DEVELOPMENT AND QUALITY EVALUATION OF JELLY PREPARED FROM MARYAAM, AJWA AND AMBAAR DATES (*Phoenix dactylifera* L.)

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Examination Roll No: 0120/02

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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

Department of Applied Chemistry and Chemical Technology

Faculty of Food Science & Technology

Chattogram Veterinary and Animal Sciences University

Chattogram-4225, Bangladesh

June 2022

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This is to certify that we have examined the above Master's thesis and have found that the thesis is complete and satisfactory in all respects and that all revisions required by the thesis examination committee have been made.

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June 2022

Dedication

DEDICATED

TO

MY BELOVED PARENTS

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PLAGIARISM VERIFICATION

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Table Of Contents

List of Tables

List of Figures

List of Abbreviations

Abbreviations	Elaboration
g/L	gram per liter
G	Gram
RDA	Recommended Daily Allowance
USDA	United States Department of Agriculture
DF	Date fruit
cal	Calorie
W	Weight
mg	mili gram
MC	Moisture Content
Abs	Absorbance
Ppm	Parts per million
TSS	Total soluble solids
AOAC	Association of Official Analytical Chemists
TA	Titratable Acidity
UV	Ultra-violate
mg/dl.	Mili gram per deciliter

Abstract

This study's objectives were to create date fruit jelly and assess the jelly's proximate composition, physicochemical characteristics, mineral content, and sensory qualities. Jelly was made using three different varieties of dates (Maryaam, Ajwa, and Ambaar). During the jelly-making process, no preservatives were applied. The prepared fruit jellies were analyzed for proximate composition, physicochemical, mineral, and sensory evaluation. The obtained results were compared using unpaired Fisher's Multiple Comparison Tests (FMCT). A group of semi-trained panelists conducted the sensory test on date jellies. The analysis showed jelly contains mean moisture content 24.573 % , 25.600 % and 27.520 % for maryaam date jelly, ajwa date jelly and ambaar date jelly respectively. Titratable acidity was found 0.0627%, 0.06370% and 0.07247% maryaam date jelly, ajwa date jelly and ambaar date jelly respectively. Total soluble solid was ranged from 0.66-0.67% in this jelly variation. The analysis showed pH ranged from 3.2-3.4, Vitamin C 0.12-0.13 mg, crude protein (0.74-0.82) %, ash (0.36-0.38)% for maryaam date jelly, ajwa date jelly and ambaar date jelly. Antioxidant capacity content and bio-active compounds and minerals content were measured in date jellies. This study demonstrated that pectin and citric acid do not substantially interact with the quality attributes of processed products. The acceptability of the samples was determined by a tasting panel of 10 panelists. Statistical analysis was used to determine the preferences of the customer. All of the samples were well received by the judges, but the ajwa date jelly received the highest praise.

Keywords: Date jelly, Nutritional value, Proximate composition, Physicochemical properties, Sensory evaluation

Chapter I: Introduction

1.1 Background

Palm date (*Phoenix dactylifera* L.) is an important fruit in Middle Eastern countries and is one of the oldest fruit in the world. It has significant religious importunate for Muslims all over the world and even it is mentioned several times in the Holy Quran. Even though we all know that fruit is an important element of a healthy diet, many people aren't aware of all the health advantages that fruit provides. Date contributes to our physical and mental health with cognitive performance and promotes weight reduction. It is an excellent source of carbohydrates, minerals, vitamins, dietary fiber, and antioxidants. Glucose, fructose, and sucrose are major constituents. Proteins and fats are not present in large quantities. There may be a variety of other chemicals present that play a crucial role in the chemical processes that take place throughout the production and storage of the product (Rahmani et al., 2014).

The dates palm, also known as Phoenix dactylifera L., is one of the first cultivated palm plants (5500–3000 BC) with economic, nutritional, decorative, and environmental benefits. It is a member of the *Arecaceae* (Palmae) family and produces delicious berries with a sugar content of more than 50 percent (Niazi et al., 2017). Date trees were historically employed as a symbol of victory by the Romans and the Greeks, while the Christian and Hebrew traditions saw them as a symbol of peace (Rahmani et al., 2014). According to its origins, the name "Phoenix" was created by the Phoenicians, who were among the first to describe this plant on their journeys. Dactylifera is derived from the Greek term dactylus, which means "date," and fero, which means "date bearing."(Khallouki et al., 2018).

According to Terral et al., (2012) dates are a key crop throughout the Middle East and Africa, where they are widely grown and exported all over the globe (Assirey, 2015). According to official data, date fruit output increased from 710,000 to 1,352,950 metric tons between 2010 and 2011, in five major nations (Iran, UAE, Algeria, Saudi Arabia, and Egypt). Its worldwide output was said to have reached over 8, 619,600 metric tonnes in 2016. It is possible to cultivate the date palm to a height of 1500 meters on a well-drained and fertile soil.

Dates may be eaten raw, dried, or cooked, depending on the preparation method. When they are at the Rutab (semi-ripe) and Tamar (totally ripe) phases, they are mostly eaten

fresh (30–40%) or in the dried form (60–70%) with hardly any processing. Dates are a popular snack, whether eaten on their own or with other foods like Arabic coffee, milk, or yogurt. In processed form, they are consumed as paste, syrup, pickles, jams, and jellies. They are also used in a variety of pastry and confectionery products along with other components including chocolate, coconut, honey, and vinegar (Khatchadourian et al., 1987). According to Masmoudi et al., (2010) different varieties of jellies made from date fruit and lemon by-products had less sugar, a lower pH, and produced jellies that were noticeably stiffer and had greater adhesiveness, chewiness, cohesiveness, and flavor qualities, as well as a higher sensory rating. In the Arab Gulf area, the average daily intake of dates varies. In Oman and the United Arab Emirates, it is believed to weigh 164 and 114 grams, respectively. In comparison to other Gulf States, Bahrain's average per capita intake of fresh dates (68g/day) appears to be lower. Changing eating habits, especially among children and teenagers, are to blame for the decline in date consumption. During the Muslim holy month of Ramadan, when dates are eaten to break the fast, consumption of dates reaches its maximum. However, changes in eating habits, improvements in living standards, ongoing urban drift, and the accessibility of a broad range of other fruits throughout the year are all affecting an effect on the consumption of dates. These factors are compounded by the fact that socioeconomic changes are impacting the consumption of dates. When compared to the elder population, younger people consume fewer dates than older people do (Ismail et al., 2006).

Dates are a delicious fruit that has a sweet taste and a meaty consistency to them. Up to 70% of a dates weight may be attributed to carbohydrates, most of which are sugars like sucrose, glucose, and fructose. Date sugars may be used to generate energy for a variety of cell processes since they digest quickly and can be quickly delivered to the bloodstream. In addition to being rich in fiber, dates are a good source of vitamins and minerals including calcium, iron and fluorine (Makki et al., 1998). Dates have also been shown to have anti-oxidant and anti-mutagenic properties. A number of recent research have indicated that dates and their aqueous extracts have anti-mutagenic and immunomodulatory properties, as well as the ability to scavenge free radicals (Vayalil, 2002).

The capacity of our body to burn calories and shed excess fat is improved when we consume a decent portion of fruit. Similar to the human body, the fruit consists of about 80% water. It indicates that excess water weight is quickly eliminated and that the body receives just the essential nutrients. For a balanced diet, people are looking for fruits that are nutritious and low in calories, although fresh and processed fruit consumption has increased as a result of these factors. These are the good source of a healthy diet, able to lessen the risk of cardiovascular diseases and cancer (Sirisena and Ajlouni, 2015).

Jelly has the smoothest texture and is prepared by smashing fruit and removing the solid lumpy residues. This leaves just the crushed fruit, which is combined with pectin and cooked to produce the gelatinous spread containing 65% sugar. Pectin, sugar, and acid are the major ingredients needed to make jellies, and they must be added in the right amounts to ensure optimal gel formation (Al-Noori et al., 1984).

Jelly that is produced from the fruit, fruit juice, or a fruit juice concentrate, and has to have at least 62% water-soluble solids in order to be considered jelly. Jelly has an acid component to balance out the fruit's natural acidity, a chemical to maintain a stable pH, and/or an anti-foaming agent. A minimum of 62% water-soluble solids and a minimum of 32% juice from the mentioned fruit must be used to make pectin jelly, which may also include an acid component to make up for the fruit's natural lack of acidity; juice from another fruit; a gelling agent; food color; a Class II preservative (such as benzoates, sorbets, or nitrites); a chemical that adjusts the pH; and/or an anti-foam.

Because pectin acts as a gelling agent, it is necessary for the development of jelly. This means that the combination of pectin chains results in the construction of a network, which in turn leads to the formation of a gel. The ideal pH range for pectin is between 2.8 and 3.2, which affects the side chain strength and efficacy, as well as the bonds they create. It serves a crucial function in food processing as additives and also as a source of dietary fiber.

Pectin gels play a crucial role in the production of jams, jellies, confections, and low-fat dairy products, as well as in their texture modification. Additionally, it is a component in the pharmaceutical sector, where it serves the purpose of reducing the glycemic response of goods. Pectin is isolated from water or buffer solutions, solutions of chelating agents, dilute acids, or dilute sodium hydroxide or sodium carbonate in order

to determine their type and concentration. There are no restrictions on the allowable daily consumption since it is also regarded as a safe addition.

Producing, eating, and preserving jelly is simple. In light of the past, just a few research on jellies have been undertaken too far. This study was carried out to identify physicochemical characteristics and sensory evaluation in order to gain more relevant data on this issue. Date jellies were subjected to minerals, antioxidant, and bio-active compound analysis.

1.2 Aim and objectives

a) To prepare jellies from a variety of date fruits (Maryaam, Ajwa and Ambaar)

b) To examine and compare physicochemical parameters and proximate analysis of jelly.

c) To analyze the minerals, antioxidant activity and bio-active compounds of date jelly.

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

Chapter II: Review of Literature

Date is a very popular fruit in Bangladesh, but research works on date related products are scarce. Now, it has received much attention to the researchers by developing products. Some available research findings in this connection have been reviewed and presented below on the following heading.

2.1 Chemical Composition of Dates

Date fruit is distinct from most other fruits in that it reaches botanical maturity at a variety of stages, which are known over the world by Arabic names such as "Kimri," "Khalal," "Rutab," and "Tamar". These stages of maturity have traditionally been identified by changes in color, texture, taste, and flavor (Myhara et al., 1999). Cultivar soil conditions, farming methods, and maturation stage all influence the date chemical composition (Al-Kharusi et al., 2009). Throughout the ripening process, the fruit starts to lose moisture and its sugars are transformed into glucose and fructose. Maltose and mannose in trace amounts have also been detected during this period. Different harvest and post-harvest procedures affect the moisture content of market-ready date varieties produced in the same country or in the same variety grown in different areas (Aidoo et al., 1996).

2.1.1 Carbohydrates and Sugars

Dates most significant components are carbohydrates, namely sugars, which may account for up to 78% of their weight and offer a quickly accessible source of energy to the human body. According to Ali et al., (2009) the carbohydrate content of three dried Omani date varieties (Khasab, Khalas, and Fardh) varied from 68.53 to 75.37 g/100 g of date flesh. The Khalas variety was found to have the highest value 75.37 g/100g, when tested. When dates were still in their early green state (Kimri), researchers discovered that they contained just trace amounts of the sugars glucose and fructose. The carbohydrate content of fresh dates ranged from 47.8 to 59.4 (mean 54.9) g/100 g, whereas the carbohydrate content of dried dates was between 66.1 to 88.6 (mean 80.6) g/100 g. No additional glucose or fructose was found in the intermediate phases (Khalal and Ruta) despite the accumulation of sucrose. Nearly all of the sucrose is transformed into glucose and fructose during the last stage of maturation (Tamar). The total sugar content of three varieties of dried Omani dates (Khasab, Khalas, and Fardh) ranged

from 56.1 to 62.2 g/100 g, with Khasab containing the least amount of sugar and Khalas containing the most (Al-Farsi et al., 2005). Three dried Omani date varieties (Khasab, Khalas, and Fardh) had total sugar content of 52.17–59.96g/100g, according to the findings of Ahmed et al., (1995). The most sugar was found in Khalas.

2.1.2 Dietary Fiber

Dates are a rich source of dietary fiber, and the amount of fiber in 14 distinct types of dates varied from 6.4% to 11.5%, depending on the variety and the stage of ripening (Al-Shahib and Marshall, 2003a). It has been discovered that certain dates of lower grade, utilized for industrial reasons, possess up to 10% crude fiber. Dates are high in both soluble and insoluble fibers. Cellulose, hemicelluloses, pectin, lignin, and insoluble proteins are the primary components. It was observed that date flesh contained 1.55% cellulose, 1.28% hemicellulose, and 2.01% lignin on a fresh-weight basis. Insoluble fiber is the primary source of dietary fiber in dates. On the other hand, the accumulation of soluble pectins continues until the date fruit reaches the Rutab stage (Karkala and Taylor, 1999). During the ripening process, the enzymes gradually convert these compounds into more soluble molecules, which causes the fruit to become more delicate and mushier. It has been observed that dietary fiber, measured as non-starch polysaccharides by gas chromatography, fell from 250 g kg^{-1} (Kimri) to 50 g kg^{-1} (Tamar) on a dry weight basis (Fayadh and Al-Showiman, 1990).

Daily consumption of 100g of dates may provide 32% of the recommended dietary allowance for dietary fiber (Marlett et al., 2002). A larger quantity of insoluble fiber produces satiety and laxative effects due to the increased stool weight. Studies show that eating a diet high in fiber lowers cholesterol and lowers the chance of developing a wide range of diseases, including diabetes, hypertension, bowel and colon cancer, heart disease, and gastrointestinal disease (Cummings et al., 1992).

2.1.3 Proteins and Lipids

Dates are a source of trace amounts of protein and fat. Approximately 1% to 3% of the date fruit is composed of proteins. The higher protein and fat content after drying is mostly due to moisture loss. However, the concentrations of each species differ from one another as a result of variations in cultivation, drying conditions, and analytical techniques used for their detection. Fresh dates provide 1.50 g of protein per 100 grams,

whereas dried dates contain 2.14 g per 100 grams. Ishurd et al., (2004) report that as organism grows, its amino acid content drops. At the same developmental stage, the content of amino acids might vary significantly. During ripening, proteins contribute to non-oxidative browning and tannin precipitation. Makki et al., (1998) observed that the protein content of the pulp varied from 1.7% to 2.95 % based on fresh weight, but the average protein content of date seeds was 5.22 %. Even though dates do not have enough protein to be considered a significant nutritional source, they do contain a number of essential amino acids that is beneficial to human needs. Dates are a good source of essential amino acids.

The majority of the lipids in a date are found in the skin, where they play a bigger part in the fruit's physiological protection than in its nutrient content. When dates are fresh, they have an average lipid content of 0.14 g/100gm, however, when dates are dried, they have an average lipid content of 0.38 g/100gm. According to Al-Hooti et al., (1995) date seed oil content ranged from 7.7% to 9.7%, whereas date flesh oil content ranged from 0.2% to 0.5% saponifiable oil. Seeds often have a higher concentration of lipids than the flesh, which may reach up to roughly 8.49% on a fresh weight basis. According to reports, compared to date flesh, date seeds have higher levels of protein (5.1 g/100 g) and fat (9.0 g/100 g) (Almana and Mahmoud, 1994). On a fresh weight basis, date pulp may include lipids in the range of 0.31% to 1.9%.

2.1.4 Fatty Acids

Dates pulp and seed are rich sources of both saturated and unsaturated fatty acids. Saturated fatty acids include capric, lauric, myristic, palmitic, stearic, margaric, arachidic, behenic, and tricosanoic acids. Unsaturated fatty acids include palmitoleic, oleic, linoleic, and linolenic acids. According to Al-Shahib and Marshall (2002) the number of fatty acids differed greatly across the seeds of 14 different date cultivars. They discovered that the oleic acid content of date seeds varied from 41.1% to 58.8%, and they suggested that date seeds may be used as a source of oleic acid if technical concerns with extraction could be handled. Organic acids and aromatic oils are known as flavor enhancers and may help specialty date products improve their sensory qualities.

2.1.5 Vitamins and Minerals

Many vitamins and minerals may be found in dates, and the mineral content of dried dates can range from 0.1 to 916 mg/100 g of date flesh, depending on the variety (Khan et al., 2008). Dates contain significant levels of manganese, iron, phosphorus, and calcium, as well as selenium, copper, potassium, and magnesium. It has also been shown that date varieties are an excellent source of selenium (Al-Farsi et al., 2005). Dates are beneficial for those with hypertension since they are rich in potassium and low in sodium. Boron is useful for treating brain cancer. Vitamins and boron may also be used to cure rheumatism (Al-Showiman, 1998). Dates may be used as a supplement for iron deficiency without the severe side effects that iron pills can induce, such as nausea, headaches, and anorexia. Dates have been shown to contain noticeable amounts of at least six vitamins, including thiamin, riboflavin, niacin, ascorbic acid, pyridoxine, and vitamin A (Al-Qarawi et al., 2004). Fresh dates have a greater vitamin content than dried dates because of the loss of vitamins during the drying process. Dried dates include trace levels of riboflavin, pyridoxine, niacin, and folic acid. The quantities of thiamin, ascorbic acid (a form of vitamin C), and vitamin A in dried dates are small.

Table 2.1: Nutritional profile of dates

Nutrient	Content (per 100g)
Energy	1178 KJ
Carbohydrates	75.03 g
Dietary Fiber	8 g
Fat	0.39 g
Protein	2.45 g
Vitamin- A	10 IU
Thiamin	0.052 mg
Riboflavin	0.066 mg
Niacin	1.274 g

Pantothenic acid	0.589 g
Vitamin- B6	0.165 mg
Folate (Vitamin- B9)	19 µg
Vitamin- C	0.4 mg
Vitamin- E	0.05 mg
Vitamin- K	2.7 µg
Calcium	39 mg
Magnesium	43 mg
Iron	1.02 mg
Phosphorus	62 mg
Potassium	656 mg
Water	20.53 g

2.2 Phytochemical Contents of Date Fruits

Phytochemicals are plant compounds that have therapeutic properties whether taken as medical remedies or as part of a healthy diet. Bioactive substances such as carotenoids, polyphenols, primarily flavonoids and phenolic acids, sterols, and tannins are present in dates in various amounts (Al-Alawi et al., 2017). Several factors, including the stage of fruit harvesting, the kind of dates, post-harvest processing, storage, soil conditions, and the dates' geographic origin, greatly affect the percentage and concentration of these ingredients (Al-Turki and Shahba, 2010). Dates include a number of bioactive chemicals that are discussed in this section.

2.2.1 Phenolic compounds

The antioxidant properties of phenolic compounds are improved by the presence of flavonoids as well as non-flavonoids. Benzoic acid and cinnamic acid derivatives are examples of non-flavonoids, whereas flavonoids are categorized as follows: flavonols, isoflavones, and anthocyanidins (Harborne et al., 1994). The potential for antioxidants

in dates was confirmed by the presence of these phenolic compounds. The composition, distribution, and type of phenolic compounds in dates are dependent on environmental circumstances, development stage, and species (Al-Laith, 2009). Dates have also been shown to contain soluble phenolic chemicals such as flavonols, hydroxybenzoates, and hydroxycinnamates (Hammouda et al., 2013). Deglet Noor and other Algerian types were found to contain flavonoids glycosides (apigenin, luteolin, and quercetin), as well as dactyliferic acid and its isomers (El-Hadrami and Al-Khayri, 2012). Additionally, dates contained around 3% DW of condensed tannins, often known as pro anthocyanidins (Hong et al., 2006). Unripe dates have an astringent taste that comes from soluble tannins in the fruit.

2.2.2 Carotenoids

Carotenoids have been identified as an important component of the phytochemicals present in the lipid fractions of date fruit (Al Juhaimi et al., 2018). They are precursors of vitamin A, which is essential for eyesight and protects cells from the damaging effects of reactive radicals by functioning as antioxidants (Julia et al., 2015). Carotenoids are classified according to the presence or lack of oxygen in their molecules. Consequently, they are divided into two subgroups: Xanthophylls (presence of oxygen atom) and carotenes (lack of oxygen atom) (Al-Alawi et al., 2017). Dates are a source of carotenoids such as lutein and beta-carotene, according to Boudries et al., (2007). In research conducted by Habib and Ibrahim, several carotenoids in United Arab Emirates-obtained Khalas-type dates were evaluated. Zeaxanthin (10.8 g/kg), lycopene (19.5 g/kg), cryptoxanthin (20.4 g/kg), lutein (1,599 g/kg), and carotene (3,142 g/kg) were the carotenoids that were extracted. However, post-harvest activities such as sun-drying might reduce the overall carotenoid content of dates by around 4% to 30% compared to fresh dates. This means that dates are still a good source of carotenoids.

2.2.3 Phytosterols

Phytosterols are a category of phytochemicals found in the lipid-soluble portion of date fruit (Chandrasekaran and Bahkali, 2013). They are often found in plants and have a chemical structure that is comparable to cholesterol (Baliga et al., 2011). The phytosterol content of vegetable oils is often used to evaluate oil quality and identify

changes (Lercker and Rodriguez-Estrada, 2000). Typically, phytosterols are found in oils in their esterified forms (Mrabet et al., 2020).

Date pits or seeds contain a high amount of phytosterols and have been used for decades to treat hormone-related health problems (Brielmann et al., 2006). Deglet Noor and Allig varieties of date seed had 3,500 and 3,000 mg/kg of total sterols, respectively (Besbes et al., 2004). Dates contain a variety of phytosterols, including esterone, ergosterol, and brassicasterol (Maqsood et al., 2020).

2.2.4 Phenolic acids

They are considered part of the essential aromatic secondary plant metabolites, which consist of an aromatic benzene ring with one or more carboxylic acid groups attached to the hydroxyl group. The Khalas date variety from the United Arab Emirates (UAE) contains phenolic acids like caffeic acid, protocatechuic acid, and coumaric acid (Habib et al., 2014). In general, the solvent chosen to extract phenolics may influence their concentration in fruits. In addition, it was discovered that phenolic acids such as caffeic, ferulic, and protocatechuic acids were the most prevalent (Al-Farsi and Lee, 2008).

2.2.5 Flavonoids

Flavonoids are an important component of the secondary metabolites that are produced when polyphenolic plants are metabolized. They exhibited antioxidant capabilities, which may contribute to the prevention of chronic illnesses and cardiovascular disorders (Machha and Mustafa, 2005). The flavonoid concentration of three Moroccan date types (Bousthammi, Majhoul, and Boufgous) was found to be between 1224 mg and 1844 mg Rutin equivalent/100 g DW, according to the research (Alem et al., 2017). During the investigation to determine the quantity and kind of flavonoid component in dates, epicatechin (46.8 g/kg) and catechin (3.38 g/kg) were found to be the major flavan-3-ols, which were found to make up nearly 99 percent of the total polyphenols. In a different study, thirteen different types of Saudi Arabian dates were shown to contain flavonoids such catechin and rutin (Al-Turki and Shahba, 2010). Dates ability to work as antioxidants was further proven by the fact that they contain flavonoids.

2.2.6 Tocopherols and Tocotrienols

Tocopherols and tocotrienols may be found in the lipid fraction of date fruits and seeds (Afiq et al., 2013). They are somewhat essential due to their antioxidant activity and are

members of the vitamin E group (Theriault et al., 1999). They may shield the biological membrane component because of their antioxidant capability. In addition, tocols protect the oil against damage caused by free radicals, which helps their stability. In comparison to synthetic antioxidant butylated hydroxytoluene (BHT), they are more effective. Different vegetable oils contain different amounts of tocol (tocopherol and tocotrienol). Additionally, vegetable oil contains several types of tocol (ά, β, γ and δ) (Wong and Radhakrishnan, 2012). Depending on where the oil is derived, one tocol may be more prevalent than the other (Greyt et al., 1999).

2.3 Nutraceutical potentials of date fruit

Dates are often a rich source of chemical substances such as phenolic acids, tannins, flavonoids, phytosterols, and carotenoids (Guido et al., 2011). These substances' potential as nutraceuticals may be improved by the presence of them in various ratios. In this part, antimicrobial activity, antioxidant capacities, anticancer qualities, and other nutraceutical potentials are explored and summarized.

2.3.1 Antimicrobial activities

The antimicrobial characteristic of a solid or liquid substance is its capacity to enter the cytoplasmic membrane, disrupt permeability, and subsequently damage the cytoplasmic membrane, resulting in cytoplasm vulnerability or cytoplasm coagulation and shape reduction, followed by cell lysis and microorganism death (Klompong and Benjakul, 2015; Martinez et al., 2020). Due to their lower cost and lack of side effects, natural antimicrobial agents are preferred over synthetic antimicrobial agents in the fighting against resistant bacteria and viruses (Al-Daihan and Bhat, 2012). To confirm the antibacterial properties of various date variety, several investigations have been conducted. For instance, Aamir et al., (2013) observed that extracts of Ajwa dates in acetone and methanol were efficient against both Gram-positive and Gram-negative bacteria. Date palm extracts have antiviral action, according to research by Jassim and Naji (2010). El Sohaimy et al., (2015) found that extracts made from Egyptian dates using ethanol and aqueous solutions have antibacterial properties against several harmful bacterial strains. Ajwa dates fruit extracts also inhibited the growth of Serratia marcescens, Staphylococcus aureus, Bacillus cereus, and Escherichia coli (Samad et al., 2016). The anti-fungal effectiveness of the medication amphotericin B was enhanced by date extracts (Belmir et al., 2016).

Date seed extracts showed antiviral activity against the Pseudomonas phage ATCC 14209-B1 that caused lysis of the bacterium, decreased phage function, and completely prevented lysis (Karasawa et al., 2011). Dates might thus be used in food items as a natural antibacterial agent.

2.3.2 Antioxidant activities

By guarding against the oxidative damage caused by dangerous chemicals known as free radicals, antioxidants serve a critical function in food systems, human body cells, and tissues (Idowu et al., 2020). These free radicals are strongly linked to many well-known disorders, including cancer, heart disease, Parkinson's, and Alzheimer's disease (Kim et al., 2015). Lipid oxidation in food items during processing and storage creates hazardous reaction products and unfavorable off-flavors in a food system because of reactive oxygen species and free radicals (Sarmadi and Ismail, 2010). To combat this issue, chemically produced antioxidants such as propyl gallate (PG), butylated hydroxyl toluene (BHT), butylated hydroxyl anisole (BHA), and tertiary butyl hydro quinone (TBHQ) are used as antioxidants against lipid peroxidation (Kim and Wijesekara, 2010). However, it has been claimed that chemically created antioxidants may cause cancer (Tekiner-Gulbas et al., 2013). As a result, dietary sources of natural antioxidants are usually favored. According to Martin-Sánchez et al., (2014), dates are an excellent source of antioxidants such tannins, carotenoids, sterols, and polyphenols. In the fruit's oil portion, Boudries et al., (2007) discovered the presence of carotenoids, namely β-carotene and lutein. Antioxidants and vitamin A precursors may be found in these carotenoids. Depending on the cultivar, date type, and origins, dates have varying levels of antioxidant potential. Additionally, the antioxidant content of dates varies depending on where they are harvested (Maqsood et al., 2020). It is thus wise to take these variables into account when choosing date fruit as a nutraceutical. The antioxidant capabilities of various date cultivars are described in this context. Using aqueous, methanolic, and ethyl acetate as the extraction media, for instance, Ajwa dates extracts demonstrated 91, 70, and 88 percent inhibition against lipid per oxidation (Zhang et al., 2017). Based on lipid peroxidation and DPPH experiments, Arshad et al., (2015) estimated that the antioxidant activity of extracts from the Ajwa date variety was 74.19 mg/mL of gallic acid equivalent. These tests work by scavenging free radicals that cause lipid oxidation using extracts from Ajwa dates (Khan et al., 2018).

According to reports, Omani dates including Khasab, Khalas, and Fard have phenolic contents that vary from 217 to 343 mg of ferulic acid equivalent per 100 g (Al-Farsi et al., 2005). High levels of antioxidant activity (580-929 mol of Trolox equivalents/g fresh weight) were found in the seeds of Oman's date cultivars. Dates came in second place among 28 fruits tested in depth in China for their antioxidant properties (Guo et al., 2003). Therefore, the antioxidant capabilities of dates may be employed to substitute synthetic antioxidants in foodstuffs.

2.3.3 Anticancer properties

Dates have been shown to be useful in reducing the development of cancerous cells in research experiments. Studies have shown that Ajwa date methanol extracts inhibit the growth of malignant cells in the colon, breast, prostate, lung, and stomach (Al-Mashiqri et al., 2017). Additionally, dates may improve the health of the colon in humans by promoting the development of healthy gut bacteria, which in turn inhibits the reproduction of tumor cells (Eid et al., 2014). Dates have been shown to contain β-glucan, which in its irradiation form, known as β-d-glucan, inhibited the growth of three cancer cell lines, including MCF7, Colo-205, and T47D (Yasin et al., 2015). To fully examine the anticancer potential of dates, additional research is also required.

2.3.4 Anti-diabetic properties

Although the current diabetes treatments are helpful, they have certain undesirable side effects, such as alteration of genetic and metabolic pathways (Maqsood et al., 2020). As a result, extracts from natural plants that may increase insulin production and reduce intestinal glucose absorption are now employed in the therapy of diabetes (Malviya et al., 2010). Dates, on the other hand, are a good source of anti-diabetic substances such as flavonoids, phenols, steroids, and saponins (Khalid et al., 2017). Several diabetic rat tests have shown that these chemicals have the capacity to scavenge free radicals (Hasan and Mohieldein, 2016). When ingested, extracts of the Ajwa date might help to reduce oxidative stress and maintain the healthy functioning of the kidney and liver (Qadir et al., 2020). This may be partially due to the phenolic chemicals in dates, which slow down ά-glucosidase, so limiting the amount of glucose absorbed by the kidneys and small intestine (Zhang et al., 2013). Therefore, dates anti-diabetic properties may be used in medical applications.

2.4 Health Benefits of date fruits

Numerous more health advantages of date fruits have also been mentioned. However, these are early studies that require more experimental and clinical research in order to confirm the benefits and determine the mechanism of action of date fruits in greater detail.

2.4.1 Anti-inflammatory Activity

Recent research has shown that DF has anti-inflammatory properties (Mohamed and Al-Okbi, 2004). It was demonstrated that oral administration of methanolic or aqueous extracts of the edible component of DF's decreased the adjuvant-induced inflammation in the foot. Additionally, after adjuvant therapy, DF treatment decreased plasma fibrinogen levels and ESR, which had both increased. DF extracts significantly increased body weight growth and food efficiency ratio as compared to the adjuvant treated controls.

2.4.2 Protective Effects against Chemical Induced Toxicity

Recent studies have shown that extracts from the meat of DF may reduce gentamicin-induced nephrotoxicity (Al-Qarawi et al., 2008). The renal proximal tubules had severe necrosis after therapy with gentamycin, which also markedly increased plasma creatinine and urea. The amount of kidney damage caused by gentamycin was successfully decreased by DF extract (50% w/w), along with plasma levels of creatinine and urea. Gentamycin-induced kidney damage may be mitigated by antioxidants found in DF.

The same group has also claimed that DF extracts reduce the liver damage caused by CCl_4 exposure (Al-Qarawi et al., 2004). Their studies revealed that DF extracts prevented hepatotoxicity by significantly decreasing aspartate amino transferase (AST), alanine amino transferase (ALT), alkaline phosphatase (ALP), and bilirubin concentrations following CCl_4 administration, compared to the DF untreated controls. It was also investigated in rats whether or not an aqueous extract of date flesh had a protective effect against the hepatotoxicity caused by thioacetamide. Date flesh extract effectively improved liver cirrhosis by decreasing the thioacetamide-induced rise in plasma bilirubin, AST, ALT, lactate dehydrogenase (LDH), γ-glutamyl transferase (GGT), and ALP levels (Ahmed et al., 2008).

2.4.3 Neuro-Protective Effects

Recently, researchers looked at the aqueous extract of DF's neuroprotective properties in rats. Pre-treatment with DF at a dose of 250 mg/kg significantly decreased neuronal death of CA1 hippocampal neurons brought on by focal cerebral ischemia as compared to the control group (Majid et al., 2008).

2.4.4 Anti-Ulcer Effect

In a rat model of ethanol-induced gastric ulceration, DF was also examined for its therapeutic benefits. Researchers found that extracts of the date fruit (DF) were effective in treating gastric ulcers and in reducing the levels of ethanol-induced plasma gastrin as well as histamine and mucus in the stomach lining (Al-Qarawi et al., 2005).

2.4.5 Date Fruit for Deficiency Diseases

Diets in poor countries tend to be inadequate in a wide variety of elements, including energy, since food intake is insufficient. Due to inadequate consumption or a poor diet, mineral and vitamin deficiencies are also common in developing nations. From a nutritional standpoint, DF is an energy-dense food and a provider of a wide range of important elements. Consumption of DF would provide a sufficient amount of many of these components, such as carbohydrates and minerals (Fe, Mg, Ca, Zn, P, Cu, Se, I, etc.), as well as a fair supply of vitamins, which would contribute greatly to the fulfillment of the daily requirements for these components (niacin, B_6, folate, etc). Anemia and other deficiency-related illnesses, such as goiter, rickets, osteomalacia and the like may all be treated by regular consumption of DF. Additionally, DF will serve as a nutritional treatment for diseases like osteoporosis, arthritis, and other conditions related to bone metabolism, multiple sclerosis, cancer, cataracts, age spots, and other illnesses by providing minerals such as Ca, Cu, Se, P, and others for the body's demands.

2.5 Pectin

Pectin is a soluble, gelatinous polysaccharide that is found in ripe fruits and utilized in jams and jellies as a setting agent. Cell walls of all fruit peels contain pectin, and a small amount of pectin may also be found in fruit pulp. Pectin is a crucial component in fruit ripening, and different types of fruits have varying amounts of pectin. Pectin originates from heteropolysaccharides, which are produced from the main cell wall of

higher plants. Due to its outstanding gelling capacity, pectin is a useful food ingredient that has been used in jams and jellies, fruit preparations, fruit drink concentrates, fruit juice, sweets, and fermented dairy products. Pectin is also commonly used in the pharmaceutical industry. According to reports, pectin lowers blood cholesterol levels and low-density lipoprotein cholesterol fractions, which is good for human health. Pectin may also help reduce the growth of malignant cells (Bhat and Singh, 2014). Pectin may be utilized in a variety of other applications as well, including biodegradable water-soluble films, bulking agents, coating agents, chelators, emulsifiers, and viscosity modifiers (Kumar et al., 2016).

2.6 Nutritional aspects of pectin

Pectin is extracted from plant cell walls and evaluated as soluble and insoluble galacturonic acid following hydrolysis. Pectin-rich fruits and vegetables often have dietary fiber levels between 1% and 2%. Pectin fibers are employed in the creation of various foods, such as bread goods, since they have better hydration qualities than other fibers. It has been claimed that substituting apple flakes, citrus fibers, and concentrates for flour in bread and confectionery goods had a satisfying sensory impact. Some multi-ingredient anti-constipation and anti-diarrhea formulations have boosted pectin's adsorbent and bulk-forming characteristics.

Chapter III:Materials and Methods

3.1 Study Area

The experiment was conducted in the laboratory of the Department of Applied Chemistry and Chemical Technology, Department of Food Processing and Engineering, Poultry Research and Training Center, Department of Animal Science and Nutrition of Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram.

3.2 Collection of Sample

Dates (*Phoenix dactylifera L.*) samples were collected from Reaz Uddin Bazar, Chattogram. The dates were carefully chosen in order to obtain the optimum maturity. Sugar, pectin and citric acid were purchased from scientific and surgical store. Other relevant materials required for the experiment were received from the laboratory stocks.

Figure 3.1: Sampling location in Chattogram, Bangladesh

3.3 Juice Extraction

Date jelly was prepared according to the preparation procedure described by Singh and Chandra (2012). With 500g fresh date, 1 kg water were added during juice extraction. There were used ajwa date, ambaar date, and marium date. The fruit samples were washed with clean water to remove the external particulate or ions that will interrupt in nutrient analysis and cut into small pieces for easy boiling.

3.4 Preparation of Jelly

Fresh dates are weighed and properly cleaned in cold water. A stainless steel knife was used to slice the cleaned date into little pieces. After that, it was stirred while boiling for a further 10-15 minutes. To remove the suspended material, which was made up of fruit tissue, skin, gums, and protein in colloidal form, the cooked pieces were crushed and the extract was filtered through a thick cloth. According to the formulation, the amounts of date juice, water, pectin, acid, and sugar were estimated. Once again boiling the liquid after straining, sugar was then added. Continuing the heating process with stirring, The mixture's end point, as determined by the refractometer, was between 67 and 68 °Bx TSS. After cooling, the jelly was put into a glass jar. The jars are labeled and kept for future research after cooling (Singh and Chandra, 2012).

Sorting

↓

Washing and cleaning

↓

Slicing

↓

Boiling of date slices in water

↓

Straining of date juice

↓

Add sugar, citric acid, pectin

↓

Heating at100 °C for 5 minute

Hot filling

Cooling

Storage

Figure 3.2: Processing steps of date jelly

Table 3.1: Formulation of jelly

Ingredients	Sample 1	Sample 2	Sample 3
Fruit Juice	550 gm	550 gm	550 gm
Sugar	450gm	450gm	450gm
Citric acid	0.3%	0.5%	0.8%
Pectin	0.5%	1%	1.5%

Among 3 samples, sample 2 was selected for final product making.

3.5 Physicochemical analysis of date jelly

The fresh sample of date jelly were analyzed for total soluble solid, pH, titratable acidity, Vitamin C determination. These samples were also analyzed for proximate analysis, bio-active compounds analysis and antioxidant analysis.

3.5.1 pH determination

A pH meter that had already been calibrated was used to determine the pH of the various jelly compositions. Prior to use, the pH meter was calibrated using buffers with pH values of 4, 7, and 10. A sample of around 10 g was suspended in 90 mL of deionized water (Mamede et al., 2013). The pH reading was obtained when the electrode of the pH meter was submerged in the suspended solution.

3.5.2 Total Soluble Solids

Total soluble solids of the jellies were found out with the help of hand refractometer. Total soluble solids (TSS) were directly recorded by digital refract meter (Atago RX 1000) and the results expressed as percent soluble solids (°Brix) as described in ISO (2173:2003).

3.5.3 Titratable Acidity

By titrating against N/10 NaOH and using the phenolphthalein indicator as instructed by AOAC (2005), the percentage of acidity was calculated in terms of anhydrous citric acid. Each time, 10ml of juice was taken in a 100ml volumetric flask, the volume was brought to 100ml by adding distilled water, and then 10ml of the diluted juice was titrated against N/10 NaOH with phenolphthalein as the indicator. The titrations endpoint is indicated by the presence of pink color. The average result was obtained after the titration was reported three times.

3.5.4 Determination of Vitamin C

Vitamin C is a vital component of the diet; nevertheless, it is very susceptible to being depleted or destroyed when food is exposed to heat and oxygen during the preparation, packing, or storing processes. The 2, 6-dichloroindophenol titrimetric technique is the approved method of analysis for determining the amount of vitamin C in juices (AOAC, 2010). In this case, the color dye caused vitamin C to oxidize into dehydroascorbic acid. The dye is also changed into a colorless substance at the same time. Therefore, it is simple to identify the reaction's end point. 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 prevented 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.

Procedure

- The dye solution was poured from the burette until it reached the 0 mark.
- Afterward, a conical flask containing 5 ml of Vitamin C solution was taken.

- The dye was added drop by drop into the conical flask, which was sitting on the bottom of the burette.
- Titration was over when the pink colour emerged and lasted for 20 seconds before disappearing.
- A minimum of 3 readings were recorded.
- The same procedure was performed for ascorbic acid solution of unknown concentration.
- The result was expressed as milligram percentage (mg %).

3.6 Proximate analysis

By using the AOAC (2000) standard procedure, the proximate compositions of the various date fruit jellies were examined. According to the oven drying technique, dry ashing method, Kjeldahl's method, gravimetric method, and Soxhlet method, respectively, the moisture, ash, crude protein, crude fiber, and crude fat contents were calculated .

3.6.1 Moisture Content

The AOAC (2000) method was used to measure the moisture content. The empty dish and lid are dried in a 105°C oven for 3 hours before being transferred to a desiccator to cool. The empty dish and lid should be weighed. Add a sample weighing 3g or less to the plate. Using a spatula, spread the sample. Place the sample-containing dish in the oven. Dry at 105°C for 3 hours. After drying, place the dish in the desiccator to cool while the lid is still partly covered. Weigh the dish and dried sample once again.

3.6.2 Determination of Crude protein

Protein content was determined using AOAC (2000) method. The method was as follows:

Procedure

A dry 300ml Kjeldahl's flask was filled with a precise 5g weight of the digesting mixture. The flask was filled with the appropriate amount of sample (1g for each). Sulphuric acid (20 ml) was added, heated continually until foaming stopped, and then quickly simmered. The solution cleared up after 15 to 20 minutes, then it was heated

for an additional 45 minutes. After cooling, 100 ml of water was added, and the total volume of roughly 500 ml was quantitatively transferred to a 1 liter round-bottom flask. The flask was immediately attached to the steam trap and condenser after adding gradually enough sodium hydroxide solution to generate a portion of cupric hydroxide. A 500ml conical receiving flask was then filled with 50ml of the boric acid solution, 50ml of distilled water, and 5 drops of the indicator solution. Positioning the condenser, the distillation was run for 4 to 5 minutes, or until a volume of around 250 ml was reached. The receiving flask's contents were then titrated with 0.1 N hydrochloric acids, and the end point was indicated by a brown color. Furthermore, a reagent blank was identified and deducted from the titration. One gram of nitrogen is equal to one milliliter of 0.1N hydrochloric acid. To compute the % protein from nitrogen determination, a protein conversation factor was used. The following equation is used to compute nitrogen and protein percentages:

3.6.3 Determination of Crude fat

This was determined using the solvent extraction gravimetric method described by AOAC (2000). Five grams of the sample were placed in a thimble after being wrapped in porous paper (Whatman filter paper). The thimble was mounted into a weighted extraction flask with 200 ml of petroleum ether and placed in a soxhlet reflux flask. A water condenser was attached to the reflux flask's top portion.

Petroleum ether was heated, brought to a boil, and allowed to cool before being condensed into the reflux flask. As soon as the reflux flask was completely full, the solvent was poured over the sample in the thimble, siphoning the oil extract down to the boiling flask. This was repeated four times, the defatted sample was taken out, the solvent was recovered, and the oil extract was left in the flask. The flask holding the oil extract was dried in the oven at 60°C for one minute to get rid of any remaining solvent. After chilling in a desiccator, it was weighed. The weight of the oil (fat) extract was estimated as a percentage of the sample weight using the following formula:

3.6.4 Determination of crude fiber

Using the AOAC (2000) technique, crude fiber was determined. A 5g processed sample was cooked for 30 minutes at reflux in 150 ml of a 1.25 percent H_2SO_4 solution. The cooked sample was washed several times in hot water with a two-fold towel to capture

the particles. It was put back in the flask and heated for a further 30 minutes under the same conditions in 150 ml of 1.25 % NaOH. The sample was transferred quantitatively to a weighted crucible and washed in several volumes of hot water before being allowed to drain dry and then dried in an oven at 105°C to a consistent weight. It was then transported to a muffle furnace and burnt until nothing but ash was left. In order to quantify the weight of the fiber as a percentage of the sample being tested, a difference between the two weights was made:

3.6.5 Determination of ash content

Applying the furnace gravimetric approach as outlined by AOAC (2000), this was performed. In a porcelain crucible that had already been weighted, 5g of the samples were measured. The sample was burned to ashes in a muffle furnace at 550°C. When at has turned into full ash. It was cooled in a desiccator, weighed, and examined as follows:

3.6.6 Determination of Carbohydrate

Carbohydrate was determined by the following formula as per AOAC, 2000.

3.7 Determination of Minerals

This method involves the extraction of minerals from the food matrix by digestion, as per AOAC, 2010. A sample of date jelly was digested in an acid solution consisting of HNO_3 and $HClO_4$ into a 2:1 ratio. In a conical flask, one gram of sample was weighed. 7 ml HNO_3 and 3 ml $HClO_4$ were added, and then the flask was placed on a hot plate at 200W for 3 minutes until complete digestion. The solution was cooled down and filtered through filter paper into a 100 ml standard flask and diluted to the volume with distilled water. This solution was used for mineral content determination. Mineral contents (potassium, magnesium, calcium, phosphorus and iron) were determined by using Humalyzer 3000. All the analyses were expressed in mg/100g.

3.7.1 Determination of Phosphorus (P)

1 ml of phosphorus reagent was used to prepare the blank solution, 1 ml of phosphorus reagent, 10 µl of phosphorus standard, and 1 ml of phosphorus reagent, 10 µl of the sample extract were pipetted into the cuvette for the sample solution. These were combined and incubated for 5 minutes after that. A blank was used as a comparison

point for the sample and standard absorbance. The concentration of phosphorus was calculated in mg/dl by multiplying the sample absorbance by the standard concentration (mg/dl).

3.7.2 Determination of Iron (Fe)

The iron is separated from the transferring-iron complex in a somewhat acidic medium. The released iron is reduced to the bivalent form using ascorbic acid. With iron ions, ferrozine produces a colourful molecule. The amount of iron in the sample affects how intense the color is. With the use of a pipette, 1 ml of reagent was added to the cuvette to create the blank solution. 1 ml of reagent and 200 µL of standard were added for standard production. For the creation of the sample solution, 200 µL of sample extract and 1 ml of reagent were added. These were mixed and then incubated for 10 minutes at room temperature. In comparison to a blank, the absorbance of the standard and sample were measured. Iron concentration was measured in µg/dl.

3.7.3 Determination of Calcium (Ca)

In an alkaline media, calcium ions and O-Cresolphthalein combine to generate a violet complex. A cuvette was filled with 1 ml of working reagent and 25 µL of distilled water to create the reagent blank solution. 1 ml of the working reagent and 25 of the (Ca++) standard were added to the standard. To create the sample solution, 25 µL of sample extract and 1 ml of working reagent were added. Both the sample's and the standard's absorbance were calculated. The concentration of calcium was determined in mg/dl by multiplying the sample absorbance by the standard concentration (mg/dl).

3.7.4 Determination of Potassium (K)

A fine turbidity of potassium tetraphenylboron is created when sodium tetraphenylboron interacts with potassium. The amount of turbidity is inversely related to the amount of potassium present in the sample. 1 ml of potassium reagent and 0.02 ml of deionized water were pipetted into the cuvette to create the blank solution. A cuvette was filled with 1 ml of potassium reagent, 0.02 ml of potassium standard, and 0.02 ml of sample extract for the standard solution. After mixing, they undergo a 5-minute retention period incubation. Within 15 minutes, the absorbance of the Standard and sample were measured in comparison to a blank. The potassium concentration was

calculated in mg/dl by multiplying the sample absorbance by the standard concentration (mg/dl).

3.7.5 Determination of Magnesium (Mg)

The strategy is based on a variation in the complex's absorption wavelength caused by the particular binding of calmagite, a metallochromic indicator, to magnesium at an alkaline pH. The amount of magnesium present in the sample has a direct correlation with the intensity of the chromophores that are produced. 1 ml of the reagent was taken in the cuvette to make the reagent blank solution. The cuvette containing the prepared sample solution received 1 ml of reagent and 10 µL of sample extract. 1 ml of reagent and 10 µl of magnesium standard were placed in the cuvette to prepare the standard solution. After mixing, allow the cuvettes to rest at room temperature for 2 minutes. In comparison to the reagent blank, the absorbance of the sample and standard at 520 nm was measured. The concentration of magnesium was calculated in mg/dl by multiplying the sample absorbance by the standard concentration (mg/dl).

3.8 Determination of Antioxidant capacity by DPPH scavenging method

Extract preparation

• Taking 5gm of sample in felcon tube

• Adding 10ml absolute ethanol and left for 72 hours

• Straining the solvent

•Collection of filtrate

• Evaporation at 60°c using rotary evaporator

• Ethanoic extract found

Procedure

With a few minor adjustments, AzlimAlmey et al., (2010) DPPH test was used to assess the extracts antioxidant mobility. Ethanoic DPPH solution was created by dissolving around 6 mg of DPPH in 100 ml of pure ethanol.

The next step was to dilute 1 ml of ethanolic extract with 2 ml of DPPH solution. The mixture was then lightly shook and permitted to sit at room temperature for 30 minutes

in the dark. Using a UV-VIS spectrophotometer, the absorbance was measured at wavelength 517 mm (UV-2600, Shimadnu Corporation, JAPAN). While ethanol was employed as a blank, the control was made by combining 1 mL of ethanol with 2 mL of DPPH solution. The reduction in absorbance of the samples in contrast to the DPPH standard solution served as a proxy for the scavenging mobility. The following equation was used to assess the extracts antioxidant capacity based on their DPPH free radical scavenging mobility:

$$\text{Scavenging activity (\%)} = \frac{\text{Absorbance of sample}}{\text{Absorbance of control}} \% \ 100$$

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

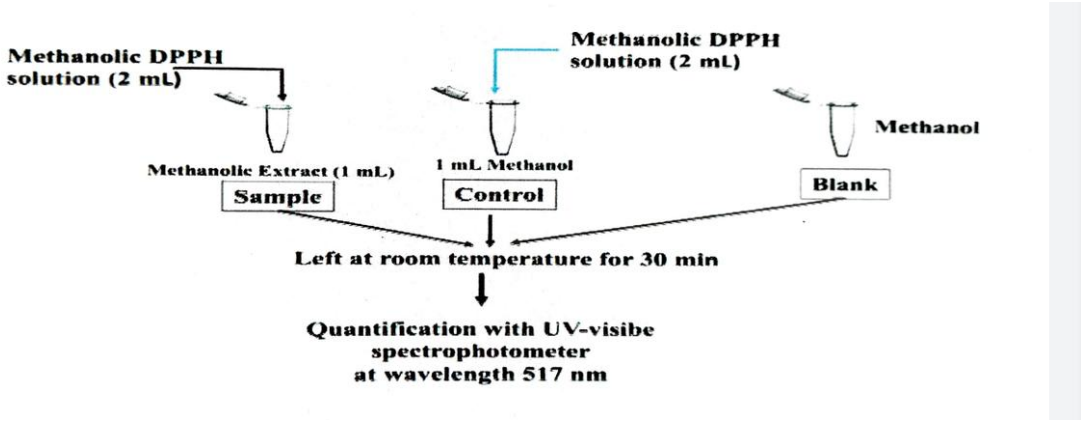


Figure 3.2: Antioxidant activity (AOA) determination procedure

3.9 Determination of Bio-active compounds

Extract preparation

- ✓ Taking 5gm of sample in Felcon tube
- ✓ Adding 10ml absolute ethanol and left for 72 hrs
- ✓ Straining the solvent
- ✓ Collection of filtrate72 hours
- ✓ Evaporation at 60°c using rotary evaporator

✓ Ethanoic extract found

Total Phenolic Content (TPC)

With a few minor adjustments, the Folin-Ciocalteu reagent technique was used to determine the TPC of the extracts (Al-Owaisi et al,, 2014). 1.5 ml of FC reagent was added to 1 ml of ethanoic extract in a falconer tube, which was then kept at room temperature for 3 min. The mixture was then given 1.5 ml of 7.5% Na_2CO_3 and was allowed to sit for 60 minutes. Using a UV-VIS Spectrophotometer (UV 2600, Shimadzu Corporation, JAPAN) and C_2H_5OH as the blank, the absorbance was measured at wavelength 765 nm. TPC was determined to be mg of gallic acid equivalents per gram of extracts (mg GAE/g).

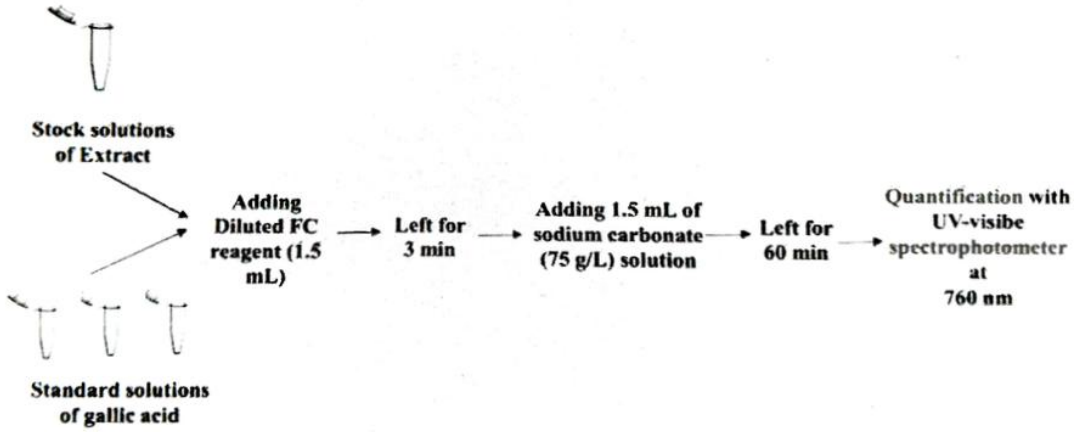


Figure 3.3: Total Phenolic Content (TPC) determination procedure

Total Flavonoid content (TFC)

The samples total flavonoid content (TFC) was calculated using a slightly modified version of the aluminum chloride colorimetric method described by Chang et al., (2002). The extracts were produced as a stock solution (1 mg/ml), and aliquots of 0.5 ml of diluted extract were diluted with 15 ml of 95% C_2H_5OH in a cuvette. The mixture in the cuvette was then treated with 0.1 ml of 10% $AlCl_3$, 0.1 mil of 1 mol/L potassium acetate, and 2.8 ml of distilled water (H2O). For 30 minutes, the mixture was kept at room temperature. An equal amount of 10% aluminum chloride replaced with D.H2O was used as the blank. The absorbance was measured at wavelength 415 nm using a UV-visible spectrophotometer (UV-2600, Shimadzu Corporation, USA). By comparing the sample extracts absorbance to a quercetin standard curve, the total quantity of

flavonoid present in the sample was determined. TFC was calculated and expressed as mg of quercetin equivalents (mg QE/g) per gram of extract.

3.10 Sensory evaluation of finished products

The samples of jelly were assessed for their sensory qualities. Color, flavor, texture, and overall acceptability of the samples were assessed. The degree of acceptance of the samples was determined using a 1–9 point hedonic rating test. 10 panelists were chosen from the academics, students, and staff members of the Chattogram Veterinary and Animal Sciences University's Department of Applied Chemistry and Chemical Technology and instructed on the process before to the review. The 10 panelists each received a part from each sample. On a scale of 1 to 9, where 1-represents a strong hate; 2-a strong dislike; 3-a moderate dislike; 4-dislike slightly; 5-neither like nor dislike; 6-like slightly; 7- like moderately; 8 like very much; 9 like extremely; the taste panelists were asked to score the sample for color, flavor, texture, and overall acceptability (Amerine et al., 2013).

3.11 Statistical Analysis

Data were sorted, coded and recorded in MINITAB 17. Descriptive statistics (mean and standard deviation) were done for proximate composition and sensory evaluation of date jelly. After that statistical analysis were conducted. Proximate composition and sensory evaluation data were analyzed by using One-way ANOVA procedures to assess significant level of variation at 95% confidence interval. The statistical analysis was conducted for at 5% level of significant (≤ 0.05).

Chapter IV: Results

4.1 Physicochemical and proximate analysis of date jelly

Physicochemical analysis of different samples of date jelly was performed in the laboratory. Table 4.1 showed the laboratory test results of Maryaam date jelly,Ajwa date jelly and Ambaar date jelly samples, respectively. These tables showed the result of physicochemical and proximate analysis. One way ANOVA (Analysis of variance) test was performed to see the overall mean difference of values for different parameter of date jelly. It can be seen from the tables that Mean±SD values of moisture content, total soluble solids, acidity, $p^{H,}$ crude protein, crude fat, ash content, carbohydrate and vitamin C. The results showed that there was significant mean difference of values of different parameters of jelly. Fisher's multiple comparison tests were performed to make sure for which parameters were the most significant.

Table 4.1: Physicochemical and proximate analysis test results for Maryaam date jelly, Ajwa date jelly and Ambaar date jelly.

Parameters	Maryaam Date Jelly	Ajwa Date Jelly	Ambaar Date Jelly
Moisture (%)	24.573 ± 0.374^{c}	25.600 ± 0.291^{b}	27.520 ± 0.310^{a}
Crude protein (%)	0.74 ± 0.020^{b}	0.82 ± 0.025^{a}	0.77 ± 0.020^{b}
Ash content (%)	0.36 ± 0.01^{b}	0.38 ± 0.01^{b}	0.37 ± 0.01^{ab}
Fat (%)	0	0	0
p^{H}	3.40 ± 0.20^{a}	3.40 ± 0.265^{a}	3.33 ± 0.153^{a}
Titratable acidity	0.0627 ± 0.0021^{b}	0.0637 ± 0.00153^{b}	0.0724 ± 0.00234^{a}
TSS(°Brix)	66 ± 0.01^{a}	67 ± 0.015^{a}	67 ± 0.020^{a}
Vitamin-C(mg/100g)	0.130 ± 0.02^{a}	0.120 ± 0.02^{a}	0.123 ± 0.025^{a}

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

Fisher's Multiple Comparison Tests (FMCT) were performed at ($p\leq0.05$) was performed to show the pairwise significant difference of chemical parameters of jellies. It was observed from the above tables obtained from one way ANOVA analysis that there is a significant difference in moisture content of every sample. Highest percentage of moisture found in ambaar date jelly (27.520 ± 0.310^{a}) and lowest percentage found in maryaam date jelly (24.573 ± 0.374^{c}). Significant amount of moisture change found in all samples (Table 4.1).

For crude protein percentage, there is no significant difference between maryaam date jelly and ambaar date jelly but there is a significant difference in ajwaa date jelly. The crude protein percentage of ajwaa date jelly is higher than the other two jelly sample.

There is no crude fat found in the jelly samples.

For ash content, there is no significant difference among the jelly samples.

For p^H, there is no significant difference among the jelly samples.

For acidity, there is no significant difference between maryaam date jelly and ajwaa date jelly but there is a significant difference in ambaar date jelly. The acidity percentage of ambaar date jelly is higher than the other two jelly sample.

For °Brix and Vitamin-C, there is no significant difference among the jelly samples.

4.2 Anti-oxidant capacity and Bio-active compounds Analysis

Antioxidant capacity and bio-active compounds were analyzed by UV-Visible spectrophotometer in the laboratory and result is shown in Table 4.2. These tables showed the result of anti-oxidant capacity, TFC (Total flavonoids content), TPC (Total phenolic content). One way ANOVA (Analysis of variance) test was performed to see the overall mean difference of values for different parameter of date jelly variations. Fisher's multiple comparison tests were performed to make sure for which parameters were the most significant.

Table 4.2: Anti-oxidant capacity and Bio-active compounds Analysis test results for Maryaam date jelly, Ajwa date jelly and Ambaar date jelly

Parameters	Maryaam Date Jelly	Ajwa Date Jelly	Ambaar Date Jelly
Antioxidant capacity (DPPH)	3.04450 ± 0.00404^a	3.04367 ± 0.00321^a	3.04567 ± 0.00325^a
Total flavonoids content (TFC)	2.2107 ± 0.0114^b	2.1723 ± 0.0225^b	2.2260 ± 0.0221^a
Total phenolic content (TPC)	10.167 ± 0.306^a	10.367 ± 0.306^a	10.600 ± 0.300^a

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

It was observed from the above tables obtained from one way ANOVA analysis that antioxidant capacity of every sample is almost same.

There is no significant difference between maryaam date jelly and ajwaa date jelly for TFC content. Highest percentage of TFC found in ambaar date jelly (2.2260 ± 0.0221^{a}). Significant amount of TFC found in all samples (Table 4.2).

For TPC, there is no significant difference among the jelly samples. Significant amount of TPC found in all samples (Table 4.2).

4.3: Minerals Analysis

Minerals were analyzed by AAS in the laboratory and result is shown in Table 4.3. One way ANOVA (Analysis of variance) test was performed to see the overall mean difference of values for different parameter of date jelly variations. Fisher's multiple comparison tests were performed to make sure for which parameters were the most significant.

Table 4.3: Minerals Analysis test results for Maryaam date jelly, Ajwa date jelly and Ambaar date jelly

Parameters	Maryaam Date Jelly	Ajwa Date Jelly	Ambaar Date Jelly
Magnesium (Mg)	0.400 ± 0.10^{a}	0.023 ± 0.015^{b}	0.047 ± 0.015^{b}
Calcium (Ca)	0.073 ± 0.0153^{c}	0.370 ± 0.0252^{b}	0.530 ± 0.02^{a}
Phosphorus (P)	0.20 ± 0.10^{c}	0.60 ± 0.10^{a}	0.43 ± 0.15^{b}
Iron (Fe)	$0.005367 \pm 0.000306^{a}$	0.00433 ± 0.00208^{a}	$0.003600 \pm 0.000265^{a}$
Potassium (K)	0.20 ± 0.10^{a}	0.33 ± 0.21^{a}	0.40 ± 0.30^{a}

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

From the above table, there is no significant difference between ambaar date jelly and ajwaa date jelly for magnesium (Mg) content. Highest amount of magnesium (Mg) found in maryaam date jelly.

There is a significant difference in calcium (Ca) content of every sample. Highest amount of calcium (Ca) found in ambaar date jelly (0.53 ± 0.02^{a}) and lowest amount found in maryaam date jelly (0.073 ± 0.0153^{c}).

For phosphorus (P), there is a significant difference among the jelly samples. Highest amount of phosphorus (P) found in ajwa date jelly and lowest amount found in maryaam date jelly.

For iron (Fe) and potassium (K), there is no significant difference among the jelly samples.

4.4 Sensory Quality Evaluation

Prepared three different date jellies were subjected to sensory evaluation test. The test had been performed by ten semi-trained panelists. The panelists comprised of female and male members who had previous a few experiences on fruit jelly products evaluation. The evaluation of jellies was carried out on sensory attributes that include taste, flavors, mouth feel, color, appearance and overall acceptability. This evaluation was performed at room temperature in the laboratory condition of department of applied chemistry and chemical technology at CVASU. Each panelist scored samples independently and recorded the scores on the prescribed evaluation sheets provided. The scale was arranged in such that: 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 verymuch-2, Dislike Extremely- 1.

This method does not, of course, reflect actual consumer perception, but it does strongly indicate attributes which a good quality product should possess (Sing et al., 2008). These jellies were compared to one another in terms of taste, flavors, mouth feel, color, appearance and overall acceptability. One way ANOVA (Analysis of variance) test was performed to see the overall mean difference of sensory parameter for scores provided by the panelists Table 4.4 showed significant difference of mean of different olive jelly.

Table 4.4: Hedonic scale scoring test results for Maryaam date jelly, Ajwa date jelly and Ambaar date jelly

Parameters	Maryaam Date Jelly	Ajwa Date Jelly	Ambaar Date Jelly
Taste	7.50 ± 0.50^{b}	7.83 ± 0.29^{a}	6.90 ± 0.36^{c}
Flavor	6.5 ± 0.30^{a}	6.2 ± 0.27^{a}	6.4 ± 0.27^{a}
Mouth feel	7.56 ± 0.40^{a}	8.07 ± 0.40^{a}	7.77 ± 0.25^{a}
Appearance	6.15 ± 0.153^{c}	7.43 ± 0.404^{b}	8.0 ± 0.20^{a}
Overall acceptability	7.33 ± 0.208^{ab}	7.77 ± 0.252^{a}	7.23 ± 0.252^{b}

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

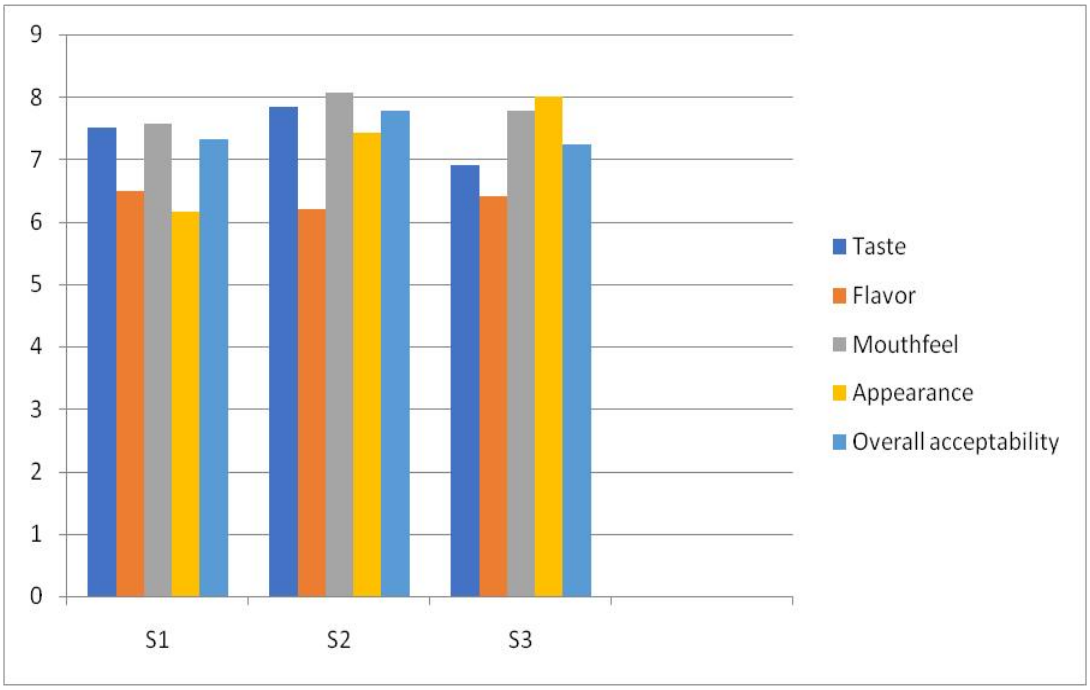
Fisher's Multiple Comparison Tests (FMCT) were performed at ($p\leq.05$) was performed to show the significant difference of sensory parameters of jellies. It was observed from

the above tables obtained from one way ANOVA analysis that,there is no significant difference in flavor and mouthfeel of the jellies.

There is a significant difference in taste of the jelly samples. Ajwa date jelly got the highest value while ambaar date jelly got the lowest.

There is a significant difference in appearance of the jelly samples. Ambaar date jelly got the highest value while maryaam date jelly got the lowest.

There is a slightly difference in overall acceptability of the jelly samples. All the jelly samples were positively accepted by the panelist but the ajwa date jelly was the most preferable.



Legends: S_1 = Maryaam Date Jelly, S_2 = Ajwa Date Jelly, S_3 = Ambaar Date Jelly

Figure 4.1: Sensory Quality Evaluation of Date Jellies

4.5 Calculation of cost in production of date jelly

The production cost of the developed ajwa date jelly was calculated and Table 4.5 showed total cost for 1 Kg ajwa date jelly is approximately Tk 640.

Table 4.5: Production cost of ajwa date jelly

Raw materials	Quantity	Price
Date	200g	100
Sugar	450g	45
Pectin	10g	250
Citric acid	5g	65
Bottling	4pcs	4×20=80
Wax	250g	100
Manpower		00
Total		**640**

Commercial one bottle jelly contain 250g jelly. By this cost we get 1kg(1000g) jelly which is equivalent to commercial 4 bottle jelly.

So, one bottle jelly costing is = $\frac{640}{4}$ = 160 Tk

Chapter V: Discussions

5.1 Physicochemical Analysis of date jelly

5.1.1 pH

The most noteworthy and least pH of maryaam date jelly, ajwa date jelly and ambaar date jelly were recorded 3.4, 3.4, 3.3. The results of this study are very similar to the pH value of 3.2 for dietetic jam produced of umbu-caja (Mamede et al., 2013). The p^H of fresh date jelly 3.57 (Youssif et al., 1990). It implies dates are acidic. Anuar and Salleh (2019), claim that the pH value is a key factor in defining the gel consistency and that a pH range of 2.8 to 3.3 is required to produce optimal jelly-like consistency and spreadability. In addition, inadequate acid is the most frequent reason for gel failure. Low acid foods are those with a pH of less than 4.6. Due to its low acidity, date fruit jelly is free of bacterial and spore-forming pathogen activities. As a result, the jam products shelf life may be increased (Food and Drug Administration, 2016).

5.1.2 Titratable Acidity

Physicochemical qualities such as acidity are one of the reasons why food goods have a longer shelf-life because it prevents the development of microbes (Tifani et al., 2018). Maryaam date jelly, ajwa date jelly, and ambaar date jelly were found to have the most notable and least titratable acidities, respectively, of 0.0627, 0.0637, and 0.07247 percent. The findings of this study differed from those of Ajenifujah-Solebo and Aina (2011), who found a total titratable acidity of 0.34 % in fruit jelly made from black-plum fruits. According to the findings of Youssif et al., (1990) the acidity of date jelly will increase with continued storage. Agarwal and Mangaraj (2005) observed that apple and olive jam had an acidity of around 0.6 and that it became more acidic as it was stored. They claimed that the cause of the rise in acidity was the oxidation of reducing sugar and the breakdown of pectic substances, as well as the breakdown of polysaccharides, which produce acids. It's possible that co-polymerization of natural acids is only partially to blame for the decrease in acidity.

5.1.3 Total Soluble Solid

The lowest and highest TSS values for maryaam date jelly, ajwa date jelly, and ambaar date jelly were 66, 67, and 67ºBrix, respectively. Probably due to the hydrolysis of

polysaccharides, TSS levels increased. Muresan et al., (2014) found that fruit jelly prepared from banana and ginger had a total soluble solid content of 66-69 ºBrix, which is consistent with our findings. Youssif et al., (1990) discovered that the TSS of date jelly was close to 69ºBrix and that it increased with storage. In addition, they suggested that the increase in the total soluble solid content of the date jelly may be a result of the breakdown of polysaccharides in the presence of acid.

5.1.4 Vitamin C

Water-soluble ascorbic acid is essential for living. Vitamin C plays a crucial role in the cellular chemistry that produces energy, aids in the formation of sperm, and is necessary for the synthesis of the collagen protein, which is crucial for the development and maintenance of cartilage, joints, skin, and blood vessels. Additionally, date fruits are rich in vitamins and include at least six different types of vitamins (Al-Shahib and Marshall, 2003b). Maryaam date jelly, ajwa date jelly, and ambaar date jelly each contained 0.13 mg/100 g, 0.12 mg/100 g, and 0.123 mg/100 g of vitamin C, respectively. The vitamin C content of orange-based low-calorie jams varied from 8.94 to 28.77 mg/100 g, which is substantially greater than this study, according to Rafeek et al., (2015). This study's low vitamin C concentration in jellies is due to the fact that processing fruits into jam or jelly has been shown to be destructive to vitamin C (Uckiah et al., 2009). According to Valente et al., (2014) vitamin C plays a crucial role in the body's metabolic processes. Additionally, it is widely used as a food additive and antioxidant.

5.2 Proximate Analysis of date jelly

5.2.1 Moisture Content

Food item's moisture content is one of the most regularly evaluated parameters used to estimate their shelf life (Naeem et al., 2017). Measurement of moisture content is also crucial for regulatory and labeling reasons. The moisture content for maryaam date jelly, ajwa date jelly, and ambaar date jelly was found to be 24.573, 25.600, and 27.520 percent, respectively, in phytochemical analysis. When compared to the figures reported by Umeh and Nwadialu (2010) for orange and Cola pachycarpa jams (90.8 percent and 96.3 percent) respectively, the moisture content figure found in this research was very low. According to them, a food's moisture level may be used as an

indication of how long it will last. This study's low moisture content indicate that the jelly would have a longer shelf life.

5.2.2 Crude protein

Although dates are not an excellent source of protein, they may still provide high-quality necessary amino acids to the diet of humans (Salem and Hegazi, 1971). Maryaam date jelly, ajwa date jelly, and ambaar date jelly each had a protein content of 0.74, 0.82, and 0.77 percent, respectively. Maryaam, Ajwa, and ambaar date jelly were found to have higher crude protein contents than apricot jam (0.43 %), blueberry jam (0.31 %), strawberry jam (0.41 %), and belimbi jam (0.41 %) (Naeem et al., 2017; Anuar and Salleh, 2019). When Borchani and his team studied eleven Tunisian dates, they discovered that the maximum protein level was 2.85 g/100 g of dry matter, which is greater than the crude protein content of date fruit jelly prepared in this study. The changes may be the result of certain nitrogen compounds dissolving and losing during the heating operation.

5.2.3 Ash content

The quantity of ash present in food items may be used to estimate the overall mineral content. Foods ash content serves as an indicator of their nutritional value. Maryaam date jelly, ajwa date jelly, and ambaar date jelly all had an average ash concentration of 0.36, 0.38, and 0.37 percent, respectively. Due to the equal quantity of date fruit pulp utilized in each formulation, the ash concentration did not change noticeably across samples. Furthermore, Bhaskar and Shantaram (2013) found that fresh belimbi fruits had an ash content of just 0.33 percent, which is lower than the ash level found in the jellies in this investigation. Mineral losses during fruit washing and cooking were thought to be the cause of this fluctuation in mineral content. According to Dandago (2009), some of the minerals present in raw materials are not present in processed meals because they leak into the water during processing, which significantly reduces their availability. However, the ash level of date fruit jellies in this investigation is comparable to that of belimbi fruit jam (0.37%) investigated by Anuar and Salleh (2019).

5.3 Anti-oxidant capacity

According to Martin-Sánchez et al., (2014) dates are an excellent source of antioxidants such tannins, carotenoids, sterols, and polyphenols. They've been shown to be excellent for the heart and may help prevent cancer and osteoporosis. Different date cultivars, date types, and date origins each have their own unique antioxidant potentials. Also, the amount of antioxidants in dates varies depending on where they are and when they are ripe. According to Wicklund et al., (2005) strawberry jams stored for three months at 20°C in the presence or absence of light experienced a decrease in antioxidant activity. The antioxidant capacity results of maryaam date jelly, ajwa date jelly, and ambaar date jelly were almost identical in each category, with values of 3.0445, 3.04367, and 3.04567 percent, respectively. This is lower than the results of cherry jam's antioxidant activity, which was found to be 39.75% (Amakura et al., 2000). The most significant factor that contributed to the considerable decrease in antioxidant activity was the temperature.

5.4 Bio-active compounds

Fruit includes bio-active compounds, which are necessary for human biological functions including the maintenance of the immune system and the avoidance of chronic diseases, in addition to basic nutrients. The results of the bio-active ingredient content found in date jelly are shown in Table 4.2. As a consequence, it is essential to quantify these substances.

Simple phenolic compounds, phenolic acids, anthocyanins, cinnamic acid derivatives, flavonoids, and tannins are examples of phenolic compounds that may be found in plants and have the ability to scavenge free radicals. According to Chen et al., (2013) tannins, which may operate as a natural antibacterial agent and increase a plant's resistance to infections, are also thought to be associated to protection against insects or phytopathogens in plants (Scalbert, 1991).

Maryaam date jelly, ajwa date jelly, and ambaar date jelly all had total phenolic contents of 10.167 mg GAE/100g, 10.367 mg GAE/100g, and 10.600 mg GAE/100g, respectively. This is much less than the cherry jams (287.18 mg GAE/100g) reported by Kim and Padilla-Zakour (2004).

According to Patras et al., (2009) who reported on the loss of total phenolics during jelly manufacturing, the reduction may be caused by the disruption of cell structure during fruit processing and the increased potential for non-enzymatic oxidation.

Flavonoids, which include a wide range of various compounds that may have a variety of biological effects, are thought to be among the compounds that could prevent cancer. According to Table 4.2, the highest amount of flavonoids was noticed in ambaar date jelly, which had a value of 2.2260 mg QE/100g. Maryaam date jelly and ajwa date jelly had values of 2.2107 mg QE/100g and 2.1723 mg QE/100g, respectively, which are higher than grape fruit jellies 1.54 mg QE/100g and lower than blood orange jellies 9.06 mg QE/100g (Kopjaret al., 2016).

5.5 Minerals Analysis

According to reports, dates contain at least 15 different minerals (Al-Shahib and Marshall, 2003a). The most common minerals were potassium, calcium, phosphorus, magnesium, and iron. Potassium is a vitamin that is very helpful in regulating the neural system of the body and in maintaining a healthy nervous system. Phosphorus interacts with calcium to support bone health and development, while calcium also supports proper muscular function (El-Sohaimy et al., 2010). Additionally, dates are thought to be a beneficial supplement for treating anemia and iron deficiency (Hadrami and Al-Khayri, 2012).

Maryaam date jelly, ajwa date jelly, and ambaar date jelly all had Mg(magnesium) contents of 0.400, 0.023, 0.047 mg/100g. When compared to maryaam date jelly, ambaar and ajwa date jelly often have lower Mg levels. This is much less than the cherry jams (11 mg/100g) reported by Kim and Padilla-Zakour (2004). The mixing of fruit pulp with sugar during the jelly-making process may be the cause of the reduced Mg content for date jellies in this study (Plessi et al., 2007).

Maryaam date jelly, ajwa date jelly, and ambaar date jelly all had Ca(calcium) contents of 0.073, 0.37, 0.53 mg/100g. Ca content of the ajwa and ambaar date jellies was near to the one reported for cherry (0.55 mg/100 g) (Amakura et al., 2000) but the maryaam date jelly had very lower amount of Ca.

Fe(iron) concentration was found to be very low in all of the jellies tested. It was found that the Fe concentration of cherry jams was likewise very low (0.002 mg/100 g) by

Muchuweti et al., (2011). Fe may have been destroyed by heat treatment during the jelly-making process, which might be the reason for the decrease in the Fe level in date fruit jellies.

Maryaam date jelly, ajwa date jelly, and ambaar date jelly all had P(phosphorus) contents of 0.20, 0.60, 0.43 mg/100g. Among the three jellies, ajwa had the most P content. In comparison, Muchuweti et al., (2011) reported P content in cherry jam (0.08 mg/100 g) which was lower than this studies.

Maryaam date jelly, ajwa date jelly, and ambaar date jelly all had K(potassium) contents of 0.20, 0.33, 0.40 mg/100g. All the jelly samples had nearly similar amount of K. Panceri et al., (2013) reported K content of cherry jam (0.13–0.90 mg/100 g) which was similar with this studies.

The mineral concentrations we discovered in date fruit are often substantially greater than those we discovered in the samples of date jelly. During the washing and boiling of date fruit, minerals are eliminated from the fruit. Due to mineral leaching into water during processing, several minerals that are present in raw materials are absent from processed foods, which has led to a significant drop.

5.6 Consumer acceptability test of date jelly

Sensory quality of olive jelly based on taste, flavor, mouthfeel, appearance and overall acceptability were evaluated. Mean sensory score of taste results were 7.50, 7.83 and 6.9 for maryaam date jelly, ajwa date jelly and ambaar date jelly respectively. Highest taste score was observed for ajwa date jelly.

For all jelly samples, the average flavor rating was almost identical. One-way ANOVA findings showed that there were no statistically significant ($p \leq .05$) differences in terms of flavour acceptability. Ajwa date jelly received the highest mouth feel rating. The pectin and citric acid content of the jelly had an impact on the mouth feel score.

Acceptability scores were gradually decreased with storage duration, Kumer et al., (2016) stated that oxidation and enzymatic browning reaction are responsible for changes in the colour and flavour of foods during processing and storage. Highest mean score of acceptability 7.77 in ajwa date jelly in hedonic rating scale it denotes "Like moderately". The acceptance of all the jelly samples varies somewhat. The panelists liked all of the jelly samples, but the ajwa date jelly was the most popular.

Chapter VI: Conclusion

Date jelly was shown to have the optimum acceptance in terms of sensory perception in this investigation. Date jellies were subjected to a physicochemical and proximate analysis test, which revealed substantial variations. Date commercial jelly was not sampled in the current investigation since it was unavailable in local stores. The nutritional values were found to be satisfactory. This study identifies a promising possibility of manufacturing jelly from several date varieties for the benefit of Bangladeshi producers, processors, and consumers. It's also worth noting that selling the highest-quality jelly of international standards may generate foreign cash, which can help the Bangladeshi economy. Further study is important for research with other necessary ingredients for trial with different types of fruits for preparation of jelly.

Chapter VII:Recommendations and Future Perspectives

These studies have been concluded with good findings in the area of developing date jelly. Modern food industries can adopt the procedure form medium and large scale of production in the bases of present investigation, the following suggestions and prospects are made for the further research work.

a) The current research might be performed to evaluate the experimental findings.

b) The recipe may be tweaked further and can try producing mixed jelly with different fruit ratios using other recipes.

c) It is simple to prepare. It's also suitable for the off-season and maybe maintained for a long period.

d) By adding value to the product's flavor and therapeutic properties, more profit may be made.

e) Similar research must to be carried out, particularly in the off-season, on other marketable fruits including papaya, mango, and so on.

f) As a byproduct of the date fruit processing business, date seeds would be cost-effective for both food and feed.

g) To improve the quality of date jelly, modern packaging and storage conditions would be implemented.

h) Adequate actions should be taken to improve the nutritional content of commercially accessible jellies.

i) Necessary steps should be made to ensure that the quality and value of commercially available jellies are controlled.

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Appendices

Appendix-A: Preparation of date jelly

Date Samples

Cutting the dates

Boiling with water

Boiling date juice with other ingredients

Checking jelly formation

Final products

Appendix-B: Laboratory Works

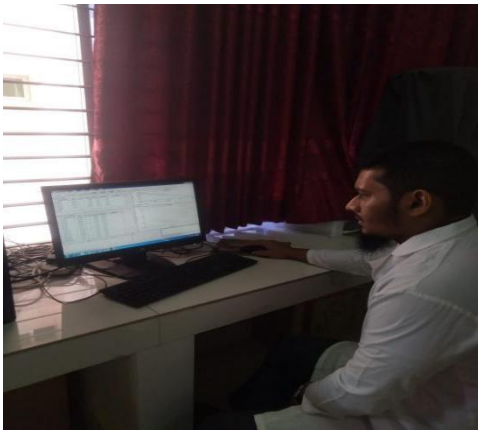
Weighing

Checking °Brix using refractometer

p^H checking

Titration

Working in UV Visible spectrophotometer



Working in UV Visible spectrophotometer

Appendix-C: Sensory Evaluation

Appendix-D: Sensory Evaluation of Date Jelly (Hedonic Rating Test)

Name:	**Product:**
Panelist No. :	**Date:**

Instructions:

Taste the given samples.Then place an √ mark on the point in the scale which best describes your feeling.

SCORE		**Taste**			**Flavor**			**Mouthfeel**			**Appearance**			**Overall acceptability**		
		S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3
9	**Like extremely**															
8	**Like very much**															
7	**Like moderately**															
6	**Like slightly**															
5	**Neither like nor dislike**															
4	**Dislike lightly**															
3	**Dislike moderately**															
2	**Dislike very much**															
1	**Dislike extremely**															

Here, S_1 = Maryaam Date Jelly, S_2 = Ajwa Date Jelly, S_3 = Ambaar Date Jelly

Brief Biography

Md. Tanvir Hasan has passed the Secondary School Certificate (SSC) Examinations in 2011 with a Grade Point Average (GPA) of 4.81 followed by the Higher Secondary Certificate (HSC) Examination in 2013 with a GPA of 4.80. He received the B.Sc. (Hon's) in Food Science and Technology in 2018 (held in 2019) from Chattogram Veterinary and Animal Sciences University (CVASU), Bangladesh. Now, he is a candidate for the degree of MS in Food Chemistry and Quality Assurance under the Department of Applied Chemistry and Chemical Technology, CVASU.