NUTRITIONAL COMPOSITION, BIOACTIVE COMPOUNDS AND ANTIOXIDANT ACTIVITY OF DIFFERENT VARIETY (WHITE SUGAR, BROWN SUGAR & HONEY) OF FIG JAM (*Ficus carica L.*)

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

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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 that all revisions required by the thesis examination committee have been made

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DEDICATED TO MY BELOVED FAMILY & TEACHERS

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The Author

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Abbreviations

%	: Percentage
&	: And
ANOVA	: Analysis of variance
AOAC	: Association of Official Analytical Chemists
TSS	: Total Soluble Solids
TDS	: Total Dissolved Solids
°C	: Degree Celsius
^{0}B	: Degree Brix
CHO	: Carbohydrate
dl	: Deciliter
DPPH	: 2,2-diphenyl-1-picrylhydrazyl
ABTS	: 2,2-Azinobis-(3-Ethylbenzthiazolin-6-sultonic Acid)
et al	: Et alii/ et aliae/ et alia
etc	: Et cetera
g	: Gram
GAE	: Gallic acid equivalent
Kg	: Kilogramme
mg	: Miligram
TE	: Trolox equivalent
cfu	: Colony forming unit
QE	: Quercetin equivalents
GAE	: Gallic acid equivalents
L.	: Linn
PPM	: Parts per million
m	: Meter
DNA	: Deoxyribonucleic acid
µg	: Microgram
SPSS	: Statistical Package for Social Science

Abstract

The current study was undertaken to investigate the quality of manufactured different fig jam samples at CVASU. Three types of fig jam samples (White sugar, Brown sugar and Honey) were produced. In context of the objectives of the study, a total of 03 samples were produced to analyze the nutritional (percentage of fat, protein, fiber, vitamin C, CHO and total solids), chemical (titrable acidity, pH), bioactive compounds (total phenolic, total flavonoid, total anthocyanin) and microbial (total viable count, yeast and mold count) parameters to evaluate the quality of the fig jam samples. The highest acidity and the lowest were 0.048±0.001 in honey fig jam and 0.0352±0.0002 in white sugar jam and brown sugar jam respectively. In case of nutritional quality of jam, the highest percentage of fiber, protein and vitamin C was 2.38±0.002, 5.95±0.05 and 8.00±0.1 respectively in case of honey fig jam. The study also revealed that the lowest moisture and ash percentage was 36.28±0.28 and 0.70±0.05 percent respectively in white sugar fig jam. The highest and the lowest TSS% were 67±1.00 and 66±1.00 in case of brown sugar fig jam and white sugar & honey fig jam respectively. It was found that all the phytochemical compound of fig jam samples was differed significantly ($p<0.01$). The highest TVC was 9.5×10^5 CFU/ml in honey fig jam and the lowest was 1.8×10^2 CFU/ml found in the white sugar fig jam sample. On the other hand, yeast and mold count was found negative in all of the samples. In this study, it was noticed that sensory evaluation of different fig jam (i.e.; White sugar, Brown sugar and Honey) was acceptable to consumers. The differences in flavor, mouth feel, sweetness and appearance were not statistically significant at the ($P>0.05$) at 5% level of significance. The quality of brown sugar fig jam from the nutritional, physical and chemical aspects was good compared to white sugar & honey fig jam but significant ($P<0.01$) variation were found among the samples.

Keywords: Jam, physicochemical, nutritional, phytochemical compound, sensory evaluation, white sugar, brown sugar, honey

Chapter 1: Introduction

It's important to eat a wide variety of fruits and vegetables since they are rich in nutrients, fiber, phytochemicals, and antioxidants. In theory, these compounds might improve human health (Yahia, 2010; Shui and Leong, 2006). Preliminary studies have suggested that consuming fruits may reduce the chance of developing certain illnesses. The health advantages of fruits, on the other hand, are highly processed. Nutritional and bioactive chemicals are affected by processing, which alters their content, activity, and bioavailability (Dhanavath and Katta, 2016). The majority of fruits are treated for safety and quality reasons, although a few are consumed raw (Nicoli et al., 1999). Because many fruits are seasonal and perishable, the nutrients and flavors they contain deteriorate quickly (Osvald and Stirn, 2008). Preservation methods, such as jam-making, are important due to fruits' seasonality and their tendency to go bad (Giannakourou and Taoukis, 2003).

Figs are deciduous trees that are coming from the southwest Asia and the Aegean. This plant was domesticated centuries ago. One million metric tons of fruits and vegetables are produced annually globally (Tanwar et al., 2014). Figs vary in color from dark purple to green (Solomon et al., 2006). Figs include nutraceutical compounds that may reduce cardiovascular disease and malignant cell growth (Allegra et al., 2017). Fig juice and honey may stop early-stage hemorrhages (Soni et al., 2014).

Polyphenols such as rutin, (-)-epicatechin, (+)-catechin and chlorogenic acid (up to 1.71 mg / 100 g fw) are found in fresh figs. 0.38 mg of Gallic acid and 0.10 mg of Syringic acid was found per 100 grams of fresh weight (Veberic et al., 2008). Hydroxycinnamic acid, flavonoid glycosides (quercetin-3-O-glucoside and quercetin-3-O-lucinoside), and psoralen and bergapten are also included in the list of components. In addition to figs, furanocoumarin has been discovered in beets. (Debib et al., 2018). Due to the obvious natural chemicals in figs, they are a popular ingredient in the Mediterranean diet (Petkova et al., 2019).

Jam is a common method for preserving fruit (Rababah et al., 2011). In order to avoid glut and utilize the surplus during the season, it is necessary to employ methods to extend storage life, for better distribution, to preserve them for utilization in the off

season both in large scale and home scale. Many processes designed to preserve food will involve a number of food preservation methods. It usually involves preventing the growth of bacteria, fungi (such as yeasts), and other microorganisms (although some methods work by introducing benign bacteria, or fungi to the food), as well as retarding the oxidation of fats that cause rancidity. Food preservation can also include processes that inhibit visual deterioration, such as the enzymatic browning reaction in apples after they are cut, which can occur during food preparation (Kodandaram et al., 2014).

Jam is semi-solid mass, which attained from the cooking fruit pulp and sugar followed by acid, pectin, flavours and colouring substances. Jams contain about 68.5% total soluble substances and 45% at least fruit pulp (Arsalan et al., 2020)

It is recommended by the Codex (2009) that jams include at least 65% of the TSS in the final product (Baker et al., 2001). There are many different types of jams and jellies, but they all start with the same basic ingredient: fruit (Shah et al., 2015). Fig jam made from whole green and ripe fruits is very popular in Bulgaria as a way to preserve the season's bounty (Petkova et al., 2019). Few researchers have looked into the impact of jam on antioxidant activity, Total Polyphenol Content and Total Anthocyanin Content. (Tanwar et al., 2014; Rababah et al., 2011).

An important consideration is how jam-making and storing affect fig nutrient value (Petkova et al., 2019). In order to make jam, the fruit pulp is heated with sugar until it thickens (Ranganna, 1977). Fruit preserves come in a variety of flavors, including pineapple, strawberry, apple, mango and mixed fruit.

Aim and Objectives

1. To prepare Fig Jam of different sweeteners (White Sugar Fig Jam, Brown Sugar Fig Jam and Honey Fig Jam).
2. To analyze and compare nutritional composition, bioactive compounds and antioxidant capacity among the prepared jams.
3. To compare the overall acceptability of the developed product.

Chapter 2: Review of Literature

2.1 Overview of Fig

Moraceae family member *Ficus carica L.* has milky latex in all parenchymatous tissue and unisexual blooms, as well as anatropous ovules and clustered drupes or achenes. It is a member of the enormous diversity of *Ficus species* (Barolo et al., 2014). Acene is the correct term for the Fig's ultimate product, which is located inside the Fig or siconio, and may be referred to as achenes (Vallejo et al., 2012). The fig's sweet and bulging flesh is a metaphor for the fertilized flower receptacles that have a fleshy and puffy appearance (Melgarejo, 1999). An evergreen tree native to southwest Asia, the fig (*Ficus carica L.*) is often planted in the Mediterranean area (Petkova et al., 2019).

Figure 2.1: Fig (*Ficus carica L.)* Fruit.

The fig is well-known across the world as a fruit that can be eaten, but it is really a syconium, which is an irregularly shaped container containing an inner out flower cluster (Arsalan et al., 2020). Moraceae genus Ficus (*Ficus carica*) includes the commonplace fig (*Ficus carica*), anjeer (Iran,Pakistan), and dumur fig (*Ficus carica*) (Bengali). In height, it may reach a height of 6.9–10m, (23–33 ft), with a white, smooth aril. These plants have savory leaves that range in length from 12–25 centimeters (4.7–9.8 in), width from 10–18 centimeters (3.9–7.1 in), and have 3–5 lobes. Many unisexual blooms adorn the inflorescence, which contains a fleshy pit known as the syconium. (Kodandaram et al., 2014).)

2.2 Taxonomy of Fig

Kingdom	Plantae
Subkingdom	Viridiplantae
Superdivision	Embryophyta
Division	Tracheophyta
Subdivision	Spermatophytina
Class	Magnoliopsida
Superorder	Rosanae
Order	Rosales
Family	Moraceae
Genus	Ficus L.
Species	*Ficus carica L.*

(Moraceae of North America Update, database (version 2011)

2.3 Origin and Distribution of Fig

Around the world, the tropics and subtropics are home to more than 800 different kinds of trees, shrubs, hemiepiphytes, climbers, and creepers (Stover et al., 2007). According to the Middle Eastern and Mediterranean diets, figs have been safeguarded as a weight-loss food from ancient times and are considered a symbol of good health in these regions (Arvaniti et al., 2019). It has been warned that the fig was originally grown in the East Mediterranean area, which then spread to the West Mediterranean region (Veberic et al., 2016).

The United Nations' FAOSTAT (2019) reports, fig fruit production in the arena is steady. There are 289,818 hectares of land under fig tree cultivation across the world, and 1,315,588 t of fig wood are expected to be produced there. Using Egypt, Morocco, Iran, Algeria, and Spain as a reference, Turkey is the leading worldwide producer in 2019, putting out 310,000 metric tons.

Because of this, the Mediterranean and Near Eastern regions remain of paramount importance in fig production. The primary European supplier of figs is Spain (51,600 metric tons), as measured by employing Greece (19,730 metric tons) and Italy (11,830 metric tons) (FAOSTAT. 2019). Turkey, Greece, Egypt, Morocco, Spain, Brazil, and other nations have warm, husky summers and mild winters (Soni et al., 2014). The

Middle east grows 75% of the world's figs. Figs are essential of the healthy, long-living Dietary patterns (Trichopoulou et al., 2006).

2.4 Importance of Fig in Our Food Regimen

Nutraceutical components present in figs reduce heart disease and cancer cell proliferation (Allegra et al., 2017). Laxative effects of fresh and dried figs, plus the syrup's (Morton, 1987). Figs are good for eye, liver, and heart health (Gani et al., 2018). Figs are used as an expectorant and fig juice and honey may cure diorrhea (Soni et al., 2014). Due to their antioxidant and antibacterial properties, dried fig macerates are popular (Debib et al., 2018).

The Mediterranean meal plan has been shown to improve health and well-being in those who adhere to it, notably with the assistance of preventing pathophysiological disorders linked to coronary heart disease and cancer (Vinson et al., 1999). Natural acids, vitamins E and carotenoids all act as antioxidants by removing free radicals from the body. This prevents the oxidative processes that might lead to degenerative diseases from taking place (DuToit et al., 2001).

As with antioxidative properties, the phenolic compounds contained in figs have antimutagenic or anticarcinogenic, antiinflammatory or antibacterial properties. Phenolic compounds (Eberhardt et al., 2000; Kim et al., 2000). For four hours after consumption, antioxidants in figs may protect plasma lipoproteins from oxidation and significantly boost plasma antioxidant capacity (Vinson et al., 2005).

It is often referred to as "Fig.". Flowering and fruiting parts of the F. Traditional Chinese Medicine (TCM) practitioners use carica to treat many conditions such as digestive problems like colitis and indigestion as well as respiratory concerns such as bronchitis or sore throat, as well as cardiovascular and inflammatory disorders (Shukranul et al., 2013). Experiments with fruit from F. Carica may be consumed fresh, dried, or made into jam. Figs are an excellent source of minerals, vitamins, CHO, and dietary fiber, in addition to having a small amount of fat and cholesterol and providing a broad range of important amino acids. Figs also have a small amount of fat and cholesterol (Ana et al., 2011). Many researchers mentioned that, figs have also been used historically as laxatives and as treatments for heart disease, lung disease, antispasmodic disorders, and inflammatory disorders (Guarrera, 2005). The treatment for bleeding consists of using freshly squeezed *F. carica* and honey (Shukranul et al., 2013).

A table summarizing twenty-one ancient and present usage of *Ficus carica*, as well as several ethnopharmacological reports, has been provided.

Uses	**Part**
Cardiovascular	Fig
Antidiarrheal	Fig, leaf and root
Indigestion	Fig, leaf and root
Loss of appetite	Fig, leaf and root
Colic treatment	Fig
Metabolic	Fig
Cough	Leaf
Respiratory	Fig
Antispasmodic	Fig
Anti-inflammatory	Fig
Antiplatelet, inflammatory, and gut motility	Fig
Antioxidant	Fig
Laxative	Fig
Prevention of nutritional anemia	Leaf
Anthelmintic	Leaf
Irritant potential	Leaf
Nutritive diet	Fruit
Various drug preparations	Fig fruit
Tuberculosis	Leaf
Anticancer	Fig
Mild laxative, expectorant, and diuretic	Fruit

(Shukranul et al., 2013)

2.5 Functional Properties and Phytochemicals

2.5.1 Functional Food

A piece of writing titled "Japan Explores the Boundary between Food and Medicine" appeared in Nature during 1993, coining the term "functional food." Dietary or food

ingredients defined as "functional" are those that may provide a fitness benefit beyond the standard vitamins they provide.

It can be said that the entire, enriched, fortified or higher components that assure fitness blessings beyond the availability of essential vitamins while consumers are consumed at effective levels as part of numerous weight reduction plans on a daily basis (Rama, 2019). The potential of helpful substances to alleviate disorder, promote fitness, and reduce fitness care expenses (Nicoletti, 2012).

2.5.2 Functional Foods from plant sources

A vegetative diet may abate the risk of long-term illness, including cancer, according to epidemiological, in vivo, in vitro, and clinical trial data. For the World Cancer Research Fund, excessive intake of vegetables and greens has a protective effect against some types of lung and stomach cancers (Boffetta et al., 2010). A negative relationship between the intake of fruits and vegetables and chronic illness, as well as certain types of malignancies, has been evaluated in various epidemiological studies. Schreiner and Huyskens-findings Keil's (2006) of the protective effects of phytochemicals have been corroborated by other researchers.

Phytochemicals are becoming more important in the field of health and fitness (Srivastava, 2011). In the US, Nutrition Labeling Education Act food labels has been passed, which mandates the labeling of vitamins for the majority of components, as well as the inclusion of disorder- or health-related information on the labels of food products (Marietta et al., 1999).

Hyperlipidemia as well as atherosclerosis are the causing factor of cardiovascular disease and demise in the majority of developed and developing nations today. An important risk factor for cardiovascular disease development is an elevated plasma cholesterol level (Félix-Redondo et al., 2013). It's vital to maintain the normal frame's capabilities by lowering the extended serum to safe levels. More beneficial elements have arisen from flowers since the dawn of the period of useful meals, and they've surfaced as an adjuvant therapy for a handful of ailments (Demigne et al., 1998).

Researchers are increasingly interested in food additives such as anthocyanin and other phenolic compounds because they may have health benefits, including a reduction in heart disease and cancer, in part because of their antioxidant activity (Seeram et al.,

2002). In light of the predicted $109 billion worth of beneficial food and beverage industry by 2010 (Watkins, 2008), various reassessments of phytochemicals are taking place. It is not rare to find polyphenols in liquid form owing to their beneficial physiological effects on physical fitness (Ina et al., 2002).

Additional research is needed to confirm the fitness benefits of these substances for which the weight-reduction plan-fitness correlations have not been properly scientifically established.

2.5.3 Phytochemicals

The bioactive, non-nutritive plant molecules found in plant sources, known as phytochemicals, have been linked to a reduction in the risk of many common but chronic illnesses (Zhang et al., 2015).

Ingredients derived from plants are thought to have a wide range of Phytochemicals and bioactive compounds, which have piqued the curiosity of researchers. When combined with complementary phytochemicals from unique reassessments (Shahidi 2008) claims that their synergistic effects can be achieved by using an aggregate of phytochemicals found in supply substances. These elements are crucial for bringing out the best in purposeful additives and indeed the desire for a healthy diet.

It is believed that more than 5,000 different phytochemicals have been found, but a significant proportion of those compounds are still a mystery. These compounds' identities must be unearthed before we can fully comprehend the positive effects they have on our health. In spite of this, there is compelling evidence that phytochemicals in fruits and vegetables may have much higher benefits than now recognized since free radicals are implicated in the genesis of a wide range of incurable illnesses (Ames and Gold, 1991).

An enormous amount of oxidizing agents is continuously ingested by the cells of humans and other animals on a daily basis. Natural sources like as air, food, and water may be used to get these sellers, or they can be made in the body utilizing metabolic processes. The body's optimal physiologic circumstances may be maintained as long as the body's oxidants and antioxidants are balanced. When the body's oxidative stress is constantly being overloaded by infections with bacteria, viruses, and parasites, an

imbalance may occur (Liu and Hotchkiss, 1995). Large macromolecules such as proteins, DNA, and lipids may be damaged by oxidative stress, which increases the risk of cancer and cardiovascular disease (Ames and Gold, 1991). Free radicals create oxidative stress, which must be countered by consuming enough antioxidants to do so. Cancer risk may be reduced by reducing the amount of oxidative damage to cells caused by polyphenols and carotenoids, which are abundant in fruits and vegetables (Van Breda and De kok, 2018).

2.5.4 Flavonoids

After discovering, Potter (1991) showed a link between a diet rich in fruits and vegetables and a lower risk of chronic illnesses, there has been a significant amount of interest in the flavonoid content of foods and plants. Several non-nutrients, perhaps bioactive chemicals, of which flavonoids form one class, have received attention as a consequence of decreased risk not correlating with traditional nutrients (Steinmetz and Potter, 1991).

Flavonoids are polyphenolic chemicals with a C_6-C_3-C_6 backbone. There are six structural categories for this group of plant pigments, that can be identified in a wide range of foods and plants, including fruits, roots, stems, vegetables, grains and flowers as well as tea, including anthocyanidins, flavan-3-ols, flavones, flavanones, flavanols and other flavanonol-containing compounds. An aglycone (substance) is usually glycosylated, although it may also be alkoxylated or esterified, depending on the kind of sugar it contains. As a consequence, plants have approximately 5000 distinct flavonoids that may be studied (Harborne and Williams, 1992). Analytical approaches for determining flavonoid content in a variety of plants were supported by use of the aluminum chloride advanced production, which is the most often used method (Grubesic et al., 2007).

Extracts from Mallow sabdariffa have been shown to contain two types of flavonoid: flavonols (gossypetin) and anthocyanins, according to a review of the literature (Bisset and Wichtl, 1994).

2.5.5 Anthocyanins

Plants also produce anthocyanins, a different family of colors. Various anthocyanidin types, sugar molecular types and amounts, and chemical synthesis group types distinguish the anthocyanins in their structural make-up. It's expected that

anthocyanins, because of their vibrant color and great water solubility, might replace artificial food dyes in the food supply chain (Mazza and Miniati, 1993). All food contains anthocyanins, which have a wide range of health benefits in addition to their color function. According to research, persons who drink red wine and eat red berries and grapes may be less likely to get heart disease because anthocyanins in these foods may reduce their risk of developing heart disease (IUFOST, 2009).

When anthocyanins donate chemical elements to highly reactive molecules, the chain reaction is disrupted and free radicals are prevented. Proper scientific evidence must be provided to back up any claims made about the health benefits of functional foods (Clydesdale, 1997).

2.5.6 Antioxidants

There are a number of antioxidants that may be responsible for preventing various illnesses linked to free radicals. Starting with initiating, propagating, and concluding, the process is connected to the loose radical mediated oxidative procedure. Numerous meals and the body as a whole both contribute for antioxidant production (Alam et al., 2020).

According to Wu et al. (2018), the fig extracts are high in anthocyanins but also have adequate antioxidant potential (DPPH IC50 = 4.06 mg/ml, ABTS IC50 = 3.7 mg/ml). The anthocyanins showed a certain degree of heat tolerance and a positive shade balance in an acidic environment.

Herbal pigments mostly in dried calyx of a fig called anthocyanins have been shown to have antioxidant properties as well as liver-protective properties. A study by Wang et al. (2000) examined the antioxidant bioactivity in the first hepatocytes of rats and the resulting hepatotoxicity. A significant reduction in lactate dehydrogenase leaking and malondialdehyde production, as well as lower levels of hepatic enzyme indicators such as alanine and aspartate aminotransferases, were reported in the presence of low quantities of fig anthocyanin (0.10 mg/ml and 0.20 mg/ml). In malignant cell lines, antioxidative activities were also recommended (Akim et al., 2011).

2.5.7 Phenolic Compounds

Compounds called phenolics are dietary nutrients that are found in abundance throughout the plant world. Many different chemical structures may be found in phenolics. Throughout the last few decades, their sensory qualities (shadeation and astringency) have been studied in food and drinks (Monagas et al., 2005).

There were 521.46 mg/100 g of phenol mostly in BJRI vegetable mesta-1 calyx, according to Mollah et al. (2020). Phenolic levels in figs extracts have already been reported as high as 546 micrograms per kilogram and as low as 582 micrograms per kilogram, in various studies. The phenolic content of the fig calyx is less varied across different fig genotypes than previously thought, according to several studies.

2.5.8 Anti-microbial Activity & Anti-fungal Activity

When tested against oral microorganisms, F. carica's methanol extract showed a strong antibacterial effect (MICs ranged from 0.156 to 5 mg/mL; MBCs ranged from 0.31 to 5 mg/mL). The synergistic effects of methanol extract with ampicillin or gentamicin on oral microorganisms indicated that figs might be used as a natural antibacterial agent, according to the results (Mi-Ran Jeong et al., 2009). F. carica latex extracts were tested for antibacterial properties in vitro against five bacterial species and seven traces of fungus using the disc-diffusion technique. Microsporum canis and ethyl acetate extracts were both highly inhibited by methanolic extract (75%), whereas Candida albicans was completely inhibited (100 percent) by a MIC of 500 g/mL and Cryptococcus neoforman was only marginally affected (Houda et al., 2010).

2.5.9 Medicinal and Health Benefits

Traditional medicine uses fig roots to treat ringworms and leucoderma and the pleasant, antipyretic, aphrodisiac, purgative and paralyzing properties of the final product have been shown to be helpful in inflammations and paralysis (Ross and Kasum, 2002). The antiviral, bactericidal, hypoglycemic, and anthelmintic properties of F. carica have been established (Wang et al., 2004; Solomon, 2006; Jeong et al., 2009). Many traditional natural medicines have been made from fig latex, with the majority of them aiming to treat viral skin diseases (Houda et al., 2010). Coumarins made up roughly 91% of the active components found in the latex of *Ficus carica*, according to one investigation. They found that *F. carica* latex has powerful anti-bacterial properties against a wide

range of bacteria species (Mi-Ran et al., 2009). *F. carica* latex's anti-inflammatory and antioxidant properties may be due to the presence of steroids and flavonoids, as well as its ability to scavenge free radicals, which are more prevalent in darker fruits than in lighter ones, according to recent studies. Hemorrhoids have traditionally been treated using the leaves of *Ficus carica* (Vaya and Mahmood, 2006).

Chapter 3: Materials and Methods

3.1 Study Area

The experiment was carried out in the various laboratories of Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram. More specifically, it was carried out in the department of Applied Chemistry and Chemical Technology, Applied Food Science and Nutrition, Food Processing and Engineering, Poultry Research and Training Center, and Animal Science and Nutrition.

3.2 Study Duration

The experiment was conducted for a period of eight months from 1st October 2021 to 31st May 2022.

3.3 Collection of Sample

Fresh samples of fig fruits were purchased from the market of Chattogram. Because of the wide range of colors available, fig fruits were carefully selected. Sugar, brown sugar, pectin, honey, citric acid, and glass jar was collected from various scientific stores.

3.4 Selection of the Method of Preservation

Boiling (to lower the fruit's moisture content and kill bacteria, yeasts, and other organisms), sugaring (to prevent their regrowth), and sealing in an airtight container were all steps in the preservation of fruit, such as jam (to prevent recontamination). Good jam has a soft even consistency without distinct pieces of fruit, a bright color, a good fruit flavor and a semi-jellied texture that is easy to spread but has no free liquid. A great advantage in its preparation is that it can be prepared in a single operation. For the preparation of good quality jam, the fruit should contain adequate amounts of pectin or pectin is added in required amounts. (Kodandaram et al., 2014).

3.5 Pre-Preparation of the Ingredients

Sorting and grading were done at first hand. The dirt was first removed from the fruits by washing. The fruit was graded according to its firmness, cleanliness, size, maturity, soundness, color, weight, form and absence of extraneous materials, insect damage and

mechanical harm. Grading being done based upon those criteria. The pulp of the figs was removed by hand after it had been graded. In order to achieve a fine pulp, it was first homogenized with a mixer. (Kodandaram et al., 2014)

3.6 Ingredients Used in Fig Jam

Fig: They should have a mildly sweet fragrance and should not smell sour, which is an indication that they may be spoiled. For the most antioxidants, choose fully ripened figs. For top quality, allow figs to ripen fully on the tree. They must be picked as they ripen or spoilage from the fruit beetle can occur. Figs have a low acid value, so you will need to acidify when canning.

Pectin: Pectin acts as a carbohydrate that causes fruit to gel. Some fruits like apples, grapes, figs and some plums contain enough pectin to form a gel, others require added pectin. We can add pectin to any fruit to ensure a good gel. Pectin may be added either in liquid or powdered form. Low or no sugar pectin can also be used which is extracted from the inner rinds of the citrus fruits and is chemically different from regular pectin.

Sweeteners: Jams need a number of sweeteners, including sugar, brown sugar or honey, as another vital component. Jams may be preserved longer with the addition of sweeteners such as sugar, brown sugar, or honey, all of which also contribute to the flavor. When preparing jam of any sort, adding insufficient sweeteners (sugar, brown sugar or honey) is one of the most frequent mistakes that may lead to failure. In order to produce a nice gel, sweeteners such as sugar, brown sugar or honey need to be present, and they need to be present in the appropriate amounts.

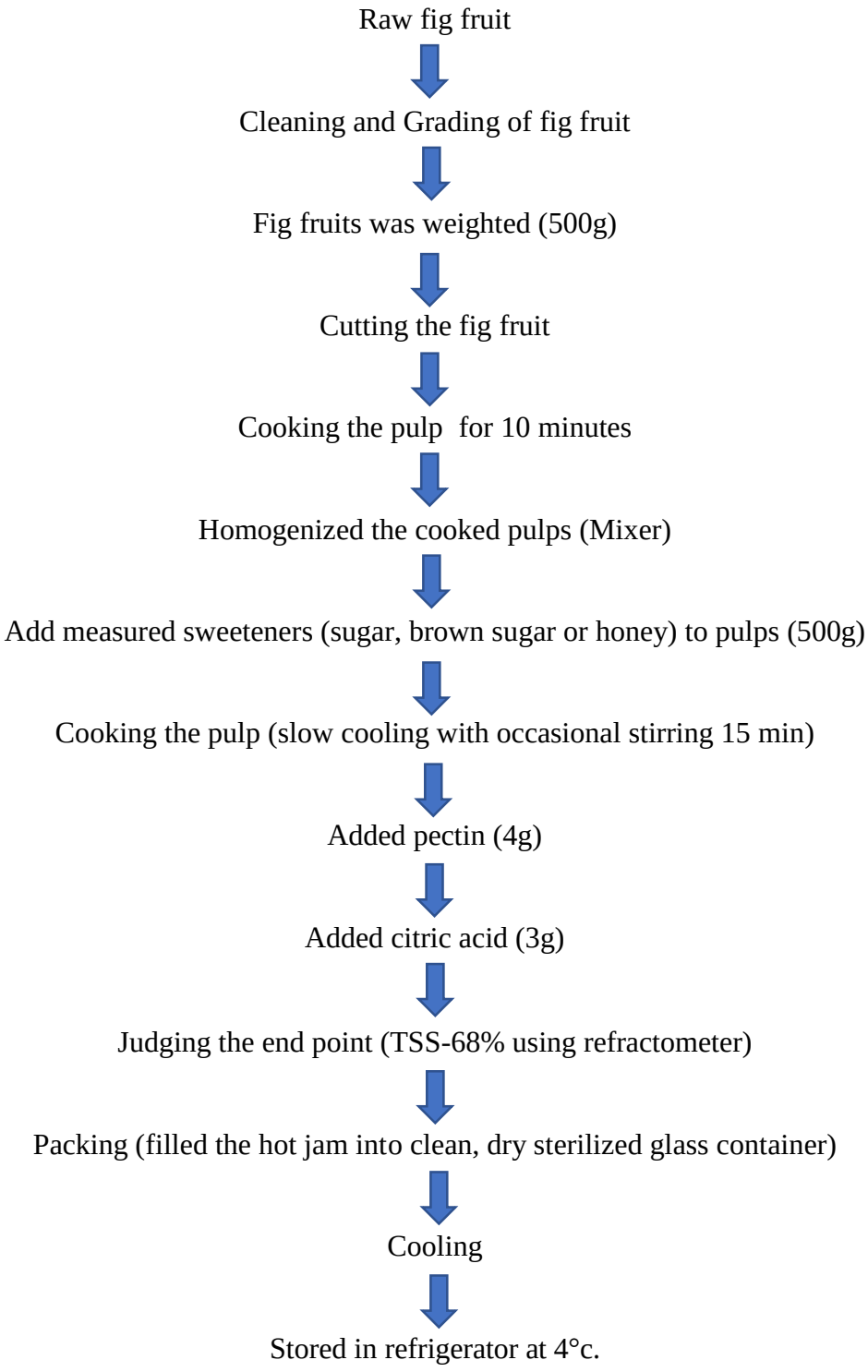
Citric acid: It is needed for gel formation and flavour. The amount of acid in fruits also varies with the fruit and degree of ripeness. When using low-acid fruits in recipes without commercial pectin, add 1 tablespoon lemon juice or 1/8 teaspoon citric acid for each cup of fruit.

3.7 Formulation of Different Jam Samples

To create a variety of fig jam samples, three different types of sweeteners were used in the sequence of Sample-1 (White Sugar Fig Jam), Sample-2 (Brown Sugar Fig Jam), and Sample-3 (Honey Fig Jam).

3.8 Preparation of Fig Jam

Jams are thick sweet spreads, made by cooking crushed or chopped fruits with sugar. By adding pectin, we need not depend up on fruits gelling quality for successful results. Jams are foods with many textures, flavors, and colors. They all consist of fruits preserved mostly by means of sugar and they mixture of fruits are usually called conserves, especially when they include citrus fruits, nuts, raisins, or coconut. Gelation gives fruit preserves their texture. Gelation depends on pectin, sugar, acid, and water.



(Kodandaram et al., 2014)

3.9 Physicochemical Analysis of Fig Jam

Fig jam was tested for moisture, total solid (including ash), total soluble solid (including ash), titratable acidity, pH in accordance with the procedures of AOAC (2016). Analyses of bioactive chemicals and antioxidants were performed on these samples, as well as proximate analyses.

3.9.1 Determination of pH

In chemistry, pH is a measure of the acidity or basicity of an aqueous solution. In technical terms, pH is the negative logarithm of the activity of the (solvated) hydronium ion, more often expressed as the measure of the hydronium ion concentrations. The pH scale is traceable to a set of standard solutions whose pH is established by international agreement. Primary pH standard values are determined using a concentration cell with transference, by measuring the potential difference between a hydrogen electrode and a standard electrode such as the silver chloride electrode. Measurement of pH for aqueous solutions can be done with a glass electrode and a pH meter, or using indicators, pH is defined as the decimal logarithm of the reciprocal of the hydrogen ion activity in a solution (McClements and Decker, 2010).

3.9.2 Total Soluble Solids

To determine the fruits' TSS, we used a hand refractometer. According to the American Oil and Gas Association's (AOAC) recommendations, an Atego RX 1000 digital refractometer was used to measure TSS, which we then converted to Brix, or the percentage of total soluble solids.

3.9.3 Total Dissolved Solids

The proportion of dissolved ionized solids in water affects the electrical conductivity, also known as specific conductivity, of the solution. A conductivity meter or TDS meter may be used to test the capacity of water to conduct an electric current due to the presence of ions from the dissolved particles. In conjunction with TDS observations in the lab, conductivity may be used to estimate TDS concentrations to within ten percent of their true value. The relationship of TDS and specific conductance of groundwater can be approximated by the following equation:

$$TDS = k_e EC$$

Electrical conductivity at 25°C is represented as microsiemens per centimeter per centimeter of water. In general, the conversion factor ke is between 0.55 and 0.80. (Atekwanaa et al.,2004).

3.9.4 Titratable Acidity

Analytical titration against N/10 NaOH with phenolphthalein indicator was used to calculate the acidity concentration in terms of anhydrous citric acid. Every time 10ml of juice was taken in a 100ml volumetric flask and the volume was raised up to 100ml by adding distilled water, 10ml diluted juice was titrated against N/10 NaOH, using phenolphthalein as an indicator. Titration is complete when pink color appears at the conclusion of the process. The titration was observed three times, with the average value being recorded each time. (AOAC, 2016).

3.10 Nutritional Composition

3.10.1 Moisture Content

By using the standard protocol of the Association of Official Analytical Chemists (AOAC), moisture content was calculated (AOAC, 2016).

3.10.2 Ash Content

Asbestos content was assessed using (AOAC, 2016) recommended procedures. The ash content is the inorganic residue that remains following the breakdown of organic materials. Pre-dried, dry crucibles were used to weigh 10 grams of dried jam. Afterwards, it was reduced to charcoal by the fire. The charcoal was then placed in a muffle furnace and heated at roughly 600°C for four hours until all of the charcoal was dissolved. Afterwards, the furnace was opened and the crucible was removed. It was thoroughly dried out in a desiccator and then weighed once it had dried out.

3.10.3 Estimation of Crude Fat

Principle: To determine fat content, food samples were dissolved in organic solvents (such as chloroform or methanol) and the filtrate was separated using filtering. The filtrate was placed into separating funnels, and the separated material was then dried to measure the extract and ultimately, the fat content was determined. A soxhlet apparatus was used to determine the crude fat content of the samples according to AOAC (2016) procedures.

3.10.4 Estimation of Crude Protein

Principle: It is possible to detect the nitrogen concentration of both organic and inorganic materials using the Kjeldahl technique. Nutritionists use Kjeldahl nitrogen measurements to calculate protein content in a wide range of meals and beverages. The Kjeldahl technique is used to measure nitrogen in wastewater, soil, and other substances. It is a recognized procedure that is detailed in a number of regulatory documents, including (AOAC, 2016).

3.10.4 Estimation of Crude Fiber

Principle: Cellulose, hemicellulose, and lignin make up the majority of crude fiber, a water-insoluble carbohydrate component. Fat-free meal samples are digested in a weak acid solution (1.25 percent H_2SO_4) for 30 minutes, followed by a weak alkali solution (1.25 percent NaOH) for 30 minutes, all at constant volume, and the ash in the residue is subtracted to arrive at an estimate. The AOAC technique was used to determine the crude fiber content (2016). Afterwards, the residue was heated in a muffle furnace (550-600°C, 4-6 hours) until it was reduced to white ash.

3.10.5 Determination of Total Carbohydrate

Calculating the difference between the Nitrogen Free Extractive Concentration and the carbohydrate content (NFE). Given as a difference between 100 and sum of the other proximate components.

3.10.6 Determination of Vitamin C

Chemically assay of the Vitamin C depends on the market reducing properties of the Vitamin C. Generally, Vitamin C is determined in plant or animal extract by its reducing action on the dyes stuff 2,6-dichloride phenol indophenols. In this matter, Vitamin C oxidized by the color dye to the dehydroascorbic acid. At the same time, the dye is reduced to the color less compound. S that end point of the reaction can easily determine. Rapid excretion and filtration are desirable as excess may be introduced in plant product by oxidized partially destroying Vitamin C during sampling and grinding. Oxidation is presented by the use of metaphosphoric acid during extraction. Strongly acidic solution will provide most accurate result. The titration should be complete

within one minute. The dye has blue color in aqueous solution. Pink in acidic solution and become colorless when completely reduced (AOAC, 2016).

Reagent requirement

Dye Solution

1. 260 mg of dye (2,6-dichlorophenol indophenols)
2. Dissolve 210 mg of sodium bicarbonate ($NaHCO_3$) in 100 ml of distilled water.

Metaphosphoric acid solution (3%)

1. 15/7.5mg of Metaphosphoric acid.
2. 40/20ml of glacial acetic acid dilutes to make 500/250 ml with distilled water.

Standard ascorbic acid solution

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

Procedure

1. Dye solution was taken in the burette to zero markings.
2. Then 5 ml Vitamin C solution was taken in a conical flask.
3. The conical flask was placed under the burette and the dye was added drop wise.
4. Titration was completed when pink color was appeared and stayed for 20 seconds and then disappeared.
5. The reading was taken at least 3 times.
6. The same procedure was performed for ascorbic acid solution of unknown concentration.

The result was expressed as milligram percentage (mg %).

3.10.7 Energy Estimation

The quantity of energy that is included in the chocolate carrot bar was calculated by first determining how much protein, fat, and carbohydrates were contained in the bar, and then using the following equation to the results (Baer et al., 1997).

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

3.11 Determination of Bioactive Compounds

Extract preparation

5 gm of sample was taken for TAC and 1 gm of sample was taken for other TPC and TFC in falcon tube. After that 10 ml absolute ethanol was added and left for 72 hours.

Continuous straining was done after 4 hours interval. After 72 hours, filtrate was collected and ethanoic extract found.

3.11.1 Total Phenolic Content (TPC)

The Folin-Ciocalteu reagent technique described with minor changes was used to determine the TPC of the extracts (Al-Owaisi et al., 2014). Based on the Folin-Ciocalteu technique provided by Vergani et al. (2016) with minor adjustments, the Fig jam's total polyphenol content was determined. Falconer tubes were filled with 1.5 ml of FC, and the mixture was incubated for 3 minutes at room temperature. The mixture was then treated with 1.5 cc of 7.5% Na2CO3 for 60 minutes. C_2H_5OH was used as the blank to measure the absorbance at a wavelength of 765 nm using a UV-VIS spectrometer (UV 2600, Shimadzu Corporation, USA). This compound's total phenolic content (TPC) was determined and is expressed as milligram gallic acid equivalents (GAE/g).

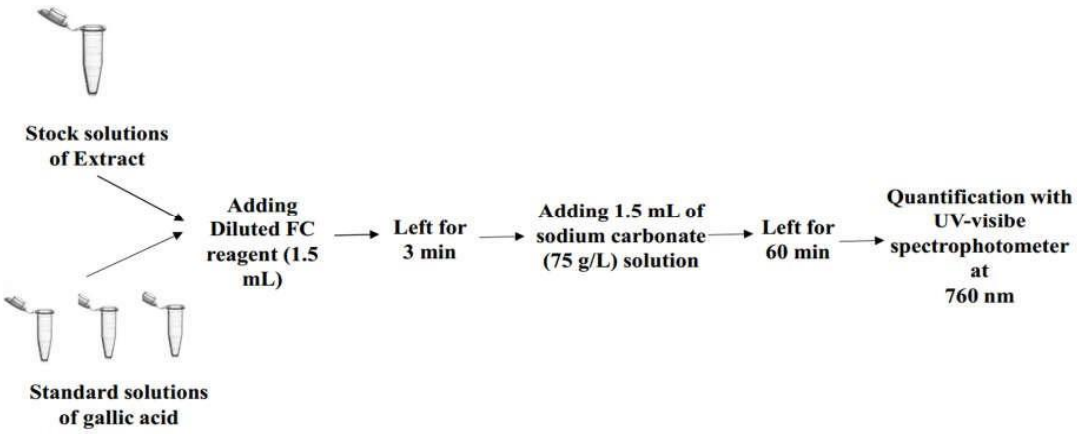


Figure 3.11.1 Determination of Total phenolic content (TPC)

3.11.2 Total Anthocyanin Content (TAC)

A 10mg/mL stock solution of the extracts was prepared for testing. A volume of 3 mL of the extract solution was pipetted into a cuvette for testing. A UV-VIS spectrophotometer was used to evaluate the extract color's intensity at 520nm wavelength. Since ethanol was employed as a control, the following equation may be used to get the TAC in milligrams per 100 ml:

TAC = Absorbance of sample × DF×100/M×E

Where,

The letters DF stand for "dilution factor," while the letter M refers to the weight of the sample that was used to produce the stock solution. The letter E stands for the extinction coefficient, which is 54.9. (Giusti and Wrolstad, 2001).

3.11.3 Total Flavonoid Content (TFC)

The total flavonoids content (TFC) of the samples was calculated by using a slightly modified version of the aluminum chloride colorimetric technique that was described by Chang et al., (2002). A stock solution of extracts at a concentration of 1 mg/mL was made, and aliquots of 0.5 mL of diluted extract were mixed with 1.5 mL of C_2H_5OH at a concentration of 95 percent in a cuvette. After that, 0.1 milliliters of a 10 percent $AlCl_3$ solution, 0.1 milliliters of a 1 mol/L potassium acetate solution, and 2.8 milliliters of distilled water were added to the immixture that was contained in the cuvette. The unmixed substance was kept out for half an hour at room temperature. The absorbance was measured at a wavelength of 415 nm using a UV-visible spectrophotometer (UV-2600, Shimadzu Corporation, USA), and a blank solution consisting of 10 percent aluminum chloride that had been replaced with D. H_2O of the same amount was used in the experiment. A quercetin standard curve was compared with the absorbance of the sample extracts in order to determine the total quantity of flavonoids present in the sample. TFC was calculated and shown as quercetin equivalents (mg QE/g) for each gram of extract.

3.12 Determination of Antioxidant Capacity by DPPH Scavenging Method

Extract Preparation

For this experiment, we used one milligram of the material in a Falcon tube. 10 ml of 100% methanol was added and left for 72 hours after that. Continual straining was carried out every four hours. Found methaneic extract in the filtrate after 72 hours of incubation.

Procedure

The DPPH test, reported by Azlim et al. (2010) with minor changes, was used to assess the extracts' antioxidant mobility. Methaneic DPPH solution was made by dissolving 6 milligram of DPPH in 100 mL of pure methanol.

After that, 2 ml of DPPH solution was added to 1 ml of methanoic extract. It was then gently shaking and left for 30 minutes at room temperature in a dark, cool location. A

UV-VIS spectrophotometer measured the absorbance at 517 nm. (UV-2600, Shimadzu Corporation, USA). One mL of water was mixed with two milliliters of DPPPH solution, while the other mL was used as a blank. It was found that when samples were compared to a DPPH standard solution, their absorbance fell. Based on the DPPH free radical scavenging mobility of extracts determined using the equation:

$$\% \text{ of inhibition} = \frac{\text{Blank absorbance - Sample absorbance}}{\text{Blank absorbance}} \times 100$$

There were two methods utilized for the calibration: Trolox as the standard and TEAC composite (Trolox equivalent antioxidant mobility). In terms of Trolox equivalents (TE) per gram of powder, the findings were given in milligrams/100 grams on a dry weight basis.

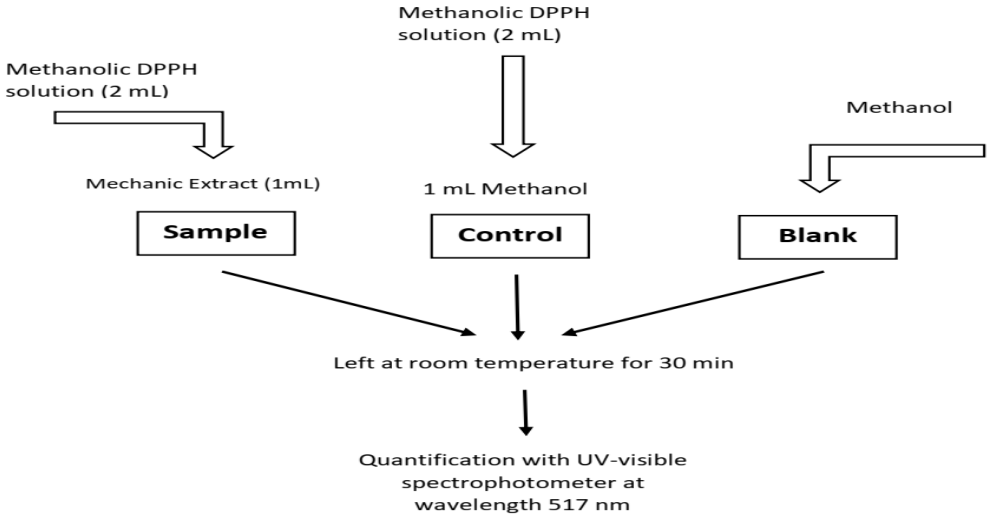


Figure 3.12: Determination of antioxidant capacity

3.13 Microbiological Analysis

3.13.1 Total Viable Count (TVC)

This test measures the number of bacteria in a sample by counting the number of aerobic plates. An aerobic plate count is known by several names, such as aerobic colony count (ACC), standard plate count, mesophilic count, and total plate count (TPC) (APC). The SPC method was used to calculate the TVC, or total viable bacterial count.

Because each cell is assumed to be capable of producing a visible colony, this test relies on this assumption. Rather of measuring the complete bacterial population, it is a general test for organisms that thrive aerobically at mesophilic temperatures (between 25°C and 40°C). Even though TVC cannot distinguish between various kinds of bacteria, it is a useful tool for evaluating the organoleptic acceptability, the sanitary

quality, and the compliance with good manufacturing procedures (GMPs). TVC may offer information about a food's shelf life or anticipated organoleptic change (Banwart, 2012).

Sample Preparation

Reliable analysis and interpretation of findings rely on proper sample collection. Sample should be indicative of overall bulk. In order to have a representative sample, the substance was properly blended. In a 250 ml flask, 25 g of Fig Jam was combined. 0.6 M KH_2PO_4 (pH 7.2) was used to dilute the sample. 100 ml of buffer saline was poured to the beaker and stirred. This volume was filled with buffer water. All equipment, solutions, and instruments should be sterilized for 15 minutes at 121°C. The sample was diluted 10 times (110-1) and used as stock solution (Andrews, 1992).

Dilution

Using 9 ml blanks, a series of dilutions were prepared as follows. The first dilution of 1/10 (1 ml in 9 ml) was carried out (b). Using a vortex mixer, this mixture was put together (c) (b) 1 ml was taken, added to (c) and well mixed. Ten to two times diluted. Using this method, the dilution was increased by a factor of 10-6.

Standard plate counts

The prepared and stored samples were analyzed using an SPC to determine the quantity of bacteria present. Indications of food quality or indicators of product shelf life might be derived from this information. Sterile pipettes were then used to transfer 1 ml of the diluted material into each sterile empty petri-dish at a temperature of 45°C. On a flat surface, plates were swirled to combine them. After the medium had solidified, the plates were inverted and incubated for 24 hours at 37 degrees Celsius (AOAC, 1990; Sharf, 1966).

Counting and Recording

For counting bacterial colonies, the quantity and ease of counting were taken into consideration while selecting the incubated plates. The plate comprising overlapping, separated, and confused colonies was ruled out. Colonies with a brightness of 30 to 250 were chosen.

Colony forming units (CFU)/g or ml. = average CFU plate x dilution factor. After preparing the sample, dilution, and standard plate counts, the count of viable bacteria

was completed. For 24 hours, the incubation was maintained at 37 degrees Celsius (AOAC, 1990; Sharf, 1966).

3.13.2 Fungal Analysis in Jam

Media Preparation

For the isolation of dermatophytes and other fungi, as well as yeasts, Sabouraud Dextrose Agar (SDA) is the best choice. This medium has a pH of roughly 5.0, which limits the development of bacteria, but allows the growth of yeasts and most filamentous fungi. Additionally, antibacterial agents may be added to enhance the antibacterial action. Fungi and yeasts thrive in SDA medium because it has an amino acid and nitrogenous component rich enzymatic digestion of casein and animal tissues. This medium is made using 40g dextrose, 15g agar, and 10 grams of mycological peptone (an enzyme digest of casein and animal tissues) at 25°C.

Autoclaving at 121°C for 15 minutes sterilized all of the material used in this study. Most selective agars for the cultivation and identification of mold and yeast cultures do not need precise nutritional requirements for development, despite their widespread use. There are several fungal strains that can thrive on Sabouraud Dextrose Agar. APHA (2012), FSSAI (2012), and Chen and Gu (2000) discuss the methods and techniques used in this study.

Procedure for Preparation of Media

To get things started, 65 g of the medium was mixed with 1 L water in a shaker. After that, the medium was thoroughly dissolved by heating it to a rolling boil and stirring it often. Autoclaved for 15 minutes at 121°C. Poured onto petri dishes at a temperature of 45°C to 50°C. The material was streaked over the medium using a sterile inoculating loop in order to separate colonies. The plates were then placed in an inverted orientation (agar side up) and incubated at 25-30°C with an increase in humidity. Weekly checks for fungal development were carried out on the cultures and they were kept for 4-6 weeks before they were declared negative (Aryal, 2015).

Interpretation

Plates should display solitary colonies in streaked regions and confluent growth in areas of strong injection after appropriate incubation. Try to find fungi with usual color and shape on your plate by looking at them It is necessary to conduct further tests to verify

the results. Colonies of yeast will be creamy to white in color. A variety of hues may be seen in the filamentous colonies of molds (Aryal, 2015).

3.14 Cost Analysis

Different Fig fruit jams were priced according to the total cost of the items used in their creation. According to our calculations, the price per kilogram of jam came out to be taka.

3.15 Sensory Evaluation

The overall acceptability of the finished product was determined by conducting a sensory review. After the product was produced, consumers were asked to taste-test it. Participants in the panel exam included both faculty and students from CVASU. The test was conducted on campus. The product derived from the Fig calyces was distributed to the 15 members of the panel. For each of the three formulas encoded with samples A, B, and C, there was a unique code. They sampled the six concoctions without telling the panelists their compositions. Sensory aspects such as flavor and sweetness were asked to be evaluated by panel members in order to determine the jam's overall acceptability and overall quality of taste. This technique does not, of course, represent real customer perception, but it does strongly highlight the traits that a high-quality product should have. Afterward, they gave each sample a score out of a possible ten. The six samples were evaluated using nine-point Hedonic measures for qualitative aspects such as taste, look, flavor, mouth feel, sweetness, and overall acceptance (Larmond, 1977). As a result of the way the scale was set up:

Table 3.15: Rating Scale for sensory evaluation

Ranks	Scores
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slight	4
Dislike moderately	3

Dislike very much	2
Dislike Extremely	1

3.16 Statistical Analysis

A Microsoft Excel 2019 spreadsheet was used to store and analyze statistical data. A total of three replicates were used for each sample. We used descriptive statistics to describe the proximate composition and sensory assessment of Fig Jam (mean ±standard deviation). IBM SPSS Statistics 25 was used to sort, code, and record the data. Statistics were compiled thereafter. One-way ANOVA were used to examine significant variance at a 95% confidence interval in the proximate composition, phytochemicals, antioxidant capacity, and sensory assessment data. Using the Post Hoc "Tukey" test, the variance in the sample groups was discovered. The statistical analysis was performed for a significant level of 5% ($p \leq 0.05$).

Chapter 4: Results

4.1 Physicochemical properties of Fig Jam

Table 4.1 illustrates that the highest acidity percentage was 0.048±0.001 in sample 3 and the acidity percentage of sample 1 and sample 2 were not differed significantly. In case of TDS, the highest percentage was 588±2.00 in sample 3 and the lowest was 408±2.00 in sample 1 shown in table 4. The highest TSS percentage was 67±1.00 in sample 2 and the lowest was 66±1.00 in case of sample 1 and 3. The average value of pH of sample 1, 2 and 3 was 4.7±0.10, 4.6±0.10 and 4.6±0.10 respectively which was not differed significantly.

Table 4.1: Physicochemical properties of Fig Jam

Component	**Formulation of Sample**			**1-ANOVA**	**Post-Hoc**
	Sample-1	**Sample-2**	**Sample-3**	**(P)**	
Acidity (%) (as Citric Acid)	0.0352±0.0002[a]	0.0352±0.0002[b]	0.048±0.001[ab]	0.000	Sample-1 vs Sample-2 are not Significant (P=1.00)
TDS (ppm)	408±2.00[a]	524±2.00[a]	588±2.00[a]	0.000	All are Highly Significant (P<0.001)
TSS (°B)	66±1.00	67±1.00	66±1.00	0.422	All are not Significant
pH	4.7±0.10	4.6±0.10	4.6±0.10	0.422	All are not Significant

Legends: Means ± SD and values in the same row with the same superscripts are statistically significant (P<0.05)
Sample A- White Sugar Fig Jam, Sample B- Brown Sugar Fig Jam, Sample C- Honey Fig Jam.

4.2 Nutritional Composition

Among the fig jam samples, lowest moisture percentage was 36.28±0.28 in sample 1 and the highest was 48.85±0.05 in sample 2 as shown in Table 4.2. In case of ash percentage, the highest percentage was 1.00±0.02 in sample 3 and the lowest percentage was 0.70±0.05 in sample 1. The lowest CHO percentage 42.43±0.193 in case of sample 3 and the highest was 59.00±0.148 in sample 1. The highest percentage of fiber, protein and vitamin c was 2.38±0.002, 5.95±0.05 and 8.00±0.1 respectively in case of sample 3. Table 4.2 shows that the highest energy content 251.36±0.830 found in sample 1 and the lowest was 197.63±0.261 in sample 2.

Table 4.2: Nutritional composition of Fig Jam

Component	**Formulation of Sample**			**1-ANOVA (P)**	**Post-Hoc**
	Sample-1	**Sample-2**	**Sample-3**		
Moisture (%)	36.28±0.28^{a}	48.85±0.05^{a}	48.13±0.13^{a}	0.000	All are Highly Significant (P<0.001)
Fiber (%)	1.8±0.03^{a}	2.04±0.04^{a}	2.38±0.02^{a}	0.000	All are Highly Significant (P<0.001)
Ash (%)	0.70±0.05^{ab}	0.97±0.03^{b}	1.00±0.02^{a}	0.000	Sample-2 vs Sample-3 are not Significant (P=0.585)
Fat (%)	0.07±0.002^{a}	0.05±0.003^{ab}	0.10±0.003^{b}	0.001	Sample-1 vs Sample-3 are not Significant (P=0.135)
Protein (%)	2.15±0.05^{a}	3.73±0.03^{a}	5.95±0.05^{a}	0.000	All are Highly Significant (P<0.001)
CHO (%)	59.00±0.148^{a}	44.36±0.087^{a}	42.43±0.193^{a}	0.000	All are Highly Significant (P<0.001)
Vitamin-C (mg/100g)	4.00±0.10^{a}	6.00±0.10^{a}	8.00±0.10^{a}	0.000	All are Highly Significant (P<0.001)
Energy (kcal/100g)	251.36±0.830^{a}	197.63±0.261^{a}	199.56±0.261^{a}	0.000	All are Highly Significant (P<0.001)

Legends: Means ± SD and values in the same row with the same superscripts are statistically significant (P<0.05)

4.3 Bioactive Compounds of Fig Jam

Table 4.3 shows that presence of bioactive components (TAC, TFC & TPC) in fig jam samples were tested in this study. Here, the highest amount of TAC was 61.30±0.645 found in sample 2 and the lowest was 14.53±0.559 in sample 1. In case of TFC, the highest amount was 29.89±0.034 in sample 3 and the lowest amount was 18.41±0.010 in sample 1. From the results, it was found that all the phytochemical compound of fig jam samples were differed significantly ($p<0.01$).

Table 4.3: Bioactive Compounds

Component	**Formulation of Sample**			**1-ANOVA (P)**	**Post-Hoc**
	Sample-1	**Sample-2**	**Sample-3**		
TAC (mg TA/100 mL)	14.53±0.559 [a]	61.30±0.645 [a]	24.41±0.322 [a]	0.000	All are Highly Significant (P<0.001)
TFC (mg QE/100 g)	18.41±0.010 [a]	25.17±0.069 [a]	29.89±0.034 [a]	0.000	All are Highly Significant (P<0.001)
TPC (mg GAE/100mL)	4.26±0.007 [a]	4±0.004 [a]	3.71±0.012 [a]	0.000	All are Highly Significant (P<0.001)

Legends: Means ± SD and values in the same row with the same superscripts are statistically significant (P<0.05)

TAC= Total Anthocyanin Content, TFC= Total Flavonoid Content, TPC= Total Phenolic Content

4.4 Antioxidant capacity

From the table 4.4, it was observed that antioxidant capacity was significantly highest (3.26±0.003 mg TE/100 g) in sample B and significantly lowest (3.22±0.005 mg TE/100 g) in sample A.

Table 4.4: Antioxidant Capacity of Fig Jam

Component	**Formulation of Sample (mg TE/100 g)**			**1-ANOVA (P)**	**Post-Hoc**
	Sample-1	**Sample-2**	**Sample-3**		
Antioxidant (mg GAE/100mL)	3.22±0.005 [a]	3.26±0.003 [a]	3.23±0.002 [a]	0.000	All are Highly Significant (P<0.001)

Legends: Means ± SD and values in the same row with the same superscripts are statistically significant (P<0.05)

4.5 Microbiological Analysis

Table 4.5 revealed total viable count and fungal count also determined from 0 day to 1 month after preparation of the jam. Samples were stored in 4°C temperature for 1 month for the evaluation. The presence of yeast and mold were not existing when the products were produced and after 1 month their presence had not been identified.

Table 4.5 also reveals that, after 1 month the highest TVC was 8.1×10^5 CFU/ml in case of brown sugar fig jam and the lowest was 9.5×10^4 CFU/ml found in the honey fig jam sample.

Table 4.5: Microbial Analysis

Formulation of Sample	**TVC (CFU/ml)**			**Mold and Yeast**		
	0 day	**15 days**	**1 Month**	**0 day**	**15 days**	**1 Month**
Sample-1	1.8×10^2	3.3×10^3	6.5×10^5	No growth	No growth	No growth
Sample-2	2.8×10^3	4.8×10^3	8.1×10^5	No growth	No growth	No growth
Sample-3	3.6×10^1	6.4×10^2	9.5×10^4	No growth	No growth	No growth

4.6 Sensory Evaluation

Among the different fig samples, taste of the sample 2 and 3 were statistically significant. In case of flavor, sweetness and appearance, the highest value was 7.90±0.738, 8.10±0.738 and 8.00±0.667 in sample 2 respectively which contains brown sugar. From the results, it was found that sample 2 is accepted overall evaluation

Table 4.6: Sensory Evaluation

Component	**Formulation of Sample**			**1-ANOVA (P)**	**Post-Hoc**
	Sample-1	**Sample-2**	**Sample-3**		
Taste	7.60±0.843[b]	8.30±0.483[a]	7.30±0.949 [a]	0.024	Sample-2 vs Sample-3 are Significant (P=0.022)
Flavor	7.50±0.707[a]	7.90±0.738[a]	7.30±0.675[a]	0.174	All are not Significant
Mouth Feel	7.90±0.994[a]	7.90±0.994[a]	7.50±0.850[a]	0.560	All are not Significant
Sweetness	7.50±0.972[a]	8.10±0.738[a]	6.80±1.317[a]	0.111	All are not Significant
Appearance	7.50±0.527[a]	8.00±0.667[a]	7.8±0.632[a]	0.203	All are not Significant
Overall Acceptability	7.80±0.789[b]	8.40±0.699[a]	7.50±0.850[a]	0.047	Sample-2 vs Sample-3 are Significant (P=0.041)

Legends: Means ± SD and values in the same row with the same superscripts are statistically significant (P<0.05)

4.7 Cost Analysis

In the table 4.7, Sample A- White sugar Fig Jam, Sample B- Brown sugar Fig Jam, Sample C- Honey Fig Jam with commercial pectin and citric acid. Per kg sample cost of sample-1 was 676.40 tk, sample-2 was 693.65 tk and sample-3 was 1153.65 tk. The preparation cost of sample-3 was significantly highest (1153.65 tk) and sample-1 was significantly lowest (676.40 tk).

Table 4.7: Production cost of Fig Jam

Heads	**Tk.** per Kg	**Quantity used (kg/1kg products)**	**Sample-1 (Tk)**	**Sample-2 (Tk)**	**Sample-3 (Tk)**
1)Expenditure Raw materials					
Fresh Fig	900	0.500	450.00	450.00	450.00
Sugar	70	0.500	35.00		
Brown Sugar	100	0.500		50.00	
Honey	900	0.500			450.00
Pectin	12000	0.004	48.00	48.00	48.00
Citric acid	1000	0.003	3.00	3.00	3.00
Sub total			536.00	551.00	951.00
2) Overhead cost @ 15% of raw material			80.40	82.65	142.65
3) Bottling cost	15 Tk./piece	4 pieces	60.00	60.00	60.00
Total production cost of 1kg Fig Jam			**676.40**	**693.65**	**1153.65**

Chapter 5: Discussion

The study was intended for the evaluation of nutritional composition and bioactive compounds found in different fig jam samples.

5.1 Physicochemical properties of Fig Jam

Titratable Acidity

The present study reveals that acidity percentage in fig jam samples was ranged from 0.035 to 0.048% which are greatly disagreed with the findings of Tanwar et al. (2014). Who demonstrated that TA from different fig products were ranged from 0.19 to 0.21%. Due to the use of citric acid as a preservative, it was observed that jam and nectar had a greater titratable acidity than the fruit pulp did. This was in contrast to the fruit pulp (Ordonez-Santos LE and Vazquez-Riascos A, 2010). Acidity of fig jam was increased due to the formation of acids by degradation of polysaccharides and oxidation of reducing sugar or by break down pectic substance and uronic acid reported by (Shah et al., 2015; Hussain et. al, 2008).

TDS

The average Total Dissolved Solids content of the fig jam samples was increased ranged from 408 to 588 for addition of sugar for the transformation of fig jam.

TSS

In this study, average TSS percentage was increased naturally because of addition sugar for the transformation of fig pulp into Fig jam. Nevertheless, the TSS of jam was greater than that of nectar, which was due to the fact that nectar was formulated by diluting it with water. The Total Soluble Sugar (TSS) of fig jam was ranged from 66-67% which were in accordance with the reported results for processed figs (Tanwar et al., 2014). It is possible that the total soluble contents of all of the samples may rise as a result of the presence of acid, which will cause insoluble polysaccharides to transform into soluble disaccharides. Due to the hydrolysisof starch into simple sugar, Ehsan et al. (2002) discovered that the total soluble solids content of watermelon and lemon jam rose from 70 to 70.8 °brix.

pH

Because citric acid was used as a preservative in the goods, the pH of jam was lower than that of fruit pulp. A pH of 4.7 was detected in the fig jam samples, which was slightly above the pH values reported by Rababah et al. (2011) and Tanwar et al. (2014)

for fruits and jams, respectively, which were determined to be between the range of 4 and 35. Preservative citric acid reduced the pH of fig jam, making it less acidic than fruits. According to Rababah et al. (2011) after five months of storage, the pH of apricot and fig jams decreased. The gelation of pectin and the durability of the prepared jams may be improved by lowering the pH. Samples of fig jam with different pH values had drastically different flavors and shelf lives. There may be an acidic chemical formed when pectic bodies are hydrolyzed and the sugar content is degraded. In part, the pH value changes over time because of the different composition of each sample (Rababah et al., 2011).

5.2 Nutritional Composition

Moisture Content

In present study, it is noticed that average percentage of moisture content of fig jam samples was ranged from 36.3 to 48.9 which are greatly disagreed with the findings of Tanwar et al. (2014) for fig jam which had 19.9% moisture content.

Ash Content

Natural increases in ash content may be attributable to the use of sugar to turn fruit pulp into jam, as was the case in this research.

Crude Fiber

According to Tanwar et al. (2014), the average crude fiber in fig jam samples varied from 1.8 to 2.38, which is greater than the stated number because to varietal variations. When compared to fig fruit pulp, the amount of crude fiber in fig jam dropped by 22% (p 0.05). Because sugar is used to sweeten fig jam, it has a lower crude fiber level than fruit.

Crude Fat

The crude fat level of fig jam samples varied from 0.07 to 0.10, perhaps owing to heat deterioration (Fennema, 1997). Crude fat content decreased by 65% and 39% (p 0.05) in fig jam and nectar, respectively. Higher temperatures degrade fats, reducing jam's fat content (Fennema, 1997).

Crude Protein

Fig jam had a lower crude protein content as a result of the heat treatment, which causes proteins to get denaturated or degraded, leading to a drop in the product's overall protein content (Whitaker, 1981). In this study, it is noticed that average percentage of protein

content of fig jam samples was higher ranged from 2.15 to 5.95 which are greatly disagreed with the findings of (Whitaker, 1981).

Carbohydrate

The present study revealed that all the fig jam samples was found to significantly increase when compared with fig fruit pulp greatly agreed with the findings of Tanwar et al. (2014). Fig jam (133%) and nectar (196%) had substantially more carbohydrates than fig fruit pulp (p 0.05). (2014). Sugar added during product development enhanced fig jam's carbohydrate content. Fig nectar has more carbs than jam since it's not heated (Whistler and Daniel, 1985). CHO content of fig jam might be increased due to the inversion of non-reducing sugar during storage. The inversion of non-reducing sugar was due to the presence of acid along with high temperature speed up the inversion process findings by Arsalan et al. (2020).

Vitamin C

In this study, tremendous decrease ranged from 4 to 8 % in vitamin C content of fig jam which are greatly agreed with the findings of vitamin C ranged from 25.10 to 40.35% Arsalan et al. (2020). Jawaheer et al. (2003) observed same effects between jam made from guava fruits. The vitamin C content of fig jam was decreased due to addition of sugar and use of heat treatment in the processing reported by Tanwar et al. (2014). This decrease also might due to oxidation taking place within the sample as well as enzymatic catalytic reaction taking place within the jam mass during storage (Arsalan et al., 2020). In addition, it is likely that oxidation is the primary cause of these vitamin C losses; in particular, the oxidation of vitamin C to dehydroascorbic acid, which is then followed by the hydrolysis of the latter to produce 2,3-diketogulconic acid, which then undergoes polymerization to produce other nutritionally inactive products (Dewanto et al., 2002). Tanwar et al. (2014) discovered that the amount of vitamin C in fig jam dropped by 84 percent and that the amount of vitamin C in fig nectar dropped by 49 percent when compared to fig fruit pulp. The present research found that storage conditions (Temperature, Time) affected ascorbic acid concentration in fig jam samples. Ascorbic acid is the most perishable vitamin. It's declining. Residual oxygen in the container head space (assuming glass is resistant to oxygen) may also reduce ascorbic acid, according to Arsalan et al. (2020).

Energy

In this study, energy content of fig jam samples was comparatively higher. Thermal breakdown of macronutrients during the production of fig jam led to a larger energy content.

5.3 Bioactive Compounds of Fig Jam

Total Anthocyanin Content (TAC)

From the results it was found that total anthocyanin content of fig jam was lower ranged from 14.53 to 24.41% when compared with fig fruit pulp greatly agreed with the findings of significantly ($p< 0.05$) lowest concentration of total anthocyanins reported by Tanwar et al., (2014). Losses of 79 % in fig jam and 33% ($p< 0.05$) in fig nectar was observed due to processing findings by Tanwar et al., (2014). Several factors such as pH, temperature, light, oxygen, metal ions and sugars are responsible for affecting the stability of anthocyanin in fruits and vegetables on processing and storage (Rhim, 2002).

Total Flavonoid Content (TFC)

The present study shows that total flavonoid content of fig jam samples was ranged from 18.41 to 29.89% which are greatly agreed with the findings of Tanwar et al. (2014) who demonstrated that TFC from different fig products were lower ranged from 0.4 to 4.4% when compared with fruit pulp. The total flavonoid content of fig jam was decreased significantly due to the addition of sugar in the processing which does not contribute to the flavonoid content of the products reported by Tanwar et al. (2014). The TFC also decreased mainly caused by chemical or thermal degradation of the flavonoids during processing findings by Crozier et al. (1995); Price and Rhodes (1997). In case of fig nectar, the flavonoid content increased by processing as extraction processes can release flavonoids from the rind (Tanwar et al., 2014) and this reveals comparatively lesser decrease in the flavonoid content of fig nectar than fig jam.

Total Phenolic Content (TPC)

According to Tanwar et al. (2014), the average TPC of the fig jam samples varied from 3.71 to 4.26 percent, which was lower than expected. Figure nectar and jam had a 25 percent and 52 percent reduction in total phenolics when compared to the fig pulp, respectively (Tanwar et al., 2014). Phenolic molecules, which are antioxidants, have

been shown by Titchenal and Dobbs (2004) to be oxidized during food storage and processing. In certain cases, phenolics may be destroyed by high temperatures or enzymatic activity, two physical and biological causes (Tanwar et al., 2014). Since high temperatures in the jam-making process usually inactivate polyphenol oxidase, the browning response of phenolics is not as noticeable as the jam is being made. Due to the cooking process, phenolic compounds may lose their useful characteristics (Kim and Zakour, 2004). When figs were stored in various ways, it had a considerable impact on their overall polyphenol concentration.

5.4 Antioxidant Capacity of Fig Jam

Antioxidant Activity

From the results it was found that the highest antioxidant capacity was detected higher in brown sugar fig jam. Antioxidant activity dropped markedly after freezing, although only slightly in the form of preserves. Similar reductions in antioxidant capacity throughout the 5 months storage period have been seen for orange, apricot, and fig jams (Rababah et al., 2011).

5.5 Microbial Analysis of Fig Jam

Total Viable Bacterial Count (TVC)

In this study, it is noticed that the total viable bacterial count was highest 9.5×10^5 CFU/ml in case of honey fig jam and the lowest was 1.8×10^2 CFU/ml found in the white sugar fig jam sample which was somewhat agreed by the findings of Mahdi et al. (2019) total viable bacterial count was 5 and $1.42x10^2$ CFU/g for Elrashidi el mizan strawberry and Menz gasser apricot, respectively. Jam manufacturing involves the application of extreme heat, which, together with the product's high pH and high sugar content, may result in a reduction in the number of microorganisms present in the finished product (Makanjuola et al., 2019). On the other hand, all Vitrac jam and all Hero jam sample were not detected in total viable bacterial count reported by Mahdi et al. (2019). On the contrary, all imported jam was higher for total viable bacterial count than the local jam (Mahdi et al., 2019).

Yeast and Mold Count

All types of fig jam sample showed no growth of yeasts and molds which was totally agreed with findings of Mahdi et al. (2019) who demonstrated that all Vitrac jam and

all Hero jam sample were not detected in Yeasts and molds. Mahdi et al. (2019) found that yeasts and molds count was 9 and 75 CFU/g for Halwani bros fig and Menz gasser apricot, respectively.

5.6 Sensory Evaluation of Fig Jam

Based on this research, it seems that various fig jams tasted just as well utilizing white sugar, brown sugar, or honey as sweeteners. For all of these features, however, fig jam got the best mean ratings. The variations in taste, mouth feel, sweetness, and appearance were found to be statistically insignificant at the ($P>0.05$) 5% level of significance in this investigation. When comparing samples 2 and 3, however, there were significant variations in flavor and overall acceptability ($P\leq0.05$) at a 5% level. Smell, texture, and flavor of the fig jam (sample 2) were the most highly rated sensory aspects (sample 2). In terms of taste, texture, and appearance, sample 2 fig jam (sample 2) was rated better than sample 1. When pectin was included in the fig jam (example 2), the spreadability of the jam was enhanced. However, the color of the fig jam has improved as a result of the employment of various sweeteners in its preparation. In general, the overall acceptability of fig fruit jam was considerably ($P\leq0.05$) altered by storage.

Chapter 6: Conclusion

The transformation of fig fruit pulp into jam resulted in a substantial rise in physicochemical qualities such as total soluble solids and total acidity, which led to a sizeable decline in pH as well as mineral composition. In addition, the amount of carbohydrates, and thus the calorie content, of fig fruit jam saw a large rise. In contrast, the microbiological quality of all three varieties of jam was found to be satisfactory. According to the findings of the research, the nutritional and physicochemical quality of brown sugar fig jam was superior to that of honey fig jam and white sugar fig jam.

Chapter 7: Recommendations and Future Perspectives

Currently, more than half of the population in our nation is affected by malnutrition. In these kinds of circumstances, fig jam might be an excellent source of the nutrients and energy since it is readily accessible in the rural parts of Bangladesh. In the process of making fig jam, our research came to a satisfying conclusion with positive results. Additionally, as a consequence of this, its economic worth and marketability have improved. The approach used on medium and large scales of manufacturing may be used by contemporary food enterprises. The following recommendations and perspectives are offered for the continuation of study activity based on the findings of the current investigation:

a) The current research may be carried out once more in order to verify the results of the experiments.
b) Due to the fact that it requires little effort to prepare. Additionally, it can be preserved for an extended period of time and is advised for use during the off season. From either perspective, from an economic perspective, it will be advantageous for those individuals who fall into the lower socio-economic segment.
c) The composition may be modified further and may try for making mixed jam with various recipes with different ratio of fruit.
d) In order to improve the quality of fig jam, more up-to-date methods of packing and storing it would be established.
e) The research will be useful from a therapeutic standpoint since they have medicinal properties.
f) It was possible to make statistically significant comparisons between the different sets of data because of the large sample size. Because of the limited sample size and the need for more research, we urge you to proceed with extreme care when interpreting our findings.
g) Similar study should be done for off-season fruits including papaya, mango, etc.
h) Sufficient actions need to be done to increase the nutritional content of jam that is available for purchase in stores.

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Appendices

Appendices A: Physicochemical properties of fig jam

Descriptives

Physicochemical properties of fig jam

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Mini.	Maxi.
						Lower Bound	Upper Bound		
Citric acid	Sample A	3	.0352	.0002	.00012	.0347	.0357	.04	.04
	Sample B	3	.0352	.0002	.00012	.0347	.0357	.04	.04
	Sample C	3	.0480	.0010	.00058	.0455	.0505	.05	.05
TDS	Sample A	3	408.00	2.000	1.15470	403.0317	412.9683	406.00	410.00
	Sample B	3	524.00	2.0000	1.15470	519.0317	528.9683	522.00	526.00
	Sample C	3	588.00	2.000	1.15470	583.0317	592.9683	586.00	590.00
TSS	Sample A	3	66.00	1.000	.57735	63.5159	68.4841	65.00	67.00
	Sample B	3	67.00	1.000	.57735	64.5159	69.4841	66.00	68.00
	Sample C	3	66.00	1.000	.57735	63.5159	68.4841	65.00	67.00
pH	Sample A	3	4.70	.100	.05774	4.4516	4.9484	4.60	4.80
	Sample B	3	4.60	.100	.05774	4.3516	4.8484	4.50	4.70
	Sample C	3	4.60	.100	.05774	4.3516	4.8484	4.50	4.70

Sample A= Control WS fig jam; Sample B= Brown sugar fig jam; Sample C= Honey fig jam

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Citric acid	Between Groups	.000	2	.000	455.111	.000
	Within Groups	.000	6	.000		
	Total	.000	8			
TDS	Between Groups	49952.000	2	24976.000	6244.000	.000
	Within Groups	24.000	6	4.000		
	Total	49976.000	8			
TSS	Between Groups	2.000	2	1.000	1.000	.422
	Within Groups	6.000	6	1.000		
	Total	8.000	8			
pH	Between Groups	.020	2	.010	1.000	.422
	Within Groups	.060	6	.010		
	Total	.080	8			

Post Hoc Tests

Dependent Variable	(I) Chemical_Test_of_ Fig_Jam	(J) Chemical_Test_of_ Fig_Jam	Std. Error	Sig.
Citric_acid	Control WS fig jam	Brown sugar fig jam	.00049	1.000
		Honey fig jam	.00049	.000
	Brown sugar fig jam	Control WS fig jam	.00049	1.000
		Honey fig jam	.00049	.000
	Honey fig jam	Control WS fig jam	.00049	.000
		Brown sugar fig jam	.00049	.000
TDS	Control WS fig jam	Brown sugar fig jam	1.63299	.000
		Honey fig jam	1.63299	.000
	Brown sugar fig jam	Control WS fig jam	1.63299	.000
		Honey fig jam	1.63299	.000
	Honey fig jam	Control WS fig jam	1.63299	.000
		Brown sugar fig jam	1.63299	.000
TSS	Control WS fig jam	Brown sugar fig jam	.81650	.483
		Honey fig jam	.81650	1.000
	Brown sugar fig jam	Control WS fig jam	.81650	.483
		Honey fig jam	.81650	.483
	Honey fig jam	Control WS fig jam	.81650	1.000
		Brown sugar fig jam	.81650	.483
pH	Control WS fig jam	Brown sugar fig jam	.08165	.483

		Honey fig jam	.08165	.483
	Brown sugar fig jam	Control WS fig jam	.08165	.483
		Honey fig jam	.08165	1.000
	Honey fig jam	Control WS fig jam	.08165	.483
		Brown sugar fig jam	.08165	1.000

*. The mean difference is significant at the 0.05 level.

Appendices B: Nutritional Composition fig jam

Descriptives

Nutritional Composition of Fig Jam

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Mini	Maxi
						Lower Bound	Upper Bound		
Moisture	Sample A	3	36.2800	.28000	.16166	35.5844	36.9756	36.00	36.56
	Sample B	3	48.8500	.05000	.02887	48.7258	48.9742	48.80	48.90
	Sample C	3	48.1300	.13000	.07506	47.8071	48.4529	48.00	48.26
Fibre	Sample A	3	1.8000	.03000	.01732	1.7255	1.8745	1.77	1.83
	Sample B	3	2.0400	.04000	.02309	1.9406	2.1394	2.00	2.08
	Sample C	3	2.3800	.02000	.01155	2.3303	2.4297	2.36	2.40
	Total	9	2.0733	.25382	.08461	1.8782	2.2684	1.77	2.40
Ash	Sample A	3	.7000	.05000	.02887	.5758	.8242	.65	.75
	Sample B	3	.9700	.03000	.01732	.8955	1.0445	.94	1.00
	Sample C	3	1.0000	.02000	.01155	.9503	1.0497	.98	1.02
Fat	Sample A	3	.07000	.002000	.001155	.06503	.07497	.068	.072

	Sample B	3	.05000	.003000	.001732	.04255	.05745	.047	.053
	Sample C	3	.10900	.018248	.010536	.06367	.15433	.097	.130
Protein	Sample A	3	2.1500	.05000	.02887	2.0258	2.2742	2.10	2.20
	Sample B	3	3.7300	.03000	.01732	3.6555	3.8045	3.70	3.76
	Sample C	3	5.9500	.05000	.02887	5.8258	6.0742	5.90	6.00
Carbohydrate	Sample A	3	59.0000	.14800	.08545	58.6323	59.3677	58.85	59.15
	Sample B	3	44.3600	.08700	.05023	44.1439	44.5761	44.27	44.45
	Sample C	3	42.4310	.19665	.11354	41.9425	42.9195	42.23	42.62
Vitamin_C	Sample A	3	4.0000	.10000	.05774	3.7516	4.2484	3.90	4.10
	Sample B	3	6.0000	.10000	.05774	5.7516	6.2484	5.90	6.10
	Sample C	3	8.0000	.10000	.05774	7.7516	8.2484	7.90	8.10
Energy	Sample A	3	251.3590	.83020	.47932	249.2967	253.4213	250.53	252.19
	Sample B	3	197.6290	.26130	.15086	196.9799	198.2781	197.37	197.89
	Sample C	3	199.3649	.45061	.26016	198.2455	200.4843	198.94	199.84

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Moisture	Between Groups	298.946	2	149.473	4585.058	.000
	Within Groups	.196	6	.033		
	Total	299.141	8			
Fibre	Between Groups	.510	2	.255	263.586	.000
	Within Groups	.006	6	.001		
	Total	.515	8			
Ash	Between Groups	.164	2	.082	64.658	.000
	Within Groups	.008	6	.001		
	Total	.171	8			
Fat	Between Groups	.005	2	.003	23.419	.001
	Within Groups	.001	6	.000		
	Total	.006	8			
Protein	Between Groups	21.865	2	10.932	5558.847	.000
	Within Groups	.012	6	.002		
	Total	21.877	8			
Carbohydrate	Between Groups	492.582	2	246.291	10842.509	.000
	Within Groups	.136	6	.023		
	Total	492.719	8			
Vitamin_C	Between Groups	24.000	2	12.000	1200.000	.000
	Within Groups	.060	6	.010		
	Total	24.060	8			
Energy	Between Groups	5593.313	2	2796.656	8734.491	.000
	Within Groups	1.921	6	.320		
	Total	5595.234	8			

Post Hoc Tests

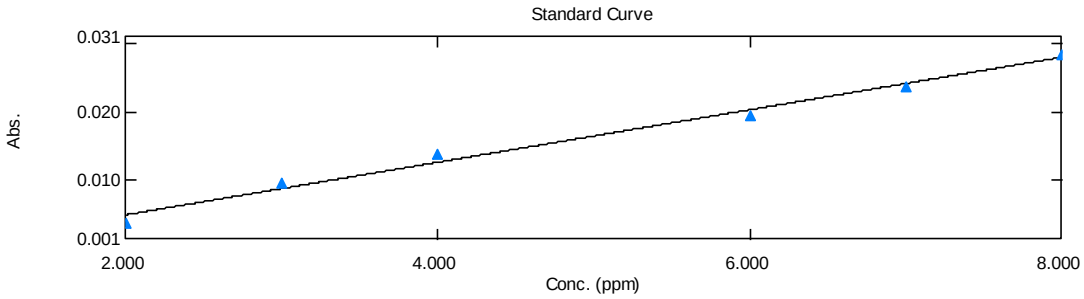
Dependent Variable	(I) Nutritional_Composition_of_Fig_Jam	(J) Nutritional_Composition_of_Fig_Jam	Std. Error	Sig.
Moisture	Control WS fig jam	Brown sugar fig jam	.14742	.000
		Honey fig jam	.14742	.000
	Brown sugar fig jam	Control WS fig jam	.14742	.000
		Honey fig jam	.14742	.007
	Honey fig jam	Control WS fig jam	.14742	.000
		Brown sugar fig jam	.14742	.007
Fibre	Control WS fig jam	Brown sugar fig jam	.02539	.000
		Honey fig jam	.02539	.000
	Brown sugar fig jam	Control WS fig jam	.02539	.000
		Honey fig jam	.02539	.000
	Honey fig jam	Control WS fig jam	.02539	.000
		Brown sugar fig jam	.02539	.000
Ash	Control WS fig jam	Brown sugar fig jam	.02906	.000
		Honey fig jam	.02906	.000
	Brown sugar fig jam	Control WS fig jam	.02906	.000
		Honey fig jam	.02906	.585
	Honey fig jam	Control WS fig jam	.02906	.000
		Brown sugar fig jam	.02906	.585
Fat	Control WS fig jam	Brown sugar fig jam	.008769	.135
		Honey fig jam	.008769	.010
	Brown sugar fig jam	Control WS fig jam	.008769	.135
		Honey fig jam	.008769	.001
	Honey fig jam	Control WS fig jam	.008769	.010
		Brown sugar fig jam	.008769	.001
Protein	Control WS fig jam	Brown sugar fig jam	.03621	.000
		Honey fig jam	.03621	.000
	Brown sugar fig jam	Control WS fig jam	.03621	.000
		Honey fig jam	.03621	.000
	Honey fig jam	Control WS fig jam	.03621	.000
		Brown sugar fig jam	.03621	.000
Carbohydrae	Control WS fig jam	Brown sugar fig jam	.12306	.000
		Honey fig jam	.12306	.000
	Brown sugar fig jam	Control WS fig jam	.12306	.000
		Honey fig jam	.12306	.000
	Honey fig jam	Control WS fig jam	.12306	.000
		Brown sugar fig jam	.12306	.000
Vitamin_C	Control WS fig jam	Brown sugar fig jam	.08165	.000
		Honey fig jam	.08165	.000
	Brown sugar fig jam	Control WS fig jam	.08165	.000

		Honey fig jam	.08165	.000
	Honey fig jam	Control WS fig jam	.08165	.000
		Brown sugar fig jam	.08165	.000
Energy	Control WS fig jam	Brown sugar fig jam	.46201	.000
		Honey fig jam	.46201	.000
	Brown sugar fig jam	Control WS fig jam	.46201	.000
		Honey fig jam	.46201	.022
	Honey fig jam	Control WS fig jam	.46201	.000
		Brown sugar fig jam	.46201	.022

*. The mean difference is significant at the 0.05 level.

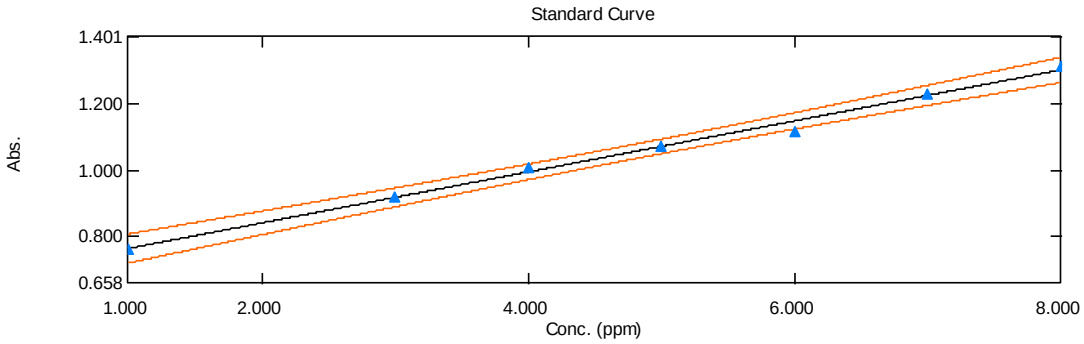
Appendices C: Bioactive Compound fig jam

Standard curve of TFC



y = 0.00385110 x - 0.00271158
r2 = 0.98868

Standard curve of TPC



y = 0.0768527 x + 0.687090
r2 = 0.99301

Descriptives

Bioactive Compound fig jam

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Mini	Maxi
						Lower Bound	Upper Bound		
TAC	Sample A	3	14.5340	.55900	.32274	13.1454	15.9226	13.98	15.09
	Sample B	3	61.3037	.64548	.37267	59.7002	62.9071	60.93	62.05
	Sample C	3	24.4097	.32274	.18633	23.6079	25.2114	24.04	24.60
TFC	Sample A	3	18.4067	.01002	.00578	18.3818	18.4315	18.40	18.42
	Sample B	3	25.1733	.06937	.04005	25.0010	25.3457	25.10	25.23
	Sample C	3	29.8927	.03470	.02004	29.8065	29.9789	29.86	29.93
TPC	Sample A	3	4.2593	.00723	.00418	4.2414	4.2773	4.25	4.26
	Sample B	3	4.0003	.00416	.00240	3.9900	4.0107	4.00	4.01
	Sample C	3	3.7113	.01290	.00745	3.6793	3.7434	3.70	3.72

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TAC	Between Groups	3646.098	2	1823.049	6563.375	.000
	Within Groups	1.667	6	.278		
	Total	3647.764	8			
TFC	Between Groups	199.988	2	99.994	49040.726	.000
	Within Groups	.012	6	.002		
	Total	200.000	8			

TPC	Between Groups	.451	2	.225	2865.928	.000
	Within Groups	.000	6	.000		
	Total	.451	8			

Post Hoc Tests

Dependent Variable	(I) Bioactive_Compound_of_Fig_Jam	(J) Bioactive_Compound_of_Fig_Jam	Std. Error	Sig.
TAC	Control WS fig jam	Brown sugar fig jam	.43032	.000
		Honey fig jam	.43032	.000
	Brown sugar fig jam	Control WS fig jam	.43032	.000
		Honey fig jam	.43032	.000
	Honey fig jam	Control WS fig jam	.43032	.000
		Brown sugar fig jam	.43032	.000
TFC	Control WS fig jam	Brown sugar fig jam	.03687	.000
		Honey fig jam	.03687	.000
	Brown sugar fig jam	Control WS fig jam	.03687	.000
		Honey fig jam	.03687	.000
	Honey fig jam	Control WS fig jam	.03687	.000
		Brown sugar fig jam	.03687	.000
TPC	Control WS fig jam	Brown sugar fig jam	.00724	.000
		Honey fig jam	.00724	.000
	Brown sugar fig jam	Control WS fig jam	.00724	.000
		Honey fig jam	.00724	.000
	Honey fig jam	Control WS fig jam	.00724	.000
		Brown sugar fig jam	.00724	.000

*. The mean difference is significant at the 0.05 level.

Appendices D: Antioxidant Capacity of Fig Jam

Descriptives

Antioxidant Capacity of Fig Jam

Anti_Oxidant_Capacity

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Mini	Maxi
					Lower Bound	Upper Bound		
Sample A	3	3.2187	.00058	.00033	3.2172	3.2201	3.22	3.22

Sample B	3	3.2617	.00351	.00203	3.2529	3.2704	3.26	3.27
Sample C	3	3.2300	.00265	.00153	3.2234	3.2366	3.23	3.23

ANOVA					
Anti_Oxidant_Capacity					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.003	2	.001	227.305	.000
Within Groups	.000	6	.000		
Total	.003	8			

Post Hoc Tests

(I) Antioxidant_Activity_of_Fig_Jam	(J) Antioxidant_Activity_of_Fig_Jam	Mean Difference (I-J)	Std. Error	Sig.
Control WS fig jam	Brown sugar fig jam	-.04300*	.00209	.000
	Honey fig jam	-.01133*	.00209	.004
Brown sugar fig jam	Control WS fig jam	.04300*	.00209	.000
	Honey fig jam	.03167*	.00209	.000
Honey fig jam	Control WS fig jam	.01133*	.00209	.004
	Brown sugar fig jam	-.03167*	.00209	.000

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

Anti_Oxidant_Capacity				
Tukey HSD[a]				
Antioxidant_Activity_of_Fig_Jam	N	Subset for alpha = 0.05		
		1	2	3
Control WS fig jam	3	3.2187		
Honey fig jam	3		3.2300	
Brown sugar fig jam	3			3.2617
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 3.000.

Appendices E: Sensory Evaluation of Fig Jam

Descriptives

Sensory Evaluation of Fig Jam

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Mini	Maxi
						Lower Bound	Upper Bound		
Taste	Sample A	20	7.6000	.84327	.26667	6.9968	8.2032	6.00	9.00
	Sample B	20	8.3000	.48305	.15275	7.9544	8.6456	8.00	9.00
	Sample C	20	7.3000	.94868	.30000	6.6214	7.9786	6.00	9.00
Flavour	Sample A	10	7.5000	.70711	.22361	6.9942	8.0058	6.00	8.00
	Sample B	10	7.9000	.73786	.23333	7.3722	8.4278	7.00	9.00
	Sample C	10	7.3000	.67495	.21344	6.8172	7.7828	6.00	8.00
Mouth_feel	Sample A	10	7.9000	.99443	.31447	7.1886	8.6114	6.00	9.00
	Sample B	10	7.9000	.99443	.31447	7.1886	8.6114	6.00	9.00
	Sample C	10	7.5000	.84984	.26874	6.8921	8.1079	6.00	9.00
	Total	30	7.7667	.93526	.17075	7.4174	8.1159	6.00	9.00
Sweetners	Sample A	10	6.6000	2.45855	.77746	4.8413	8.3587	.00	8.00
	Sample B	10	8.1000	.73786	.23333	7.5722	8.6278	7.00	9.00
	Sample C	10	6.8000	1.31656	.41633	5.8582	7.7418	5.00	9.00
Appearance	Sample A	10	7.5000	.52705	.16667	7.1230	7.8770	7.00	8.00

	Sample B	10	8.0000	.66667	.21082	7.5231	8.4769	7.00	9.00
	Sample C	10	7.8000	.63246	.20000	7.3476	8.2524	7.00	9.00
Overall_acceptability	Sample A	10	7.8000	.78881	.24944	7.2357	8.3643	6.00	9.00
	Sample B	10	8.4000	.69921	.22111	7.8998	8.9002	7.00	9.00
	Sample C	10	7.5000	.84984	.26874	6.8921	8.1079	6.00	9.00

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Taste	Between Groups	5.267	2	2.633	4.283	.024
	Within Groups	16.600	27	.615		
	Total	21.867	29			
Flavour	Between Groups	1.867	2	.933	1.867	.174
	Within Groups	13.500	27	.500		
	Total	15.367	29			
Mouth_feel	Between Groups	1.067	2	.533	.593	.560
	Within Groups	24.300	27	.900		
	Total	25.367	29			
Sweetners	Between Groups	13.267	2	6.633	2.391	.111
	Within Groups	74.900	27	2.774		
	Total	88.167	29			
Appearance	Between Groups	1.267	2	.633	1.693	.203
	Within Groups	10.100	27	.374		
	Total	11.367	29			
Overall_acceptability	Between Groups	4.200	2	2.100	3.436	.047
	Within Groups	16.500	27	.611		
	Total	20.700	29			

Post Hoc Tests

Dependent Variable	(I) Sensory_evaluation	(J) Sensory_evaluation	Mean Difference (I-J)	Std. Error	Sig.
Taste	Sample A	2.00	-.70000	.35066	.132
		3.00	.30000	.35066	.672
	Sample B	1.00	.70000	.35066	.132
		3.00	1.00000*	.35066	.022
	Sample C	1.00	-.30000	.35066	.672
		2.00	-1.00000*	.35066	.022
Flavour	Sample A	2.00	-.40000	.31623	.427
		3.00	.20000	.31623	.804
	Sample B	1.00	.40000	.31623	.427
		3.00	.60000	.31623	.159
	Sample C	1.00	-.20000	.31623	.804
		2.00	-.60000	.31623	.159
Mouth_feel	Sample A	2.00	.00000	.42426	1.000
		3.00	.40000	.42426	.618
	Sample B	1.00	.00000	.42426	1.000
		3.00	.40000	.42426	.618
	Sample C	1.00	-.40000	.42426	.618
		2.00	-.40000	.42426	.618
Sweetners	1.00	2.00	-1.50000	.74486	.128
		3.00	-.20000	.74486	.961
	2.00	1.00	1.50000	.74486	.128
		3.00	1.30000	.74486	.207
	3.00	1.00	.20000	.74486	.961
		2.00	-1.30000	.74486	.207
Appearance	Sample A	2.00	-.50000	.27352	.180
		3.00	-.30000	.27352	.524
	Sample B	1.00	.50000	.27352	.180
		3.00	.20000	.27352	.747
	Sample C	1.00	.30000	.27352	.524
		2.00	-.20000	.27352	.747
Overall_ acceptability	Sample A	2.00	-.60000	.34960	.218
		3.00	.30000	.34960	.671
	Sample B	1.00	.60000	.34960	.218
		3.00	.90000*	.34960	.041
	Sample C	1.00	-.30000	.34960	.671
		2.00	-.90000*	.34960	.041

*. The mean difference is significant at the 0.05 level.

Appendix F: Questionnaire for Hedonic test of fig jam

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,A- White sugar Fig Jam.

B- Brown sugar Fig Jam.

C- Honey Fig Jam.

Hedonic	Taste			Flavour			Mouth feel			Sweetness			Appearance			Overall Acceptability		
Sample	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Like Extremely																		
Like very much																		
Like moderately																		
Like slightly																		
Neither like or dislike																		
Dislike slightly																		
Dislike moderately																		
Dislike very much																		
Dislike Extremely																		
Comments																		

Appendix G: Photo Gallery

Raw Fig Fruit

Cleaning and Grading

Weighted the Fig Fruits

Cutting Fig Fruit

Blanching

Homogenization

Adding White Sugar

Adding Brown Sugar

Adding Honey

Cooking

Adding Pectin

Adding Citric Acid

Judging End Point

Packing

Stored at 4°C

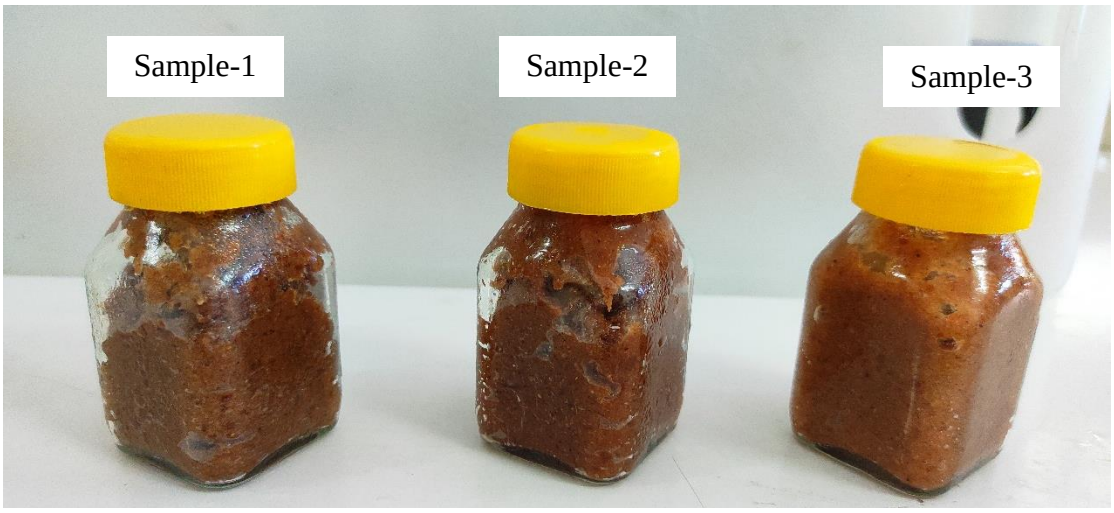


Fig Jam

pH Determination

TDS Determination

Acidity & Vitamin-C Determination

Protein Digestion

Fat Determination

Ash Determination

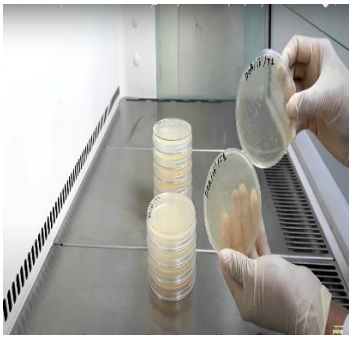
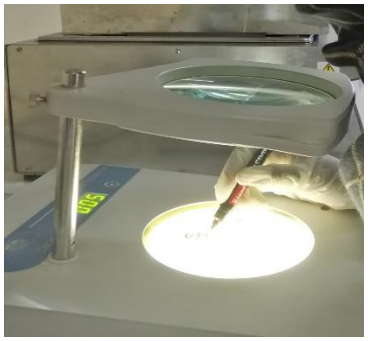
Crude Fiber Determination

Ethanoic Extract Preparation

Working in UV Spectrophotometer



Sensory Evaluation

Microbiological Analysis

Brief Biography

Md. Masuduzzaman Manik passed the Secondary School Certificate Examination in 2011 from BAF Shaheen College, Jashore, Bangladesh and also Higher Secondary Certificate Examination in 2013 from BAF Shaheen College, Jashore, Bangladesh. 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 improving the health status of people through proper guidance and suggestions and to create awareness among people about food safety and nutrition.