat and protein, palmyrah is a good source of carbohydrates, calcium, magnesium, iron, and fibre.

Table 2.1: nutritive value of ice apple fruit pulp

Constituents	Amount
Water	87.6 g
Pectin	8g
Fat	1g
Carbohydrates	10.9g
Fiber	1g
Calcium	27 mg
Phosphorous	30mg
Iron	1mg
Thiamin	0.04 mg
Riboflavin	0.02mg
Niacin	0.3mg
Vitamin C	5mg

2.6 Pectin:

The hydrocolloid that is most frequently utilised in processed fruits is pectin. The primary food type that uses higher levels of pectin is jams and jellies. Higher plants include a type of complex hetero polysaccharides called pectin in their cell walls, where they serve as a hydrating agent and a cement for the cellulose network (Mualikrishna & Tharanathan, 1994).

Pectins are primarily a polymer of d-galacturonic acid (homopolymer of [1→4]-α-d-galacto-pyranosyluronic acid units with varying degrees of carboxyl groups methylated esterified) and rhamnogalacturonan (hetero polymer of repeating [1→2]-α-l-rhamnosyl [1-l]-α-d-galactosyluronic acid disaccharide units), making it an α-d-galacturonan (Lau et al., 1985). The molecule is formed by l-1,4-glycosidic linkages between the pyranose rings of d-galacturonic acid units. As both hydroxyl groups of d-galacturonic acid at carbon atoms 1 and 4 are on the axial position, the polymer formed is 1,4-polysaccharide (Sakai et al., 1993).

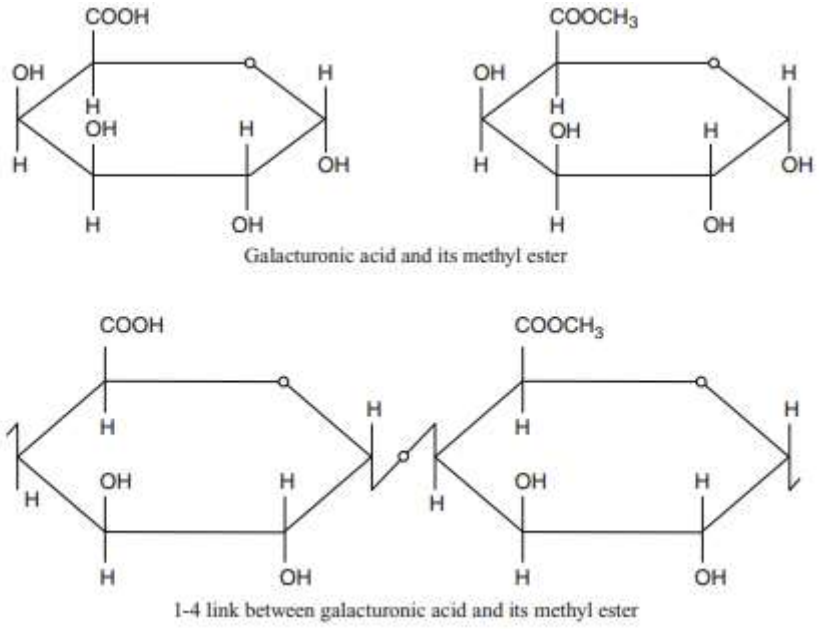

Figure 2.1: Chemical structure of galacturonic acid and its methyl ester

2.7 Overview of Date:

Date fruits are said to have a total of 6.5% to 11.5% dietary fibre (up to 90% of which is insoluble and 10% of which is soluble), 1% to 2% protein, and 2% ash. It also contains a significant amount of phenolic antioxidants (Yun et al., 2006). Similar to this, the soft dates are predominantly composed of invert sugars (fructose and

glucose), but the dry dates include a significant amount of sucrose. According to the different forms of sugar they contain, the fruits are categorised into three groups: Invert sugar types include Barhi and Saidy, which are primarily made of glucose and fructose; mixed sugar types include Khadrawy, Halawy, Zahidi, and Sayer, which are mostly made of sucrose; and cane sugar types include Deglet Nour and De, which are mostly made of sucrose (Ghnimi et al., 2017).

Date fruits are particularly nutritious since they contain a wide range of vital components. Sugar makes up the majority of the ripe fruits' content (80%), while protein, fibre, and trace minerals like boron, cobalt, copper, fluorine, magnesium, manganese, selenium, and zinc are present in minor levels.

Table 2.2: One pitted Medjool date has the following nutrients: (Devanand & Chao, 2003)

Constituent	Amount
Calories	66.5
Fat	0.04g
Carbohydrate	18g
Sodium	0.24mg
Protein	0.43g
Fiber	1.61g

Dates are entire, unprocessed fruits, thus their naturally occurring sugar content results from this. For instance, if an energy bar is only sweetened with dates, its nutritional information could state that it contains no added sugar at all (Graham & Roberto, 2016).

Experts suggest minimising your intake of added sugar. According to some data, the risk of heart disease and obesity is increased by added sugar (Rippe & Angelopoulos, 2016).

A study published in 2017 showed that dates contain many antioxidants, including: (Al-Alawi et al., 2017)

- Polyphenols, such as phenolic acids, isoflavones, lignans, and flavonoids;
- Carotenoids;
- Sterols
- Tannins

2.8 Overview of honey:

The consumption of honey has a very long history among human beings. It has been used in innumerable foods and beverages as sweeting and flavoring agent. Since ancient times, honey has been known for its nutritive and therapeutic values.

The presence of carbohydrates in the form of maltose, isomaltose, maltulose, sucrose, turanose, fructose, glucose, and monosaccharides, fructose, glucose, and disaccharides, is what gives honey its sweetness. In addition, it has enzymes including amylase, oxidase peroxide, catalase, and acid phosphorylase as well as oligosaccharides like anderose and panose. Honey also contains minerals, iron, zinc, trace amounts of vitamin B, vitamin B6, vitamin C, niacin, folic acid, amino acids, and antioxidants (Ball, 2007);(Shugaba, 2012). The presence of several metabolites in honey bees, including vitamins and vital minerals in addition to enzymes and coenzymes, is primarily responsible for their health-promoting properties. Honey is a beneficial complement for a healthy population in theory (Denisow & Denisow-Pietrzyk, 2016). Honey is very nutritive and has beneficial anti-inflammatory, anti-oxidant, and antibacterial effects. Honey's function is influenced by its concentration and place of origin. Honey is a powerful antioxidant with various preventive qualities against a wide range of medical illnesses, including inflammatory disorders, coronary artery diseases, worsening neurological issues, and ageing (Kishore et al., 2011).

2.9 Acidulants:

Conventionally, citric acid is also utilized as an antioxidant synergist and to slow the browning response. Citric acid has been discovered to have use levels of 0.1-0.3% and antioxidant values of 100-200 ppm. One of the specific use is as a gelling agent. You can use structured fruits as an example to highlight the particular point.

CHAPTER 3: MATERIAL AND METHODS

3.1 Study area

The study was conducted in the lab of Department of Applied Food Science and Nutrition, Food Processing and Engineering, Poultry Research and Training Centre, Animal Science and Nutrition, and Physiology, Biochemistry and Pharmacology of Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram.

3.2 Study duration

From February to June the experiment was conducted.

3.3 Collection of sample

Ice apple fresh samples were gathered at the local market near khulshi in Chattogram. Fruits with a variation in colour, such ice apples, were chosen carefully. We went to the scientific and super shop to get pectin, citric acid, sugar, honey, and dates. Additional relevant items required for the experiment were provided by the laboratory stock.

3.4 Jelly preparation

Sample A

Jelly was created using a fresh ice apple, sugar, pectin, and citric acid. About 328.42gm ice apple paste, 164.21 g of sugar, 4.91 gm of pectin, and 0.5% citric acid were used to make ice apple jelly, which was used as the control sample A.

Sample B

Jelly was created using a fresh ice apple, sugar, pectin, and citric acid. Ice apple paste 358.26gm, 11o.43 gm honey, 4.91 gm of pectin, and 0.5% citric acid were used to make ice apple jelly, which was used as the control sample B.

Sample C

Jelly was created using a fresh ice apple, sugar, pectin, and citric acid. Using 394.12 g boiling ice apple paste, 98.53 gm honey, 4.91 g pectin, and 0.5% citric acid were used to make ice apple jelly, which was used as the control sample C.

Sample D

Jelly was created using a fresh ice apple, sugar, pectin, and citric acid Ice apple jelly was made using 370.92 gm boiling ice apple paste 121.83 g date, 4.91 g pectin, and 0.5% citric acid as sample D.

Sample E

Jelly was created using a fresh ice apple, sugar, pectin, and citric acid Ice apple jelly was made using using 405.79 gm boiling ice apple paste 86.82 g date, 4.93 g pectin, and 0.5% citric acid as sample E.

Table 3.1: Formulations of ice apple jelly

Sample	Ingredients					
	Ice apple juice	Sugar	Honey	Date	Pectin	Citric acid
A	65.68% =328.42 g	32.84% =164.21 g	0 g	0 g	1% =4.91g	0.5% =2.46 g
B	71.65% =358.26 g	0 g	22.09% =110.43g	0 g	1% =4.91g	0.5% =2.46 g
C	78.82% =394.12 g	0 g	19.71% =98.53 g	0 g	1% =4.91g	0.5% =2.46 g
D	74.8% =370.92 g	0 g	0 g	24.36% =121.83 g	1% =4.91g	0.5% =2.46 g
E	81.15% =405.79 g	0 g	0 g	17.36% =86.82 g	1% =4.91g	0.5% =2.46 g

Ice apple was utilized to prepare jelly using the open kettle methods. Fruits that were firm and had a consistent size, shape, and colour were selected. Fruits from iced apples were washed individually in extra potable water after the outer layer had been cleaned to remove contaminants. Ice apple pulp was removed. The fruit samples were then mixed for 5 to 10 minutes at high speed. A good quality dates were purchased from the market and used for the juice extraction. The dates were cleaned with water to get rid of any contaminants, and then they were soaked in water over night. The dates were seeded after they had been soaked, and the pulp was created by boiling the dates in water for 10 to 15 minutes. After that, the juice was drawn out of the pulp using a fresh muslin cloth. Then, in order to create the necessary soluble solid, sugar, honey, and dates are added to the various samples. The entire mixture is then heated to a boil while being stirred continuously. Citric acid and commercial pectin are both used as preservatives. The jelly was assessed once the TSS of roughly 68% was reached. After that, the jam was hot-filled with the least amount of headspace possible into sterilized bottles. It was draped and let to cool. The whole process describe below in a flow chart:

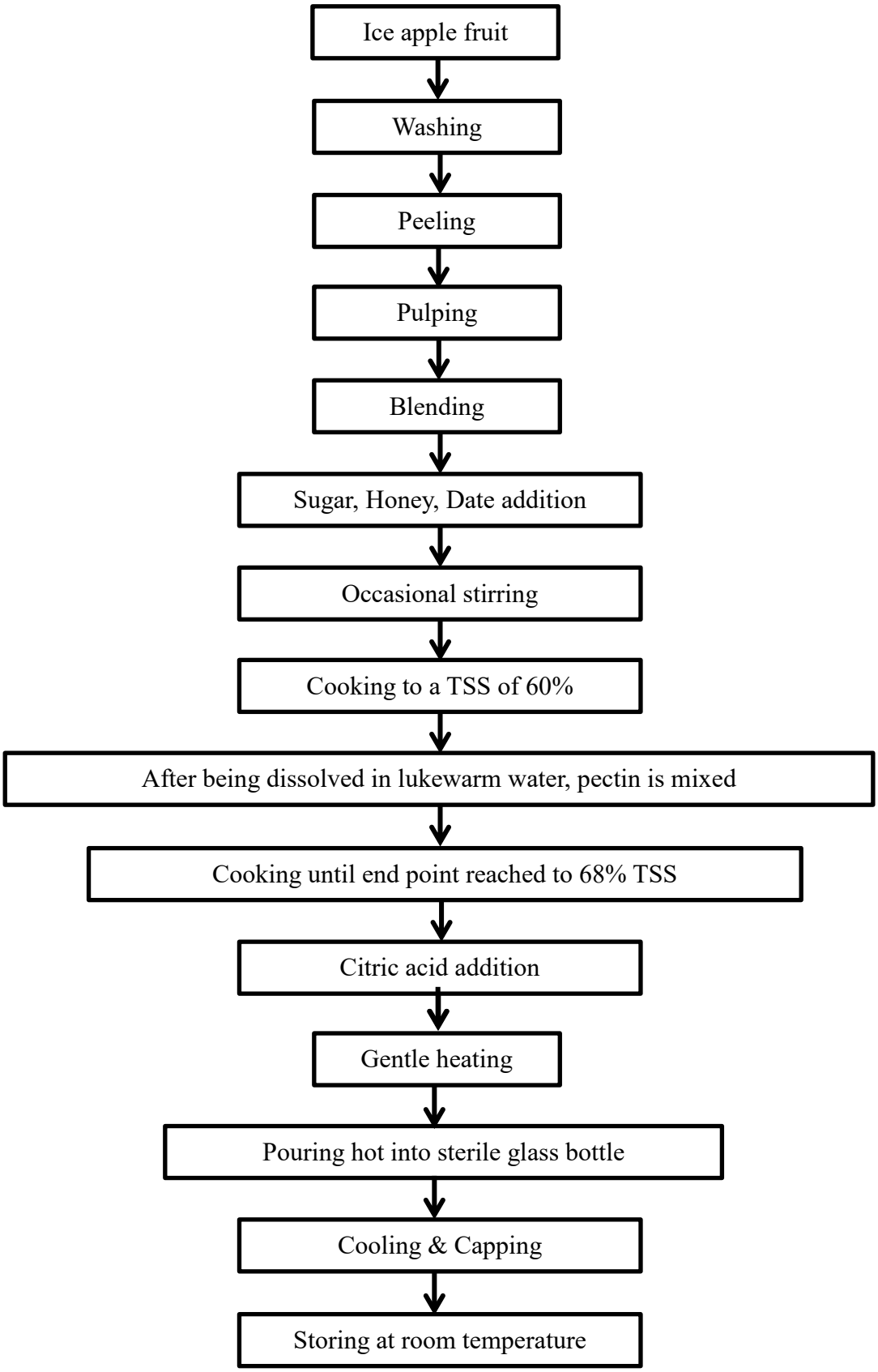

Figure 3.1: processing steps of Ice apple fruit jelly

3.5 Physicochemical analysis of ice apple jelly

Fresh jelly samples were analysed for moisture, total solids, ash, total soluble solids, pH, and titratable acidity in accordance with AOAC (2016) methods. Furthermore, proximate, bioactive component, and antioxidant investigations for these samples were carried out.

3.5.1 Determination the pH

The acidity or basicity of an aqueous solution is determined using the pH scale in chemistry. Although pH is actually a measurement of the concentration of hydronium ions, it is more commonly referred to as the negative logarithm of the activity of the (solvated) hydronium ion.

The pH scale can be traced using a set of reference solutions whose pH has been established by international agreement. To determine the primary pH standards, the potential difference between a hydrogen electrode and a standard electrode—such as the silver chloride electrode is measured using a concentration cell with transference. Using a glass electrode and a pH metre, the pH of aqueous solutions may be calculated. pH is calculated using the decimal logarithm of the reciprocal of the hydrogen ion activity in a solution.

3.5.2 Total soluble solids

Total soluble solids in the fruits were calculated using a hand refractometer. Using a digital refractometer (Atago RX 1000), total soluble solids (TSS) were measured directly, and the results were presented as peecent soluble solids (Brix) in accordance with AOAC recommendations.

3.5.3 Titratable acidity

Using the phenolphthalein indicator and titrating against N/10 NaOH to calculate anhydrous citric acid, the acidity percentage was ascertained. Each time, 10 ml of juice was added to a volumetric flask with a capacity of 100 ml, and then 100 ml of distilled water was added to the mixture to make 100 ml. Following that, 10 ml of the diluted juice was titrated using phenolphthalein as the indicator against N/10 NaOH. The titration is complete when a pink hue appears. The result was three times the average of the titration. As shown below, titratable acidity can be calculated:

$$\text{Titratable acidity (\%)} = \frac{\text{T.V} \times \text{Factor}}{\text{W}}$$

Where,

T.V = Sample's titer value in ml

W=Amount of the test sample collected in ml

Citrus fruit has a citric acid factor of 0.0064 and malic acid of 0.0067.

3.5.4 Determination of Vitamin C

In its chemical assay, vitamin C has market-diminishing properties. The ability of a plant or animal extract to decrease 2, 6-dichloride phenol indophenols is typically used to determine how much vitamin C is present. The colour pigment in this case oxidised vitamin C into dehydroascorbic acid. The dye is also changed into a colourless substance concurrently. It is simple to pinpoint the point at which the reaction comes to a stop. Since too much might be released by oxidized Vitamin C during sampling and grinding, rapid elimination and filtration are preferred. Oxidation is demonstrated by utilizing metaphosphoric acid during extraction. Utilizing metaphosphoric acid during extraction serves as a demonstration of oxidation. The solution should be somewhat acidic for the best outcomes. The titration should be completed in one minute. The dye is blue when it is dissolved in water. Acidic solutions turn pink and eventually turn colourless when completely.

About 260 mg of dye (2, 6-dichlorophenol indophenols), 210 mg of NaHCO3, 100 ml of distilled water, and a 3% solution of metaphosphoric acid are required to create dye solutions.

15/7.5 mg of metaphosphoric acid and 40/20 ml od glacial acetic acid dilutions are used to create a 500/250 ml Metaphosphoric Acid Solution (3%) solution. Additionally, 50/25 mg of crystalline ascorbic acid was dissolved to create standard ascorbic acid solution in a mixture of 500 ml/250 ml metaphosphoric acid.

Procedure

The burette contained a dye solution. A conical flask was then filled with 5 ml of Vitamin C solution. The dye was added drop by drop while the conical flask was positioned beneath the burette. A pink tinge that initially developed, remained for 20 seconds, then vanished signified the end of the titration. At least three separate readings were conducted. The ascorbic acid solution underwent the same treatment, but at an undetermined concentration. The outcome was represented using milligrams percentages (mg%).

3.5.5 Moisture content

Moisture measurement is one of the most important and often used metrics in the production and testing of food items. Since the amount of dry matter in a seving of food is inversely related to the amount of moisture it contains , the moisture content is directly relevant economically for both the processor and the consumer. The impact of moisture on the consistency and the quality of food, however, is significantly more significant. The Association of official Analytical chemists (AOAC, 2016) has standardized a method for calculating moisture content. Following is how the percentage of moisture was computed.

$$\text{Moisture\%}=\frac{\text{Initial weight}-\text{Final weight}}{\text{sample weight}}\times 100$$

3.5.6 Total solids

The total solids was calculated using AOAC (2016) methodology. The information gathered during the measurement of moisture was used to calculate the percentage of the total solid content.

$$\text{\% Total solids} = 100 - \text{\%moisture content}$$

3.5.7 Ash content

The ash content was estimated via AOAC (2016) procedures. Ash is an inorganic residue that remains after organic stuff is destroyed. 10 g of dried jam were placed in a weighted, pre-dried crucible. Then it was used to make charcoal. The charcoal was then placed in a muffle furnace and burned for the following four hours at a temperature of roughly 600°C until it was entirely consumed. Then the crucible was removed from the furnace. Carefully cool it un a desiccator before weighing it. The equation used to calculate the ash content is listed below.

$$\text{Ash \%}= \frac{\text{The amount of the ash supplied sample X 100}}{\text{sample weight}}$$

3.5.8 Estimation of crude fat

Food samples may be dissolved in organic solvents like chloroform or methanol to measure the fat content. The various components can then be separated from the filtrate by filtering. The filtrate is divided into various funnels, the mixture is dried, and the estimated fat content is then computed to determine how much extract is needed. The crude fat content of the samples was determined using a Soxhlet device in accordance with AOAC (2016) recommendations. The crude fat percentage was expressed using the formula below

$$\text{Fat\%} = \frac{\text{Weight of the extract}}{\text{Weight of the sample}} \times 100$$

3.5.9 Estimation of crude protein

Using the Kjeldahl method, the nitrogen content of both organic and inorganic materials is determined. Kjeldahl nitrogen testing is used to identify the protein level of foods, beverages, meat, feeds, cereals and forages .The Kjeldahl method is also used to estimate nitrogen levels in wastewater, soils, and other materials. It is an acceptable approach that is mentioned in various normative documents, such as AOAC (2016). The type of receiving solution used and any dilution variables used during the distillation process must be taken into consideration when calculating the percentages of nitrogen or protein. The symbol "N" in the equations below stands for normalcy. When the receiving solution is standard acid, "ml blank" refers to the ml of base required to back titrate reagent blank; when the receiving solution is boric acid, it refers to the ml of standard acid required to titrate a reagent blank. Equation for utilizing boric acid to create a solution is:

$$\text{Nitrogen \%} = \frac{(\text{ml Standard acid} - \text{ml blank}) \text{x N of acid x} 1.4007}{\text{Wt of sample in gram}}$$

3.5.10 Estimation of crude fiber

The main components of "crude fibre," or the water-insoluble portion of carbohydrates, are cellulose, hemicellulose and lignin. By first boiling a known quantity of fat-free food in a weak acid solution (1.25% H2SO4) for 30 minutes, it can be calculated during digestion. Then, boil it at a constant volume for 30 minutes in a weak alkali solution (1.25% NaOH). Lastly, subtract the ash from the resulting residue. The AOAC (2016) technique was used to identify the crude fibre. The leftover material was then heated to 550–600°C (white ash) by being burned for 4-6 hours in a muffle furnace. The following formula is used to compute crude fibre percentage:

$$\text{\% Crude fiber} = \left(\frac{W - W_1}{W_2} \right) \times 100$$

Where,

W = Weight of the crucible, raw fibre, and ash is equal to W.

W1 = Weight of the crucible and the ash

W2 = Sample weight

3.5.11 Determination of total carbohydrate

The overall percentage of carbs was estimated using Edeogu et al.'s (2007) distinguishing technique. Calculating the amount of readily available carbs involves subtracting the sum of the values for moisture ,ash, protein and fat (per 100 g) from 100. In order to estimate it, the following formula was used:

$$\% \text{ CHO} = 100 - (\text{Protein} + \text{Fat} + \text{Ash} + \text{Moisture content})$$

3.6 Estimation of energy

The energy content of ice apple was calculated using the following equation and the amounts of protein ,fat and carbs in each type of food.

Energy= (Protein x 4.1) + (Fat x 9.2) + (Carbohydrate x 4.1)

3.7 Microbiological analysis

3.7.1 Aerobic plate count (bacterial plate count)

The number of aerobic plates on a sample can be used to estimate its bacterial population. APC is also known as the Aerobic Colony Count (ACC), Mesophilic Count, Standard Plate Count (SPC), and Total Plate Count (TPC). Using the Standard Plate Count (SPC) method, the total number of live bacteria was counted. The premise of the test is that every cell would manifest as a visible colony when combined with nutrient-rich agar. It is not a comprehensive count of bacteria; rather, it is a general test for organisms that thrive aerobically at mesophilic temperatures (25 to 40°C). APC is unable to distinguish between the several microorganisms employed to assess organoleptic acceptability, good manufacturing practises compliance, sanitary quality, or safety.

Sample preparation and dilution

The validity of the analysis and the interpretation of the results are significantly influenced by the accuracy with which the sample was gathered. The sample must be a true representation of the entire bulk. The product was thoroughly mixed for this reason in order for the sample to appropriately represent the entire mass of the

products. 25 g of this well-combined ice apple jelly were added to a 250 ml flask. The sample was diluted using phosphate buffer saline (0.6 ml KH2PO4 which has a pH of 7.2). Buffer saline was added, and by swaying the beaker back and forth, it was thoroughly mixed. The identical buffer water was used to fill the volume. Each piece of equipment, solution, or other object must be heated to 121°C for 15 minutes in order to be sterilized. After being diluted 10 times, or 110-1 times, the resultant sample was then used as a stock solution. The following dilutions were made using 9 ml blanks. First, a 1/10 dilution was created (1 ml in 9 ml) (a). This was mixed with a vortex mixer (b). 1 ml was taken from (a), added to the following tube, and thoroughly mixed. It was 10-2 times less concentrated. The dilution was increased to 10-6 times in this manner.

Typical plate counting, recording, and counting The number of microorganisms in the collected and conserved samples was calculated using an SPC, or standard plate count. This information could be applied as a food quality indicator or a predictor of product shelf life. The diluted substance was then pipetted into each of the sterile, empty petri dishes containing the nutrition ager(plate count agar) medium, at a rate of 1 ml per dish. The plates were swirled together on a flat surface. The plates were turned over and left to incubate for 24 hours at 37°C once the medium had solidified. The incubated plates were then chosen for counting after incubation depending on the quantity and ease of the bacterial colony count. The plate with the scattered, overlapping, and perplexing colonies was best avoided. We selected the plates with 30 to 250 countable, bright, and clear colonies. Colony forming units (cfu) per gramme or milliliter = average cfu plate times dilution factor The viable bacterial count was calculated using the sample preparation, sample dilution, standard plate counts, counting, and recording techniques. The incubator was kept at 37°C for 24 hours.

3.7.2 Fungal analysis in jelly

Procedure for preparation of media

The selective medium Sabouraud Dextrose Agar (SDA) is mostly used for the isolation of dermatophytes, different fungi, and yeasts. It can support the growth of filamentous bacteria like Nocardia. The pH of this medium is acidic (about 5.0), which inhibits the growth of bacteria but promotes the development of yeasts and the majority of filamentous fungi. Antibacterial agents may be used to boost the

antibacterial effect. The SDA medium, which provides fungi and yeasts with a healthy source of amino acids and nitrogenous compounds, is composed of enzyme-digested casein and animal tissues. 10 g of Mycological peptone , an enzyme digest of casein and animal tissues , 40 g of Dextrose , and 15 g of pH-5.6 agar are added to 1 liter of SDA medium are used at 25°C. Following their preparation in accordance with the manufacturer's instructions, all of the media were sterilized in the autoclave for 15 minutes at 121 °C. Different selective agars are available for the formation and identification of mold and yeast cultures, however the majority of them do not have strict nutritional requirements for growth. Numerous fungus strains can grow on Sabouraud Dextrose Agar. About 65 gm of the medium were initially dissolved in 1 liter of distilled water. The medium was then thoroughly dissolved by cooking for one minute at a high temperature while stirring regularly. 15 minutes in an autoclave set at 121 °C. Following a 45° to 50°C cooling period, the mixture was then transferred to petri dishes. Using a sterile inoculating loop, the sample was streaked over the medium to create isolated colonies, which were then used to process the sample. After that, the plates were placed upside-down (agar side up) in an incubator set at 25 to 30 °C with a high humidity level. Weekly examinations for fungal development were made on the cultures, which were kept for four to six weeks before being judged to be negative.

Interpretation

Following sample incubation, the plates should show single colonies in streaked areas and confluent development in areas of forceful injection. Look for fungus colonies on plates that are the right color and shape. The outcomes should be confirmed using further methods. Yeast colonies develop in shades ranging from cream to white. Molds will develop into colonies of colorful filaments.

3.8 Cost analysis

The price of the jelly was determined using the total cost of the ingredients used to make it, which included ice apple fruit, honey ,date. The quantity, which was stated in taka, was determined using the jelly's per-kg cost.

3.9 Sensory evaluation

Sensory evaluation was done to see if consumers would find the finished product to be generally satisfactory. The acceptance of the manufactured good by consumers was assessed by a panel of tasters. Both faculty and students from the university participated in the panel test, which was held on the CVASU campus. The fifteen members of the panel received the ice apple jelly product that was produced. The five encoded formulas were sample A, sample B, sample C, sample D, sample E. The panelists tasted each of the five samples without being aware of their composition. The panelists were asked to assign a score to each of the sensory qualities of the jelly, including its look, color, flavor, texture, taste, sweetness, and general acceptability. Even though it is obvious that this technique does not reflect genuine customer perception, it makes evident the traits that a high-quality product should possess. According to their assessment, they chose four items at random and gave each one a score. Hedonic nine-point ratings were used to determine how well the five samples measured up in terms of taste, mouth feel, appearance, flavor, and acceptability. The scale was made in order to:

Table 3.2: Rating scale foe sensory evaluation

Ranks	Scores
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

3.10 Statistical analysis

In order to evaluate statistical analysis, data were gathered and entered into a Microsoft Excel 2013 spread sheet. Every sample was used three times. Descriptive statistics (mean and standard deviation) were used to analyse the ice apple jelly. It's nearly composition, phytochemicals, antioxidant potential, and sensory evaluation. Minitab 19.0 software was used to calculate the statistics. Using a one-way analysis of variance (ANOVA) on the acquired data , the amount of variation that is statistically significant at a95% confidence level was determined. Using a post hoc "Tukey" test, the variance difference between the sample groups was estimated. At a significance threshold of 5% ($P<0.05$), the statistical analysis was conducted.

CHAPTER 4: RESULT

4.1 Physiochemical properties of jelly

Jelly's pH is an important element of the optimum gel state. Sample D has the highest pH (3.03 ± 0.02^{a}), while sample B has the lowest pH (2.93 ± 0.02^{b}) in table 4.1. The maximum TSS was found in sample E (67 degree brix), while the lowest TSS was found in sample A (61 degree brix). The highest acidity value (1.63 ± 0.02^{a}) was also found in sample C, while the lowest value (0.64 ± 0.02^{c}) was found in sample A.

Table 4.1: Physicochemical properties of ice apple jelly

Components	Formulations of ice apple jelly				
	Sample A	**Sample B**	**Sample C**	**Sample D**	**Sample E**
pH	2.93 ± 0.02^{b}	3.00 ± 0.02^{a}	3.01 ± 0.02^{a}	3.03 ± 0.02^{a}	3.02 ± 0.02^{a}
TSS(^{0}B)	61 ± 0.5^{c}	65 ± 0.5^{b}	62 ± 0.5^{c}	66 ± 0.5^{b}	67 ± 0.5^{a}
Acidity(%)	0.64 ± 0.02^{c}	0.60 ± 0.02^{c}	1.63 ± 0.02^{a}	1.03 ± 0.02^{b}	1.01 ± 0.02^{b}

Data are expressed as Means ± SD, different letter (a, b, c, d) indicates statistically different ($p<0.05$)

In the table,

Sample A- jelly made from ice apple with sugar

Sample B- jelly made just from ice apple with 50% honey

Sample C- jelly made just from ice apple with 33% honey

Sample D- jelly made just from ice apple with 50% date

Sample E- jelly made just from ice apple with 33% date

4.2 Nutritional composition

The nutritional value of ice apple jelly is listed in Table 4.2; nevertheless, practically all samples differed greatly. Sample D included the highest levels of crude protein (2.33 ± 0.02^{a}), crude fat (2.01 ± 0.01^{a}), crude fiber (2.92 ± 0.01^{a}), and crude fat (2.01 ± 0.01^{a}). Sample A had the lowest concentrations of crude fiber (0.64 ± 0.01^{e}), crude fat (0.31±0.01e), and crude protein (1.21 ± 0.02^{e}).

Table 4.2: Nutritional composition of ice apple jelly

Parameters (%)	Sample A	Sample B	Sample C	Sample D	Sample E	P value
Dry matter	71.96 ± 0.01^{a}	68.87 ± 0.01^{c}	69.29 ± 0.01^{b}	66.20 ± 0.01^{d}	65.21 ± 0.01^{e}	0.001
Moisture	28.04 ± 0.01^{e}	31.13 ± 0.01^{c}	30.71 ± 0.01^{d}	33.80 ± 0.01^{b}	34.79 ± 0.01^{a}	0.001
Crude Fiber	0.64 ± 0.01^{e}	1.30 ± 0.01^{c}	1.11 ± 0.01^{d}	2.92 ± 0.01^{a}	2.62 ± 0.01^{b}	0.001
Ash	0.65 ± 0.01^{e}	0.81 ± 0.01^{c}	0.72 ± 0.01^{d}	1.89 ± 0.01^{a}	1.63 ± 0.01^{b}	0.001
Fat	0.31 ± 0.01^{e}	0.92 ± 0.01^{c}	0.66 ± 0.01^{d}	2.01 ± 0.01^{a}	1.67 ± 0.01^{b}	0.001
Protein	1.21 ± 0.02^{e}	1.98 ± 0.02^{c}	1.87 ± 0.02^{d}	2.33 ± 0.02^{a}	2.25 ± 0.02^{b}	0.001
Carbohydrate	69.79 ± 0.01^{a}	65.16 ± 0.01^{c}	66.04 ± 0.01^{b}	59.97 ± 0.01^{d}	59.66 ± 0.01^{e}	0.001

Data are expressed as Means ± SD, different letter (a, b, c, d) indicates statistically different ($p<0.05$)

4.3 Energy content

Figure 4.1 shows that sample A had the highest energy content (293.95 kcal/100 g), whereas sample E had the lowest energy content (269.2 kcal/100 g).

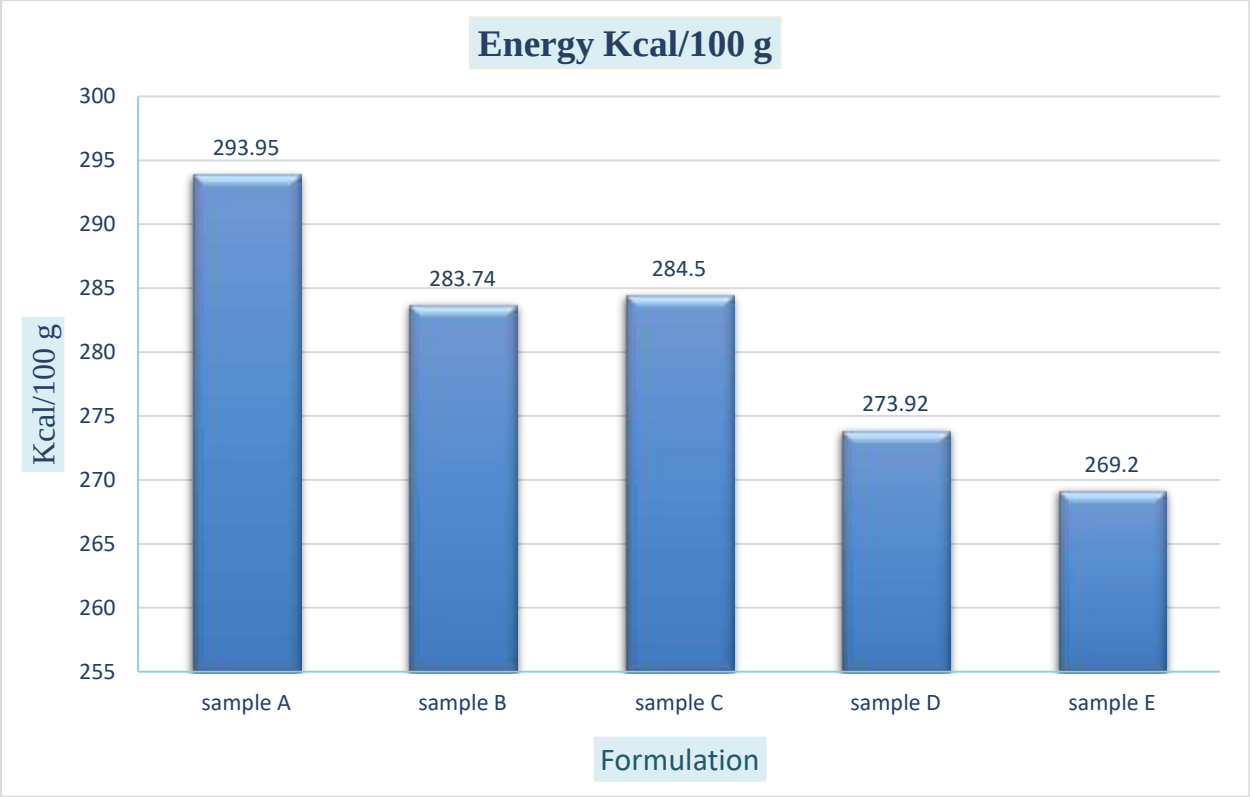

Figure 4.1: Comparison of Energy content among five sample of ice apple jelly

4.4 Micronutrient composition of ice apple jelly:

The nutritional information for frozen apple jelly is shown in Table 4.3; practically all samples differed greatly. Sample E had the highest concentration of vitamin C (25.97 ± 0.01^{a}), while samples D and E had the highest concentrations of calcium (32.46 ± 0.02^{a}) and iron (9.77 ± 0.02^{a}), respectively.

Table 4.3: Micronutrient composition of ice apple jelly

Components (mg/100)	Formulations of ice apple jelly					1-ANOVA (p value)
	Sample A	Sample B	Sample C	Sample D	Sample E	
Vitamin C	21.01 ± 0.01^{e}	22.92 ± 0.02^{d}	25.22 ± 0.02^{b}	23.74 ± 0.02^{c}	25.97 ± 0.01^{a}	0.017
Iron	1.97 ± 0.03^{e}	2.59 ± 0.01^{d}	2.75 ± 0.02^{c}	9.77 ± 0.02^{a}	7.75 ± 0.01^{b}	0.018
Calcium	26.26 ± 0.04^{e}	28.66 ± 0.02^{d}	31.53 ± 0.03^{b}	29.67 ± 0.02^{c}	32.46 ± 0.02^{a}	0.027

Data are expressed as Means ± SD, different letter (a, b, c, d) indicates statistically different ($p<0.05$)

4.5 Microbial analysis

From 0 to 15 days after the manufacture of the jelly, the total viable count and fungal count were calculated, as shown in Table 4.5. Jam samples were maintained at 4°C for 15 days as part of the evaluation. Mould and yeast were not present when the items were manufactured, and after 15 days, there was no sign of either.

Additionally, each sample contains the identical amounts of pectin, citric acid, honey, dates, sugar, and honey.

Table 4.4: Microbiological evaluation of ice apple jelly

Formulations of ice apple jelly	TVC(CFU/mL)		Mold and Yeast	
	0 day	15 days	0 days	15 days
Sample A	Not found	0.4×10^{1}	No growth	No growth
Sample B	Not found	1.0×10^{2}	No growth	No growth
Sample C	Not found	0.9×10^{2}	No growth	No growth
Sample D	Not found	1.6×10^{3}	No growth	No growth
Sample E	Not found	1.1×10^{3}	No growth	No growth

Data are expressed as Means ± SD, different letter (a, b, c, d) indicates statistically different ($p<0.05$)

4.6 Cost analysis

Table 4.5: Production cost of ice apple jelly

Heads	**Tk/kg**	**Quantity used g/Kg product**	**Total Tk. For sample A**	**Total Tk. For sample B**	**Total Tk. For sample C**	**Total Tk. For sample D**	**Total Tk. For sample E**
(1)Expenditure Raw material of ice apple paste	120	1111	35.47	38.69	42.57	40.06	43.83
Sugar	135	164.15	22.16	0	0	0	0
Honey	900	208.94	0	99.38	88.67	0	0
Date	450	208.62	0	0	0	54.82	39.06
Pectin	18000	24.43	88.38	88.56	87.12	86.94	88.74
Citric Acid	1000	12	2.4	2.4	2.4	2.4	2.4
Sub total			148.41	229.03	220.77	184.22	174.03
(2) processing cost @15% of raw material			22.26	34.35	33.12	27.63	26.10
(3) Bottling cost 2 piece		15Tk/piece	30	30	30	30	30
(4) Total production cost of ice apple jelly			200.67	293.38	283.89	241.85	230.13

This recipe may be used to make 1.11 kg of jelly.

The cost of jelly for per kg jelly, therefore, is,

Sample A = 200.67Taka

Sample B=293.38Taka

Sample C=283.89Taka

Sample D=241.85Taka

Sample E=230.13 Taka

4.7 Sensory evaluation

Sample C has the highest (8.80±0.42) acceptance rate for all criterion. Sample E, in contrast to the other samples, had the lowest grade for acceptance. Table 4.7: Ice, apple, and jelly were evaluated using the hedonic rating test.

Table 4.6: Hedonic rating test for sensory evaluation of ice apple jelly

Parameters	**Formulations of sample**					**1-ANOVA (P value)**
	Sample A	**Sample B**	**Sample C**	**Sample D**	**Sample E**	
Taste	7.00 ± 0.67^{b}	7.30 ± 0.48^{b}	8.50 ± 0.53^{a}	4.50 ± 0.53^{c}	4.00 ± 0.67^{c}	0.579
Sweetness	6.90 ± 1.10^{b}	7.40 ± 0.52^{b}	8.70 ± 0.48^{a}	4.40 ± 0.70^{d}	5.60 ± 0.52^{c}	0.702
Mouth feel	6.20 ± 0.63^{c}	7.80 ± 0.42^{b}	8.60 ± 0.52^{a}	5.60 ± 0.52^{c}	5.60 ± 0.52^{c}	0.525
Flavor	7.30 ± 0.67^{b}	7.70 ± 0.48^{b}	8.20 ± 0.42^{a}	4.00 ± 0.94^{c}	3.30 ± 0.67^{c}	0.665
Appearance	6.10 ± 0.57^{b}	8.40 ± 0.52^{b}	8.80 ± 0.42^{a}	5.60 ± 0.52^{d}	6.40 ± 0.52^{c}	0.510
Overall acceptability	6.70 ± 0.48^{c}	7.70 ± 0.48^{b}	8.80 ± 0.42^{a}	4.40 ± 0.52^{d}	3.20 ± 1.03^{e}	0.629

Data are expressed as Means ± SD, different letter (a, b, c, d) indicates statistically different ($p<0.05$)

CHAPTER 5: DISCUSSIONS

5.1 Physicochemical properties of ice apple jelly

The pH of the jelly must be considered for the best gel quality (Devanand, 2003). Additionally, low pH in food prevents the growth of germs (Rajendran, 2008). Samples D had a higher pH value (3.03±0.02), whereas Sample B had the lowest value (2.93±0.02).

A lack of acid is one of the most prevalent reasons for jelly failure. Once the jelly has been concentrated sufficiently to pour, the pH level needs to be determined. Citric acid should be used to decrease the pH to a range of 3.0 to 3.4. In the presence of a lot of sugar, citric acid can create a viscous semi-solid with a pH of 3.2 to 3.4. The pH may be better managed and the amount of pre-gelling and pectin hydrolysis in the batch may be decreased by adding the citric acid towards the end of the boiling process. Depending on the extract's natural acidity and capacity for buffering, different extracts require varying amounts of added acid. The pH can be changed to obtain the best flavour, regulate or alter the rate of setting, and alter the intensity of sugar inversion.

In this study, testing on ice apple jelly produced TSS values of 0.61 and 0.67. The TSS of fruit jelly was found to be close to 0.69, which suggests that the hydrolysis of polysaccharides is what increased it.

5.2 Nutritional composition

To provide the necessary nutrients, such as protein, fat, fibre, CHO, and vitamins and minerals, pectin and sugar are added with the icy apple paste for manufacturing jelly. The proximate makeup of five different jelly types was displayed in table 4.2. Sample E has more moisture than control sample A, whereas sample B has less moisture.

A significant impact of moisture on the freshness and shelf life of products. High moisture food products have a low shelf life. The approximate composition of jelly is shown in Table 4.2. The table shows that the moisture content of the control samples is higher than that of the other samples made with pectin that has been removed. It's possible that sugar, which lowers moisture content and prevents the growth of germs that ruin food, is the cause of the comparatively low moisture level found in samples A and C. Comparing Sample B to Sample D and E, the moisture content is greater. It might be because honey acts in low humidity as a hydrophilic material. Since the

sample has less moisture than the sample with honey, it will have a longer shelf life when stored in the same manner. High levels of fat, protein, and fibre in sample D.

The D sample showed the highest levels of crude fibre (2.92±0.01%), ash (1.89±0.01%), crude protein (2.33±0.02%), and crude fat (2.01±0.01%) when compared to the control sample. Sample A had the largest amount of carbs (69.79±0.01%), in contrast. It's likely that adding fruit sugar or commercial pectin drastically changed the nutritional profile of jam. Pectin is a kind of polysaccharide that enhances the CHO profile of a product (Mualikrishna, 1994). The amount of ash in food products reflects the minerals that are present.

5.3 Micronutrient composition

Ascorbic acid, or vitamin C The existence of life depends on ascorbic acid. The maximum concentration of vitamin C was found in sample E (25.97±0.01 mg/100 g), which was greater than samples A, B, C, and D. Another element that contributes to the fruit's strong antioxidant capacity is its high vitamin C concentration, a potent antioxidant that helps the body fight off harmful free radicals. Numerous studies have provided evidence in favour of the idea that adding additives like sugar may reduce the antioxidant content in the final product and that heat during cooking reduces the antioxidant level (Rajashekhara, 2000). Nevertheless, after being transformed into jelly, they only retain 65% of their antioxidant value.

5.4 Microbial analysis

Microbiological tests (total viable count, yeast, and mould count) were done on each of the five samples of frozen apple jelly. There was no yeast or mould in the ice apple jelly that was shown in Table 4.5.Mould is an aerobic organism that cannot survive in low-oxygen settings. However, yeast has the ability to thrive both aerobically and anaerobically (Sakai, 1993). There are a number of different acid/alkaline requirements for yeast and mould growth in a variety of food products, ranging from pH 2 to above pH 9. Because the jelly was kept in airtight bottles, mould and yeast growth was prevented.

The use of extremely high heat during the production of jelly, along with the product’s high pH and sugar content, may result in a reduction in the number of microorganisms discovered in the finished product.

Ice apple jelly had a total viable count that was not found. After 15 days of storage at a low temperature of 8 °C, the bacterial count rose and ranged from ($0.4x10^1$ cfu/ml) to ($1.1x10^3$ cfu/ml).

5.5 Sensory evaluation

Ice apple jelly underwent sensory analysis to discover which jelly had the highest organoleptically pleasant percentage. Data from Table 4.8 sensory analysis demonstrate that at the 5% ($P<0.05$) level of significance, differences in taste, flavour, appearances, mouth feel, sweetness, and general acceptance were determined to be statistically insignificant. Nevertheless, sample C (a jelly produced with 50% honey) had the highest overall approval score (8.80±0.42). Perhaps it's the taste, flavour, or appearance. The flavour and consistency of the jelly might also vary depending on the individual. The lowest (3.201.03) hedonic score was seen in sample E when compared to control sample A, which included 33% date puree. It could be the date's enhanced sweetness, diminished flavour, or outside appearance. This jelly loses its acceptability in terms of appearance and sweetness due to sweetness and a higher moisture content.

CHAPTER 6: CONCLUSION

The study was divided into five sections: jelly preparation and nutritional value assessment, shelf life study, jelly sensory evaluation, and production cost analysis. Its distinctive flavour and nutritional benefits make it a terrific choice for anyone looking to discover something new and exciting. This study determined that honey-based frozen apple jelly had the highest sensory perception acceptance. In addition to being high in carbs, frozen apple jelly was found through proximate analysis to be a trustworthy supply of protein, fat, and vitamins. Since it wasn't offered in the nearby markets, commercial ice apple jelly wasn't sampled in the current inquiry. In order to increase nutritional status, it was found that the nutritional values were good. This method can be used by the consumer because making jelly is economic and easy. For the benefit of Bangladeshi growers, processors, and consumers, this study offers a potential technique for turning ice apples into jelly. It can be demonstrated that exporting jelly of the highest caliber and in compliance with international standards may lead to the creation of foreign currency, which is beneficial for Bangladesh's national economy.

CHAPTER 7: RECOMMENDATIONS AND FUTURE PERSPECTIVE

Currently, malnutrition affects more than half of the population in our country. Ice apple jelly may be an excellent source of nutrients and energy in this situation as they are widespread in rural Bangladesh. Additionally, this has increased its marketability and monetary value. The method employed in medium- and large-scale production may be used by contemporary food businesses. These investigations successfully concluded with positive results in the emerging field of creating new technologies for fruit value addition. Additionally, it improved its marketability and acceptability. Following are the study's recommendations:

- To avoid microbial contamination, the sample should be collected in a clean sampling bag and stored in the freezer.
- Overripe fruit peel should not be used.
- The pH range for hydrolyzing peel should be 1.2-2.6.
- Jelly formation shouldn't result in foam creation.

Future perspectives include the following:

- Seasonally available fruits can be used in this way; Fruit waste won't harm the environment. It will lessen the amount of waste produced by the processing industries.
- Low-cost extraction method.
- New jelly variety
- Appropriate actions should be taken to improve the nutritional value of jelly that is supplied commercially.
- It is necessary to take the required actions to improve jelly that is sold commercially.

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Appendix A: Questionnaire for Hedonic test of ice apple jelly

Name of the Taster: ..... **Date: ...**

Please taste these samples and check how much you like or dislike each one on four sensory attributes such as color, flavor, texture and overall acceptability. Use the appropriate scale to show your attitude by checking at the point that best describe your sense and feeling about the sample please give a reason for this attribute. Remember you are the only one who can tell what you like. An honest expression of your personal feeling will help us. For Taste/Flavor/Mouth feel/Appearance/Overall Acceptability.

The scale is arranged such that; 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, and Dislike extremely =1.

Here,
Sample A-jelly made just from ice apple with sugar.
Sample B-jelly made just from ice apple with 50% honey.
Sample C-jelly made just from ice apple with 33% honey.
Sample D-jelly made just from ice apple with 50% date.
Sample E-jelly made just from ice apple with 33% date.

Appendix B:

Hedonic	Taste					Flavor					Mouth feel					Sweetness					Appearance				Overall acceptability					
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Like extremely																														
Like very much																														
Like moderately																														
Like slightly																														
Neither like or dislike																														
Dislike slightly																														
Dislike moderately																														
Dislike very much																														
Comments																														

Appendix C: Photo Gallery

Separating pulp from ice apple fruit

ice apple paste

Boiling of ice apple jelly

Boiling of ice apple jelly

Ice apple jelly

Ice apple jelly using different type of sweetener

pH determination

Acidity determination

Crude fiber determination

Protein determination

Fat determination

Sensory evaluation

Ice apple jelly sample (Honey 50%, Honey 33%, Date 50% and Date 33% respectively)

Brief Biography

Maimuna jahangir passed the Secondary School Certificate Examination in 2013 from Aparna Charan City Corporation Girls High School and college, Chattogram and then Higher Secondary Certificate Examination in 2015 from Govt. Women College, Chattogram. She obtained her B.Sc. (Honors) in Food Science and Technology from the Faculty of Food Science and Technology at Chattogram Veterinary and Animal Sciences University, Chattogram, Bangladesh. Now, she is a candidate for the degree of Master of Science in Applied Human Nutrition and Dietetics under the Department of Applied Food Science and Nutrition, Chattogram Veterinary and Animal Sciences University (CVASU). She has an immense interest to work in improving the health status of people through proper guidance and suggestions and to create awareness among people about food safety and nutrition.