PHYSICOCHEMICAL, MICROBIAL AND SENSORY PROPERTIES ANALYSIS OF OLIVE JELLY PREPARED FROM DIFFERENT MATURITY STAGES OF OLIVE

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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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Dedication

I dedicate this small piece of work to my beloved family members and respected teachers.

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The Author

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List of Abbreviations

g/L	gram per liter
%	Percent
G	Gram
RDA	Recommended Daily Allowance
USDA	United States Department of Agriculture
mg	mili gram
cal	Calorie
USD	United States Dollar
UK	United Kingdom
W	Weight
hr	Hour
TA	Titratable Acidity
MC	Moisture Content
Abs	Absorbance
Ppm	Parts per million
TSS	Total soluble solids
RTS	Ready to serve
°C	Degree Centigrade
ml	mili liter
°Brix	Degree Brix
TV	Titratable Value
AOAC	Association of Official Analytical Chemists
nm	Nano meter
cm	Centi meter
mmol/L	Milimole per liter
Conc.	Concentration
UV	Ultra-violate
mg/dL	Mili gram per deciliter

Abstracts

This study was conducted to prepare olive jelly from different maturity stages olive. Olive was collected from Bangladeshi local olive tree at premature stage, matured stage and ripe stage. Fresh olive (*Elaeocarpus Serratus*) was collected from Khagrachari, Bangladesh. Three different types of jelly were prepared from this three types of olive with variation of 1%, 0.5% and without pectin and with 0.5% citric acid. No preservatives were added during processing of jelly. In this study, the physiochemical and nutritive properties of olive jelly were evaluated. The parameters evaluated in physiochemical parameters include pH, moisture content, TSS, titratable acidity, and Vitamin C. Samples were taken for estimating each type of test. Proximate analysis was performed for olive jelly variation. Microbiological analysis was also performed for each sample. The sensory test was performed for olive jellies by a set of the semi-trained panelist. The analysis showed jelly contains mean moisture content ranged from (29.98-32.55) %, (70.45-78.29) % and (80.69-85.23) % for premature olive jelly, matured olive jelly and ripe olive jelly respectively. Titratable acidity was found 0.19%, 0.18% and 0.16% for premature olive jelly, matured olive jelly and ripe olive jelly respectively. Total soluble solid was ranged from 0.65-0.75% in this jelly variation. The analysis showed pH ranged from 2.8-2.9, Vitamin C 0.29-0.68 mg, crude protein (2.18-2.5) %, ash (0.09-0.5)% for premature olive jelly, matured olive jelly and ripe olive jelly. No fiber was found in this olive jelly variation. Anti oxidant capacity content and Bio active compounds were measured in olive jellies. This study showed pectin and citric acid do not significantly interact with quality attributes of processed product. Total bacterial load in jelly were not found (acceptable limit ≤105cfu/ml) satisfactory. A taste panel consisting 15 panelists adjudged the acceptability of the samples. The consumer's preferences were measured by statistical analysis. Among the samples, ripe olive jelly was commended as best product by the panelists.

Keywords: *olive jelly, pectin, AOA, TPC, TAC and TAC.*

Chapter-1

Introduction

1.1 Background

We all know the importance of fruit as a part of a well-balanced diet, but most people do not know how good fruit is for health. Not only does fruit aid in our good physical health, but it also provides benefits for our good mental health. Fruit makes weight loss more efficient and heightens functions of brain. Fruits contain high source of carbohydrates, minerals, vitamins, dietary fibers, and antioxidants. They possess an outsized amount of glucose, fructose, and sucrose. Presence of fats and proteins are very negligible. Other constituents such as organic acid, phenolic substances, volatile substances, and minerals may be present and they play an important role in the chemical reactions which occur during processing and storage (Ong et al., 2012).

Eating a healthy amount of fruit increase the ability for our body to lose weight. Fruit contains eighty percent water like the human body. It means that extra water weight is easily disposed of and the body only absorbs the inherent nutrients. Fresh and processed fruits consumption have been step-up in present times due to the demand for a balanced diet, the health benefits, low calories in fruits and the superior flavor of the fresh fruits are compared to canned fruits. These are the good source of a healthy diet, able to lessen the risk of cardiovascular diseases and cancer (Mohammed, 2007; Ragaert et al., 2004).

Olive (*Elaeocarpus serratus*) is a tropical fruit belongs to Elaeocarpaceae family found in the Indian Subcontinent, Indo-China and South East Asia. It is popularly known as" Jalpai" in the northern parts of West Bengal & Bangladesh. It also referred to as Veralu in Sri Lanka, Veralikkai in Tamil, Kaarakka or Kaara in Malayalam, Zolphai in Assamese, Chorphon in Manipur and as Ceylon olive in English (USDA, ARS-2011).

Elaeocarpus has a genus of 350 plants species with a wide distribution in Bangladesh, Madagascar, India, Southeast Asia, Malaysia, southern China, Japan, Australia, New Zealand, Fiji and Hawaii in the east (Burkill et al., 1966). This acidic mature and immature fruit is especially used for preparation of chutney, pickles. The medicinal properties and the Phenolic contents, antioxidant and cytotoxic activities of *Elaeocarpus*

floribundus was reported by the several scientists (Dhadich et al., 2013; Utami et al., 2013).

It is an Asia-tropical fruit tree. It has a medium to large-sized evergreen tree with hairy branches. It is found in Indian subcontinent. Almost the whole year the red leaves are found on the tree. The tree can be easily recognized by its red leaves. This plant known as medangteja (in Malay) and infusion of bark and leaves is used as a mouthwash for its inflamed gums (Wiart, 2006).

This fruit is a drupe, sour, bronze-colored, about 2.5 cm long and the edible portion of the fruit is the mesocarp around the seeds. Flowers appear during the summer months (April to May) and fruits are matured during August to October. Although largely a homestead plant, it also occurs wild within the forests of Chattogram and Sylhet regions.

The fruit has nutritive and medicinal values as it is a beneficial herbal plant used to cure various diseases. Olives are a good source of vitamin E and minerals like iron, copper, and calcium. They also contain high amounts of sodium if it packaged in saltwater. It is also rich in vitamin C and cures common cold, dyspepsia, gum disease and physical weakness.

Olives are commonly recognized as a high-fat food (about 80-85% of the calories in olives come from fat),in addition to they provide a small amount of the essential fatty acid called linoleic acid, and small amount of alpha-linolenic acid, an omega-3 fatty acid. The high monounsaturated fat content of olives reduces the risk of cardiovascular disease. When diets low in monounsaturated fat are altered to extend the monounsaturated fat content which decrease in their blood cholesterol, LDL cholesterol, and LDL: HDL ratio. All of those changes lower our risk of heart condition.

Olives contains 80% water, TSS 8.20 to 11.33O brix, ascorbic acid content 12.65 to 18.72 mg/100g of fruit pulp. Indian olive fruits are utilized for preparation of chutney, making delicious pickles and other culinary purposes. In Sri Lanka pickled Ceylon olives are eaten as popular street food(USDA , ARS, FDC – 2019).

Jelly is a smoothest consistency and which is made by crushing a fruit and discarding the solid chunky leftovers. This leaves only the fruit crush, which is then mixed with a substance called pectin and heated to make the gelatinous spread with 65% sugar. During storage study of jelly TSS, titratable acidity, reducing sugars and total sugar were increased, whereas moisture content, vitamin C and organoleptic quality was slightly decreased with increased storage period. The main components used in the preparation of jellies are pectin, sugar and acid which need to be added in correct proportion for proper gel formation (Charles et al.,2009).

In Canada, the Food and Drug Regulations of the Food and Drugs Act of Canada categorizes jelly into two types: these are jelly, and jelly with pectin. Jelly made from the fruit, the fruit juice, or a fruit juice concentrate, and it must contain at least 62% water-soluble solids. Jelly contains an acid ingredient which makes up for any lack in the natural acidity of the fruit, a chemical to adjust the pH, and/or an antifoaming agent. Jelly with pectin must be made with a minimum of 62% water-soluble solids and a minimum of 32% juice of the named fruit, which may contain an acid ingredient that compensates for the lack in the natural acidity of the fruit; the addition to juice of another fruit; a gelling agent; food color; a Class II preservative (such as benzoates, sorbets, or nitrites); a chemical which adjust the pH; and/or an antifoaming agent (Reginald et al., 1991).

Pectin is essential to the formation of jelly because of its action as a gelling agent, meaning when the pectin chains combine, it create a network which results in a gel. The strength and effectiveness of the side chains and therefore the bonds they form depend upon the pH of the pectin the optimal pH is between 2.8 and 3.2. It plays an important role in food processing as food additives and as a source of dietary fiber.

Pectin gels are very important in creating or modifying the texture of jams, jellies, confectionaries and in low fat dairy products. It is also used as ingredients in the pharmaceuticals industry and it also lower the glucose response of products. In order to know their type and content, pectin is separated supported their solubility by sequential extraction in water or buffer solutions, solutions of chelating agents, dilute acids, or dilute sodium hydroxide or sodium carbonate. It is also considered a safe additive with no limits on acceptable daily intake (Gnanasambandam and Proctor, 1999).

Citric acid ($C_6H_8O_7$), which is a weak organic tricarboxylic acid found in citrus fruits. Citrus fruits (lemons, oranges, tomatoes, beets etc.) are those fruits which contains sufficient amount of citric acid and they are classified as acid fruits. It is a natural constituent and metabolite of plants and animals is versatile and widely used organic acid in the field of food and pharmaceuticals industries. It is a good preservative and acidic in taste. Citric acid are often easily manufacture and simply soluble. It is utilized in flavoring agent and increases stability of the fruit. Citric acid is allowed as non-synthetic under 'acids', with non-agricultural annotation that must be produced by microbial fermentation of carbohydrate sources. Olden day's acid is produced by three methods fermentation, chemical synthesis and extraction from citrus fruits (Vasanthabharathi et al., 2013).

Jelly production is easy to produce, consume and preserve. According to the Portuguese law (Law-Decree No.230/2003), jelly is defined as a product sufficiently gelled that result from the mixture of sugar and juice and/or aqueous extract of 1 or more types of fruit (Fernandez et al., 2014). Considering the previous history only few studies have been conducted to date on jellies. In order to obtain more valuable data on this subject, this study was carried out to determine physicochemical parameters, sensory evaluation, microbial analysis, antioxidant and bioactive compound analysis of jellies that have been made of olive from different stages (premature stage, mature stage and ripe stage).

1.2 Aim and objectives

a) To prepare olive jelly with different maturity level of olive fruits.

b) To examine and compare physicochemical parameters of jelly .

c) To compare the overall acceptability of the developed product with the commercial product.

d) To analyze the antioxidant activity and bioactive compounds of olive jelly.

Chapter-2

Review of Literature

Jolpai or Ceylon olive (*Elaeocarpus serratus*, family: Elaeocarpaceae) is a popular fruit of Bangladesh. It is a medium to large-sized evergreen tree with hairy branches. It is mainly found in Indian subcontinent. Almost all the year the red leaves are found on the tree. The trees are often easily recognized by the red leaves. Leaves are elliptic to lanceolate, 10-15 cm long and 4-5 cm wide, edge deeply dented, glossy green, alternate, acuminate at apex. Flowers are very beautiful. They borne in axillary racemes, 8-10 cm long, bear many small creamy-white flowers. Flower blooms in June-July (Tropical Fruits of Sri Lanka. Ministry of Agriculture and Lands, Sri Lanka. p. 29).

Olive is an important fruit in Bangladesh, but research works on olive related products are scarce. Now, it has received much attention to the researchers by developing products. Some available research finding in this connection have been reviewed and presented below on the following heading.

2.1 Physical properties of olive

The consumption of fruits has become increasingly important due to their potential beneficial health effects related to their nutrient composition (Albuquerque et al., 2016), such as the presence of vitamins, phenolic, anthocyanin, flavonoids, tannins, among others (Dimitrios, 2006). Most of these compounds have the ability to prevent cancer, cardiovascular diseases, diabetes, neurodegenerative diseases and osteoporosis (Scalbert et al., 2005). In this context, studies concerning the evaluation of bioactive compounds, especially from unconventional fruit and vegetables, may provide important data concerning their use as food or medicinal product. Besides that, the evaluation of the content of nutrients and bioactive compounds from unconventional crops may be an alternative to their enhancement, providing information concerning the discovery of significant or high levels for specific nutrients or bioactive compounds which will improve the market demand (Herraiz et al., 2016).

Elaeocarpus serratus (Elaeocarpaceae) is a decorative tree of Asiatic origin. Furthermore, it is a medium size tree with simple leaves, commonly called by Ceylon-olive, being found at East Africa, subtropical and tropical Asia either tropical Australia

(Ghani, 2003). Their fruits are considered as drupes and are used to prepare juices in order to increase the appetite of patients by stimulating secretions from taste buds (Biswas et al., 2012). The main characteristic of E. serratus fruit is that the astringent taste when consumed in natural, which are related with the upper amount of alkaloids and tannins present in its composition (Sharker and Shahid, 2010).

Elaeocarpus serratus may be a tropical fruit found within the Indian Subcontinent, Indo-China and South East Asia. It is a decorative medium-sized tree indigenous to Sri Lanka, producing smooth, ovoid green fruits. The fruit has nutritive and medicinal values. This Ceylon olive is a beneficial herbal plant which is used to cure various diseases. It is an ornamental medium-sized tree. Bears smooth ovoid green fruits the dimensions of about 2.5 cm long. Recommended varieties are local cultivars (round and oval fruits). It has a brown colour seed inside the fruit. The seed features a hard outer shell. The seeds are slow for germination .germination can take up to 2 years. The wood is whitish yellow.

Ramesh et al. (2014) worked on *Elaeocarpus serratus* and its physical properties. They found the habit of the plants up to 18 m tall, trunk & barks are brownish, smooth; blaze orange red, branches and branchletsterete, glabrous, with scars of fallen leaves. Leaves simple, alternate, spiral, clustered at twig ends; stipules small, lanceolate, caducous; petiole 1.2-4 cm long, swollen at both ends, planoconvex, glabrous, with subulate appendage at the junction of lamina; lamina 5.5-12.5 x 2.5-5 cm, elliptic, apex acuminate with blunt tip, base acute, margin serrate, chartaceous, glabrous, red when senescent; midrib slightly raised above; secondary nerves 5-9 pairs, branched with glabrous domatia at axils beneath; tertiary nerves reticulo-percurrent; higher order reticulation slender, minute. Inflorescence are racemes; flower petals white, laciniate, anthers ciliate.Fruit and Seed are drupe, oblong or ovoid to 2.5 cm long; seeds 3-4.

2.2Chemical properties of olive

Geetha et al. (2013) made an experiment on chemical profiling of Elaeocarpusserratus L. by GC-MS. The objectives of the study was to determine the possible bioactive components of the ethanoic extract of leaves of *Elaeocarpus serratus* (*E. serratus*).The research was carried out by using GC-MS analysis, while mass spectra of the compounds found in the extract was matched with the National Institute of Standards and

Technology and Wiley library. Thirty components from leaves of the above said plant were identified. The active principles with their retention time, formula, relative molecular mass and concentration (%) within the ethanol extracts of leaf of *E. serratus* are obtained.

Among the identified phytochemicals, the carboxylic acid esters namely, docosanoic acid, 1,2,3-propanetriyl ester, palmitic acid methyl ester have the property of antioxidant, hypocholesterolemic, nematicide, pesticide, flavouring agent, lubricant and anti-androgenic activities. Analogous to this study, palmitic acid methyl ester was identified within the methanol extract of Spirulinaplatensis. The ethanolic extract of Mussaendafrondosa was subjected to GC-MS analysis and 20 chemical constituents namely quinic acid, 4-((1e)-3-hydroxy-1-propenyl)-2-methoxyphenol, naphthalene,decahydro-2-methoxy,1, 2, 3-benzenetriol, hexadecanoic acid ethyl ester, linoleic acid ethyl ester, oleic acid, etc. were identified. The compounds farnesol and citronellylisobutyrate are present in the ethanolic leaf extract of *E. serratus*. The compound farnesol is an acyclic sesquiterpene alcohol, and it's been suggested to function as a chemopreservative and anti-tumor agent. It is also used as a deodorant in cosmetic products due to its anti-bacterial activity. The anti-fungal activity of farnesol has also been reported. Citronellylisobutyrate is an ester of propionic acid which is widely used as flavoring agent and is understood to possess insectifuge and antimicrobial properties.

Our systematic investigation reveals the potential of *E. serratus* leaves as an honest source of bioactive compounds like carboxylic acid esters, alcohols, hydrocarbons, aldehydes, alkenes, fatty acids and amides that justify the utilization of this plant for its various ailments by traditional practitioners. Further research interest in the study of these active bio compounds may yield nature friendly strong antioxidant, anti-microbial, anti-inflammatory agents and analgesic agents.

The present study “Quality evaluation and Value Addition of fruits of Elaeocarpus serratus L. (Ceylon Olive Tree)” was conducted in Vazhachal forest division of Thrissur district, Kerala. From the chosen trees the fruits were collected to guage their physical parameters, biochemical and mineral composition. Two products were also, prepared

from the fruits and their bio chemical parameters were analyzed. The physical characteristics of the fruits revealed that the mean fruit weight, volume, length, diameter for the fruit were 3.55 g, 5.97 cm3, 23.07 mm and 15.58 mm respectively. The mean pulp and seed weight was observed as 2.03 g and 1.52 g respectively for the fruits. The pulp and seed proportion was estimated to be 57.50 per cent and 42.50 per cent of the entire *Elaeocarpus serratus* fruit content. Correlation matrix revealed a big and positive relation among all the studied physical parameters. The biochemical parameters of the fruit like moisture, total soluble solids, total sugar, reducing sugar, starch, fibre, titratable acidity, beta carotene, vitamin C were obtained as 62.45 per cent, 5.99^0 brix, 12.05 per cent, 8.26 per cent, 18.78 per cent, 1.73 per cent, 1.36 per cent, 1.04 μ g /100gm and 2.9 mg /100gm respectively. Minerals like phosphorous, potassium, iron and calcium were found to be 62.80 mg/100g, 331.48 mg/100g, 2.14 mg/100g and 10.94 mg/100g. The nutritional composition of the fruits was found to be in par with other tropical fruits like tamarind, passion fruit, jackfruit etc. In terms of organoleptic evaluation the fruit showed the mean scores for appearance, colour, flavour, texture, odour, taste, after taste was found as 6.7, 6.8, 5, 5, 4.9, 4 and 4.1 respectively. Since the mean value for the above characteristics of the fruit are low, the overall acceptability of the fruit is low with the value of 4.1. Two products were developed from the fruit i.e. pickle and candy. The chemical composition of the fruit product pickle was analysed to guage the acidity, total soluble solids, vitamin C, total sugar and reducing sugar which were found to be 1.2 per cent, 10.450 brix, 2.6 mg/100g, 6.05 mg/100g and 0.76 mg/100g respectively. Similarly Candy chemical composition analysed values was found to be 1.42 per cent, 68.060 brix, 2.8 mg/100g, 40.10 mg/100g and 15.01 mg/100g respectively. The organoleptic scores for the pickle and candy showed high values for all the parameters with the general acceptability mean score of 8.4 and 7.7 respectively. Hence, this study of fruits of *Elaeocarpus serratus* clearly reflects the potential of this underutilized wild produce for commercial utilization. Hence, this study of fruits of *Elaeocarpus serratus* clearly reflects the potential of this underutilized wild produce for commercial utilization.

Phytochemical composition by spectrophotometry was done by lima & breda (2018) where flavonoids content was determined in the acetonic extracts of E. serratus using the colorimetric method involving the reaction with aluminum chloride (Sigma, St. Louis,

USA), as described by Chang et al. (2002). Extracts were prepared with 100 g of sample added in 500 mL of acetone (50% w/v) (Sigma Aldrich, Duque de Caxias, Brazil), and they were kept under constant agitation (150 rpm) for seven days. The sample was filtered and the filtrate was considered the flavonoid extract for analysis. The extract was reacted with aluminum chloride and therefore the readings were performed during a spectrophotometer (Biochrom – LibraS60) adjusted at 415 nm. Quercetin solutions at nine concentrations (0.01 to 0.2 µg.µL-1) were reacted with sodium aluminum chloridein order to construct a standard curve. The results were expressed as milligrams of quercetin equivalent (QE mg.100 g-1sample) using the quercetin (Sigma Aldrich, São Paulo, Brazil) standard curve.

The content in tannins was determined in the acetonic extracts of E.serratus through the colorimetric method described by Maxson and Rooney (1972). Extracts were prepared with 4 g of sample added in 20 mL of acetone (50% w/v), and they were kept under constant agitation (150 rpm) for seven days. The samples were filtered and therefore the filtrate was considered tannins extract for analysis. The reaction mixture consisted of 1 mL of the extract with 4 mL of vanillin (Dinâmica, Diadema, Brazil) solution (v/v) (concentrated HCl (Vetec, Duque de Caxias, Brazil)) in methanol (Vetec, Duque de Caxias, Brazil) and 8% vanillin in methanol (4%). The absorbance readings were performed after 20 min at a wavelength of 500 nm, employing a spectrophotometer (Biochrom – Libra S60). Vanillin solution was used as the blank. The results were expressed as milligrams ofcatechin equivalent (CE mg.100 g-1of sample) using the catechin (Sigma, St. Louis, USA) standard curve.

2.3 Antimicrobial properties of olive

Indhiramuthu et al. (2014) made an experiment on “Evaluation of antimicrobial potential of *Elaeocarpus serratus*” and found that the plant extracts exhibited a dose-dependent inhibition of microorganisms. The acetone and methanol extracts of leaf and stem bark of E. serratus displayed maximum antibacterial activity against all the bacterial species studied. The plant extracts also displayed high antifungal activity against Candida albicans especially, the acetone extract was found to be more active antifungal.

Generally, the lower concentrations of the extracts were vulnerable to the fungal

pathogen. E. serratus extracts contained phenols, flavonoids and tannins at varying levels.

The ability of the crude extracts of the test plant to inhibit the growth of bacteria and fungi is an indication of its broad spectrum antimicrobial potential which may be employed in the management of microbial infections.

Lima & Breda (2018) worked on Antimicrobial activity of E. serratus extract evaluated in the concentration range between 1.95 and 2000 µg.mL-1 was only observed for B. cereus, E. coli, S. cholaresuis, S. aureus and X. campestris, with MIC values between 500 and 2000 µg.mL/l. According to Duarte et al. (2005), *E. serratus* pulp extract presented elevated inhibition against X. campestris, moderate inhibition for *E. coli* and *S. cholaresuis*and weak inhibition against B. cereus and S. aureus. According to MBC, the extract showed bactericidal effect for all inhibited microorganisms (Donlan and Costerton, 2002).

The antimicrobial activities of E. serratus fruit may be interpreted by higher content of phenolic compounds, flavonoids and tannins. Flavonoids are common polyphenolic compounds which are widely found in edible plants, especially fruit, vegetables, tea and wine and are categorized into several subgroups (Puupponen-Pimiä et al., 2001). According to Ammar et al. (2013), the probable mechanism of flavonoids on antimicrobial activity is due to its properties of complexion with soluble extracellular proteins, resulting in microorganism cell wall break, allowing the inhibition of important enzymatic pathways as P450 oxidases dependents, with specific action in blocking steroid hydroxylases dependents.

Condensed tannins are compounds constituted by oligomeric or polymeric various flavonoid units that consist of two phenolic rings with different vicinities (Çakar et al., 2016). These compounds are liable for defending plants against insects and pathogens attacks (Haslam, 1988). According to Scalbert (1991), the action mechanism of tannins includes action on membranes, enzyme inhibition, substrate or metal ions deprivation. Some hydrolysable tannin has demonstrated antimicrobial activity.

Das &Kar (2017) worked on phytochemical screening and antioxidant activity of Elaeocarpusserratus L. of Assam. Phytochemicals found in plants are known with many potent applications for the well-being of mankind. In the current study, the phytochemical

screening of leave extracts (aqueous, ethanol and methanol) of *Elaeocarpus serratus L.*showed positive result with the presence of significant amount of phytochemicals like saponins, tannins, cardiac glycosides, flavonoids, steroids, etc. While the DPPH antioxidant analysis showed the standard Ascorbic acid with EC50 value at 25.53 µg/ml, whereas methanolic extract of *E. serratus* showed EC50 at 75.47 µg/ml. the HR-MS analysis revealed the presence of 5 novel compounds within the methanolic leave extract, viz., clotrimazole, etamiphylline, 2'-O-Methylcytidine, aspidocarpine and leupeptin. On the idea of the general finding, it are often concluded that the plant E. serratus L. has been identified as potential source of medicinally important plants, for that further extensive analyses is required.

2.4 Nutritional facts about olives

Olives are popular as both a snack and an ingredient in salads, sandwiches, and stews. They have a chewy texture and a rich, salty taste. People have cultivated olive trees for quite 7,000 years, and that they have long associated its fruit with health benefits. There are many olive species, and these fruits and their oil form an integral a part of the Mediterranean diet, which can help people prevent disease and live longer. Olives and vegetable oil have an extended history of reported health benefits, and there's a growing body of scientific evidence to copy these claims. Olive oil, which manufacturers make by crushing olive fruits then separating the oil from the pulp, plays a key role within the Mediterranean diet. Olives are low in cholesterol and an honest source of dietary fiber, which the body needs permanently gut health. They are also rich in iron and copper. Research shows that following the diet can help people live longer. One study of almost 26,000 women found that the Mediterranean diet could cut the risk of developing cardiovascular disease by up to 28% compared with a control diet. The Mediterranean diet involves a daily intake of whole grains, fruits, vegetables, legumes, and nuts. People who follow the diet eat fish and lean meat carefully but limit red and processed meats to 2–3 portions per month.The diet also emphasizes swapping unhealthful fats, such as the trans fats and saturated fats that are present in butter and margarine, with healthful fats, such as the polyunsaturated and monounsaturated fats that are in olives and olive oil.

Olives are an honest source of oleate, which may be a monounsaturated carboxylic acid. A 2016 study found that eating more monosaturated fat reduced the danger of premature

death thanks to disease compared with eating more carbohydrates. The American Heart Foundation also states that monounsaturated fats can have a beneficial effect on heart health when an individual consumes them carefully. Virgin vegetable oil is additionally high during a sort of antioxidant called polyphenols, which may help prevent diseases concerning the guts and blood vessels.

Some people believe that these antioxidants can slow the progression of neurodegenerative diseases and even cancer. However, more studies are necessary to verify these claims. It is worth noting that food producers usually preserve olives in brine, which features a high salt content. Over time, excess levels of salt within the body can cause high vital sign, heart attacks, and stroke, so people should eat olives carefully.

Table-2.1: Nutritional value of Black olive (ripe), Green olive (ripe), and Olive oil

Parameters(\100gm)	Ripe black olive	Ripe green olive	Olive oil
Energy(calories)	116	145	119
Protein(g)	0.84	1.03	-
Total Fat(g)	10.90	15.32	15.5
Carbohydrates(g)	6.04	3.84	-
Fiber(g)	1.60	3.30	-
Calcium(mg)	88	52	-
Iron(mg)	6.28	0.49	0.08
Magnesium(mg)	4	11	-
Potassium(mg)	8	42	-
Sodium(mg)	735	1556	-
Zinc(mg)	0.22	0.04	-
Copper(mg)	0.25	0.12	-
Vitamin C(mg)	0.90	-	-
Niacin(mg)	0.04	0.24	-
Vitamin A (µg)	17	20	-
Vitamin E(mg)	1.65	3.81	1.94
Vitamin K(µg)	1.4	1.4	8.13
Vitamin B_6	0.01	0.03	-

A person can enjoy vegetable oil by adding it to salads and vegetables. People can add olives and additional virgin vegetable oil to all or any manner of foods, including salad, raw or roasted vegetables, and whole-grain pasta. Mild-flavored variants of additional virgin vegetable oil can replace butter or other oils in baking. People can also cook with

olive oil. While olives and vegetable oil contain many useful nutrients, people should consume them carefully as a part of a diet. Olive oil is high in fat, and therefore the preservation process means olives are often high in salt.

Generations of individuals have enjoyed olives and vegetable oil for his or her health-promoting qualities. Olives are low in cholesterol and an honest source of dietary fiber, which the body needs permanently gut health. They are also high in minerals that the body requires to function, like iron and copper. However, it's best to consume olives carefully, as producers usually preserve them in brine that's high in salt.

Olive oil is an integral a part of the Mediterranean diet, which may help people maintain a healthy weight, prevent heart condition, and live longer. The diet includes foods that contain high levels of monounsaturated fats, which are healthful fats which will benefit heart health.

2.5 Olive Juice

A study published within the Journal of Pharmacognosy and Phytochemistry in 2017 says Indian olives are the foremost under-utilised fruit crop. It is mainly utilized in at the household level only. Jalpai has several medicinal properties—its fruits contain 0.69 per cent protein; 19.5 per cent carbohydrates; 0.59 per cent mineral matter; and, the vitamin C content of dry leaves is 257mg/100 gm. The fruits are wont to treat dysentery and diarrhoea, says another study. It is also used to treat swollen gums.

The fruits are greenish in colour and elongated. It has a large seed inside. We eat the flesh. The fruit when bitten raw has an acerbic taste, makes the mouth and lips tingle feel. People eat it raw adding chillies, salt and sugar.

Jiguo Zhang(2015) works on effect of the Olive Juice on Anxiety and Depression Behavior. In order to guage the effect of olive juice, the paper uses olive juice concentrate as experimental material, and uses mice as experimental subjects. Mice are randomly divided into negative, positive, high, medium and low-dose group, administered orally for 7 days, and observing the impact on the mice elevated plus maze test, the opening acts test and forced swim test. The experimental result shows that under

conditions olive juice can induce anti-anxiety behavior of mice, but also has the potential to enhance depression of mice.

Recently in Bangladesh, a study was done on determination of physicochemical and microbiological qualities of some packed mango juice (Amin, 2015). In the study the highest quantity of monosaccharide was recorded in ACME mango juices while the lowest in homemade mango juice. The Total Soluble Solid (TSS) content of all samples varied from 19% to 12 %. The study also found as most of the mango juices were low in protein content and very low in fat content which was negligible.

Sánchez et al. (2000) worked on "Comparative Study on Chemical Changes in Olive Juice and Brine during Green Olive Fermentation". From this study changes found in physicochemical characteristics, substrate depletion, and merchandise formation during fermentation were followed in both brine and olive juice so as to realize an entire knowledge of fermentation chemistry in Spanish-type green olives. Both spontaneous and controlled fermentations were investigated by them. Fermentation rate, irrespective of the type of fermentation, was lower in olive juice than in brine, but the main acid products eventually reached in equilibrium. Final free acidity remained significantly ($p < 0.05$) higher and combined acidity remained lower and in brine than in olive juice in both fermentations, but differences in final pH was not significant in controlled fermentation. Final concentrations of lactic and formic acids were significantly ($p < 0.05$) higher, and those of ethanol and succinic acid were lower, in controlled fermentation than in spontaneous fermentation. Butanediol, attributable to Enterobacteriaceae growth, was formed only in the latter case of the study. Calculated carbon recoveries were not significantly ($p < 0.05$) different in any case of the study, giving a mean of some 78%.

Elenjikkl and Raji (2016) worked on "Cloning of Ceylon olive (*Elaeocarpus serratus L.)*using conventional methods". There found in the study that Ceylon olive (*Elaeocarpus serratus L.*; family Elaeocarpaceae) is an under-utilized edible fruit tree that is sparsely distributed in the southern peninsula of the Indian sub-continent. Fresh, mature and ripened fruit are edible and are used to prepare various value-added products such as squash, jams and pickles. Methods to produce clonal E. serratus plants using softwood cuttings, air-layers, and grafts were investigation this study. Softwood cuttings were

collected during the wet summer season (June–August) and showed 96.7% rooting success following 2.5 mM indole-3-butyric acid (IBA) treatment for 3 h. Hardwood cuttings collected during the wet summer season and subjected to IBA treatment did not root. The duration of the auxin treatment significantly influenced the rooting percentage of softwood cuttings. Seasonal variations in the rooting response of softwood cuttings were also noted. The wet summer (June–August) was the simplest season for rooting softwood cuttings. Air-layers of hardwood branches, prepared during the wet summer season by pre-treating with 7.5 mM IBA resulted in 87.1% rooting. The spliced grafting technique might be applied also to elite Ceylon olive clones, with 70% and 50% survival rates of softwood and hardwood grafts, respectively. Ceylon olive could therefore be cloned by adopting these methods. Propagation supported softwood cuttings would facilitate moderate-scale cloning of this valuable, elite germplasm.

2.6 Health benefits of Olive Juice

It is about the health benefits of olive juice. We already know that extra virgin olive oil is one of the healthiest fats out there. The Mediterranean diet, taken from Italy and Greece especially, is sort of reliant on monounsaturated fats, an honest source of fat content that's also great for heart health.

Matthews (2006) revealed that consumption of fruits juices may prevent many degenerative diseases such as cardiovascular problems and several cancers. Rico et al. (2007) came into a decision that the risk for numerous chronic diseases can be eradicated by eating fruits and vegetables. In many cases which have been shown to be initiated by long term inflammation and other researcher working collaboratively with Rico found the same thing. Fruit juices possess low sodium and high potassium which can easily maintain normal blood pressure and cardiovascular system can be well maintained by drinking fruit juices because fruit juices contain a negligible amount of fat which is beneficial for health (Dai et al., 2006). Many studies have been come out with that fruit juices play an important role in slowing down the progress of Alzheimer’s disease and development of cancer (Kyle et al., 2010). Fruit juices are beverages and nutritious drinks with great taste and which are commonly consumed for his or her refreshing attributes,

nutritive values or vitamin content and health benefits (Suaad and Eman, 2008; Nwachukwu and Aniedu, 2013; Rashed et al., 2013).

This food plant has been used for traditional purposes to treat/manage diseases like diabetes, hypertension, dysentery, and rheumatism. Though the fruit is well employed by men as pickles and chutney, there's lack of an integrated research and important appraisal of the prevailing literature on the utilization of *Elaeocarpus floribundus*. One element to think about that has attracted researchers to the present plant is that the big selection of pharmacological potential that the Elaeocarpaceae family has been highlighted for. The Eleocarpaceae is documented for the presence of indolizidine alkaloid and inhibitory properties against glucosidases. Another facet of interest is potentially of multitude cucurbitacin within the Elaeocarpaceae family which has documented to possess a diversity of health benefits. Various compounds are isolated from different species of the Elaeocarpus like the cucurbitacins D and F, 1,2,3,4,6-penta-O-galloyl-b-d-glucose, and rudrakine that has been related to therapeutic effects on many diseases. The aim is to bring back light this highly undocumented plant and existing pharmacological activities that are expressed by parts of the plant. Current findings on E. floribundus have shown a plethora of phytochemicals especially phenolic compounds. It has also been reported to exhibit antibacterial, inhibitory action against glucosidases and also interesting inhibitory effect against HeLa neoplastic cell also as strong cytotoxic activities on the proliferation of four human cancer cells. Thus, this plant has realm of possibility to be utilized in treatment of diabetes, cancer, and infectious diseases. This amalgamation of ethnobotanical and pharmacological data would enable a well-rounded understanding of *Elaeocarpus floribundus* and its wider potential. The highlights thus far are attractive and promise potential outlets with different pharmacological properties (Sookhy et al., 2018).

Parvin and Sarwar (2009) made an experiment on In-vitro Cytotoxicity and Antioxidant Studies of *Elaeocarpus serratus*. The pet-ether soluble fraction (PEF), carbon tet soluble fraction (CTSF) and Chloroform soluble fraction (CFSF) of the methanolic extract of stem bark of Elaeocarpus serratus were investigated for cytotoxic activity using brine shrimp lethality bioassay. The methanolic extract was also evaluated for possible antioxidant activity using nitric oxide scavenging activity and reducing power assays. In

Elaeocarpus serratus, the LC50 value were found to be 14.94, 0.831 & 3.288 µg/mL in pet-ether soluble fraction (PEF), Carbon tetrachloride soluble fraction (CTSF) and Chloroform soluble fraction (CFSF) of the methanolic extract respectively. The extract showed significant antioxidant activity in gas scavenging activity and reducing power assay. In gas scavenging activity, the IC50 value of *Elaeocarpus serratus* extract was 89.325µg/mL while the IC50 value of vitamin C was 47.684µg/mL. It was found that scavenging of gas by the extract was concentration dependent. Based on the results of the study, it can be concluded that the plant extract possesses remarkable antioxidant and analgesic potential.

a) Improved nerve function: Olive juice is often a sodium-rich substance. Sodium can promote the proper transmission of nerve impulses in our bodies providing health benefits. If ones diet is usually low in sodium otherwise it just do not like putting salt on food, a swig or two of olive juice combined with a healthy diet could improve nerves function.

b) Increased muscle control: Another advantage of the sodium found in olive juice is improved muscle control. Normal muscle movement requires a couple of electrolytes and minerals to occur. Olive juice from that vacant glass jar can provide the boost of healthy fats body must get over a high-intensity workout or an endurance exercise, especially because it comes from natural sources.

c) Healthier hair growth: Most olive varieties, including green olives and black olives, contain a healthy dose of vitamin E. Vitamin E has been shown to extend blood circulation to hair follicles, leading to healthier hair growth. That said, both olive juice and vegetable oil consumption can help hair to grow well. Some people even go as far as rubbing warm olive juice into their entire scalp, but we cannot cause you to do this.

d) Reduced blood sugar and blood pressure: More often than not, vinegar is involved in an olive's lifecycle at some point. As a preservative, many pickling methods finish the olives during a solution of vinegar and salt. That said, vinegar has been shown to scale back blood glucose levels. We're not doctors, but if an attempt of olive juice can get our blood glucose levels down as against a manufactured pill we'll happily self-prescribe. The

strong olive flavor could be a touch much for a few, but well worth the health benefits. Additionally, olive juice is high in monounsaturated fatty acid, a carboxylic acid that naturally occurs in plant-based fats. It can help reduce high vital sign and increases fat burning to assist in weight loss and fighting obesity.

e) Balanced water levels: Electrolytes can help to get water levels where they need to be. Because of the sodium utilized in making olives, olive juice is inherently a hydrating substance. Olive juice is beneficial for overall health and performance, and balance water levels.

f) Boosted immune system: Antioxidants help body system function at its best. It has been inundated with antioxidant-focused articles for years now. The anti-inflammatory properties of olive juice especially are useful in maintaining a robust system from natural sources. Olive juice consumption equals antioxidant consumption which, in turn, equals an immunity boost.

g) Controlled free radicals: The vitamin E in olives can help neutralize free radicals within the physical body. Eating an olive will offer more vitamin E than drinking olive juice. Olive brine inherently contains vitamin E. Thus, drinking a small quantity of olive juice may help cut down on those free radicals. It can help lower risk of heart diseases, cancers, strokes, and many other nasty ailments. The oxidative stress relief from many inflammatory diseases can work to stop attack and gastritis.

2.7 Jelly

Jelly may be a semi-solid product prepared by boiling a transparent strained fruit extracts free from pulp after the addition of required amount of sugar, acid and pectin. It should contain minimum 65 percent of total soluble solids and minimum 45 percent of fruit portion (Dhawan, 1998). Traditionally, jelly desserts are mainly produced with edible gelatine, water, sugar and flavors. Although jelly desserts have low content of gelatine this sort of protein contains 18 different amino acids, including eight essential amino acids (GME, 2015) being particularly rich in glycine, proline and hydroxyproline. Furthermore, gelatine is a natural colloide with properties of gelling and a stabilizing effect. Therefore, gelatine features a quite high nutritional value but with a coffee caloric

power (17 kJ/kg or 4 kcal/g). Other important components of jelly desserts are sugars. It is widely known that their excessive consumption is related to tooth decay, diabetes and obesity (Edwards, 2002; O'Donnell and Kearsley, 2012), among other illnesses. Concretely, white sugar, which contains high percentage of sucrose, is one of the most usual sweetening agent in confectionary products but it requires calcium and potassium to be digested in detriment for vital organs (Shukla and Kandra, 2015).

Despite the fact that this type of dessert is not considered with a high nutritional value, it is important to point out that this situation might change if natural vitamins and antioxidants provided from fruit crush were included in its formulation rather than the water.

Citrus fruits such as orange, lemon, olive and mandarin orange have many beneficial properties due to their high content of fibre, vitamins, minerals, ascorbic acid and specially high content in antioxidant compounds, like carotenoids, flavonoids and phenolic compounds (Álvarez et al., 2014). As far as we know, a jelly dessert prepared with a mixture of different citrus juices does not exist in the market and it could expand the possibilities of commercialization.

2.8 Research on jelly

Desrosier (1963) reported in the technology of food preservation that gel formation occurs only without certain range of hydrogen ion concentration, the optimum acidity figure for jelly being pH 3.2. The gel strength falls slowly on decreasing and rapidly on increasing the pH value. Beyond pH value 3.4 jelly formation occurs at the usual soluble solid range. The optimum concentration of sugar is about 67.5%, it is however possible to make jellies with high content of pectin and acid containing less than 60% sugar. Too high concentration of sugar results also in a jelly of stick consistency. The quality of pectin necessary to form a gel depends largely on the quality of pectin. One per cent should be sufficient to produce a firm jelly.

Currently awareness of health-related issues in society has increased the demand of latest functional foods and consequently food industry must be constanly innovating to supply consumers' new alternative products (Shukla and Kandra, 2015). In the confectionary

and beverage sectors this concern is especially focused on the achievement of an adequate sweetness while improving health and appearance, and as a result the utilization of artificial sweeteners has increased. However artificial sweeteners, like aspartame, acesulfame-k, saccharin and sodium cyclamate, or polyalcohols have negative connotations thanks to their possible risk to health and that they must be subject to a rigorous assessment before their use in food products and beverages (de Queiroz Pane et al., 2015). In view of this the reformulation of jelly desserts with new non-cariogenic sweeteners available in the market could be a good chance to achieve this goal.

Srivastava and Kumar (2005) wrote in foods grown from the ground safeguarding that a jam is a semi-strong item arranged by heating up an unmistakable, stressed arrangement of gelatin containing organic product extricate, liberated from mash, after the expansion of sugar and corrosive. An ideal jam ought to be straightforward, well-set, yet not very firm and ought to have the first kind of the natural product. Organic products can be partitioned into four gatherings as indicated by their gelatin and corrosive substance. Gelatin, corrosive, sugar (65%) and water are the four basic fixings.

Acosta et al. (2008) examined on the model impacts of three components (sugar, low methoxyl (LM) gelatin and calcium content) at three levels every one of organic product jam, it was assessed by Response surface technique (Box-Behnken structure). He additionally detailed the general worthiness of a tropical blended organic product (pineapple, banana and enthusiasm natural product) jam which was tried by 100 buyers. A good connection among genuine and fitted qualities ($R2=0.940$ and balanced $R2=0.832$) was appeared and there was likewise a perception that the model fit was critical ($p=0.014$). The model displayed no huge absence of fit ($p=0.253$). He further revealed that calcium level significantly affected generally speaking adequacy, yet LM gelatin and sugar levels had no critical impact on that. The factual model was utilized to update the variables' levels for most noteworthy adequacy with the goal that jam could be gotten that gave under 12 calories for every serving, permitting the item to be marked as "low calorie".

Rahman et al. (1997) made an examination on organoleptic quality for jamun jelly. They announced that there was slow abatement of organoleptic score for jamun jelly and drink

after 4months stockpiling period was watched and furthermore revealed that organoleptic nature of jamun jelly diminished strongly during capacity. Be that as it may, there was likewise a perception that organoleptic quality could be improved by the expansion of SO2 (1000-1500 ppm) for as long as a half year. In any case, higher portion (2000 ppm) of SO2 affected the jelly enhances and that was it conceal the kind of jelly.

Donchonko et al. (1988) saw that at pH 6.0 the quality of jam/jelly was 4 KPa; expanding citrus extract fixation brought about expanded jelly (quality) at pH 3.2 the quality was 40.0 KPa and at pH (2.8 it was 53.2 KPa). The pH esteems in the range 2.8−3.2 are viewed as ideal for most extreme quality of jelly.

Oziezak (1998) detailed that texture, season and other physical characteristics of Anola jam had been expanded easily toward the start yet a short time later they demonstrated diminishing and furthermore revealed that unpredictable enhancing mixes are lost during handling. Vait et al. (1998) revealed that the ascorbic corrosive substance of apple jam had been decreased during stockpiling. Yousuf and Agrandi (1999) uncovered that absolute dissolvable solids of date jam showed a little increment as long as a half year of capacity at room temperature.

Madhav et al. (2002) reported that in a study, the different fruit wastes selected for pectin extraction and preparation of jelly were rinds of jackfruit, nutmeg, passion fruit and mangosteen, peels of pummelo, mango, pineapple, citrus, and banana; and cocoa pod husk. The quality of the jellies prepared was evaluated visually (setting property, consistency, syneresis, crystallization, cloudiness, color) and organoleptically (appearance, transparency, color, consistency, taste, aroma, flavor, acceptability as bread-spread), then compared with that of guava jelly. Corrective treatments were applied to the jellies with defects and whose quality did not reach the standard of guava jelly. Some of the jelly defects noticed include syrupy consistency (pineapple peel, cocoa pod husk and mangosteen rind jellies), cloudiness (banana peel jelly), bitter taste (pummelo and lime peel jellies), firm consistency (pummelo peel and passion fruit rind jellies), and syneresis (cocoa pod husk and mangosteen rind jellies). Application of the corrective treatments, such as blending with pectin of other fruit wastes at the ratio of 1:1, reduction of

extraction time, and boiling the chopped peel in sodium chloride or hydroxide, resulted in quality improvement for the jellies.

2.9 Pectin

Pectin is a soluble gelatinous polysaccharide which is present in ripe fruits and used as a setting agent in jams and jellies. All fruit peels contain pectin at their cell wall and some pectin is also found in fruit pulp. Pectin is an important factor during fruit ripening, and the amount of pectin varies in different types of fruits. Pectin is derived from heteropolysaccharides, which is extracted from the primary cell wall of higher plants. Pectin is a functional ingredient in the food industry because it has a good gelling ability and has been used in jams and jellies, fruit preparations, fruit drink concentrates, fruit juice, desserts and fermented dairy products. Also, the pharmaceutical industries widely use pectin. It has been reported that, pectin lower the blood cholesterol levels and low density lipoprotein cholesterol fractions, which is beneficial for human health. It is also stated that, pectin may help decrease tumor cell formation (Bhat et al., 2014). Pectin can also be used in several ways like biodegradable water-soluble films, bulking agents, coating agents, chelators, emulsifiers and viscosity modifiers (Kanmani et al., 2014).

2.10 Nutritional aspects of pectin

Pectin is collected from plant cell walls and is analyzed as a soluble and insoluble fraction in the form of galacturonic acid after hydrolysis. Those fruits and vegetables which are rich in pectin have dietary fiber contents in the range of 1-2%. Pectin fibers have higher hydration properties than other fibers and this property is used in different food production, for example in bakery products. It has been reported that replacement of flour with citrus fibers, apple flakes and concentrates in bakery and confectionery products had a positive sensory effect. Adsorbent and bulk-forming properties of pectin have been promoted in some multi-ingredient anti constipation and anti-diarrhea preparations.

Dietary fiber can absorb and exchange mineral and ion. Pectin has the ability to associate ions Due to high content of negative charges and calcium binding pectin has the ability to associate with ions.

Chapter-3

Materials and Methods

3.1 Study Area

The experiment was conducted in the laboratory of the department of Applied Food Science and Nutrition, Applied Chemistry and Quality Assurance, 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 Study Duration

The experiment was conducted for a period of six months from 1st July 2019 to 31th December 2019.

3.3 Collection of Sample

Olives (*Elaeocarpus Serratus*) samples were collected from Khagrachari of Chattogram division. The olives were carefully chosen in order to obtain the optimum maturity because its pectin content depends on 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.

3.4 Juice Extraction

Olive jelly was prepared according to the preparation procedure described by Srivastava and Kumar (2005). With 1 kg fresh olive, 1.5 kg water and 1 kg sugar were added during jelly preparation. There were used premature olives, mature olives and ripe olives. Treatment applied in use of pectin and citric acid with different percentages. Pectin was applied in product at 1%, 0.5% with fixed 0 .5% citric acid. The fruit samples were washed with deionized water to remove the external particulate or ions that will interrupt in nutrient analysis and cut into small pieces for easy boiling.

3.5 Preparation of Jelly

Fresh olive were weighed and washed thoroughly in cold water. The washed olive was cut into thin slices with a stainless steel knife. Then it was boiled with one and half times

the weight of fruit for about 30 minutes with stirring. The boiled pieces were crushed and strained the extract through a thick cloth to remove the suspended matter consisting of fruit tissue, seed, skin, gums and protein in colloidal form. The amount of olive juice, water, pectin, acid and sugar were calculated according to the formulation. The strained juice was boiled again and sugar was added at a ratio of 1:1. Heating was continued with stirring. The end point was indicated by 67−68° Bx TSS in the mixture which was measured by Refractometer. The Jelly was then filled in a glass jar. It was then covered with melted wax and cooled. After cooling the cans or jars are labelled and stored for further studies (Srivastava and Kumar, 2005).

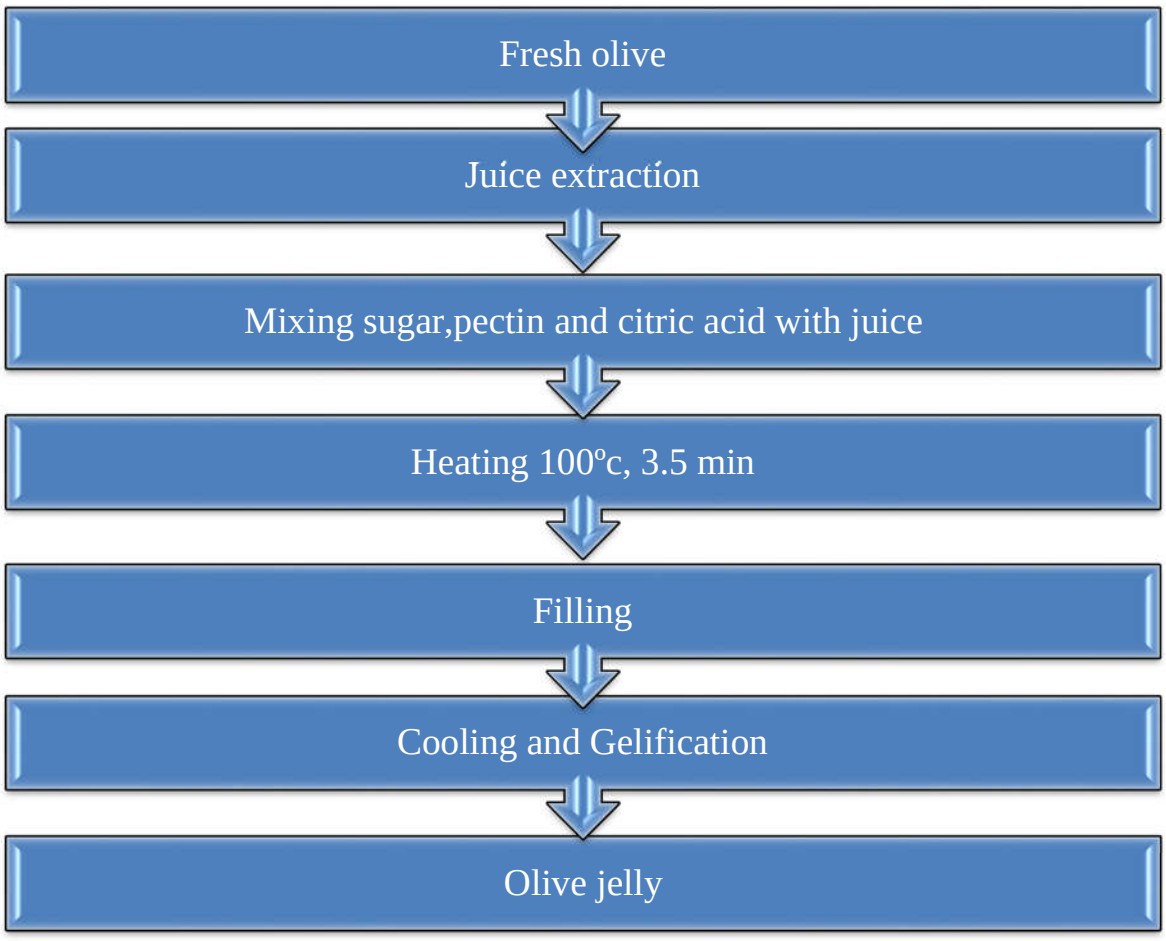


Figure 3.1: Processing steps of Olive jelly

3.6 Physicochemical analysis of olive jelly

The fresh sample of prematured olive jelly matured olive jelly, ripe olive jelly were analyzed for moisture, total solid, ash, total soluble solid, pH, titratable acidity as per the methods of Ranganna (2002). These samples were also analyzed for proximate analysis, bioactive compounds analysis and antioxidant analysis.

3.6.1 Determination of pH

In chemistry, pH is a measure of the acidity or basicity of an aqueous solution. Solutions with a pH less than 7 are said to be acidic and solution with a pH greater than 7 are basic or alkaline. Pure water has a pH very close to 7. 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, 2009).

3.6.2 Total Soluble Solids

Total soluble solids of the fruits 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 AOAC.

3.6.3 Titratable Acidity

The percentage of acidity was determined in terms of anhydrous citric acid by titrating against N/10 NaOH using phenolphthalein indicator. Every time 10ml of juice was taken in a 100ml volumetric flask and the volume was made up to 100ml by adding distilled water then 10ml diluted juice was titrated against N/10 NaOH, using phenolphthalein as indicator. The appearance of pink color indicates the endpoint of the titration. Titration was reported thrice at the average value was recorded. Titratable acidity can be determined as below:

Titratable acidity (%) = (T.V × Factor)/W

Where

TV = Titer value of the sample in ml

W = Quantity of the sample taken for the test in ml

Factor - Citric acid: 0.0064 (Citrus Fruit); Malic Acid: 0.0067

3.6.4 Determination of Vitamin C

Chemically assay of the Vitamin- C depends on the market reducing properties of the Vitamin C. Generally, Vitamin-C is determining in plant or animal extract by its reducing action on the dyes stuff 2,6dichloride 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.

Reagent requirement

A) Dye Solution

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

B) Metaphosphoric acid solution (3%)

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

C) Standard ascorbic acid solution

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

Procedure

- Dye solution was taken in the burette up to 0 marks.
- Then 5 ml Vitamin C solution was taken in a conical flask.
- The conical flask was placed under the burette and the dye was added drop wise.
- Titration was completed when pink color was appeared and stayed for 20 seconds and then disappeared.
- The reading was taken at least 3 times.
- The same procedure was performed for ascorbic acid solution of unknown concentration.
- The result was expressed as milligram percentage (mg %)

3.6.5 Moisture content

Moisture content was determined by methods of Ranganna (2002). Five gram fruit was taken in crucible and placed in an oven at 105°C for 24 hours until constant weight attained. Percent moister content was calculated using following formula:

$$\% \text{ Moisture content} = \{(IW - FW)/IW\} \times 100$$

Where, IW = Initial weight of olive

FW= Final weight of oven dried olive

3.6.7 Total solids

Total solid was determined by methods of Ranganna (2002). Percent total solid content was calculated by using the data obtained during moisture estimation using the following formula:

% Total solids = 100 – % moisture content.

3.6.8 Ash content

Ash content was determined by methods of Ranganna (2002). Ash content is the inorganic residue remaining after destruction of organic matter. 10 gram dried fruit was taken in a pre-dried weighed crucible. It was then burned to charcoal. The charcoal was then taken in a muffle furnace and heat at around 600°C for 4 hours till the charcoal is completely removed. The crucible is then taken out of the furnace. Cool it in a desiccator carefully and then weighed.

$$\% \text{ Ash content} = \{(W3 - W1)/ (W2 - W1)\} \times 100$$

Where,

W1 = the weight of dried empty crucible
W2 = the weight of dried crucible with sample
W3 = the weight of the crucible with ash

3.6.9 Estimation of Ether Extract

AOAC method (2012) was used to estimate the ether extract.

Apparatus

1. Soxhlet apparatus
2. Hot water bath
3. Hot air oven
4. Electric balance
5. Desiccator
6. Hand gloves.

Procedure

1. Sample was dried to make moisture free sample.
2. Then the dry extraction flasks were weighted carefully.
3. Weighing 2 g of sample and transferring into the thimble.
4. Placing the thimble into the extractor and the top was closed with cotton.
5. Fitting the extractor and the ether was poured up to siphoning.

6. Again, pouring ether half of the previous amount.

7. Then switching on the heater and continued boiling at 40°C - 60°C for 6-8 hrs.

8. After complete extraction, the extraction flasks were dismantled and dried on water the bath

9. Placing the flask in the hot air oven and heated at 100°C up to constant weight.

10. At last, cooling the flask in a desiccator and ether extracts weight was measured.

Calculation

The calculation of the ether extracts percentage as follows:

$$\% \text{ Either Extract} = \{(A-B)/ W\} \times 100$$

Where,

A= Weight of the flask with ether extract

B= Weight of the flask,

W=Weight of the sample

3.6.10 Estimation of Crude Protein

AOAC method (1995) was used to estimate the crude protein. The Kjeldahl method for nitrogen analysis is composed of three steps.

These are -

1. Digestion
2. Distillation and
3. Titration

Apparatus

1. Kjeldahl apparatus
2. Electric balance
3. Hot air oven
4. Desiccator
5. Metal tongs

6. Crucible
7. Measuring cylinder
8. Burette
9. Pipette
10. Hand gloves.

Digestion

1. Weighing accurately 1 g of jelly sample.
2. Adding 5 g of digestion mixture.
3. 20 ml concentrated H_2SO_4 was added.
4. Placing the digestion mask on Kjeldahl digestion set.
5. Gradually increasing the heat and digested up to clear residue.
6. The flask was removed and cooled it.

Distillation

1. Adding 20 ml distilled water.
2. Transferring the content to the distillation flask.
3. 100 ml 40% NaOH solution was added and setting in the condenser.
4. Adding 20 ml 2% Boric acid solution and mixing indicator in a conical flask.
5. Heating the distillation flask and continue up to the collection of app.100 ml of distillate.

Titration

1. Titration was performed of the distillate against standard N/10 HCl solution.
2. The titration volume was calculated and the value was predicted.

Calculation

Calculation of the nitrogen percentage as follows:

$$\% \text{ Crude Protein} = \{(A \times B \times 0.014)/ W\} \times 6.24 \times 100$$

3.6.11 Estimation of Crude Fiber

Procedures

1. Weighing accurately 2.0 g of ground sample.
2. Adding 125 ml 1.25% H_2SO_4 solution to the beaker.
3. Then add 3-5 drops of n-octanol as antifoam agent.
4. Boiling it 30 minutes at exactly constant volume.

5. Then washing three times with distilled water to make it acid-free.
6. After draining the last wash, 125ml 1.25% NaOH and 3-5 drops of antifoam were added.
7. Again boiling 30 minutes at exactly constant volume.
8. Filtering and washing the residue as above.
9. Then second wash with 1% HCl solution was performed to make it acid-free.
10. The residue was dried in hot air oven at 105°C up to constant weight.
11. The residue was cooled in a desiccator and weighted.
12. Burning the residue up to no smoke.
13. Then, ignited the residue in muffle furnace up to white ash (550-600°C, 4-6 hrs)
14. Lastly the ashes were weighted and deduct the value to get fiber weight.

Calculation

Calculation of the crude fiber percentage as follows:

% Crude fiber = $\{(W-W1)/ W2\}\times100$

Where,

W= Weight of crucible, crude fibre and ash

W1=Weight of crucible and ash

W2= Weight of sample

3.7 Determination of Antioxidant capacity by DPPH scavenging method

Extract preparation

- Taking 5gm of sample in felcon tube
- Adding 10ml absolute methanol and left for 72 hours
- Straining the solvent
- Collection of filtrate
- Evaporation at 60^0c using rotary evaporator
- Methanoic extract found

Procedure

Antioxidant mobility of the extracts was determined using DPPH assay as the process described by AzlimAlmeyet al. **(2010)** with slight modifications. About 6 mg of DPPH was dissolved in 100 mL absolute methanol and prepared methanoic DPPH solution.

Then 1 ml methanoic extract was diluted with of 2 ml DPPH solution. Then the mixture was mildly shaken and left for 30 min in dark at room temperature. The absorbance was read at wavelength 517 nm using UV-VIS spectrophotometer (UV-2600, Shimadzu Corporation, USA). Control prepared by mixing 1 mL of methanol with 2 mL of DPPH solution whilst methanol was used like a blank. The scavenging mobility was measured as the decrease in absorbance of the samples in comparison with the DPPH standard solution. Antioxidant capability based on the DPPH free radical scavenging mobility of extracts calculated using the following equation:

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

Trolox used as standard and TEAC composite (Trolox equivalent antioxidant mobility) was used for the calibration standard curve. The results were revealed in mg/ 100 g of Trolox equivalents per gram of powder on a dry weight (DW) base.

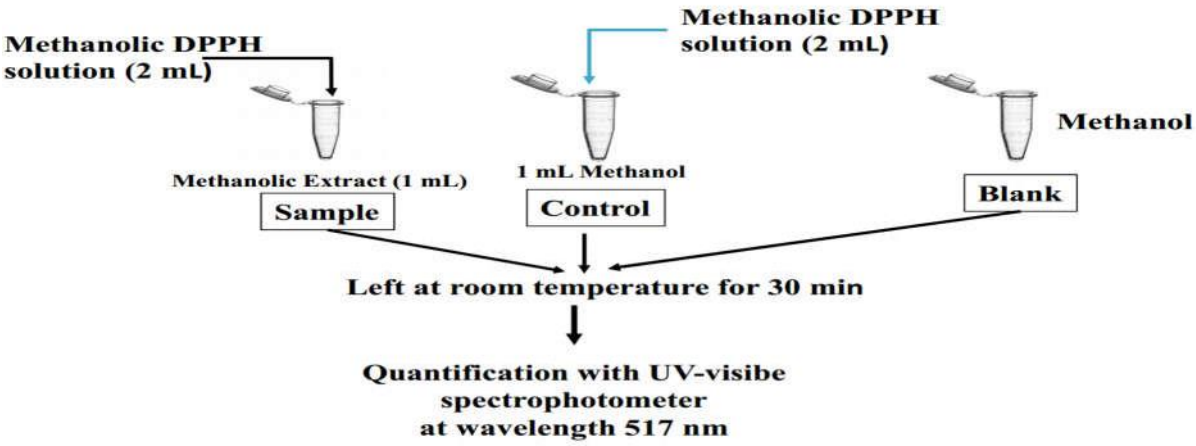


Figure 3.2: Antioxidant activity (AOA) determination procedure flow diagram

3.8 Determination of Bioactive compounds

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 60^0c using rotary evaporator
- Ethanoic extract found

Total Anthocyanin content (TAC)

- Stock solutions of 10mg/mL of extracts were prepared. Extract solution (3mL) was pipetted into a cuvette.
- The intensity of the extract color was measured at wavelength 520nm using UV-VIS spectrophotometer.
- Ethanol was used as a blank
- TAC will be calculated and expressed as milligrams per 100g (mg/100g) using the following equation:

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

  Where,

  DF stands for dilution factor;

  m means weight of sample used to make stock solution

  E refers to extinction coefficient (55.9)

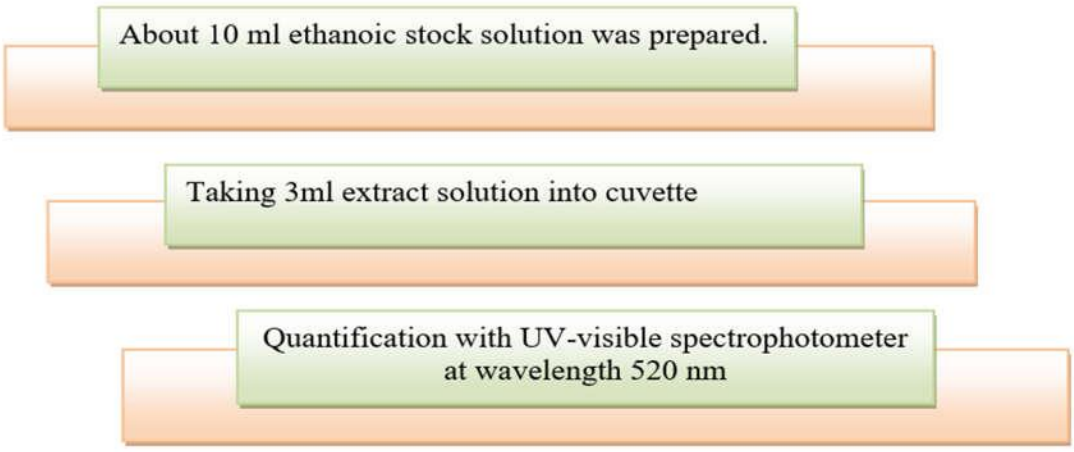


Figure 3.3: Total anthocyanin contents (TAC) determination procedure flow diagram

Total Phenolic Content (TPC)

TPC of the extracts were determined according to the Folin-Ciocalteu reagent method described with slight modifications (Al-Owaisi et al., 2014). Total polyphenol content (TPC) of the olive jelly determined according to the Folin-Ciocalteu method reported by Parthasarathy et al. **(2009)** with slight modifications. 1 ml ethanoic extract was taken in a falconer tube and added 1.5 ml of FC reagent and left for 3 mins at room temperature. Then 1.5 ml Na_2CO_3 (7.5%) was added into the mixture and left for 60 minutes. The absorbance was read at wavelength 765 nm using a UV-VIS Spectrophotometer (UV-2600, Shimadzu Corporation, USA) and C_2H_5OH was used as the blank. TPC was calculated and revealed as mg of gallic acid equivalents (GAE) per gram of extracts (mg GAE/g).

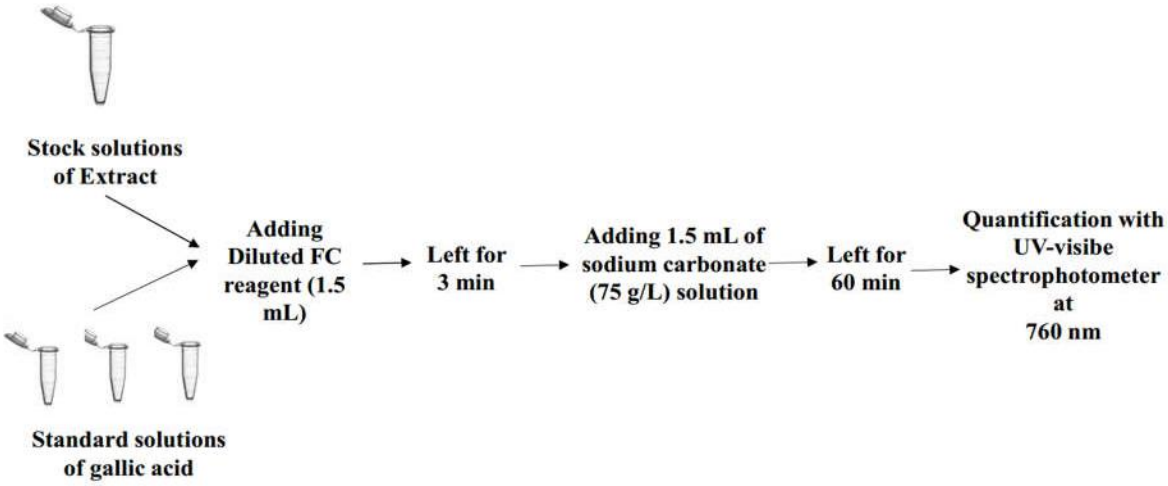


Figure 3.4 Total phenolic contents (TPC) determination procedure flow diagram

Total flavonoid content (TFC)

Total flavonoids content (TFC) of the samples was determined by using the aluminum chloride colorimetric process reported by Chang et al. (2002) with slight modifications. Stock solution (1 mg/mL) of extracts was prepared and aliquots of 0.5 mL of diluted extract diluted with 1.5 mL of 95% C_2H_5OH in a cuvette. Then 0.1 mL of 10% $AlCl_3$, 0.1 mL of 1 mol/L potassium acetate, and 2.8 mL of distilled water ($D.H_2O$) were added to the immixture in the cuvette. The immixture left at room temperature for 30 min. The

absorbance was read at wavelength 415 nm in UV-visible spectrophotometer (UV-2600, Shimadzu Corporation, USA) and 10% aluminum chloride substituted with D.H_2O of the same quantity were used as the blank. Total flavonoids amount in the sample was calculated by comparing absorbance of the sample extracts with a quercetin standard curve. TFC estimated and revealed as mg quercetin equivalents (QE) per gram of extract (mg QE/g).

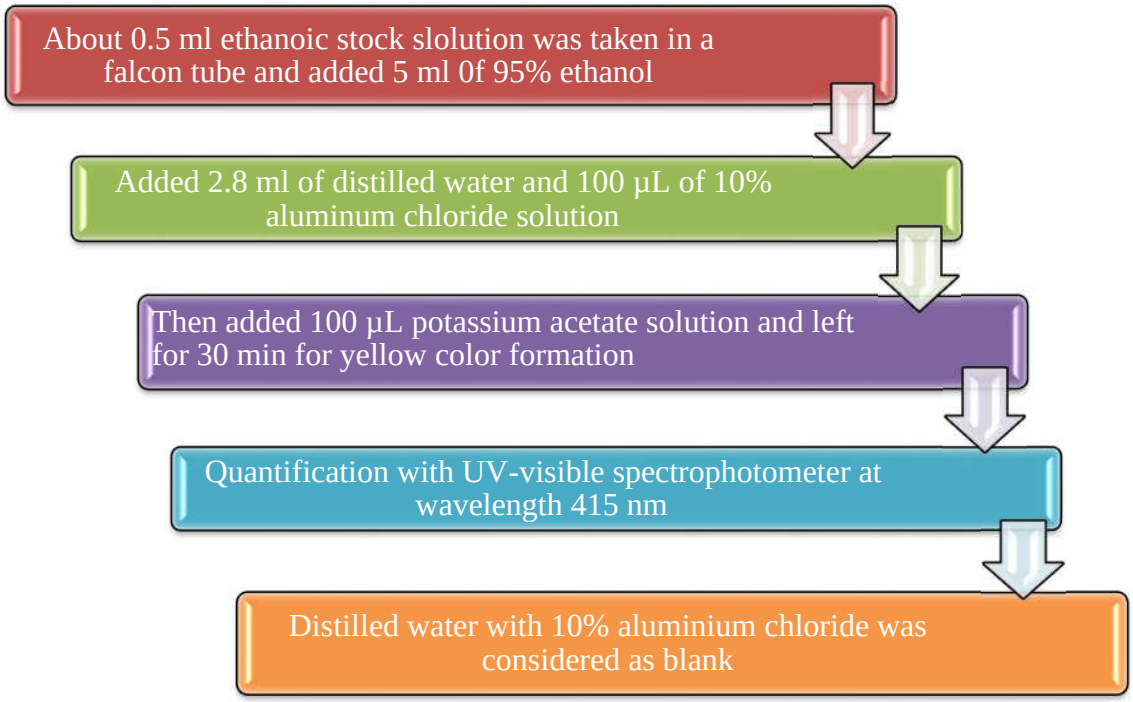


Figure 3.5: Total flavonoid contents (TFC) determination procedure flow diagram

3.9 Microbiological analysis

3.9.1 Aerobic plate count (Bacterial plate count)

The Aerobic Plate Count is used as an indicator of bacterial populations on a sample. Aerobic Colony Count (ACC), Standard Plate Count (SPC), Mesophilic Count and Total Plate Count (TPC) are different names of Aerobic Plate Count (APC). Total viable bacterial count (TVC) was determined through the Standard Plate Count (SPC) technique.

The test is based on an assumption that each cell will form a visible colony when mixed with agar containing the appropriate nutrients. It is a generic test for organisms that grow aerobically at mesophilic temperatures (25 to 40°C), not a measure of the entire bacterial population. APC cannot differentiate types of bacteria can use to gauge organoleptic acceptability, sanitary quality, adherence to good manufacturing practices and as an indicator of safety. Information regarding shelf-life or impending organoleptic change in a food can be provided by APC (Banwart, 2012).

3.9.1.1 Sample preparation

The reliability of the analysis and interpretation of the results depend largely on the correct manner in which the sample was taken. The sample should be a true representative of the whole mass. For this purpose the product was thoroughly mixed so that sample would be the representative of the whole mass of the products. 25 g of this well mixed guava jelly were taken in 250 ml flask.

Phosphate buffer saline (0.6 mM KH_2PO_4 of pH 7.2) was used for dilution of the sample. About 100 ml of the buffer saline was added to the beaker and mixed well by to-and-fro movement. The volume was made up with the same buffer water. All the apparatus, solutions and other tools used should be sterilized i.e. heated at 1210C for 15 minutes. The prepared sample was then diluted to 10 times i.e. 1×10-1 time's dilution and used as stock solution (Andrews, 1992; US Food and Drug Administration, 2012).

3.9.1.2 Dilution

A series of dilution were made as follows using 9 ml blanks a) The initial 1/10 dilution (1 ml in 9 ml) was performed b) This was mixed in a vortex mixer c) 1 ml from (b) was taken, added to the next tube and mixed well. It was become 10-2 time's dilution. In this way, the dilution was made up to 10-6 times.

3.9.1.3 Standard plate counts

A SPC was used to estimate the level of microbes in the prepared & stored guava jellies. This data could be used as the indicators of food quality or predictors for the shelf life of the product. Using a sterile pipette, 1 ml of the diluted sample was then taken into each of the sterile empty petri-dishes having nutrient agar media (Plate count agar) at a

temperature of 45°C. Plates were mixed by swirling on a flat surface. After solidification of the media the plates were inverted and incubated at 37 °C for 24 hours in an incubator (AOAC, 1990; Sharf, 1966).

3.9.1.4 Counting and recording

After incubation the incubated plates were selected for counting the bacterial colony based on the number and easy of counting of the colony. The plate containing segregated, overlapping and confusing colonies was avoided. The plates containing 30 to 250 bright, cleared and countable colonies were selected.

Number of colony forming unit (cfu)/g or ml. = average cfu plate x dilution factor.

The viable bacterial count was done through the steps of sample preparation, sample dilution,standard plate counts and counting and recording. The incubation was performed at 37°C for 24 hours (AOAC, 1990; Sharf, 1966).

3.9.2 Fungal analysis in jelly

3.9.2.1 Media Preparation

Sabouraud Dextrose Agar (SDA) is a selective medium primarily used for the isolation of dermatophytes, other fungi and yeasts but can also grow filamentous bacteria such as Nocardia. The acidic pH of this medium (pH about 5.0) inhibits the growth of bacteria but permits the growth of yeasts and most filamentous fungi. Antibacterial agents can also be added to augment the antibacterial effect. The SDA media is comprised of enzymatic digest of casein and animal tissues which provide a nutritious source of amino acids and nitrogenous compounds for the growth of fungi and yeasts. 10 g Mycological peptone (enzymatic digest of casein and animal tissues), 40 g Dextrose and 15 g Agar with pH 5.6 at 25 0C are used for 1 liter SDA media.

All media used were prepared according to the manufacturer's instructions and sterilized in the autoclave at 121°C for 15 minutes. Although many selective agars exist for the cultivation and determination of mold and yeast cultures, a majority of them do not depend on strict nutritive requirements for growth. Many fungal strains will grow on

Sabouraud Dextrose Agar. Methods and technique are followed here as described by FSSAI (2012), APHA (1996) and Chen (2000).

3.9.2.2 Procedure for preparation of media

1. At first 65 g of the medium was suspended in one liter of purified water.

2. Then heated with frequent agitation and boiled for one minute to dissolve the medium completely.

3. Autoclaved at 121° C for 15 minutes.

4. Then cooled to 45 to 50°C and poured into Petri-dishes.

5. For processing of specimen, the specimen was streaked onto the medium with a sterile inoculating loop in order to obtain isolated colonies.

6. Then the plates were incubated at 25 – 30°C in an inverted position (agar side up) with increased humidity.

7. Cultures were examined weekly for fungal growth and were held for 4–6 weeks before being reported as negative.

3.9.2.3 Interpretation

After sufficient incubation, the plates should show isolated colonies in streaked areas and confluent growth in areas of heavy inoculation. Examine plates for fungal colonies exhibiting typical color and morphology. Additional procedures should be performed to confirm findings. Yeasts will grow as creamy to white colonies. Molds will grow as filamentous colonies of various colors (Aryal, 2015).

3.10 Sensory evaluation

Nine focuses Hedonic rating test technique as prescribed by Joshi (2006) was utilized with the end goal of tangible assessment. This test quantifies the buyer's agreeableness. The customer agreeableness of created items was assessed by a testing board. The specialists were undeveloped and chosen from the understudies, educators and workers of the Department of Applied science and concoction innovation, Chattogram Veterinary

and Animal Sciences University, Chattogram. The specialists (15) were approached to allocate suitable score to every item tried on a 1 to 9 point decadent scale for trademark shading, flavor, surface and generally adequacy of the examples of jam.

The scale is masterminded with the end goal that; 9 = Like amazingly, 8 = Like without a doubt, 7 = Like modestly, 6 = Like marginally, 5 = neither like nor loathe, 4 = Dislike somewhat, 3 = Dislike decently, 2 = Dislike definitely, and 1 = Dislike incredibly.

3.11 Statistical Analysis

Data were determined and stored in Microsoft Excel 2013 spread sheet to evaluate statistical analysis. All samples were in three replicates. Descriptive statistics (mean and standard deviation) were done for proximate composition and sensory evaluation of guava jelly. Data were sorted, coded and recorded in IBM SPSS Statistics 25. After that statistical analysis were conducted. Proximate composition and sensory evaluation data were analysed by using One-way ANOVA procedures to assess significant level of variation at 95% confidence interval. Post hoc "Tukey" test was conducted to identify the variation within the sample groups. The statistical analysis was conducted for at 5% level of significant ($p \leq 0.05$).

Chapter-4

Results

4.1 Physicochemical and proximate analysis of olive jelly

Physicochemical analysis of different samples of olive jelly was performed in the laboratory. Table 4.1 showed the laboratory test results of Prematured olive jelly, Matured olive jelly and Ripe olive jelly samples, respectively. These tables showed the result of 8 parameters of physicochemical properties. One way ANOVA (Analysis of variance) test was performed to see the overall mean difference of values for different parameter of olive jelly. It can be seen from the tables that Mean ±SD values of moisture content, total soluble solids, acidity, pH, crude protein, crude fat, ash content, and vitamin C. The results showed that there was significant mean difference of values of different parameter on different maturity stages of jelly. Tukey'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 Premature olive jelly, Matured olive jelly, and Ripe olive jelly-

Parameters	Premature olive jelly	Matured olive jelly	Ripe olive jelly
pH	2.8667 ± 0.0577^{a}	2.9000 ± 0.0000^{a}	2.8889 ± 0.0333^{a}
Moisture (%)	31.1380 ± 1.3037^{c}	75.0400 ± 4.0882^{b}	83.0167 ± 2.2721^{a}
Ash content (%)	0.2500 ± 0.0100^{a}	0.0900 ± 0.0100^{b}	0.0500 ± 0.0100^{c}
Crude protein(%)	2.500 ± 0.1000^{a}	2.0600 ± 0.0100^{b}	2.1900 ± 0.0100^{b}
Crude fat (%)	0.0500 ± 0.0100^{a}	0.2800 ± 0.0100^{a}	0.0300 ± 0.0100^{a}
Vitamin C (mg)	0.5533 ± 0.2194^{a}	0.5533 ± 0.2194^{a}	0.5633 ± 0.1769^{a}
Titratable acidity	0.1867 ± 0.0058^{a}	0.1830 ± 0.0115^{ab}	0.6133 ± 0.0058^{b}
TSS (ºBrix)	0.6900 ± 0.0361^{a}	0.7000 ± 0.0000^{a}	0.7167 ± 0.0351^{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 ($p\leq0.05$) among samples.

Tukey's Multiple Comparison Test (TMCT) 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 moisture content of every

sample increases with maturity. Highest percentage of moisture found in Ripe olive jelly (83.0167 ± 2.2721^{a}) and lowest percentage found in Premature olive jelly (31.1380 ± 1.3037^{c}). Significant amount of moisture change found in all samples (Table 4.1).

The pH content of olive jelly varieties is almost significant. On the other hand, acidity of olive jelly decreased gradually with maturity of olives, but acidity difference was not statistically significant ($P>0.05$). The TSS of jelly increased in different stages of maturity. However, the difference of TSS was not statistically significant ($P>0.05$) in some samples.

The variation was observed in ash content which decreases in different stages of olive maturity. And the differences in jellies are statistically significant ($P<0.05$). Vitamin C content of olive jelly is almost same in all variations of olive jelly but this difference was not statistically significant ($P>0.05$).

The crude protein percentage of olive jelly different stages of maturity is slightly decreases and these are statistically significant with difference. The crude fat percentage of olive jelly different stages of maturity is slightly decreases and these are statistically significant with difference.

4.2 Anti-oxidant capacity and Bioactive compounds Analysis

Antioxidant capacity and bioactive 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) and TAC (Total anthocyanin content).One way ANOVA (Analysis of variance) test was performed to see the overall mean difference of values for different parameter of olive jelly variations. Average antioxidant capacity of Premature olive jelly, Matured olive jelly and Ripe olive jelly were 60.33 ± 0.02, 61.74 ± 0.01 and 60.02 ± 0.01. Total flavonoids content (TFC) of Premature olive jelly, Matured olive jelly and Ripe olive jelly were 91.65 ± 0.02, 36.13 ± 0.01, 23.0267 ± 0.00.Total phenolic content (TPC) of Premature olive jelly, Matured olive jelly and Ripe olive jelly were 3.82 ± 0.01, 0.04 ± 0.01, 0.03 ± 0.01 and total anthocyanin content (TAC) content were 82.71 ± 0.01, 67.07 ± 0.01, 33.500 ± 21.75 respectively.

Table 4.2: Anti-oxidant capacity and Bioactive compounds Analysis test results for Premature olive jelly, Matured olive jelly, and Ripe olive jelly

Parameters	Premature olive jelly	Matured olive jelly	Ripe olive jelly
Antioxidant capacity (DPPH)	60.33 ± 0.02^{b}	61.74 ± 0.01^{a}	60.02 ± 0.01^{c}
Total flavonoids content (TFC)	91.65 ± 0.02^{a}	36.13 ± 0.01^{b}	23.0267 ± 0.00^{c}
Total phenolic content (TPC)	3.82 ± 0.01^{b}	0.04 ± 0.01^{c}	0.03 ± 0.01^{a}
Total anthocyanin content (TAC)	82.71 ± 0.01^{a}	67.07 ± 0.01^{b}	33.500 ± 21.75^{c}

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 ($p\leq0.05$) among samples.

Tukey's Multiple Comparison Test (TMCT) at ($p\leq0.05$) was performed to show the pairwise significant difference of these parameters of jellies. It was observed from the above tables obtained from one way ANOVA analysis that antioxidant capacity of every sample almost same in different stages of maturity. The TFC is decreasing in different stages of maturity of olive. Highest percentage of TFC found in Premature olive jelly (91.6533 ± 0.02082^{a}) and lowest percentage found in Ripe olive jelly (23.0267 ± 0.001528^{c}). Significant amount of TFC found in all samples (Table 4.2).

The TPC is decreasing in different stages of maturity of olive. Highest percentage of TPC found in Premature olive jelly (3.8267 ± 0.01528^{b}) and lowest percentage found in Matured olive jelly (0.04113 ± 0.01528^{c}). Significant amount of TPC found in all samples (Table 4.2).

The TAC is decreasing in different stages of maturity of olive. Highest percentage of TPC found in Premature olive jelly (82.7133 ± 0.01528^{a}) and lowest percentage found in Ripe olive jelly (33.500 ± 21.7571^{c}). Significant amount of TAC found in all samples (Table 4.2).

4.3 Microbial study of Olive jelly

Microbiological attributes are pointers of security, quality and timeframe of realistic usability of arranged olive jelly. The quantity of microscopic organisms that can develop and frame countable provinces on supplement agar in the wake of hatching at 37oC for 24 hours is all out suitable bacterial include in an example. This investigation was performed by standard plate check technique. The all out number of reasonable microbes

was controlled by duplicating the province framing unit (cfu) with weakening number. The all out quantities of suitable microbes in tests premature olive jelly, Matured olive jelly and Ripe olive jelly individually have been appeared in table 4.3. At first noteworthy measure of bacterial burden was not recognized.

Table 4.3: Microbial analysis test results for Premature olive jelly, Matured olive jelly, and Ripe olive jelly-

Samples	TVC (/ml CFU)	Yeast & mold
Pre matured olive jelly	7.8×10^2	No growth
Matured olive jelly	4.5×10^3	No growth
Ripe olive jelly	5.0×10^2	No growth

Investigation on yeast and mold growth was performed. No significant amount of fungal growth was detected in 7 days incubation in Sabouraud Dextrose agar.

4.4 Sensory Quality Evaluation

Prepared three different olive jellies were subjected to sensory evaluation test. The test had been performed by fifteen semi-trained panelists. The panelists comprised of female and male members who had previous a few experience 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 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 very much = 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

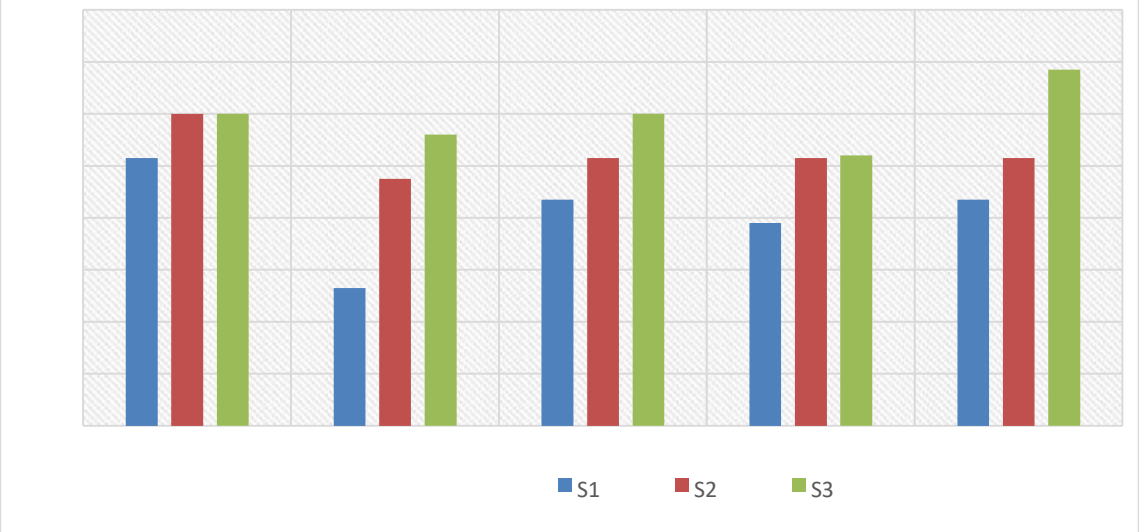
the panelists. Table 4.4 showed significant difference of mean of different olive jelly sample.

Table 4.4: Hednoic scale scoring test results for Premature olive jelly, Matured olive jelly, and Ripe olive jelly

Parameter	Premature olive Jelly	Matured olive jelly	Ripe olive jelly
Taste	7.83 ± 0.01^{b}	8.00 ± 0.10^{ab}	8.1 ± 0.10^{a}
Flavor	7.33 ± 0.01^{c}	7.75 ± 0.01^{b}	7.92 ± 0.01^{a}
Mouth feel	7.67 ± 0.01^{c}	7.83 ± 0.01^{b}	8.00 ± 0.10^{a}
Appearance	7.58 ± 0.01^{b}	7.82 ± 0.01^{a}	7.83 ± 0.01^{a}
Overall acceptability	7.67 ± 0.01^{c}	7.83 ± 0.01^{b}	8.17 ± 0.01^{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 ($p\leq0.05$) among samples.

It was observed that the mean scores of hedonic scales were significantly different for taste and appearance between samples. The mean and standard deviation score of mouth feel, flavor and overall acceptability were statistically significant and the multiple Tukey's Multiple Comparison Test (TMCT) at ($p\leq0.05$) was performed to show pairwise significant difference of the parameters.



Legend: (S1 = Premature olive jelly, S2 = Matured olive jelly, S3 = Ripe olive jelly)

Figure 4.1: Descriptive attributes of all samples of olive jelly in Hedonic Rating Test

4.5 Calculation of cost in production of olive jelly

The production cost of the developed olive jelly was calculated and Table 4.5 showed total cost for 5 Kg olive jelly is approximately Tk.986.16.

Table 4.5: Production cost of olive jelly

Heads	Tk./Kg	Quantity used (kg/10kg products)	Total Tk
1)Expenditure Raw materials			
Fresh Olive	50	5	250.00
Sugar	65	2.5	162.50
Pectin	12000	0.015	180.00
Citric acid	180	0.060	11.00
Sub total			603.50
2) Processing cost @ 15% of raw material			90.45
3) Bottling cost	25 Tk./piece	10 piece	250.00
4) Handling cost excluding Raw materials @ 7% of raw material			42.21
Total production cost of 5kg olive jelly			**986.16**

This olive jelly bottled in 250gm in a bottle and found 10 bottle jelly which production cost was calculated Tk. 50 per bottle and Tk. 197 per kg approximately. The commercial price of mango jelly found in market Tk. 440 per kg. The commercial price of the imported guava jelly found in super shop is Tk. 630 per kg. A Bangladeshi local brand of jelly found in the market that's price is Tk. 250 per Kg.

Chapter-5

Discussions

5.1 Physicochemical Analysis of olive jelly

5.1.1 pH

One of the most common causes of jelly failure is insufficient acid. The pH value of jelly should be taken when the jelly is concentrated sufficiently to pour. If the pH is above 3.3, citric acid should be added to reduce the pH to the range of 3.1 to 3.2 (Smith, 2006). Adding the citric acid at the end of the boiling period gives better control of the pH and minimizes pre-gelling of the batch and hydrolysis of the pectin. Different juices will require different amounts of additional acid, depending upon the original acidity of the juice and the buffering capacity of the juice. The pH may be adjusted to attain optimum flavor, to control or modify the rate of setting and to modify the degree of sugar inversion.

The most noteworthy and least pH estimations of were recorded as 2.9 and 2.8, separately. According to Shah & Khan et al. (2015), the pH of apple and olive jam was found nearly 3.4 and decreasing with storage. It implies olives are acidic and its taste is harsh. As per Lehkoživová et al. (2009), the discovered estimation of pH characterizes the mash of E. serratus organic product as a corrosive nourishment (pH < 4.5), which is affirmed by the corrosiveness esteem. It is normal that pH of olive changes dependent on the development area, collect time, natural product development and different elements that impact pH parameters (Bartolome et al., 1995). Various juices will require various measures of extra corrosive, contingent on the first sharpness of the juice and the buffering limit of the juice. The pH might be acclimated to achieve ideal flavor, to control or adjust the pace of setting and to alter the level of sugar reversal.

5.1.2 Titratable Acidity

Estimation of acidity is significant as speaks to the nature of organic product squeezes from jelly and jams. It was effectively estimated in the research center condition as portrayed in the material and strategy segment. The most noteworthy and least titratable acidity of premature olive jelly, matured olive jelly and ripe olive jelly was recorded as

0.192 and 0.1792; 0.156 and 0.1664; and 0.1664 and 0.16 individually. According to Shah & Khan (2015), the acidity of apple and olive jam was found nearly 0.6 and increasing with storage. They said that increase in acidity was due to the formation of acids by degradation of polysaccharides and oxidation of reducing sugar or by break down pectic substance and uronic acid. The reduction in acidity may be incompletely because of copolymerization of natural acids with results of the sautéing responses. Lewis et al. (1949) proposed that natural acidity can respond with decreasing sugars to create darker shade. Acidity of jelly expanded with the expansion of capacity time. Measure of acridity is fundamentally identified with detailing of included citrus extract. Higher level of citrus extract demonstrated lower higher sharpness. This inclination is like the past examinations performed by Saka et al. (2007).

5.1.3 Moisture Content

In phytochemical evaluation, the moisture content for premature olive jelly, matured olive jelly and ripe olive jelly was discovered 63.1406, 75.0426, and 83.0206 percent separately, demonstrating high moisture content trait of tropical organic product, which is confirmed by the high estimation of aw. In this study, soil nutrients and composition of the growing area and inefficient measurement or instrumental error has influenced in varietal difference. The high estimation of water movement describes it as exceptionally short-lived nourishment (Fontana, 1998).Campeanu et al. (2009) said that the moisture content in apple jelly varieties might be varied a range between 76.67 and 88.37 percent.

5.1.4 Total Soluble Solid

The least and most noteworthy TSS of various olive jelly tests was recorded 0.69, 0.70 and 0.72, individually. Increment in TSS was presumably because of the hydrolysis of polysaccharides. According to Shah &Khan et al. (2015), the TSS of apple and olive jam was found nearly 0.69 and increasing with storage. They also said that, the increasing in total soluble solid of the apple olive jam might be due to the degradation of polysaccharides in the presence of acid. Singh et al. (2004) announced that the critical increment ($P < 0.05$) in TSS could be because of the corruption of polysaccharides during capacity into solvent mixes.

5.1.5 Vitamin C

Ascorbic acid is water-soluble compound that is fundamental for life. The normal Vitamin C content in premature olive jelly, matured olive jelly and ripe olive jelly were discovered 0.553, 0.553, and 0.583 percent individually. In spite of the fact that the Vitamin C Concentration was discovered lower, it doesn't make the jam less sound in light of the fact that ascorbic acid, even in less centralization of ascorbic acid can in any case secure the essential particles of the body against harm by free radicals. Temperature influences nutrient C level. The region with cool night reasonable to produces citrus natural products with higher nutrient C levels. Hot tropical regions produce natural product with lower levels of nutrient C (Padayatty et al., 2003). Additionally, natural conditions that expansion the sharpness of citrus organic products increment nutrient C levels. The maintenance of nutrient C is regularly utilized as a gauge for the general supplement maintenance of nourishment items since it is by a long shot the least steady supplement. It is profoundly touchy to oxidation and filtering into water-soluble media during capacity (Davey et al., 2006; Franke et al., 2004).

The presence of carotenoids and vitamin C in fruits is often associated with antioxidant activity. Carotenoids are precursors of vitamin A and can prevent the development of chronic diseases (Singh et al., 2012), whereas the consumption of fruit rich in vitamin C is associated with the prevention of cardiovascular diseases and obesity (González-Molina et al., 2010; Ramful et al., 2011). Thus, the supplement of these nutrients from dietary intake of fruits and vegetables is vital, since the human body is unable to synthesize them (Leong and Oey, 2012).

5.1.7 Ash content

The average ash content of premature olive jelly, matured olive jelly and ripe olive jelly were recorded 0.2563 percent, 0.14 percent and 0.277 percent respectively. There is no available literature found to compare with ash content for olive jelly.

5.1.8 Crude protein and crude fiber

The values of protein of premature olive jelly, matured olive jelly and ripe olive jelly were 2.5, 2.06 and 2.19 g respectively. The protein content is in accordance with other olive species which constituted 2.9 to 5.3 $g.100g^{-1}$ protein (Nogueira, 2012). Concerning

the crude fiber content, E. serratus fruit may be considered a good source of fibers. The dietary fiber intake recommendation for adults is >25 g/day (Nishida et al., 2004). In other words, the consumption of 100 g of the pulp from E. serratus fruit (approximately 6 fruit) could provide 70% of the necessary fiber's amount for an adult. As jelly is made from olive juice without pulp there was no fiber found in olive jelly.

5.2 Bioactive compounds

Besides the basic nutrition, the fruit presents in their composition some bioactive compounds that exert an important role in biological functions for humans, such as chronic diseases prevention and maintenance of immune system (Liu, 2004, 2013). Thus,the quantification of these compounds is of utmost importance and the results of bioactive compounds content found in olive jelly are shown in Table 4.2.

According to McClements and Decker (2010), phenolic compounds may be found in plants as simple phenolic, phenolic acids, anthocyanins, cinnamic acid derivatives, flavonoids and tannins, whose structures allows free radicals scavenging activity. In plants, these compounds are believed to be related to protection against phytopathogens or insects (Chen et al., 2013), as well as tannins, which can act as a natural antimicrobial agent, increasing the plant resistance against pathogens (Scalbert, 1991).

Total phenolic content of premature olive jelly, matured olive jelly and ripe olive jelly found 3.81, 0.04 and 0.03.The highest TAC found in premature olive jelly which value was 3.81 and the lowest TAC contained by ripe olive jelly which value was 0.03.

As shown in Table4.2, premature olive jelly, matured olive jelly and ripe olive jelly showed the results that highest amount of flavonoids found in premature olive jelly, which value was 91.66 mg and others were 36.12mg and 23.04 mg respectively. This value is in accordance with the values of phenolic compounds found by Machado et al. (2013)in olives cv. Cobrançosa under three irrigation regimes and on three different picking dates.

Total anthocyanin content of premature olive jelly, matured olive jelly and ripe olive jelly found 82.71, 67.07 and 33.50.The highest TAC found in premature olive jelly and the lowest TAC contained by ripe olive jelly.

5.3 Anti -oxidant capacity

Olives are very high in vitamin E and other powerful antioxidants. Studies show that they are good for the heart and may protect against osteoporosis and cancer. The healthy fats in olives are extracted to produce olive oil, one of the key components of the incredibly healthy Mediterranean diet. Anti-oxidant capacity results of premature olive jelly, matured olive jelly and ripe olive jelly found almost same in each category, whose values were 60.36, 61.76 and 60.00 respectively.

5.4Microbial study of olive jelly

Microbiological analyses (Total viable count, yeast and mold count) were performed for each of three samples of each type olive jellies. Yeast and mold were not found in the olive jelly showed in Table 4.3. Koburger (1971) reported mold is aerobic organisms and cannot grow well under conditions where oxygen is limited. Yeast, on the other hand, can grow in aerobic and anaerobic conditions. Acid/alkaline requirements for yeast and mold growth in a wide range food product are quite broad, ranging from pH 2 to above pH 9. Due to preserving jellies in air tight bottle yeast and mold growth were inhibited.

The result was similar to previous studies performed by researchers. For instance, Pramanick et al. (2014) studied “Microbial Status of mangrove fruit (Sonneratiaapetala) Jelly”. Pramanick et al. (2014) reported that the complete absence of TCC, TFC, E.coli, Streptococcus spp.,Vibrio spp.,Salmonella spp. in S.apetala jelly was an indication of better and safe quality fruit production.

TVC found in premature olive jelly, matured olive jelly and ripe olive jelly were 780,450 and 500 cfu/ml respectively. Bacterial load in 120 days was above the acceptable limit (≥105 cfu/ml) reported by Zealand, (2001) in guidelines for the microbiological examination of ready-to-eat foods. For a production of high quality fruit juice and jelly, free from any microbial contamination, use of good quality raw material is essential. Jellies obtained from fruits which are damaged and bruised contain more bacterial count than the juice obtained from sound fruits (Wolford and Berry, 1948).

When considering growth rates of microbial pathogens, time is a critical consideration. Food manufacturers address the concept of time as it relates to microbial growth when a

product's shelf life is determined. Shelf life is the time period from when the product is produced until the time it is intended to be consumed or used. Several factors are used to determine a product's shelf life, ranging from organoleptic qualities to microbiological safety. For the purpose of this report, the key consideration is the microbiological safety of the product. The Uniform Open Dating Regulation requires the shelf life of a perishable food product to be expressed in terms of a sell by date (Sidhu, 2006).

5.5 Consumer acceptability test of olive jelly

Sensory quality of olive jelly based on maturity attributes viz. taste, flavor, mouth feel, appearance and overall acceptability were evaluated. Mean sensory score of taste results were 7.83, 8 and 8.1 for premature olive jelly, matured olive jelly and ripe olive jelly respectively. Highest taste score was observed for ripe olive jelly.

Mean score of flavour was observed the highest for ripe olive jelly. Flavor score was decreased with storage period but increased with increasing amount of pectin and citric acid in guava jelly. Results of one way ANOVA revealed that it was statistically significant ($p<0.05$) differences in flavor acceptability. Mouth feel score was found the highest for ripe olive jelly. The mouth feel score was affected by the composition of pectin and citric acid in jelly. The texture score of jelly increased with increase of percentage of pectin and citric acid. Similar propensity was reported by Bakshi et al. (2005) and Selvamuthukumaran et al. (2007).

It was found explicit that the effect variation in percentage of pectin and citric acid on overall acceptability score were found significant at $p<0.05$ level of significance at one way ANOVA analysis. 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 8.17in ripe olive jelly in hedonic rating scale it denotes “Like Very Much”. From present investigation, it was concluded that olive jellies prepared from ripe olive was found to be better organoleptically than other compositions.

Chapter-6

Conclusions

This study revealed that Olive jelly have the greatest acceptability in terms of sensory perception. The physicochemical test was performed for olive jellies which showed significant differences. Proximate analysis was performed for jellies. Due to the unavailability in the local markets, olive commercial jelly was not tasted in the current study. It was observed that the nutritional values were good. Microbiological analysis results revealed a negative result for all samples. This study points out a prosperous probability of processing of jelly from different maturity stages of olive for the advantage of the growers, processors and the consumers in Bangladesh. It may also be observed that by exporting the best quality jelly of international standard may earn foreign exchange that may positive contributions in the national economy of Bangladesh. Further study is important for research with other necessary ingredients for trial with different types of fruits for preparation of jelly.

Chapter-7

Recommendations and Future Perspectives

These studies have been concluded with good findings in the area of developing olive jelly. It is also resulted with its commercial value and better marketability. Modern food industries can adopt the procedure form medium and large scale of production. On the basis of present investigation, the following suggestions and prospects are made for the further research work.

a) The present studies may be repeated for confirmation of the experimental findings.
b) The composition may be modified further and may try for making mixed jelly with various recipes with different ratio of fruit.
c) This study can also be repeated with addition of preservative.
d) Since it is easy to prepare. It can be also kept up to long time and recommended for off season.
e) On the other hand, it will be helpful from economic point of view for those people who come under economically weaker section. Considering the products flavor and medicinal values, more profit can be earned through value addition.
f) Such types of research should be done for other fruits like papaya, mango etc. available in markets especially for off season.
g) Modern packaging and storage condition would be developed for the betterment of olive jelly.
h) The findings will be helpful from therapeutic point of view as it has medicinal value.
i) Value added olive products is improved a variety of canned products.
j) From the research it is clear that homemade jellies are more nutritious and healthier compared to commercial apple jelly. It also saves money as well as provides mental satisfaction.
k) Although the sample size was sufficient to perform statistical comparisons between analytical data. Our conclusion should be considered with caution

because of the small number of analyzed samples and results would need to be confirmed with another larger study.

l) Sufficient steps should be taken to enrich commercially available jellies with more nutritional value.

m) Necessary steps should be taken to control quality and value of commercially olive jellies

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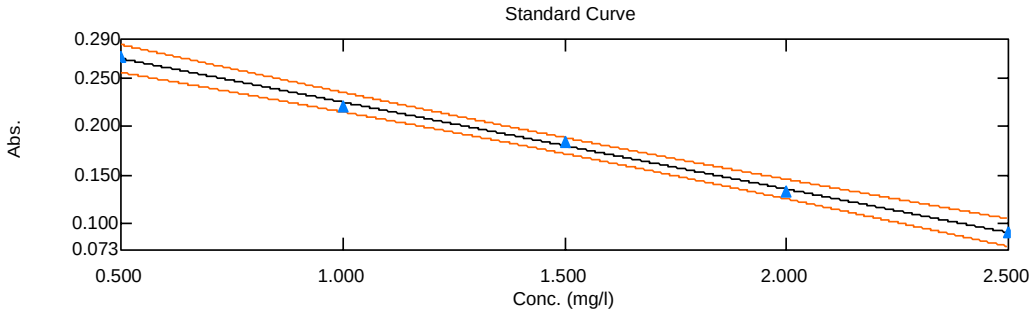
Appendices

Appendix-i: Standard Curve & Sample Curve of Antioxidant capacity determination

Table: Concentration and Absorbance for Standard solution for AOA

Sample ID	Type	Ex	Conc. (ppm)	WL 517. 0	Wt. Factor	Comments
1	Std2	Standard	1.000	0.221	1.000	
2	Std3	Standard	1.500	0.185	1.000	
3	Std4	Standard	2.000	0.133	1.000	
4	Std5	Standard	2.500	0.092	1.000	

Standard curve



y = - 0.0894539 x + 0.314536
r2 = 0.99735

Figure: Standard curve for antioxidant capacity determination test

Table: Concentration and Absorbance forantioxidant capacity determination testof Sample

Sample ID	Type	Conc	WL517.0
S1	Unknown	3.018	0.045
S2	Unknown	3.088	0.038
S3	Unknown	3.000	0.046

Curve for antioxidant capacity determination test of Sample

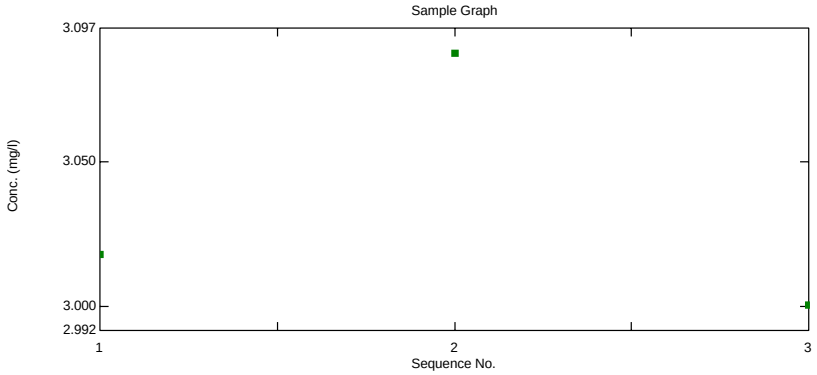


Figure: Curve of sample for antioxidant capacity determination test

Appendix-ii: Standard Curve & Sample Curve of TFC

Table: Concentration and Absorbance for Standard solution for TFC

Sample ID	Type	Ex	Conc	WL 517. 0	Wgt.Factor
1	Std1	Standard	1.000	0.041	1.000
2	Std2	Standard	3.000	0.088	1.000
3	Std3	Standard	5.000	0.171	1.000
4	Std4	Standard	7.000	0.234	1.000

Standard curve

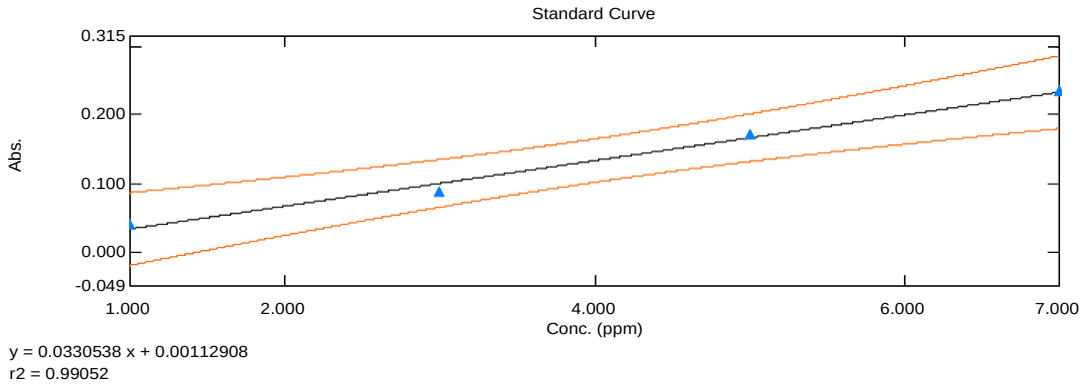


Figure: Standard curve for TFC capacity determination test

Table: Concentration and Absorbance for Sample

Sample ID	Type	Conc	WL517.0	Comments
S1	Unknown	4.583	0.015	
S2	Unknown	1.806	0.004	
S3	Unknown	1.152	0.002	

Sample curve

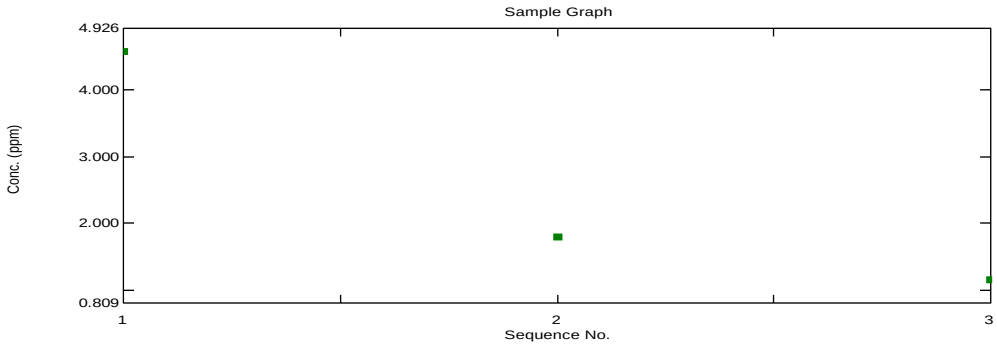


Figure: Sample curve for TFC capacity determination test

Appendix-iii: Standard Curve & Sample Curve of TPC

Table: Concentration and absorbance for Standard solution for TPC

Sample ID	Type	Ex	Conc	WL 517. 0	Wgt. Factor
1	Std1	Standard	1.000	0.763	1.000
2	Std2	Standard	2.000	0.780	1.000
3	Std3	Standard	3.000	0.920	1.000
4	Std4	Standard	4.000	1.007	1.000
5	Std5	Standard	5.000	1.074	1.000
6	Std6	Standard	6.000	1.115	1.000
7	Std7	Standard	7.000	1.230	1.000
8	Std8	Standard	8.000	1.314	1.000

Standard curve

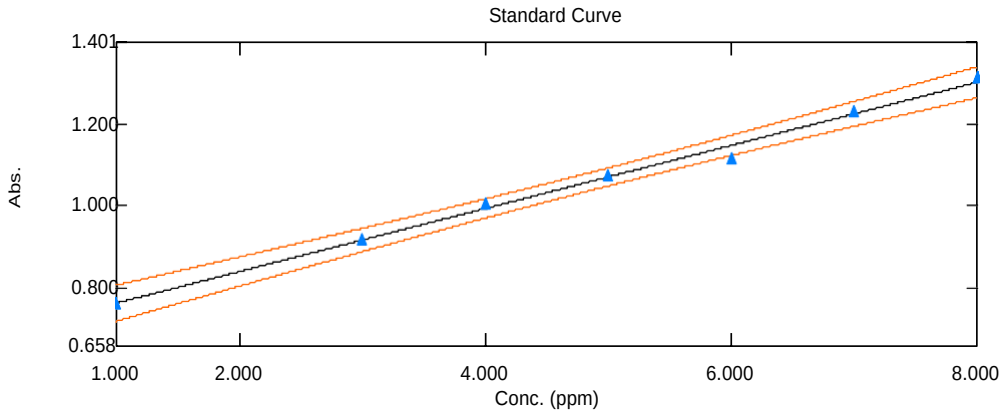


Figure: Standard curve for TPC capacity determination test

Table: Concentration and Absorbance for Sample

Sample ID	Type	Conc	WL517.0
S1	Unknown	0.635	0.736
S2	Unknown	0.069	0.692
S3	Unknown	0.752	0.629

Sample curve

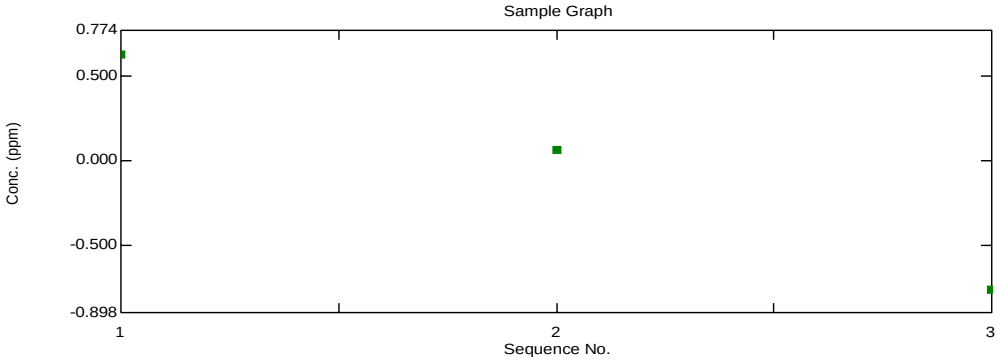


Figure: Standard curve for TPC capacity determination test

Appendix-iv: Photo gallery

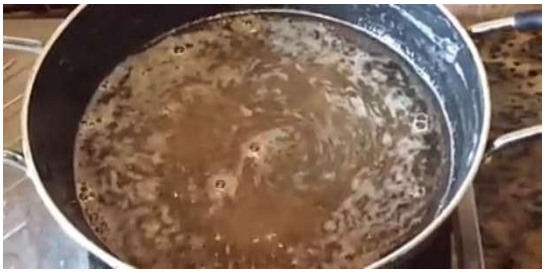
Samples

Cutting the olives

Washing the olives

Soaking in water

Boiling with water



Boiling olive juice with other ingredients

Heating

Checking jelly formation

Testing Brix value using refractometer

Final products

Sensory Evaluation

Sensory Evaluation

Laboratory work

Weighing

Working in UV spectrophotometer

Checking samples

Fiber analysis

Titration

Working in fibre analyzer

Crude protein distillation

Samples after distillation

Appendix v: Sensory Evaluation of Olive Jelly (Hedonic Rating Test)

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, flavour, 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

Hedonic	Taste					Flavor					Mouth feel					Appearance					Overall acceptability				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Like Extremely																									
Like very Much																									
Like Moderately																									
Like slightly																									
Neither like or dislike																									
Dislike Slightly																									
Dislike Moderately																									
Dislike very Much																									
Dislike Extremely																									
Comments (if any) :																									

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= Prematured olive jelly

B= Matured olive jelly

C= Ripe olive jelly

D= Commercial Pineapple jelly from local market

E= Commercial Apple jelly from local market

Brief Biography of the Student

Jannatul Fatema Chowdhury passed the Secondary School Certificate Examination in 2009 and Higher Secondary Certificate Examination in 2011. She also received Bachelor of Science (Hons.) in Food Science and Technology degree from Faculty of Food Science and Technology, Chattogram Veterinary and Animal Sciences University, Khulshi-4225, Chattogram. Now, she is a candidate for the MS degree in Food Chemistry and Quality Assurance under the Department of Applied chemistry and chemical technology of same faculty.