DEVELOPMENT OF GUAVA-STRAWBERRY JELLY AND ANALYSIS OF ITS PHYSICO CHEMICAL PROPERTIES AND BIOACTIVE COMPOUND

Abdullah Al Noman

Roll No.: 0119/02

Registration No: 652

Session: 2019-2020

A thesis submitted in the partial fulfillment of the requirements for the degree of Master of Science in Food Chemistry and Quality Assurance

Department of Applied Chemistry and Chemical Technology

Faculty of Food Science and Technology

Chattogram Veterinary and Animal Sciences University

Chattogram-4225, Bangladesh

June 2022

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Supervisor	**Chairman of the Examination Committee**
Md. Fahad Bin Quader	**Dr. Shamsul Morshed**
Associate Professor	Associate Professor
Department of Applied Chemistry	Department of Applied Chemistry
& Chemical Technology	& Chemical Technology

Department of Applied Chemistry & Chemical Technology
Faculty of Food Science and Technology
Chattogram Veterinary and Animal Sciences University
Chattogram-4225, Bangladesh

June 2022

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June 2022

Table of Contents

List of Tables

List of Figures

Abbreviations

G	: Gram
°C	: Degree Celsius
°B	: Degree Brix
CHO	: Carbohydrate
et al	: Et alii/ et aliae/ et alia
Mg	: Milligram
%	: Percentage
MC	: Moisture Content
TSS	: Total Soluble Solids
TA	: Titratable Acidity
AOAC	: Association of Official Analytical Chemists
ANOVA	: Analysis of variance
GAE	: Gallic acid equivalent
TE	: Trolox equivalent
Abs	: Absorbance
Cal	: Calorie

ABSTRACT

The purpose of the study was to create laboratory-made Guava strawberry jelly. The research was conducted to compare with developed and commercially available jelly of physicochemical properties, antioxidant capacity, sensory evaluation, nutritional composition, bioactive compound & the comparison is noticeable. The guavas and strawberries utilized in this experiment were all fresh and fully ripe. To boost the acid concentration of the guava and strawberry juices, citric acid was added to the jelly process. The level of significance at $P \leq 0.05$ was determined using one-way analysis of variance (ANOVA). The antioxidant capacity was found from 1.988 to 3.819 mg TE/100gm. Sample A had the highest antioxidant capacity & commercial jelly was the lowest. Total polyphenol content ranged from 6.233 to 12.166 mg GAE/100ml. The highest total polyphenol content was in sample A, whereas commercial jelly had lowest TPC. TFC content varied from commercial jelly (1.119 mg QE/100g) to sample A (1.54 mg QE/100g). Sample A had the lowest moisture content (29.46%). Highest protein percentage was found in sample A (0.85%). Sample A had ash content of (0.37%), which was the highest. Vitamin C content in the formulated jellies were found ranging from 4.6-10.80 mg%, whereas lowest vitamin C content (4.6%) was found in commercial jelly. In sensory evaluation, sample A got the highest score by panelist among all samples according to 9 Point hedonic scale. This study revealed that the developed jelly is a great resource of bioactive compound, Vitamin C & Antioxidant activity with high nutritious value. The cost of the developed jelly can be affordable to the consumer. The manufacturing process of developed jelly was also easy & convenient which is favorable for commercialization of the product.

Keywords: Jelly, formulation, bioactive compounds, antioxidants etc

CHAPTER 1: INTRODUCTION

The guava (*Psidium gujava*), a significant fruit of the Myrtaceae family, holds a prominent position among the fruit trees and is cultivated all over the world. All around the world, it is frequently utilized in traditional medicine and gastronomy. One of the most popular and significant fruits in Bangladesh is the guava. It asserts to be, after mango, the most significant fruit in terms of production and area (Hossen et al., 2009). In Bangladesh, guava trees cover roughly 0.15 million hectares and yield 1.80 million tonnes of fruit (Mitra et al., 2007).

Guavas contain pectin, which is used to make jams and jellies, and are an excellent source of vitamin C (260 mg/100g of fruit) (Jolhe et al., 2020). The minerals calcium and phosphorus are also abundant in guava. The nutritional composition varies on the cultivation, stage of maturity and season. It contains 84.2 percent water, 9.68 percent total soluble solids, 0.50 percent ash, 4.45 percent reducing sugar, 5.23 percent nonreducing sugar, 1.25 percent acid, and 560 mg/100g vitamin C. Everyone is familiar with guava jelly, which may be converted into fruit butter or caned in sugar syrup. Guava juice is up to five times more vitamin C than fresh orange juice (Boonpangrak et al., 2016). The leaves are also used for dyeing and tinning in various nations in addition to treating diarrhea.

(i) Guavas are an excellent source of fiber, carbs, proteins, iron, calcium, and phosphorus. Guavas also have trace levels of phosphate and calcium.

(ii) They are a fantastic source of lycopene, vitamin C, and antioxidants, all of which are beneficial to the skin.

(iii) Manganese, which is abundant in guavas, aids in the body's absorption of other essential minerals from the food we eat. The mineral folate, which aids in promoting reproduction, is found in guavas.

The hybrid strawberry plant belongs to the genus Fragaria. The fruit's flavor, color, and perfume are all praised. The fruit has a lot of pectin (0.55 percent), which is perfect for making jelly since it comes in the form of calcium pectate. Vitamins A (60 IU/100g) and C (30–120 mg/100g) are abundant in the fruit (Mitra et al., 2001). A diet rich in fruits and vegetables is frequently linked to a decreased prevalence of many chronic pathologies, such as obesity, infections, cardiovascular and neurologic disorders, and cancer, according to Gonzalez-Castejón and Rodriguez-Casado (2011), Aune (2019), Furman et al. (2019), and others. Strawberries are one of the most important fruits because of their abundant phytochemical content. Fresh strawberries or strawberries in processed forms like jams, juices, and jellies are also often consumed. They are also important from an economic and commercial standpoint (POP et al., 2013; Curi et al., 2016). It should be justified to use processing and preventative methods at both the farmer and industrial scales to stop the seasonal fruit excess from being lost. Such initiatives will aid in the growth of processing industries in the nations' developing regions.

The majority of synthetic beverages and certain confectionary goods that are consumed everyday pale in comparison to jelly's ease of digestion, deliciousness, and better nutritional value (Bogha et al., 2020). To make jelly, a translucent food with a semisolid consistency, the strained juice or aqueous extracts of one or more fruits are mixed with foods that have sweetening properties, with or without the inclusion of water (Bogha et al., 2020). While being soft enough to spread, jelly should maintain its form. Processing fruits and vegetables to make jelly and other valuable goods is one method to use the plentiful produce to cut down on waste and provide the farmer a profit. Guavas, grapes, strawberries, apples, mangos, pineapple, and other fruits are frequently used to make jelly.

Crushing fruit and removing the firm, chunky remnants yields jelly, which has the smoothest consistency (Krissoff, 2016). The only thing left is the fruit smash, which is combined with pectin and cooked to create the gelatinous spread containing 65% sugar. Increases in titratable acidity, reducing sugars, and total sugar were seen in the jelly TSS storage research, whereas small decreases in moisture content, vitamin C content, and organoleptic quality were observed with longer storage times (Rahman and Moshiur, 2018). Pectin, sugar, and acid are the three major ingredients needed to make jellies, and they must be added in the right amounts to ensure optimal gel formation (Srivastava and Malviya, 2011). Jelly uses citric acid as a preservative. This weak organic acid, having the chemical formula $C_6H_8O_7$, gives food goods a sour flavor while also serving as a natural preservative (Mondhe et al., 2018). It functions as a flavoring agent, chelating agent, and acidifier (Park et al., 2022).

Due to its function as a gelling agent, pectin is necessary for the development of jelly because it forms a network when pectin chains unite (Sharma et al., 2006). The pH of the pectin, which is best between 2.8 and 3.2, affects the strength and efficiency of the side chains and, consequently, the bonds they create. Fruits and vegetables are crucial for human nourishment as well as for business. To get their full advantages, however, they must be processed into more stable forms like jams, jellies, and juice because they are seasonal and very perishable (Sinha et al., 2012). Jelly processing is one appealing and practical method of using fruit. This study was conducted to ascertain the physiochemical & proximate analysis, sensory assessment, and antioxidant and bioactive substances of jelly in order to get more useful data on this topic.

Aim and Objectives:

i) To develop the Guava strawberry jelly by using commercial pectin and adding more value to the products.

ii) To determine the physicochemical properties of formulated & commercially available jelly.

iii) To determine the proximate analysis, bioactive compounds, antioxidant capacity of jelly.

iv) To compare the overall acceptability of the developed product.

CHAPTER 2: REVIEW OF LITERATURE

2.1 Overview of Guava and Strawberry

Tropical guavas are cultivated in South America, Africa, and Asia. This fruit can adapt to many environmental conditions and is a native of tropical and subtropical regions (Nath et al., 2019). The Myrtaceae family includes guava. The tree is slender, smooth, and irregularly shaped with an average height of 10 meters. The round, stalked leaves have a length of 5–15 cm with strong pinnate veins. The blooms are little and unassuming, with pale petals that can reach a length of 2 cm and many stamens (Bapat et al., 2020). The edible mesocarp of the fruits is pink or white in color and has small spherical seeds within. They are round to ovoid, meaty, yellow, and have a diameter of around 5 cm. The flavor ranges from acidic to extremely sweet, with a scent that can be either somewhat agreeable or intensely unpleasant (Adsule and Kadam, 1995). Guava may be grown in a wide variety of soil types, from deep clay to fine sand, and in a pH range between 4.5 (acidic) to 8.5. (alkaline). The two most popular guava varieties are red (P. guajava 'Pomifera') and white (P. guajava 'Pyrifera'). The region of production and customer tastes influence the type of guava that is consumed.

Taxonomy of Guava

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Myrtales
Family: Myrtaceae
Genus: *Psidium*
Species: *P. guajava*
Binomial name: *Psidium guajava* L.

Numerous hybrid species that are frequently raised for their fruit make to the genus Fragaria, also known as the strawberry (Sudha et al., 2018). The fruit is well-known for its unusual aroma, vibrant red color, juicy texture, and sweetness. Foods like jam, juice, pies, ice cream, milkshakes, and chocolates, both fresh and prepared, are consumed in large quantities. A lot of items, including confectionery, soap, lip gloss, perfume, and many more, contain artificial strawberry flavorings and fragrances. When moved and stored, strawberries quickly lose their freshness. The alternative option for increasing shelf life and maintaining the flavor and juiciness of strawberries is freezing. The most typical initial raw material utilized in the production of strawberry juices, concentrates, and jams is frozen strawberries. Before freezing, strawberries can be given a pre-treatment by being mixed with dried sugar to increase their sugar content, lessen textural deterioration, and enhance color stability (Oszmiaski et al., 2009).

2.2 Nutritional properties

Fresh guava and strawberries have different nutritional profiles according to different studies, which is most likely due to the variety of plant kinds, genetic makeup, habitat, ecology, and harvesting conditions. It displays the guava's chemical make-up. Between cultivars, this varies. Proteins and fats make up the least amount of the guava fruit's composition, whereas the fruit's carbohydrate content accounts for little more than 14% of its weight. Compared to other common fruits like watermelon, fresh guava has a greater DF content with values for guava ranging from 5 to 54 percent (Li et al., 2002; Ramulu and Udayasekhara Rao, 2003). Guava contains DF, which has been shown to have a high concentration (48.55 to 49.42 percent) in the pulp and peel fractions (Jiménez-Escrig et al., 2001). According to Martnez et al. (2012), guava fruit has a DF value of 61.9 percent, with a soluble fraction of 11.1 percent and an insoluble fraction of 57.7 percent. The many vitamins included in guava are frequently highlighted, with special focus on vitamin C (ascorbic acid), vitamin A, thiamine, riboflavin, niacin, and pyridoxine. One piece of regular guava fruit (50 g) has almost four times as much vitamin C as an orange (Lim et al., 2007; Medina and Pagano, 2003).

2.3 Bioactive Compounds Present in Guava Fruit

It has been shown that some molecules, known as bioactive compounds (BCs), which make up a small fraction of food but are not considered nutrients, can improve health (Gua-Garca et al., 2022). The US National Institutes of Health describe bioactive food molecules as "constituents in meals or dietary supplements, other than those needed to meet fundamental human nutritional needs that are responsible for changes in health status." The most significant chemicals in this category are carotenoids and polyphenols (PPs). They have many health impacts and are abundant in fruits and vegetables (Tokuşoglu and Hall III, 2011).

2.3.1. Carotenoids

Plants naturally contain organic colours called carotenoids in their chromoplasts. Lutein, beta-carotene, and cryptoxanthin are among the carotenoids found in guava fruit, according to Table 53.2. (Mercadante et al., 1999). Guava is a top source of carotenoids, which are a precursor to vitamin A, according to (Setiawan et al., 2001). However, there isn't much information available regarding the carotenoids in guava, therefore there is need for more research in this area.

2.3.2. Polyphenols

Polyphenols have been shown to be abundant in tropical fruits like guava (PPs). According to research, guava has a PP content of 5480 mg gallic acid equivalents per 100 g dry weight (dw) (Mahattanatawee et al., 2006). Guavin B, a compound exclusive to guavas, was found by (Vijaya Anand et al., 2020). Guava fruits also contain considerable levels of quercetin, myricetin, apigenin, ellagic and gallic acids, and anthocyanins (Miean et al., 2001). (Misra and Seshadri, 1968). Ellagic acid occurs naturally in guava as ellagitannins, hydrolyzable tannins that are comparable to galloyl glucosides and are a component of the fruit's cell wall (Flores et al., 2015). With levels up to 240 mg/100 g DW, guavas have a higher total PP content than other fruits like pineapple and passion fruit (Martnez et al., 2012). These authors claim that there is a direct correlation between fruit tissue PP content and antioxidant capacity.

2.3.3. Triterpenes

Additional BCs identified in guava fruit include triterpenes, predominantly sesquiterpenoids, such as abscisic acid, pedunculoside, guavenoic acid, and made classic acid (Begum et al., 2007; Flores et al., 2015). Guava fruit includes extra terpenoid compounds such limonene, β-caryophyllene, α-gurjunene, and α-humulene, according to many studies (Nunes et al., 2016). Reports claim that guava leaves also contain guajavanoic acid and goreishic acid (Begum et al., 2002).

2.3.4. Volatile Compounds

Guava fruit's distinctive scent, which is influenced by the volatile chemicals contained in the fruit, is one of its primary characteristics in addition to its flavor. Guava was found to contain 28 volatile chemicals, the majority of which were terpenes and terpene derivatives (Thuaytong et al., 2011). Copaene, caryophyllene, aromadendrene, humulene, alloaromadendrene, bisabolene, cadinene, and (Z)-bisabolene were the main substances found. Three varieties of Colombian guava were studied, and (Quijano and Pino, 2007) characterized the volatile fraction and identified the structures of 96 compounds, including acetaldehyde, ethanol, methyl acetate, acetic acid, ethyl acetate, methyl propanoate, 2-ethylfuran, ethyl propanoate, methyl butanoate, 2-methyl propyl acetate, hexanoic acid, ethyl benzoate, octanoic acid etc. In addition to giving the fruit taste, these volatile molecules can enhance the fruit's health benefits. To our knowledge, no study has been done to assess the volatile fraction's functional qualities or antioxidant capability.

2.4. Health Effects of Guava Fruit

The skin and pulp of the guava tree have also shown positive effects in certain studies. The leaves and bark have long been utilized in traditional medicine for their health benefits. Some of these findings are shown in Table 53.4. Consumption of guava leaf extract at 200 and 400 g/mL significantly improved glucose absorption in both healthy and insulin-resistant cells, according to research by (Liu et al., 2015). In an amazing finding, guava extract (10 mg/kg BW) significantly reduced blood glucose levels and reduced fat accumulation in mice liver tissues. This study demonstrated P. guajava's beneficial effects on type 2 diabetes phenotype and liver disease. These results demonstrated that guava can be used to improve and/or prevent diabetes mellitus, despite the fact that guava juice had a shorter half-life and less potent effects than the diabetes drug clorpropamida. When rats on high-fat, high-fructose diets were fed fruit by-products like guava, (Amaya-Cruz et al., 2015) saw similar results. They found an unexpected decrease in lipid buildup in liver tissue by histological investigation, which avoided vesicular micro steatosis.

2.5. Bioactive components present in Strawberry

The strawberry is one of the most eaten fruits globally. Oszmiaski et al. (2009) claim that they are an especially abundant source of bioactive chemicals, including vitamins (such as vitamin C), beta-carotene, and phenolic compounds (phenolic acids, flavonoids, and anthocyanins). These bioactive substances, such as antioxidants, minimize oxidative stress by lowering the overproduction of reactive oxygen species (ROS), which has been connected to the onset of several diseases (Podsdek and Technology, 2007; Atmani et al., 2009). In epidemiological studies (Forbes-Hernandez et al., 2014; Giampieri et al., 2014a; Forbes-Hernandez et al., 2016), strawberry consumption has been linked to health benefits, including the prevention of oxidative stress (Giampieri et al., 2012; Giampieri et al., 2014b), cardiovascular diseases (Hannum and nutrition, 2004; Alvarez), inflammation (Liu and Lin, 2013 (Zunino et al., 2012).These negative health effects have been linked to phenolic compounds' antioxidant properties, particularly those of ellagitannins and anthocyanins (Chen and Li, 2006; Larrosa et al., 2006). Strawberries are particularly renowned for their high vitamin C content, with roughly 60 mg per 100 g of fresh fruit. Strawberries also contain lower levels of a variety of other vitamins, including thiamine, riboflavin, niacin, and vitamin B6. A variety of fat-soluble vitamins, including carotenoids, vitamin A, vitamin E, and vitamin K, are also present in them. With 43 g of folate per 100 g of fresh fruit, strawberries are one of the greatest natural sources of the vitamin among fruits and exhibit a remarkable level of antioxidant activity. Strawberries are also rich in the element’s manganese, iodine, magnesium, copper, iron, and phosphorus (Souci et al., 2000; Giampieri et al., 2015; Nour et al., 2017). Additionally, strawberries contain a variety of bioactive substances, with flavonoids, particularly anthocyanidins, and phenolic acids like hydroxycinnamic and hydroxybenzoic acids taking the lead (Rothwell et al., 2013).

2.5.1. Carbs

Fresh strawberries have an extremely low total carb value of fewer than 8 grams per 3.5 ounces (100 grams) of fruit due to their comparatively high-water content (Greger, 2020). Less than 6 grams of net digestible carbohydrates are present in the same serving size. These berries have a fair amount of fiber along with simple sugars like glucose, fructose, and sucrose that make up the majority of their carbohydrates. The glycemic index (GI) of strawberries is 40, which is a comparatively low value (Jenkins et al., 2014). As a result, strawberries are thought to be safe for those with diabetes and shouldn't cause significant blood sugar rises.

2.5.2. Fiber

Approximately 26% of strawberries' carbohydrate content is made up of fiber. Every 3.5-ounce (100-gram) portion of strawberries, according to Tles and Ozgoz (2014), contains 2 grams of soluble and insoluble fiber. Dietary fibers are crucial for feeding your gut's beneficial microorganisms and promoting digestive health. They aid in illness prevention and help people lose weight (Lattimer and Haub, 2010).

2.5.3. Vitamins and minerals

The nutrients that strawberries contain in the highest concentrations are:

- **Vitamin C.** The antioxidant vitamin C, which is crucial for the immune system and skin's health, is abundant in strawberries.
- **Manganese.** This trace element is typically found in high amounts in whole grains, legumes, fruits, and vegetables. It is crucial for a number of biological processes.
- **Folate (vitamin B9).** One of the B vitamins, folate is crucial for older people and pregnant women because it supports normal cell and tissue growth.
- **Potassium.** This mineral is important for several vital bodily processes, especially controlling blood pressure.

Along with the vitamins B6, K, and E, strawberries also contain trace levels of magnesium, phosphorus, copper, iron, and copper.

2.5.4. Other plant compounds

The following plant components and antioxidants are abundant in strawberries:

- **Pelargonidin.** This substance, which is strawberries' main anthocyanin, gives the fruit its vivid red color (Yousuf et al., 2016).
- **Ellagic acid.** Ellagic acid, a polyphenol antioxidant present in high concentrations in strawberries, may have a number of positive health effects (Williams et al., 2014).
- **Ellagitannins.** In your stomach, ellagic acid is converted from ellaagitannins, which are linked to it (Williams et al., 2014).
- **Procyanidins.** Antioxidants with potential for improving health are typically found in strawberry flesh and seeds (Cos et al., 2004; Koleckar et al., 2008).

2.5.5 Anthocyanins

Strawberries have been shown to have over 25 distinct anthocyanins. The most prevalent is pelargonidin (da Silva et al., 2007). The vibrant hues of fruits and flowers are caused by anthocyanins. Anthocyanins are often concentrated in the fruit's skin, however berries like strawberries also frequently have them in their meat.

Typically, anthocyanin concentration increases significantly as a fruit ripens, in direct proportion to color intensity (Wang et al., 2000; Basu et al., 2010b). Foods high in anthocyanins are linked to several health advantages, notably for heart health (Kong et al., 2003; Mazza, 2007).

2.5.5 Ellagitannins and ellagic acid

Strawberries consistently rank among the top sources of phenolic antioxidants, with levels 2–11 times greater than other fruits (Halvorsen et al., 2002; Scalzo et al., 2005). These antioxidants in strawberries are mostly made up of ellagic acid and ellagagitannins (Aaby et al., 2007). They have drawn a lot of interest and are associated with several health advantages. This includes preventing cancer and battling germs (Sharma et al., 2010; Nile and Park, 2014). Sanguiin H-6 is the primary ellagitannin found in strawberries.

2.6 Health benefits of strawberries

Nile and Park (2014) and Paredes-López et al. (2010) both found a correlation between consuming strawberries and a decreased risk of certain chronic diseases. Strawberry consumption may lower blood sugar levels, improve heart health, and prevent cancer.

2.6.1. Heart health

The leading cause of mortality globally is heart disease. Berries, or berry anthocyanins, have been linked in studies to better heart health (Basu et al., 2010b; Ellis et al., 2011; Wallace, 2011). Berries are linked to a decreased risk of heart-related mortality in large observational studies including thousands of participants (Rissanen et al., 2003; Mink et al., 2007). According to a study on middle-aged people with known risk factors for heart disease, berries may improve HDL (good) cholesterol, blood pressure, and blood platelet function (Erlund et al., 2008).

Possibly a strawberry as well (Mazza, 2007; Huntley, 2009; Basu et al., 2010b; Henning et al., 2010; Tulipani et al., 2011; Basu et al., 2014).

- raise blood antioxidant levelsdecrease oxidative stress
- minimize inflammation
- enhance vascular performance
- enhance the lipid profile of your blood
- lessen dangerous LDL (bad) cholesterol oxidation

The effects of freeze-dried strawberry supplements on type 2 diabetes or the metabolic syndrome, particularly in overweight or obese individuals, have been the subject of much investigation. Following 4–12 weeks of supplementation, participants had a significant decrease in a number of significant risk factors, including LDL (bad) cholesterol, inflammatory markers, and oxidized LDL particles (Basu et al., 2009; Basu et al., 2010a; Tulipani et al., 2011).

2.6.2. Blood sugar regulation

One's body converts carbohydrates into simple sugars during digestion, then releases these sugars into your circulation. Your body then secretes insulin, telling your cells to absorb the sugar from your circulation and use it as fuel or as storage. Obesity, type 2 diabetes, and heart disease are all connected to high-sugar diets and inconsistent blood sugar control (Ludwig, 2002; Schwingshackl et al., 2013; Rizkalla and Care, 2014). According to studies (Törrönen et al., 2010; Edirisinghe et al., 2011; Törrönen et al., 2013), strawberries appear to slow down the digestion of glucose and reduce increases in both glucose and insulin after a meal high in carbs. Strawberries may assist a lot in preventing metabolic syndrome and type 2 diabetes.

2.6.3. Cancer prevention

The unchecked proliferation of aberrant cells is what makes cancer a disease. Oxidative stress and persistent inflammation are frequently connected to the development and progression of cancer (Mantovani, 2010; Reuter et al., 2010). Berries' capacity to combat oxidative stress and inflammation has been linked in multiple studies to their potential role in cancer prevention (Wedge et al., 2001; Seeram and Chemistry, 2008). Strawberries have been discovered to inhibit tumor development in human liver cancer cells and animal models of oral cancer (Meyers et al., 2003; Casto et al., 2013). The anti-cancer benefits of strawberries may be due to ellagic acid and ellaagitannins, which have been shown to suppress the growth of cancer cells (Xue et al., 2001; da Silva Pinto et al., 2010). Before any firm conclusions can be drawn, further human study is required to advance our understanding of how strawberries affect cancer.

2.7. Adverse effects

Although allergies are very prevalent, especially in young children, strawberries are often well tolerated. A protein present in strawberries can cause the syndrome known as pollen-food allergy, which can cause symptoms in those who are hypersensitive to birch pollen or apples (Karlsson et al., 2004; Muoz et al., 2010). Common symptoms include stinging or tingling in the mouth, hives, headaches, swelling of the lips, cheeks, tongue, or throat. Severe instances may also cause breathing difficulties (Patiwael et al., 2010). The anthocyanins in strawberries are thought to be connected to the allergen-causing protein. People who would otherwise be allergic typically tolerate colorless, white strawberries well (Hjern et al., 2006). Strawberries also contain goitrogens, which can affect how well the thyroid gland works in those who already have thyroid issues.

CHAPTER 3: MATERIALS AND METHODS

3.1 Study Area

The experiment was carried out at Department of Applied Chemistry and Chemical Technology, Department of Food Processing and Engineering and Department of Animal Science and Nutrition in Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram.

3.2 Study Duration

The experiment was carried out from 1 October 2021 to 20 April 2022 during a six-month period.

3.3 Collection of Sample

A Commercial guava jelly was purchased from Khulshi mart super shop. Fresh and ripened, mature, uniform size of guava and strawberry were collected from local market of Riazuddin bajar of Chattogram district. Sugar, pectin and citric acid were purchased from scientific and surgical store. Other relevant materials required for the experiment were received from the laboratory stocks.

3.4 Preparation of Jelly

3.4.1 Preparation of guava juice extract

The eyes of the guava were removed before it was cut into pieces. Clean, disease-free guavas were picked. It was then boiled with equal volume of water. The pulp-free juice was then filtered through the muslin cloth.

3.4.2 Preparation of strawberry juice extract

Ripe strawberries were selected. The crown portion were removed and the fruit was washed and and cut into pieces. Then subjected to the boiling with equal amount of water. The fresh juice without pulp was then filtered with the muslin cloth.

3.4.3 Combination of Guava and Strawberry juice extract

Mixed fruit extract was prepared by mixing guava and strawberry juices in different ratios. The amount of pectin (1%), citric acid (.5%) and sugar (40-45%) were calculated according to the formulation and added to the mixed juices. The strained juice was boiled. Heating was continued with stirring. The mixture's end point, as determined by the refractometer, was 65–68°Bx TSS. After cooling, the jelly was put into a glass jar. The jars are labeled and stored for future research after cooling (Singh and Chandra, 2012).

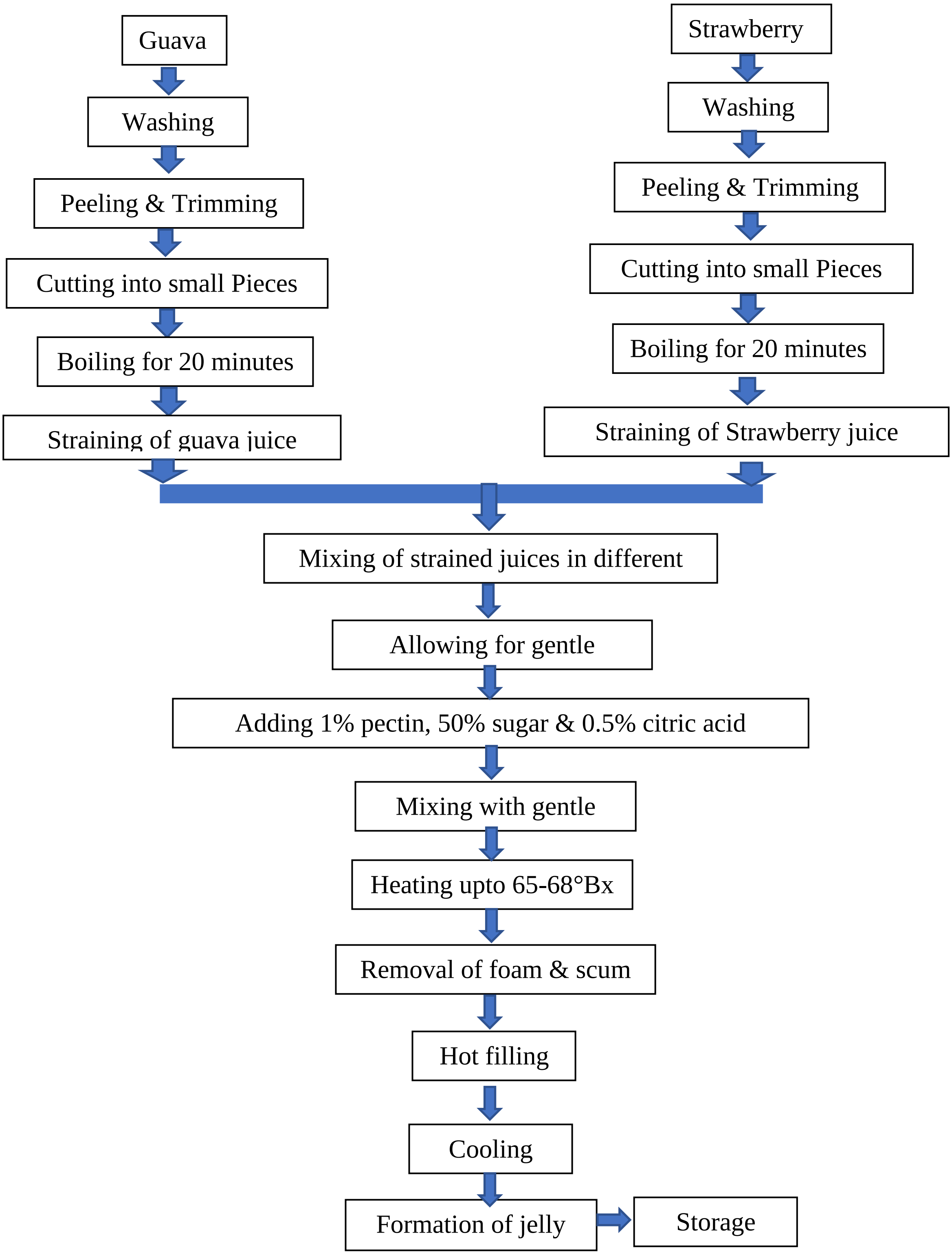

Figure 3.1: Process flow chart for preparation of Guava-Strawberry Jelly

Table 3.1: Formulation of jelly

Formulation	Juice	Pectin	Citric acid	Sugar
Sample A (70:30)	600ml	1%	0.5%	400gm
Sample B (80:20)	600ml	1%	0.5%	400gm
Sample C (60:40)	600ml	1%	0.5%	400gm

Here,

Control = commercial jelly

Sample A = guava extract juice 70: strawberry extract juice 30

Sample B = guava extract juice 80: strawberry extract juice 20

Sample C = guava extract juice 60: strawberry extract juice 40

3.5 Physicochemical analysis of guava-strawberry jelly

Total soluble solid, pH, titratable acidity, and Vitamin C levels were assessed in fresh samples of guava-strawberry jelly. Additionally, proximate analysis, bioactive component analysis, and antioxidant analysis were performed on these samples.

3.5.1 Determination of pH

The pH scale is used to determine how acidic or basic an aqueous solution is. Using a pH meter that has already been calibrated, the jelly's pH was determined. Prior to use, the pH meter was calibrated using buffers with pH values of 4, 7, and 10. Around 10 g of the samples were suspended in 90 mL of deionized water (MAMEDE et al., 2013). To get the reading, the electrode of the pH meter was dipped into the suspended solution, and the result was then recorded.

3.5.2 Total Soluble Solids

With the use of a hand refractometer (Atego RX 1000), the total soluble solids of the jelly were calculated and the findings were presented as percent soluble solids (Brix) in line with ISO standards (2173:2003).

3.5.3 Titratable Acidity

According to AOAC guidelines, the acidity was measured as a percentage of anhydrous citric acid by titrating against N/10 NaOH and using phenolphthalein indicator (2005). Each time, 10ml of juice was taken in a 100ml volumetric flask, the volume was brought to 100ml by adding distilled water, and then 10ml of the diluted juice was titrated against N/10 NaOH with phenolphthalein as the indicator. The titration's endpoint is indicated by the development of pink color. The average result was recorded after the titration was reported three times. As shown below, titratable acidity can be calculated:

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

3.6 Proximate analysis

Using the AOAC standard procedure, the close components of the guava-strawberry jelly were examined (2000). The oven drying technique, dry ashing method, Kjeldahl's method, gravimetric method, and Soxhlet method were used to determine the levels of moisture, ash, crude protein, crude fiber, and crude fat, respectively. (Respectively, AOAC method 977.11, AOAC method 923.03, AOAC method 955.04, AOAC method 991.43, and AOAC method 960.39).

3.6.1 Moisture Content

The moisture content was calculated using the AOAC method (2000). Before being transferred to the desiccator to cool, the empty dish and lid are dried in the 105°C oven for three hours. Weigh the empty dish and lid. The sample weight should be about 3g in the dish. Spread the sample using a spatula. In the oven, place the baking pan containing the sample. 105 °C drying for three hours. Transfer the dish to the desiccator for chilling after drying with a slightly closed lid. Reweigh the dish and the dried sample.

Calculation:

Moisture (%) = $\frac{(\text{W1}-\text{W2}) \text{ x } 100}{\text{W1}}$

Where,

W1 = weight (g) of sample before drying

W2 = weight (g) of sample after drying

3.6.2 Determination of Crude protein

AOAC (2000) method 2.049 was used to calculate the protein content.

Reagent required

i) 20 ml of concentrated sulfuric acid without nitrogen

ii) Digestion mixture:

- 100 gm of potassium sulfate
- 10 gm of copper sulfate

2.5g of selenium oxide, well mixed in a mortar, should be kept in a dry area.

iii) 2 % solution of boric acid in water

iv) Alkali solution: 400 grams of sodium hydroxide dissolved in 1 liter of water.

v) Mixture of indicators 250 ml of ethyl alcohol was used to dissolve 0.1g of bromocresol and 2 gm of methyl red.

vi) 0.1N Standard HCl

Procedure

A dry 300ml Kjeldahl's flask was filled with a precise 5g weight of the digesting mixture. The flask was filled with the appropriate amount of sample (1g for each). Sulphuric acid (20 ml) was added, heated continually until foaming stopped, and then quickly simmered. The solution was heated for another 45 minutes after becoming clear after 15-20 minutes. The complete volume-roughly 500 ml was quantitatively transferred to a One-liter round-bottom flask after chilling and the addition of 100 ml of water. Immediately after placing gently on the side enough sodium hydroxide solution to generate a participant of cupric hydroxide, the flask was connected to the steam trap and condenser. Then, 50 ml of the boric acid solution, 50 ml of distilled water, and 5 drops of the indicator solution were added to a 500 ml conical receiving flask. The distillation was carried out for 4 to 5 minutes, or until a volume of around 250 ml was obtained, after positioning the condenser. After adding 0.1 N hydrochloric acids to the receiving flask's contents, the end point was determined by a brown color. Additionally, a reagent blank was found and subtracted from the titration. One gram of nitrogen is equal to one milliliter of hydrochloric acid at a concentration of 0.1N. The % protein from nitrogen determination was calculated using a protein conversation factor. The formula presented below is used to compute the percentages of nitrogen and protein:

Nitrogen (%) = $\frac{\text{(Ts−Tb) x N of HCLx 14 x Vol.made up the digest}}{\text{Wt of the sample (gm) x A liquor of the digest taken}}$x 100

Where,

Ts = total sample volume (ml), and Tb = total blank volume (ml)

Protein (%) = Nitrogen% x Protein factor.

3.6.3 Determination of Crude fat

This was verified using the AOAC-described solvent extraction gravimetric technique (2000). The sample was wrapped in porous paper and five grams were put in a thimble (Whatman filter paper). A weighted extraction flask containing 200 ml of petroleum ether and a soxhlet reflux flask were used to hold the thimble after mounting it in them. The upper part of the reflux flask has a water condenser connected.

After being heated, brought to a boil, and then given time to cool, petroleum ether was condensed into the reflux flask. The reflux flask was swiftly filled, and the oil extract was siphoned down to the boiling flask before the solvent was quickly poured over the sample in the thimble. The defatted sample was removed, the solvent was recovered, and the oil extract was kept in the flask after this process was done four times. To remove any leftover solvent, the flask containing the oil extract was dried in the oven at 60°C for one minute. It was weighed after cooling in a desiccator. The following formula was used to determine the weight of the oil (fat) extract as a percentage of the weight of the sample being studied:

Fat (%) = $\frac{\text{Petri dish weight with sample} - \text{Petri dish weight without sample}}{\text{Sample weight}}$ x 100

3.6.4 Determination of crude fiber

The AOAC method was employed to determine crude fiber (2000). 5 gm processed sample was boiled in 150 ml of a 1.25 percent H2SO4 solution for 30 minutes while maintaining reflux. A two-fold towel was used to catch the particles while the cooked sample was rinsed in varied amounts of hot water. It was returned to the flask and cooked once again for 30 minutes in 150 cc of 1.25 percent NaOH under the same conditions. The sample was rinsed with hot water several times, let dry, and then transferred quantitatively to a weighted crucible where it was dried at 105°C to a constant weight. After that, it was taken to a muffle furnace and burned until only ash remained. Difference analysis was used to determine the fiber's weight, which was then expressed as a percentage of the sample's weight:

Crude fiber (%) = $\frac{W2 - W3}{\text{Sample weight}} \times 100$

Where,

$W2$ = Sample weight after drying and washing + Crucible weight

W_3= Crucible weight + Sample weight

3.6.5 Determination of ash content

The AOAC-described furnace gravimetric method was used to achieve this (2000). In brief, 5g of the samples were weighed into a porcelain crucible and measured there. The sample was burnt until it was completely reduced to ash in a muffle furnace that was heated to 550°C. It was weighted, desiccated-cooled, and analyzed in the following ways:

Ash content (%) = $\frac{\text{wt of the crucible with ash residue} - \text{wt of empty crucible}}{\text{sample wt}} \times 100$

3.6.6 Determination of Carbohydrate

According to AOAC, 2000, the following formula was used to calculate carbohydrate.

Carbohydrate (%) = 100-[Crude protein (%)+ Crude fat (%) +Crude fiber (%) +Ash(%) +Moisture(%)]

3.7 Determination of Vitamin C

Despite being a necessary ingredient for health, vitamin C is quickly decreased or destroyed by heat and oxygen during food preparation, packaging, and storage. The 2, 6-dichloroindophenol titrimetric method is the approved technique for determining the amount of vitamin C in juices (AOAC, 2010). In this case, the color pigment oxidizes the vitamin C to dehydroascorbic acid. The dye is also turned into a colorless compound at the same time. such that it is simple to identify the reaction's termination point. As excess may be introduced into plant products by oxidized vitamin C during sampling and grinding, rapid excretion and filtering are preferred. Metaphosphoric acid is used during extraction to stop oxidation. The most accurate result will come from a very acidic solution. Within a minute, the titration ought to be finished. When totally reduced, the dye loses all color and turns colorless in an aqueous solution and pink in an acidic solution.

Reagent required:

A) Dye Solution

- 260 mg of dye (2,6-dichlorophenol indophenols)
- 210 mg of $NaHCO3$ dissolved in 100 ml of distilled water.

B) Metaphosphoric acid solution (3%)

- 15/7.5mg of Metaphosphoric acid.
- 40/20ml of glacial acetic acid dilutes to make 500/250 ml with distilled water.

C) Standard ascorbic acid solution

- 50/25 mg of crystalline ascorbic acid dissolved in 500 ml/250ml of metaphosphoric acid solution.

Procedure

- In the burette, dye solution was added up to 0 marks.
- Then, a conical flask containing 5 ml of Vitamin C solution was used.
- Drop by drop, dye was added to the conical flask as it was positioned beneath the burette.
- When a pink tint first appeared, stayed for 20 seconds, and finally disappeared, the titration was complete.
- At least three different readings were taken.
- The ascorbic acid solution was treated using the same process but with an unknown concentration.
- The result was expressed as milligram percentage (mg %)

3.8 Determination of Antioxidant capacity by DPPH scavenging method

Extract preparation

• Taking 5gm of sample in falcon tube

• Adding 10ml absolute methanol and left for 72 hours

• Straining the solvent

•Collection of filtrates

• Evaporation at 60°c using rotary evaporator

• Methanoic extract found

Procedure

The DPPH test developed by Azlim Almeyet al. (2010) was applied with a few minor modifications to determine the extracts' antioxidant mobility. The methanolic DPPH solution was made by dissolving roughly 6 milligram of DPPH in 100 ml of pure methanol.

Then, 1 ml of methanolic extract was combined with 2 ml of DPPH solution. The mixture was then given a gentle shake and left to stand at room temperature in the dark for 30 minutes. The absorbance was measured using a UV-VIS spectrophotometer at a wavelength of 517 mm (UV-2600, Shimadzu Corporation, USA). Methanol was used as a blank, and 1 mL of methanol and 2 mL of DPPH solution were combined to create the control. The reduction in absorbance of the samples in contrast to the DPPH standard solution served as a proxy for the scavenging mobility. Based on extracts' ability to scavenge DPPH free radicals, the antioxidant capacity was determined using the following equation:

$$\text{Scavenging activity (\%)} = \frac{\text{Absorbance of Sample}}{\text{Absorbance of Control}} \times 100$$

The calibration standard curve was constructed using TEAC composite (Trolox equivalent antioxidant mobility), which was also utilized as the standard. On a dry weight (DW) basis, the results were expressed as mg/100 g of Trolox equivalents per gram of powder.

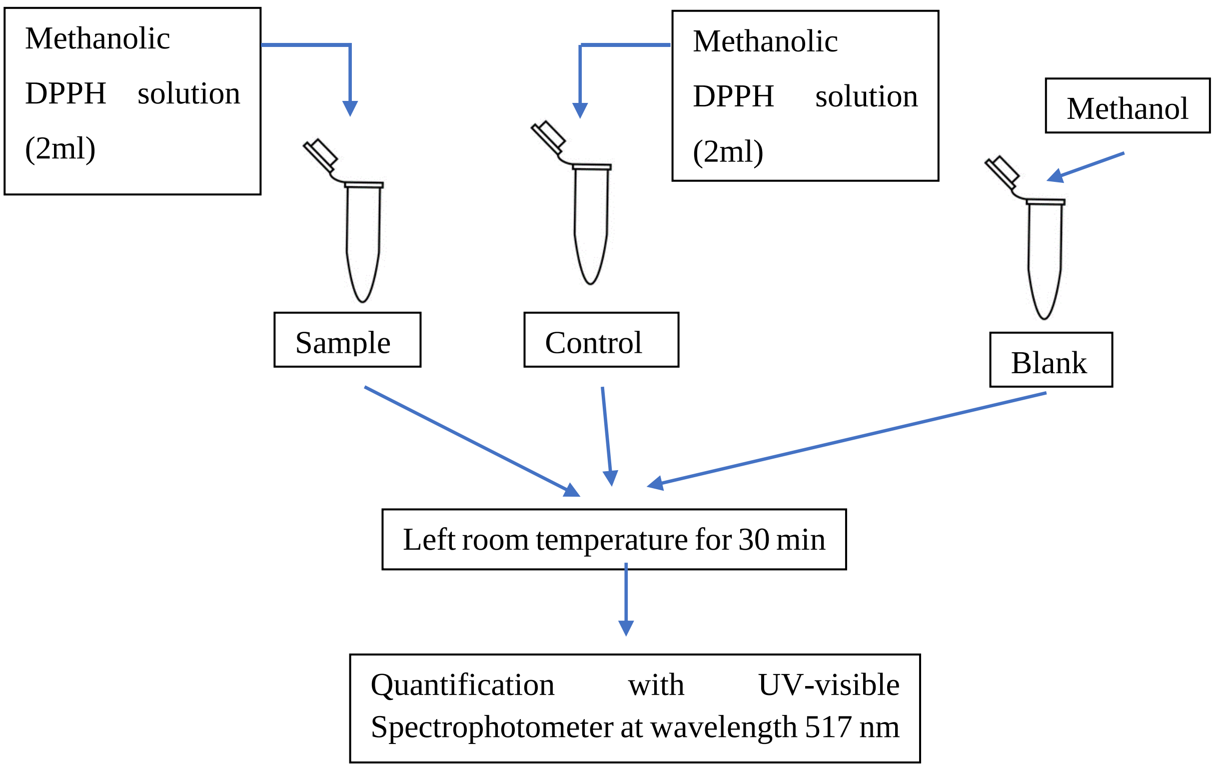

Figure 3.2: An illustration of the process for determining antioxidant activity

3.9 Determination of Bio-active compounds

Extract preparation

- ✓ Taking 5gm of sample in Felcon tube
- ✓ Adding 10ml absolute ethanol and left for
- ✓ Straining the solvent

- ✓ Collection of filtrate72 hours
- ✓ Evaporation at 60°c using rotary evaporator
- ✓ Ethanoic extract found

3.9.1 Total Phenolic Content (TPC)

The Folin-Ciocalteu reagent method was used to calculate the TPC of the extracts with a few minor modifications (Al-Owaisi et al, 2014). A falconer tube containing 1 ml of ethanolic extract and 1.5 ml of FC reagent was held at room temperature for 3 minutes after the addition. The mixture was then given 1.5 ml of 7.5 percent Na_2CO_3 and left to settle for 60 minutes. The absorbance was determined at a wavelength of 765 nm using a UV-VIS Spectrophotometer (UV 2600, Shimadzu Corporation, USA) with C_2H_5OH as the blank. TPC was calculated as mg of gallic acid equivalents (mg GAE/g) per gram of extracts.

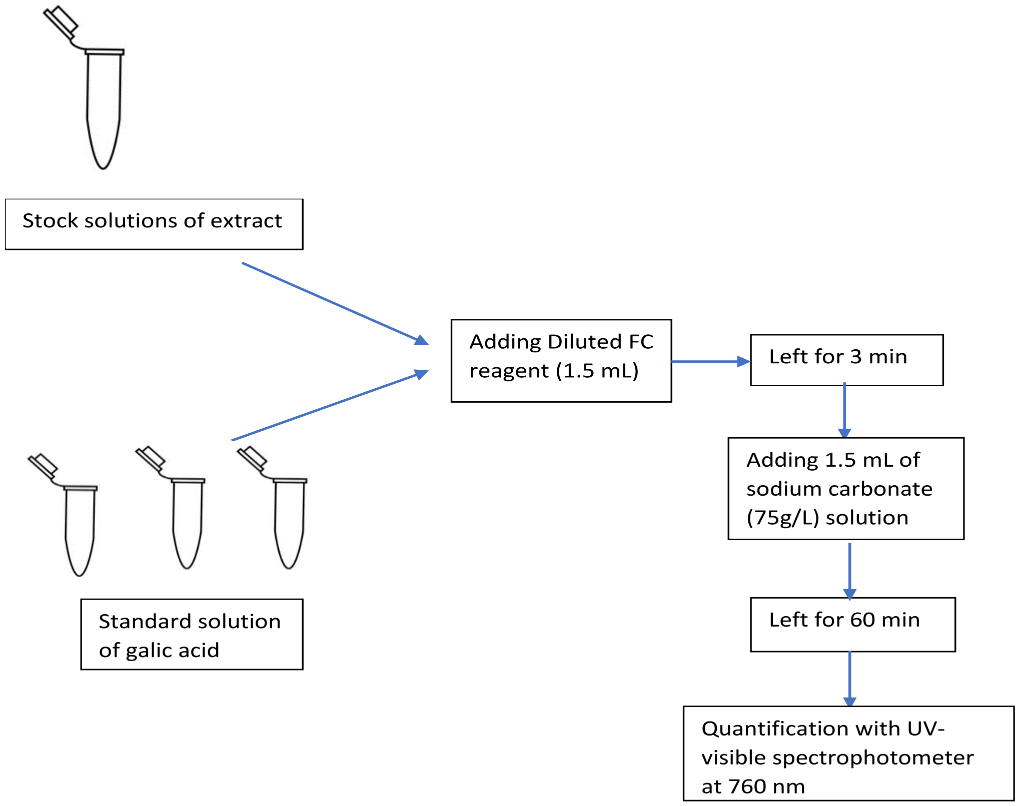

Figure 3.3: Flow chart for the process used to determine The Total Phenolic Content (TPC)

3.9.2 Total Flavonoid content (TFC)

The total flavonoid content of the samples was determined using the aluminum chloride colorimetric technique reported by Chang et al. (2002) with a few minor modifications (TFC). To create a stock solution of the extracts (1 mg/ml), aliquots of 0.5 ml of diluted extract were diluted with 15 ml of 95 percent $C2H5OH$ in a cuvette. Following that, 0.1 ml of 10% $AlCl3$, 0.1 ml of 1 mol/L potassium acetate, and 2.8 ml of distilled water were added to the liquid in the cuvette (D.$H2O$). The mixture was allowed to sit at room temperature for 30 minutes. The absorbance was determined using a UV-visible spectrophotometer (UV-2600, Shimadzu Corporation, USA) at a wavelength of 415 mm. The blank was made up of 10% aluminum chloride replaced with the same amount of D.$H2O$. By comparing the sample extracts' absorbance to a quercetin standard curve, the total quantity of flavonoids in the sample was determined. TFC was calculated and determined to be mg of quercetin equivalents (mg QE/g) per gram of extract.

3.10 Energy estimation

The energy in the guava-strawberry jam was determined using the following equation given the quantities of protein, fat, and carbs in each food item (Baer et al., 1997). Energy = [(Carbohydrate × 4.1) + (Protein × 4.1) + (Fat × 9.2)]

3.11 Cost analysis

The price of the overall ingredients used to prepare the jelly was used to determine the price of the guava-strawberry jelly. The sum was given in taka and the price per kilogram of jelly was calculated.

3.12 Sensory evaluation

The overall acceptability of the finished product by customers has been determined via sensory evaluation. A panel of tasters assessed if the new product was acceptable to consumers. The panel test was conducted on the grounds of CVASU, and the panelists included both CVASU instructors and students. The product made from guava-strawberry jelly was distributed to the panel of 10 participants. Samples A, B, C, and D were used to encrypt four different formulas. The panelists examined the four products without disclosing the formulas to them. For the jelly's appearance, taste, texture, sweetness, and general acceptability, the panelists were asked to provide the jelly an acceptable grade. Although this strategy does not necessarily represent how consumers really perceive products, it strongly suggests several qualities that a high-quality product should have (Sing et al., 2008). After trying four of the products, they provided feedback and a grade. The sensory evaluation of the four samples' qualitative traits (taste, look, flavor, texture, sweetness, and overall acceptability) was done using nine-point Hedonic measures (Larmond, 1977). Each of the ten panelists was given a portion of each sample. On the basis of taste, appearance, flavor, texture, sweetness, and general acceptability, the panelists were asked to rate the sample: Very dislike, Very Much Dislike, Somewhat Dislike, Neither Like nor Dislike, Slightly Like, Moderately Like, Very Much Like, and Excessively Like are the nine extremes (Amerine et al., 2013).

3.13 Statistical Analysis

To assess statistical analysis, data were collected and kept on a Microsoft Excel 2019 spreadsheet. For the sensory analysis of the guava-strawberry jelly and its approximate composition, descriptive statistics (mean and standard deviation) were performed. In IBM SPSS Statistics 22, data were organized, coded, and recorded. Proximate composition, bioactive component, and sensory assessment data were then evaluated using one-way ANOVA techniques to determine the significance of the amount of variance at a 95% confidence interval. To find the variance among the sample groups, a post hoc "Tukey" test was used. A 5% level of significance ($p \leq 0.05$) was used for the statistical analysis.

CHAPTER 4: RESULTS

4.1 Physicochemical analysis of Guava-Strawberry jelly

For the best gel condition, jelly's pH is a crucial consideration. In table 4.1, lowest value (3.09±0.69) pH found in sample A and highest value (3.43±0.69) in sample B. TSS (total soluble solids) was highest (68degree brix) in sample A, lowest in (66degree brix) in Control & sample C. The maximum value (0.69±0.45%) of acidity obtained in sample A and the least value (0.27±0.1%) found in control sample.

Table 4.1: Physicochemical properties of jelly

Formulation	pH	TSS(°B)	Acidity (%)
Control	3.16 ± 0.25^{b}	66 ± 0.01^{c}	$0.27\pm.0.01^{d}$
Sample A	3.09 ± 0.69^{a}	68 ± 0.03^{a}	0.69 ± 0.45^{a}
Sample B	3.43 ± 0.22^{d}	67 ± 0.10^{b}	0.43 ± 0.52^{c}
Sample C	3.32 ± 0.13^{c}	66 ± 0.01^{c}	0.58 ± 0.23^{b}

Legends: All values in the table showed (ME±SD) of data, where ME = Mean and SD = Standard Deviation, superscripts a, b, c, d denotes significant difference ($p\leq.05$) among samples.

4.2 Proximate analysis of Guava-Strawberry jelly

Proximate analysis of Guava-Strawberry jelly is shown in Table 4.2, almost all samples are significantly different. Where Sample A contained the highest percentage of crude fat (0.19±0.05%) and Sample A contain the most abundant percentage of crude protein (0.85±0.04%). The lowest crude fat (0.10±0.08%) and crude protein (0.62±0.09%) found in sample B.

Table 4.2: proximate analysis test results for guava-strawberry jelly.

Formulation	Moisture%	Ash%	Crude Fat %	Crude Protein %	CHO %
Control	30.82 ± 0.17^{c}	0.19 ± 0.01^{d}	0.12 ± 0.01^{c}	0.72 ± 0.021^{b}	62.68 ± 0.409^{d}
Sample A	29.46 ± 0.25^{c}	0.37 ± 0.01^{a}	0.19 ± 0.05^{a}	0.85 ± 0.048^{a}	69.13 ± 0.374^{a}
Sample B	32.49 ± 0.29^{b}	0.29 ± 0.01^{b}	0.10 ± 0.08^{d}	0.62 ± 0.090^{d}	66.50 ± 0.942^{b}
Sample C	37.52 ± 0.35^{a}	0.27 ± 0.01^{c}	0.15 ± 0.02^{b}	0.67 ± 0.047^{c}	61.39 ± 0.654^{c}

Legends: The table contained all values as (ME ± SD), where ME stands for Mean and SD for Standard Deviation. The superscripts a, b, c, and d indicate significant differences (p≤.05) across samples.

4.3 Bio-Active compound of Guava -Strawberry jelly

The results of bioactive compounds (TFC and TPC) are presented in table 4.3. There have a significantly different values found among all samples. Sample A carried the highest value of total flavonoid content (88.33±0.18 mg QE/100 g) & total phenolic content (12.166±0.057 mg GAE/100mL). Lowest value of total flavonoid content (1.119±0.048 mg QE/100 g) and total phenolic content (6.233±0.015 mg GAE/100mL) found in control sample.

Table 4.3: Bio-active compounds Analysis test results for guava-strawberry jelly

Formulation	Total flavonoids content (TFC) (mg QE/100 g)	Total phenolic content (TPC) (mg GAE/100mL)
Control	1.119 ± 0.048^{b}	6.233 ± 0.0152^{d}
Sample A	1.540 ± 0.042^{a}	12.166 ± 0.057^{a}
Sample B	1.236 ± 0.043^{b}	7.066 ± 0.208^{c}
Sample C	1.289 ± 0.056^{b}	7.933 ± 0.152^{b}

Legends: The table contained all values as (ME ± SD), where ME stands for Mean and SD for Standard Deviation. The superscripts a, b, c, and d indicate significant differences (p≤.05) across samples.

4.4 Antioxidant & Vitamin C content

The results of antioxidant and Vitamin C content are showed in table 4.4

Here, Sample A carried the highest value of antioxidant capacity (3.819±0.001 mg TE/100 g) & Vitamin C content (10.8±.09 mg%). Lowest value of antioxidant capacity (1.988±.002) & Vitamin C content (4.6±0.2 mg%) in control sample.

Table 4.4: Anti-oxidant capacity and Vitamin C content analysis test results for guava-strawberry jelly

Formulation	Antioxidant capacity (TAC) (mg TE/100 g)	Vitamin C (mg%)
Control	1.988 ± 0.002^{d}	4.6 ± 0.2^{d}
Sample A	3.819 ± 0.001^{a}	$10.8\pm.09^{a}$
Sample B	3.614 ± 0.006^{b}	$10.2\pm.03^{b}$
Sample C	3.529 ± 0.007^{c}	$9.8\pm.06^{c}$

Legends: The table contained all values as (ME ± SD), where ME stands for Mean and SD for Standard Deviation. The superscripts a, b, c, and d indicate significant differences ($p\leq.05$) across samples.

4.5 Sensory Evaluation

There was not a significant difference ($p<0.05$) in all the sensory parameters assessed (table 4.4). In all the parameters sample A had the highest acceptance rate. However, control scored least acceptance compared to other samples.

Table 4.5: Sensory evaluation test results for guava-strawberry jelly.

Formulation	Appearance	Texture	Flavor	Taste	Sweetness	Overall acceptability
Control	6.1 ± 1.969^{d}	6.7 ± 1.494^{b}	6.1 ± 2.211^{d}	5.2 ± 1.764^{d}	5.8 ± 1.874^{d}	5.1 ± 2.587^{d}
Sample A	8.4 ± 0.699^{a}	7.7 ± 0.949^{a}	7.4 ± 0.843^{a}	7.2 ± 0.789^{a}	7.4 ± 1.174^{a}	7.8 ± 0.789^{a}
Sample B	7.3 ± 0.823^{b}	6.5 ± 1.179^{c}	6.8 ± 0.632^{b}	6.3 ± 0.675^{b}	6.4 ± 1.075^{b}	6.6 ± 0.843^{b}
Sample C	6.5 ± 1.354^{c}	5.6 ± 2.171^{d}	6.4 ± 1.647^{c}	6.1 ± 1.491^{c}	6.3 ± 1.897^{c}	6.3 ± 1.494^{c}

Legends: The table contained all values as (ME ± SD), where ME stands for Mean and SD for Standard Deviation. The superscripts a, b, c, and d indicate significant differences ($p\leq.05$) across samples.

4.6 Energy content

From the figure 4.1, Energy content in sample B was calculated in highest amount (287.89 kcal/100g) and lowest (258.26 kcal/100g) in control sample.

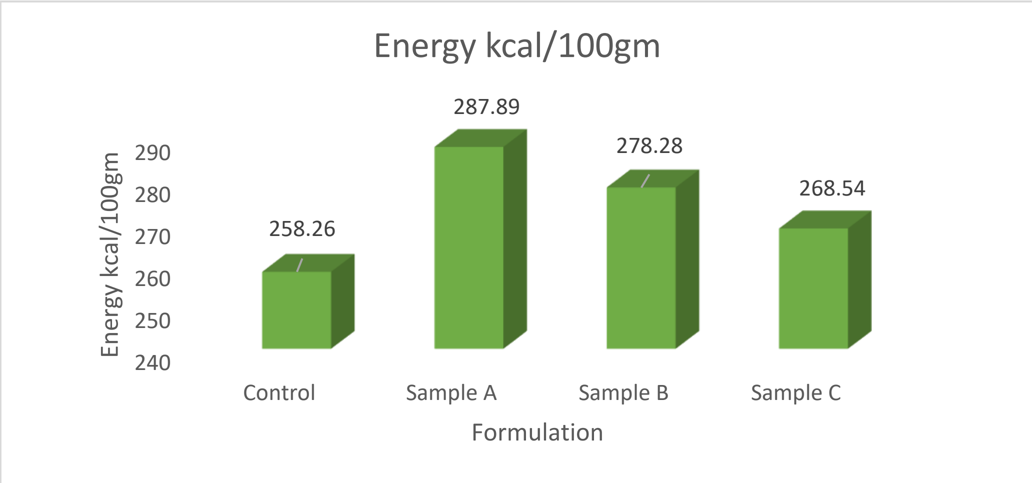

Figure 4.1: Comparison of energy content among four guava-strawberry jelly

4.7 Calculation of cost in production of jelly

The production cost of the developed (Sample A) jelly was calculated and Table 4.6 showed total cost for 1 Kg of Sample A jelly is approximately Tk 450.

Table 4.6: Production cost of guava-strawberry jelly

Materials	Quantity	Price (Taka)
Guava	420 gm	32
Strawberry	180 gm	18
Sugar	400 gm	32
Pectin	10 gm	150
Citric acid	5 gm	70
Glass Bottle	4pcs	20
Wax	100 gm	30
Total		**352**

Commercial one bottle jelly contains 500g jelly which cost is 140 tk. By this cost we get 1kg(1000g) jelly which is equivalent to commercial 2 bottle jelly. So, one bottle jelly costing is = $\frac{352}{2}$ = 176 taka, which is slightly higher than the commercial jelly. The cost can be minimized if it is produced in bulk amount for the commercialization of product.

CHAPTER 5: DISCUSSIONS

5.1 Physicochemical properties of guava-strawberry jelly:

5.1.1 pH

pH is one of the important parameters. Jelly quality and the stabilization of jelly is mainly due to the pH effect. The pH content of prepared guava-strawberry jelly was determined by pH meter. One of the most common causes of jelly failure is insufficient of acid. The pH value of jelly should be taken when the jelly is concentrated sufficiently to pour (Eke-Ejiofor et al., 2013)**.**

The results in table 4.1 showed that the pH value had a slightly change among all samples, ranged between 3.07±0.06 to 3.43±0.22 where sample A contains lowest pH which indicates the shelf life is higher than other sample. Acidity can be increased due to degradation of polysaccharides or breakdown of pectin to pectenic acid (Kanwal et al., 2017)**.** In the study the pH of guava jelly was observed 4.19 ± 0.2 and the pH of strawberry jelly was observed 3.56 ± 0.01 (Moura et al., 2011)**.** According to (Singh et al., 2012) the of the fruit jellies increases with the storage period at room temperature. We can conclude our developed guava-strawberry jelly shelf life will be higher than the jellies developed by (Moura et al., 2011)

5.1.2 Total Soluble Solid (TSS)

The number of soluble solids in the jelly affects the flavor and sweetness. In our study the highest brix was observed in sample A (68º). We found in sensory evaluation Sample A was highest acceptance in test parameter. It denotes that high TSS increases the taste & smell of jelly. The TSS% varies with the different formulation of guava-strawberry jelly. In our study, the formulation ratio of guava-strawberry in sample A was 70:30. This is the reason behind the highest TSS value in sample A. A similar outcome was seen by (Jolhe et al., 2020). In accordance with their investigation, the TSS was seen to be greater when the jelly was given the most sugar. They also demonstrated that the TSS rises with storage time. Pectin and gum polysaccharides' hydrolysis might lead to an increase in TSS (Kanwal et al., 2017) .

5.1.3 Titratable Acidity

One of the physicochemical characteristics of acidity is its ability to limit the growth of microorganisms in food goods, which contributes to the shelf-life of those products.

(Tifani et al., 2018). In our study the highest acidity was found in sample A and the lowest acidity was observed in commercially available guava jelly. Since the ascorbic acid in the jelly gradually changes into other organic acids during storage, the titratable acidity rises.. (Kumar and Deen, 2017; Jolhe et al., 2020)

5.2 Proximate Analysis of guava-strawberry jelly

5.2.1 Moisture

The impact of moisture on the freshness and shelf life of jelly is significant. High moisture content jelly has a low shelf life. In our investigation, sample C had the greatest moisture content, while guava jelly that was readily accessible had the lowest in the formulated samples, sample A has the lowest moisture content (31.53%). As we did not perform the shelf life study yet, we can assume that the shelf life of sample C is less than other samples. Commercially available and sample A has no significance difference in their moisture content. That means they have the highest storage life. Lower moisture content also indicates the higher percentage of other nutrients. According to (Khatun, 2011), the moisture of developed guava jelly was 27.17% initially. After 30 days the moisture was 27.21%, and in 90 days the moisture became 28.30%. It denotes that moisture will increase along with storage time.

5.2.2 Ash

To detect the presence of ash, the sample was burned at a high temperature, oxidizing and volatilizing all organic material and leaving just the mineral. (Cho and Lwin). In our study the ash content varies from 0.27 to 0.34 which is relevant to (Hossen et al., 2009).

5.2.3 Protein content & CHO

In this present study, sample A carried the most abundant value of crude protein (0.85±0.04%) & CHO content (69.13±0.03%). One of the key nutritional components is carbohydrate. In this study, the carbohydrate content of jelly was determined using a different method of calculation: Carbohydrate (percent) = 100 - [protein (percent) + fat (percent) + water (percent) + ash (percent) + fiber (percent)].

In our study, the CHO & protein content found is slightly higher than the research study of (Cho and Lwin) whereas the carbohydrate content of the prepared guava jelly 30.21% & the protein content (0.08 %).

5.3 Bio-active compounds

In addition to providing essential nourishment, bioactive substances are crucial for maintaining the immune system and preventing chronic diseases in humans. (Liu and Hotchkiss, 1995). The results of the bioactive chemical content identified in guava-strawberry jelly are reported in Table 4.3, and it has been found that there are significant number of bioactive compounds in our developed mixed fruit jelly. The highest amount of total phenolic content was found in sample A (12.166±0.057 mg GAE/100mL) and the lowest amount was found in commercially available guava jelly. According to (Reissig et al., 2016), the highest total phenolic content was found 123.31 mg GAE/100mL. This result is higher from our result. Seasonal & geographical differences can cause the variation of this result. Jellies are made by heating the ingredients, which may result in significant losses in the nutrients, bioactive chemicals, and product quality.(Kamiloglu et al., 2015). On the other hand, total flavonoids content was found in jelly which had no significant changes where sample A contain highest amount of TFC (1.119±0.048 mg QE/100 g).

5.4 Antioxidant capacity:

The antioxidant activity of guava-strawberry jelly is shown in table 4.4. In the examined samples, antioxidant activity varied between 1.988 and 3.819 (mg TE/100 g). Fruit and fruit jellies' phenolic component levels closely correlated with their capacity to serve as antioxidants, and these components were susceptible to degradation by physical-chemical processes associated with food preparation, according to (Dávalos et al., 2005; Ruberto et al., 2007). In a prior investigation, it was found that ascorbic acid content has an impact on antioxidant capacity. According to (Kanwal et al., 2017), the antioxidant capacity for 1st treatment was 39.50 mg/100g while the ascorbic acid was found 29.43 mg/100g. In our study, the antioxidant capacity of sample A was observed 3.8 mg/100g and the ascorbic acid was found 10.8 mg%. So, we can conclude that the antioxidant capacity in our sample is lower because of the ascorbic acid is less in our sample.

5.5 Vitamin C

Ascorbic acid is fundamental for life. Vitamin C content in sample A & sample B contain higher (10.8±.09) mg% and (10.2±0.03) mg% in respectively than other samples. Commercially available guava jelly contains low amount of vitamin C compare to formulated guava-strawberry jelly. According to reports, ascorbic acid content was lowered by high processing temperature (Martinsen et al., 2020). According to Singh et al., (2012). The ascorbic acid/vitamin C content of the guava carrot jelly table was 6.361 mg percent. Along with the time period for storage this study discovered that vitamin C levels gradually decreased. In the fresh raw guava the average ascorbic acid content varies from 95.42-201.1 mg% (Jawaheer et al., 2003). As the ascorbic acid degraded due to heat treatment and other processing. That's why ascorbic acid content in our developed jelly was lower than raw guava.

5.6 Sensory Evaluation:

Data were collected on the sensory evaluation of guava-strawberry jelly in terms of appearance, texture, flavor, taste, sweetness. All samples underwent sensory analysis to determine which organoleptic component had the highest percentage. According to sensory analysis results from Table 4.5, jelly of guava and strawberry (sample A) received the highest overall acceptancy of 7.8±0.789. It may be due to texture, sweetness and appearance. Sample A received the highest score (8.4) for aesthetics, whereas commercially available guava jelly received the lowest score (6.1). Sample A has a taste score of (7.2), whereas commercial guava jelly receives the lowest score of (7.9) on a scale of 1 to 9. Nine points Hedonic rating test method was used for the purpose of sensory evaluation and mean scores obtained by various treatment (Joshi, 2006). Sample A had the highest score (7.7) for texture, while Sample C received the lowest score (5.6). The texture score of jelly increased with increase of percentage of pectin and citric acid. Similar propensity was reported by (Basu and Shivhare, 2010). Highest mean score of acceptability is 7.8 in sample A of guava-strawberry jelly in hedonic rating scale. It denotes "Like moderately". So, we can conclude that sample A got the highest score by panelist among other samples which can be used for further studies.

CHAPTER 6: CONCLUSION

Jelly is beneficial to health because it has many nutritive components. In this study, sample A which is formulated with guava (70) & strawberry (30) has the highest level of sensory acceptance. The physicochemical test was performed in formulated samples which showed some significant differences. Bioactive compound and proximate analytical test on formulated jelly samples also found significant differences. It also has good amount of vitamin C content and antioxidant which is excellent for human body. The manufacturing of jelly is simple & it has cost effectiveness so consumer can attract to buy this & it is sustainable alternate to them. Additionally, exporting jelly of the highest caliber and meeting international standards might bring in foreign currency, which benefits Bangladesh's national economy. It's crucial to conduct more research to test other components with various fruit varieties when making jelly.

CHAPTER 7: RECOMMENDATIONS AND FUTURE PERSPECTIVES

Guava -strawberry jelly which we can call mixed fruit jelly available in Bangladesh's rural areas, may be a useful source of nutrients and energy in these circumstances. We came to a successful conclusion about the guava- strawberry jelly Furthermore, it has improved marketability and commercial worth. The practice from medium and large-scale production can be adopted. The following recommendations and study opportunities are offered based on the current investigation.

a) For confirmation of the experimental results, the current research may be replicated.
b) Other marketable fruits including papaya, mango, and others should be the subject of this kind of study, particularly during the off-season.
c) Because it is simple to prepare. It is also advised for long-term storage during the off-season. On the other hand, it will benefit individuals who fall under the economically weaker segment from a standpoint.
d) To increase the nutritional value of commercially available jellies, appropriate measures should be adopted.
e) The microbiological study can be done for upgrading the shelf life of jelly.
f) There is opportunity for cost minimization by regulating some steps.
g) The mixture can be further altered, and users can experiment with making mixed jelly using different recipes and fruit ratios.
h) By market study, if it is helpful for consumer or not it can be identified.

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APPENDICES

Appendix A: Questionnaire for Hedonic test of guava strawberry 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 Appearance/texture/ Flavor/Taste/Sweetness/ 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,

Control= Guava jelly

Sample A= guava extract juice 70: strawberry extract juice 30

Sample B = guava extract juice 80: strawberry extract juice 20

Sample C = guava extract juice 60: strawberry extract juice 40

Formulation	Appearance	Texture	Flavor	Taste	Sweetness	Overall acceptability
Control						
Sample A						
Sample B						
Sample C						

Appendix B: Photo Gallery

Guava & strawberry sample

Boiling

Boiling juice with other ingredients

Jelly formation

Formulated jelly and commercially available jelly

p^H checking

Acidity determination

Checking °Brix

TPC test

TFC test

Working in UV spectrophotometer

Sensory Evaluation

Sensory Evaluation

Sensory Evaluation

BRIEF BIOGRAPHY

Abdullah Al Noman passed the Secondary School Certificate Examination in 2010 from Chattogram Collegiate School, Chattogram and then Higher Secondary Certificate Examination in 2012 from, Govt. Hazi Mohammad Mohsin College Chattogram. He obtained his 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, he is a candidate for the degree of Master of Science in Food Chemistry and Quality Assurance under the Department of Applied Chemistry and Chemical Technology, Chattogram Veterinary and Animal Sciences University (CVASU). He has an immense interest to work in food safety issues including food chemistry, quality assurance, food quality control, environmental chemistry, product development and processing etc.