Substitution of Sugar with Different Sweetener in Gel Pudding (Carrot and Coconut Milk): A Comparative Study

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Roll No. : 0121/01

Registration No. : 983

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A thesis submitted in the partial fulfillment of the requirements for the degree of Master of Science in Applied Human Nutrition and Dietetics

Department of Applied Food Science and Nutrition

Faculty of Food Science and Technology

Chattogram Veterinary and Animal Sciences University

Chattogram-4225, Bangladesh

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

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PLAGIARISM VERIFICATION

Title of Thesis: **Substitution of sugar with different sweetener in gel pudding (carrot and coconut milk): A comparative study**

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Dedicated To My

Beloved Family

& Respected Teachers

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The Author

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Table of content

List of tables

List of Figures

Abbreviation

%	Percentage
&	And
˚C	Degree Celsius
µg	Microgram
ANOVA	Analysis of variance
AOAC	Association of Official Analytical Chemists
cfu	Colony forming unit
dl	Deciliter
et al	Et alii/ et aliac/et alia
etc.	Et cetera
g	Gram
kcal	Kilocalorie
Kg	Kilogram
mg	Milligram
ml	Milliliter
N	Normality
SD	Standard deviation
Spp.	Species
SPSS	Statistical package for Social science

Abstract

Excessive consumption of sugar-sweetened food products has become an intractable public health concern worldwide, making investigation of healthy alternatives of sweetener from natural sources. This study was carried out to find a possible replacement of white sugar in desert like products. In this experiment, different organic sweetener were used in coconut milk gel pudding as a sugar substitution to observe their effects on the nutritional qualities and sensory properties of the formulated products. Coconut milk and sugar (C1) and coconut milk, sugar and carrot (C2) were considered as control ones whereas honey and dates as replacement of sugar added in different concentration were the sample products (T_1-honey 12.87%, T_2-honey 10%, T_3-honey 8.14%, T_4-date 13%, T_5-date 10.3% and T6-date 8.54%). At the end of experiment, data on physiological properties, nutritional composition, energy content, sensory evaluation, microbial load and cost analysis were collected for further assessment. The results showed that, among all formulations sample F (date 13%) has the highest percentage of crude fiber (12.88±0.005), Vitamin A (30.85±0.05), protein (4.12±0.03), fat content (10.20±0.00), Calcium (2.98±0.02), Potassium (2.83±0.02), and Sodium (68.90±0.02) which significantly ($p<0.05$) differ from other samples such as- honey samples and control samples. Maximum energy content and overall acceptability were seen in the control gel pudding (C1). No yeast and mold growth was observed in either samples during 7 days of incubation. Whereas, microbial load was found to be higher in the control samples than the treatment ones. Although, increased energy content and overall acceptability rate were found in sugar based products, the nutritional value was found to be significantly ($p < 0.05$) higher in the treatment puddings specially the one made with date (13%). Also the microbiological content was moderate according to the food safety regulations. Moreover, the cost benefit analysis indicated that, using dates as a substitute doesn't increase the cost of pudding per cup compared to the control cups. This study concludes that, complete replacement of white sugar in coconut carrot milk pudding improves not only the nutritional value but also the microbiological quality of the pudding.

Keywords: Coconut milk pudding, sugar substitutes, nutritional qualities, sensory properties

Chapter 1: Introduction

There is a wide variety of desserts that captivate our senses with their tasteful fusion of flavors and textures in the world of culinary delights. Among these indulgent creations, pudding stands out as a timeless classic, offering a comforting and satisfying treat for any occasion. This thesis explores the blending of two distinct ingredients, carrots and coconut milk, to create a distinctive and delicious dessert: Carrot Coconut Milk Gel Pudding. It draws inspiration from the rich traditions of dessert-making. Puddings have long been cherished for their smooth creamy texture. They have changed over time, incorporating different ingredients and adapting to various cultural preferences, creating a wide range of flavors that tempt our taste buds. The quest for innovation and the desire to push the boundaries of traditional pudding recipes has led to the exploration of unlikely combinations, culminating in the creation of remarkable desserts that surprise and delight.

A greater demand has emerged in recent years for healthier food options that use natural ingredients and offer nutritional advantages (Walidayni & Chaldun, 2020).Traditional desserts made with milk, cream, and sugar have too many calories and a high fat content (Nepovinnykh et al., 2019). People are looking for alternatives to satisfy their sweet tooth without endangering their health. Due to numerous health advantages, coconut milk and carrots are considered popular ingredients for developing creative dessert recipes.

Carrots, renowned for their vibrant orange color and high beta-carotene content, have long been recognized as a valuable source of essential vitamins and minerals such as- Vitamin A, B1, B2, B3, C, E, folate, choline, calcium, magnesium, potassium, phosphorous, sodium and other trace minerals (Kwiatkowski et al., 2015). Among 39 fruits and vegetables carrots have been ranked 10th in nutritional value(Acharya et al., 2008). Their inclusion in this recipe not only adds a natural sweetness but also enhances the nutritional profile of the pudding. Additionally, the unique combination of flavors and textures that carrots bring adds an interesting dimension to the overall dessert experience. Carrots have a unique flavor because of glutamic acid's presence and the calming effects of free amino acids. There have also been detected trace amounts of succinic acid, ketoglutaric acid, lactic acid, and glycolic acid (Sharma et al., 2012).

Coconut milk, derived from the flesh of mature coconuts, boasts a rich and creamy consistency that has been enjoyed across the globe. Beyond its luscious texture, coconut milk offers numerous health benefits, including a high concentration of medium-chain triglycerides (MCTs), which are known to provide a readily available source of energy (Suyitno, 2003)

By combining these two ingredients, this research aims to explore the possibilities of creating a Carrot Coconut Milk Jelly Pudding that is not only delicious but also packed with essential nutrients. The utilization of agar powder as a gelling agent further enhances the texture and stability of the dessert while presenting an alternative option for individuals with dietary restrictions or preferences.

1.1 Justification and Importance of the study

The search for nutritious foods has drawn a lot of attention from people looking to improve their well-being in recent years. As a result, there is an increasing desire to discover creative recipes that satisfy both the palate and the need for essential nutrients. As both carrots and coconut milk are recognized for their unique nutritional advantages, Carrot Coconut Milk Gel Pudding provides a healthier alternative by incorporating nutrient-dense ingredients and decreasing the reliance on processed sugars and unhealthy fats. Medium-chain triglycerides (MCTs), healthy fats, and important nutrients are all present in coconut milk, while carrots are a good source of dietary fiber(da Silva Dias, 2014), antioxidants, vitamins, and minerals. The goal of the research on carrot coconut milk gel pudding is to evaluate the dessert's nutritional profile with a focus on its potential as a healthier substitute for conventional high-sugar, high-fat desserts. Despite the fact that coconut milk and carrots have long been used separately, their combination in gel pudding offers a unique chance for innovation and creativity in the kitchen. This thesis contributes the culinary arts and encourages experimentation in recipe development by looking at the possibility and acceptability of this unusual pairing. The results of this thesis can encourage the creation of desserts that put flavor first without sacrificing health. The Carrot Coconut Milk Gel Pudding is one such creation that combines indulgence and health.

1.2 Aims and objectives

1) To develop carrot coconut milk gel pudding by using different percentage of sweeteners.

2) To analyze and compare the nutritional value, sensory and microbial properties of gel pudding.

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

Chapter 2: Review of Literature

2.1 Overview of Carrot

The most common root vegetable grown worldwide is the carrot (*Daucus carota L.*).Along with celery, parsley, coriander, cumin, and parsnip, which are all members of the Apiaceae family, carrot are also important. The Apiaceae family's most valuable member is considered to be the carrot (Nagraj et al., 2020) . Due to the high nutritional value, phytochemical composition, antioxidant capacity, and health advantages, carrot consumption has significantly increased in recent years. ((Leja et al., 2013).

Carrots were utilized for medical purposes in Europe in the 10th century. Few time later, it became a popular food source. Carrots can be found in different colors like- white, yellow, orange, red, purple and dark purple (da Silva Dias, 2014).Initially carrot plant was used for its scented flowers, leaves and seeds. But then advantages of carrot root were discovered and after that it has been using as a staple food around the world (Nagraj et al., 2020).

Figure 2.1: White, purple, orange, yellow Carrot (Nagraj et al., 2020)

White carrot contain very little pigments. Carrots rich in anthocyanin are purple in color (Sun et al., 2009). Carrots rich in lutein are yellowish in color. Macular degeneration can be prevented with the help of lutein. (Pauleikhoff et al., 2001).Orange color carrot

contains high amount of α and β carotene. These α and β carotene is responsible for almost half of the provitamin A carotenoid found in the food (Sun et al., 2009).

Orange carrot gain its popularity due to its high content of provitamin A content (Simon, 2000). The first domesticated carrots were purple and yellow. In Afghanistan, Iran, and Pakistan, it was initially grown 5000 years ago. The color and flavor of the carrot changed as a result of domestication (Nagraj et al., 2020).But wild carrot which is white and pale in color are aromatic and acrid which makes their flavor undesirable. That is the reason wild carrots are not used as a dietary option and often considered as weeds in most countries (John & Jules, 2011)

2.1.1 Taxonomy of Carrot

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Apiales

Family: Apiaceae

Genus: *Daucus*

Species: *D.carota*

Binomial name: *Daucus carota*

2.2 Utilization and economic impact of Carrot

2.2.1 Leaf

Children are lancet-shaped leaves (lines); carrot leaves are compound pinnate double two or three. Petioles on each plant range in size from 7 to 15 inches. The leaf's cutting edge is limp and thin, while the petiole is firm, thick, and has a smooth surface (Yadav & Deepak, 2018). Fresh carrot leaves can be used as herbs in place of parsley or basil. It goes with pasta, salad, soups and also roasted vegetables.

2.2.2 Roots

Carrot roots is used for the preparation of salad and curries in India. Roots can be used for making nutritionally enrich food products like- juice, concentrate, dried powder, canned, preserves, candy, pickle and gazrailla (Sharma et al., 2012).

With the help of canned or processed carrot food products like-canned, dehydrated juice, beverages, candy preserves, intermediate moisture products like halwa can be

made. An emerging market with economic importance has been observed for carrot juices and derived products such as (ATBC) (α-Tocopherol, β-carotene, vitamin supplement) (Schieber, 2019),(Sun et al., 2006).

2.2.3 Carrot pomace

Up to 50% of the raw material presents in pomace due to the lower yields involved in the manufacturing of carrot juice, which is often disposed of as manure or feed. However, a significant number of beneficial substances are present in this pomace, such as- dietary fiber, carotenoids (Nicolle et al., 2003) and uronic acids and neutral sugars(Stoll et al., 2003). Carrot products are well-known for being a good source of dietary fiber due to the fact that carrot pomace contains 4-5% protein, 8-9% reducing sugar, 5-6% minerals, and 37-48% total dietary fiber (on a dry weight basis). (Bao & Chang, 1994). Carrot pomace has been utilizing in food products such as – bread, pickle, dressings, fortified wheat bread, cake, high fiber biscuits(Mousa, 2010), and in functional drinks.

2.3 Nutritional properties

The nutritional composition of carrots differ between studies due to different varieties, environmental, ecology, harvest condition and processing techniques. Carbohydrate and minerals like- Ca, P, Fe, Mg are found in carrots. Carrots have a moisture content that ranges from 86 to 89%. In one study it was reported that carrot have moisture (86%), protein(0.9%), fat(0.2%), carbohydrate(10.6%), crude fiber(1.2%), total ash(1.1%), Ca(80mg/100gm), Fe(2.2 mg/100 gm.), P(53mg/100gm)(Aykroyd et al., 1963). With a small amount of starch, the simple sugars sucrose, glucose, and fructose form the majority of the carbohydrate part (Arscott & Tanumihardjo, 2010). The roots contain a lot of fiber, including cellulose (50%) and lignin (4%). Minerals like calcium, magnesium, potassium, phosphorus, sodium, and certain other trace minerals are abundant in the vegetable. Carrots contain considerable amounts of the vitamins C, E, and K, folate, and choline in addition to known phytochemicals.

2.4 Functional properties and phytochemicals

2.4.1 Functional foods

The term 'functional food' was first used in the publication 'Japan explores the Boundary between Food and Medicine'. It refers to foods or food substances that offer health advantages beyond their traditional nutrients. These foods are whole, fortified,

enriched, or enhanced products, promising health benefits when consumed regularly in diverse diet (Rama, 2019). Functional food helps to reduce disease, promote health, and deduce health care cost (Nicoletti, 2012).

Biomolecules found in edible and non-edible parts of food and agricultural matrices that have different physiological benefits are known as bioactive compounds, sometimes known as functional components. Probiotic-fortified foods, however, were regarded as functional foods (Nath et al., 2023). Prebiotics, probiotics, amino acids, peptides, proteins, omega-3, structured lipids, phytochemicals and plant extracts, minerals, vitamins, fibers, unique carbohydrates, carotenoids, and antioxidants are the main bioactive ingredients. These elements are all available to customers in the form of functional foods, beverages, personal care items, and supplements from a variety of sources (Fernandes et al., 2019)

The high beta-carotene content of carrots makes them popular despite their high fiber and mineral content. The root also contains additional beneficial substances such polyactylene, vitamin C, phenolic compounds, and other carotenoids in different forms. Carrot phenolic components, such chloregenic acids, have antioxidant properties as well. Polyacetylenes are found in carrot roots. Previously thought to be toxicants because they are strong skin sensitizers and irritants and are neurotoxic at high concentrations, they are now thought to be bioactive substances. Carrots contain phytochemicals that can be utilized in complementary medicine to treat and prevent a variety of illnesses and conditions (Ergun, 2018).

2.4.2 Phytonutrients

Phytonutrients are parts of plants, primarily secondary metabolites that have positive effects on health (Sharma et al., 2012). In vitro research suggested that besides protecting biological systems from the effects of oxidative stress (Wilhemina Kalt, 2005). The phytonutrients including phenolic (Babic et al., 1993), polyacetylenes (Hansen et al., 2003), and carotenoids (Block, 1994) are all high in carrots. Carotenoids, phenolic compounds including anthocyanin, vitamin C and polyactylenes are the phytochemicals isolated from carrot roots (Tab. 2.1)(Ergun, 2018)

Table 2.1 Major Phytochemicals present in carrot roots (Ergun, 2018)

Carotenoids	Alpha-carotenoids Beta-carotenoids Lutein Beta-cryptoxanthin Lycopene Zeaxanthin
Phenolic	Cholorogenic acid derivatives P-hydroxybenzoic Caffeic acid Luteolin Keampferol Myricetin Cyaniding Pelargonidin Peonidin
Polyacetylenes	Falcarinol Falcarindiol Falcarindiol-3-acatate
Vitamins	Ascorbic acids(Vitamin C) Vitamin E Vitamin k Folate(Vitamin B1) Choline(Vitamin B4)

Carotenoids

Carotenoids are phytonutrients present in the cells of plants, algae and bacteria. Carotenoids play crucial biological functions and serve as significant natural food pigments. Carotenoids have several roles in the body, including regulating gene expression, preventing monocyte adherence, and activating platelets. The activity of provitamin A is different from the previously mentioned biological processes.

However, they are connected to carotenoids' antioxidant abilities (Sharma et al., 2012). Vegetables contain α-carotene, β-carotene, lycopene, lutein, zeaxanthin, and -cryptoxanthin as their predominant carotenoids. The most prevalent type of carotenoid, beta-carotene, contains the highest provitamin A content. Most of the time, a carrot's color determines the carotenoid types and quantities present. For instance, carrot roots that are orange have maximum levels of alpha and beta carotene, red ones have high levels of lycopene, and yellow ones have high levels of lutein(Singh et al., 2012). According to (Nicolle et al., 2003), the primary physiological role of carotenoids is as precursors of vitamin A. Because they may have a preventive effect against certain cancers, carotenoids like β-carotene have drawn a lot of interest in the last 10 years (Onwubalili & Scott, 1985).In the human body, one molecule of β-carotene produces two molecules of retinol which is essential to vision. Carotenoids have been associated with the improvement of the immune system and reduced risk of degenerative diseases such as cancer, cardiovascular disease, age-related macular degeneration, and cataract formation(Mathews-Roth, 1985). According to (Zaman et al., 1992), carotenoids have been found as a potential Alzheimer's disease inhibitor. Carrots may have biological and therapeutic benefits due to their high concentration of antioxidant carotenoids, particularly β-carotene. According to reports, carrots have diuretic and efficient uric acid removal characteristics .Numerous research on animals and epidemiological findings suggest that carotenoids may have anti carcinogenic effects on humans in addition to inhibiting the development of cancer in mice and rats. According to Deshpande et al. (1995), β-carotene has antimutagenic, chemo preventive, photo protective, and immune enhancing effects in biological systems. It also serves as a free radical-trapping agent and a single oxygen quencher.

Phenolic

Phenolic are common plant elements that are predominantly produced from phenylalanine through the phenylpropanoid metabolism(Sharma et al., 2012). Carrot roots contain phenolic all over, although the periderm tissue contains the highest concentration (Mercier et al., 1994). Because of their physiological properties, such as antioxidant, antimutagenic, and anticancer activity, phenols or polyphenols have drawn a lot of attention. According to reports, they could be a contender in the fight against free radicals, which injure our bodies and food systems(Nagai et al., 2003). Hydroxycinnamic acids and para-hydroxybenzoic acids are two main classes of

phenolics (Babic et al., 1993). Chlorogenic acid, which made up 42.2–61.8% of all phenolic compounds found in various carrot tissues, was a significant hydroxycinnamic acid. Chlorogenic acids, quercetin, luteolin, kaempferol, and myricetin as flavonoids (Bahorun et al., 2004), as well as cyaniding, pelargonidin, and peonidin as anthocyanins (Kammerer et al., 2004), are the main phenolic chemicals found in carrot roots. The phenolic content in the various tissues reduced peel > phloem > xylem in that order. Different tissues' antioxidant and radical-scavenging capacities declined in the same order as their phenolic concentration(Sharma et al., 2012)

Dietary Fiber

The parts of plant foods that the body cannot digest or absorb are referred to as roughage or bulk, another name for dietary fiber. Unlike other meal constituents like lipids, proteins, or carbs that the body breaks down and absorbs, fiber is not digested by the body. Instead, it leaves the body relatively intact through the stomach, small intestine, and colon. According on whether it dissolves in water or not, fiber can be classified as either soluble or insoluble. Non-cellulosic polysaccharides that dissolve in water to form a gel-like substance are known as soluble fibers. Examples include pectin, gums, and mucilage. It might aid in decreasing cholesterol and blood sugar levels. Soluble fiber can be found in oats, peas, beans, apples, citrus fruits, carrots, and barley. Insoluble fiber, which is primarily composed of cell wall components like cellulose, hemicellulose, and lignin, may be helpful for people who have constipation or irregular stools because it encourages material flow through the digestive tract and increases stool size. Whole-wheat foods including flour, wheat bran, nuts, beans, and vegetables like potatoes, cauliflower, and green beans are high in insoluble fiber.

According to (Los, n.d.),the carrot cell wall is made up of lignin (trans-coniferyl alcohol, trans-sinapyl alcohol, and trans-pcoumaryl alcohol), cellulose (β-4, D-glucan), and hemicellulose (xylans, glucuronoxylans, β-D-glucans, and xyloglucans), pectin (galacturonans, rhamnogalacturonans, arabinans, galactans and arabinogalactans-1). Diets high in dietary fibres are linked to the prevention, reduction, and treatment of some diseases like diverticular and coronary heart diseases (Gustafson & Anderson, 1994).Carrots are high in dietary fibers (Bao & Chang, 1994), which are important for human health. According to (Nawirska & Kwasniewska, 2005), fresh carrots contain the following amounts of dietary fiber per dry weight: pectin (7.41%), hemi-cellulose (9.14%), cellulose (80.94%), and lignin (2.48%).

2.5 Health benefits

The addition of carrot in the human diet has several health benefits because of the amazing phytochemical and nutritional composition of this vegetable. Although it is generally known that carrots promote good vision, there are many more advantages that can help to stay healthy and fight against disease. The combination of dietary fiber, carotenoids, anthocyanins, and flavonoids in carrots enables the vegetable to offer a wide range of benefits to people who consume it(Sharma et al., 2012) . Carrots have the most provitamin A of any vegetable when it comes to vitamin content.

TABLE 2.2 The health benefits associated with carrot consumption (Nagraj et al., 2020)

Prevention of	Improve
Coronary heart disease	Eyesight
Hypertension	Immune system
Cancer	Digestive health
Stroke	Blood sugar regulation
Cataracts	Cholesterol levels
Night blindness	
Diabetes	
Macular degeneration	

2.6 Maintaining eye sight and eye health

Eating carrots is considered to be excellent for the eyes. It is a myth that eating carrots can improve vision or make it possible to see clearly at night. Vitamin A deficiency is the main cause of night blindness, and carrots are a great source of this vitamin. Carrots should be included in the diet to maintain consistent levels of vitamin A in the body (Nagraj et al., 2020). Given that they account for 14%–17% of all vitamin A consumption, carrots are considered to be the most important single source of provitamin A. Carotene and beta-carotene are the two main carotenoids found in carrots. According to (Nicolle et al., 2003), beta-carotene predominates over the other one.

2.7 Overview of coconut milk powder

The coconut (Cocosnucifera L.) is a member of the Arecaceae family of palms. It is grown abundantly in Malaysia and other parts of southern Asia. Spanish explorers gave them the name cocos, which means to "grinding face" in English. The coconut, which is categorized as a fruit but is usually mistaken for a nut, is actually a one-seeded drupe(Alyaqoubi et al., 2015). Coconut milk, coconut oil, coconut water, and coconut meat are some products of the coconut palm (Patil & Benjakul, 2018). According to estimates, coconut milk is made from 25% of the coconuts grown worldwide. Despite being a crucial component in many South East Asian regional dishes, knowledge of the chemistry and science of coconut milk is fairly limited (Seow & Gwee, 1997). The liquid generated by exerting manual or mechanical pressure to coconut meat is referred to as "coconut milk" (Narataruksa et al., 2010). With or without additional water, it is a white, oil-in-water emulsion that is derived from fresh coconut flesh. The ingredients are filtered after being soaked in boiling water with finely grated coconut meat. Water and fat are the two main components of coconut milk, which also contains ash, carbohydrate, and protein(Tansakul & Chaisawang, 2006).According to (Tansakul & Chaisawang, 2006), coconut milk has roughly 54% moisture, 35% fat, and 11% solid non-fat. Compared to cow's milk, regular coconut milk has more calories and fat (Alyaqoubi et al., 2015).Proteins like albumin, globulin, prolamin, and glutein are abundant in it. The phospholipids, cephalin, and lecithin that have been discovered in coconut milk are three examples of emulsifying agents that helps increase the stability of food emulsions.

Figure 2.2: Coconut milk and coconut milk powder (Seow & Gwee, 1997)

Instant coconut milk powder, a creamy white substance that is readily soluble in water at room temperature, is produced commercially using the preferred method of spray

drying(Seow & Gwee, 1997). According to (Seow &Leong,1988) and (Gonzalez,1986), chemical composition of commercial spray dried coconut milk powder as reported as-

Table 2.3 Chemical composition of commercial spray dried coconut milk powder

Component(% w/w)	**Seow & Leong (1988)**	**Gonzalez (1986)**
Moisture	2.2	0.8-2.0
Fat	63.6	60.5
Protein(N× 6.25)	4.5	6.9
Ash	1.0	1.8
Carbohydrate	28.7	27.3
Crude fiber	_	0.02

2.7.1 Health benefit of coconut milk

1. Research(Wang et al., 2018) suggest that coconut milk-
   - decrease body weight and fat accumulation
   - increase the duration of satiety after eating
   - improve insulin sensitivity, which could aid in weight reduction
   - increase physical endurance

2. Lauric acid, an antioxidant found in coconut milk, may aid in the prevention of heart disease and stroke.(Alyaqoubi et al., 2015)

3. Coconut's phenolic content may help protect the body's lipids, proteins, and DNA from oxidative stress-related harm. (Karunasiri et al., 2020)

4. Due to the antibacterial and anti-inflammatory qualities, lauric acid may aid in boosting the immune system. The growth of *Staphylococcus aureus*, *Streptococcus*

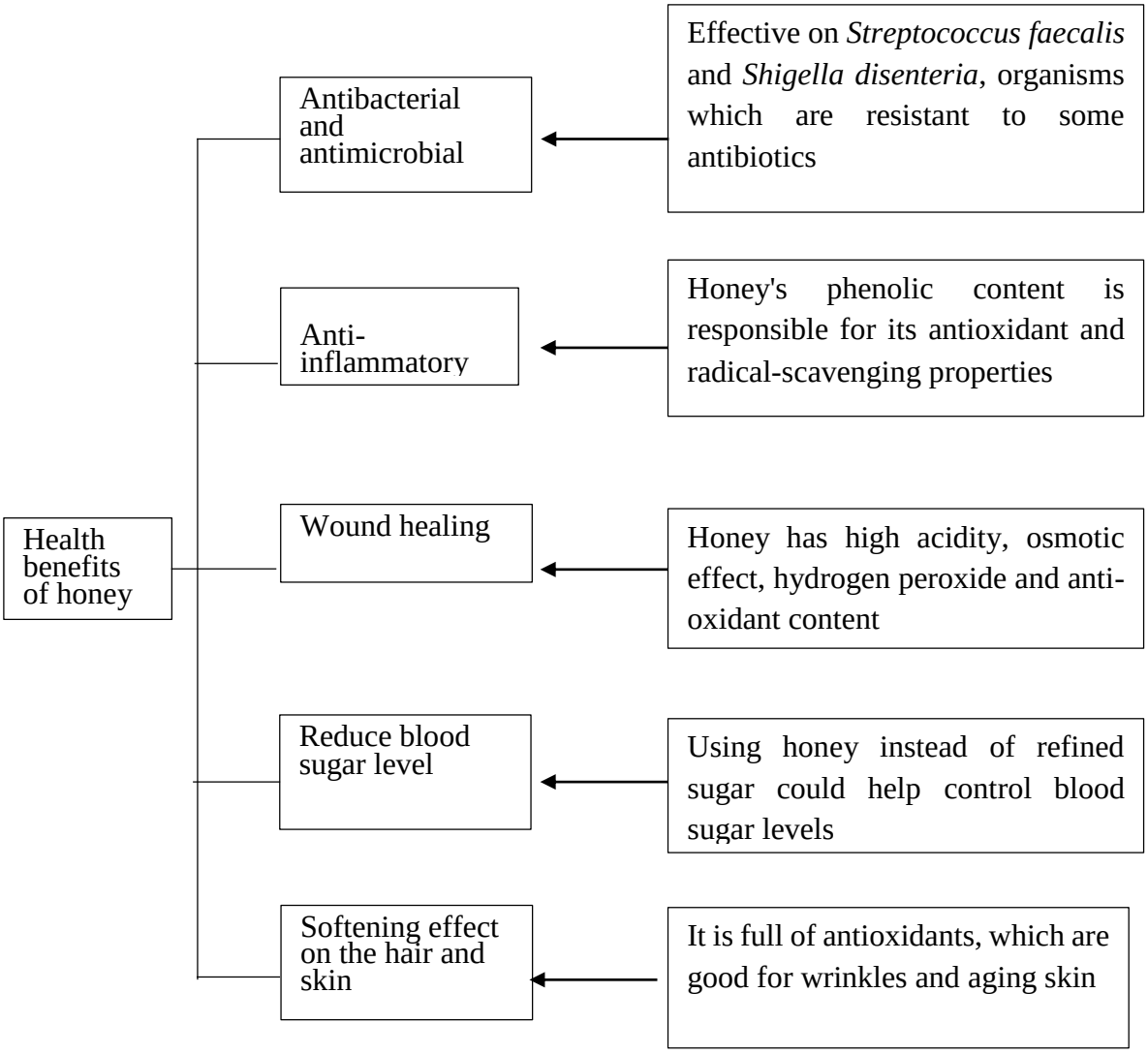
pneumoniae, and *Mycobacterium tuberculosis* were all successfully stopped by lauric acid(Matsue et al., 2019)

2.8 Overview of honey

Various honey bee species (Apis mellifera, Apis cerana indica, and Apis mellipodae) generate honey, a naturally sweet viscous liquid made from the nectar of flowers or from the secretion of plant living components that have been ingested since ancient times(Ogidi & Otenep, 2020). The only sweetening substance that may be used and kept exactly as it is created in nature is honey. Before consuming this special substance, no processing or refinement is required. A number of substances of nutritional importance in honey which support good health and customer recovery(Cozzolino et al., 2011). Man's first sweet, honey, was first used ceremonially and as a component in medicines. Honey wasn't considered to be food until the time of the Greeks and Romans. It did so until recently when cane and beet sugar replaced it throughout the previous century. Honey mostly consists of carbohydrates, with smaller amounts of water and a large variety of other ingredients. Other disaccharides, Melezitose Amino acids, proteins, Acids, Water content, Fructose, Glucose, and Sucrose, pH (Hasam et al., 2020). The high nutritional value of honey and the range of nutrients it contains, while in little amounts, encourage its use as food. Adults need consume substantial amounts of natural honey (70-95 g daily) to fully benefit from its nutritional and health advantages because several of its essential components are only found in trace amounts (Al-waili, 2004).

2.8.1 Health benefits of honey

Figure 2.3 Health benefits of honey (Yaghoobi et al., 2013),(Yaghoobi et al., 2013),(Batt & Liu, 2012)



Honey has numerous health advantages that can be used (Kumar & Bhowmik, 2010)

- To treat infections and acne.
- fight against colds and burns
- lower your cholesterol
- bladder infection healed
- arthritic pain reduces
- relieves toothache
- healthy sinuses

- improve fertility
- digestion, fatigue
- help lose weight.
- strengthen immune system
- Honey has antibacterial properties because of its high acidity, hydrogen peroxide action, and low water activity.

2.8.2 Medicinal properties of honey

The medicinal and curative properties (Kumar & Bhowmik, 2010)of honey are-

- Honey has sedative properties. Before going to bed, mix one teaspoon of honey with warm milk can help in sleeping peacefully.
- As a cold medicine, honey pairs well with both warm milk and the juices of lemon and radish.
- Sore throats can be soothed by mixing warm milk or water with honey.
- Honey in the mouth is particularly effective for gingivitis.
- Honey can be added to food on a daily basis to promote digestion and control the acidity of gastric fluids.
- For constipation, hyperacidity, and obesity, one spoon of fresh honey combined with the juice of half a lemon in a glass of lukewarm water is particularly helpful.
- Intestinal issues can be treated with honey. It is used to treat stomach and duodenal ulcers as well as gastritis. Or, for illnesses that include an increase in acidity.
- When honey and rose petals are combined and consumed in the morning during the early stages of tuberculosis, the best results are attained.
- For those with heart issues or heart problems, moderate amounts of honey and pomegranate (anar) are thought to be beneficial.

Figure 2.4 Honey (Al-waili, 2004)

2.9 Overview of dates

One of the first plants to be domesticated, the date palm (Phoenix dactylifera L., Arecaceae) is a common sight in the warm and arid areas of Asia, the Middle East, Africa, the Arabian Peninsula. People in these places rely heavily on it as a source of food and it is essential to their daily existence (Shafiei et al., 2010). The time given the current uncertainty in the global food supply and anticipated increases in demand, palm is likely to continue to be a fantastic source of affordable food (Al-Farsi & Lee, 2008). Dates can be used to make a variety of products, such as date paste, syrup, alcohol, animal feed, and date powder, breads of all kinds, marmalade, and sweet candies. In addition to playing a significant part in the desert ecology, date palms are also useful for farming and livestock raising. The agricultural economy also depends on other date palm parts. The stem, for instance, is employed in the production of fiber, paper, and wood products, as well as the construction of boats and the roofing of rural homes. The foliage is used to create crafts like straw hats and fans(Ashraf & Hamidi-Esfahani, 2011). Date skin, date flesh, and pit are the three main components of a date palm fruit (Shafiei et al., 2010). The dates derived from the date palm (Phoenix dactylifera L.) have a high carbohydrate content (total sugars, 44/88%), low fat content (0.2/0.5%), high levels of protein (2.3/5.6%), vitamins, and dietary fiber (6.4/11.5%). Dates' flesh only has 0.2–0.5% oil while the seeds have 7.7–9.7% oil(Al-Shahib & Marshall, 2003). About two thirds of date flesh is made up of sugars. Protein, fat, crude fiber, minerals, several vitamins (particularly vitamin B), tannins, and many other substances are included in the remaining weight of the dates. While a kilogram of dry dates contains more than 3000 calories, a kilogram of fresh dates only contains about 1570 calories(Ashraf & Hamidi-Esfahani, 2011).

Figure 2.5 Dates (Al-Farsi & Lee, 2008)

2.9.1 Health benefits of dates

Due to the fact that 100g of dates can supply roughly 32% of the RDI for dietary fiber, dates are a good source of dietary fiber. Dietary insoluble fiber has a major physiological impact on our bodies. By making the stool heavier and acting as a laxative, it can shield our body from conditions including diverticular disease and bowel cancer (Marlett, et Al., 2002). Date fruit is used to treat ailments like tuberculosis, gastroenteritis, coughs, respiratory diseases, asthma, and more. It is also a demulcent, expectorant, nutritive, emetic, laxative, and sensual (Vayalil, 2012). Dates contain significant amounts of total phenolics, vitamins, and dietary fiber, according to a number of compositional tests on dates and their byproducts(Al-Shahib & Marshall, 2002). This demonstrates that dates are a good source of antioxidants and can be a functional food or an ingredient in functional food. Dates include a number of functional and bioactive components, including carotenoids, anthocyanins, phenolics, antioxidants, and dietary fiber. These components have anti-tumoral, anti-ulcer, anti-microbial, and immunomodulatory properties. Additionally, dates are regarded as a nutritious and useful food.

Chapter 3: Materials and Methods

3.1 Sample collection:

Samples were collected from local market of Chattogram, Basket super shop, and Khulshi mart, Shopping Bag. Fresh carrots were the first priority as a sample.

3.2 Preparation of carrot:

The carrots were cleaned with water and peeled with a sharp knife. Then the carrots were cut into pieces to blend. The carrots pieces were finely blended using household blender. Then the blended portion were kept in a plate before making the product.

3.3 Preparation of coconut milk:

Coconut milk were prepared by mixing coconut milk powder with lukewarm water. For thick cream was needed to mix 1/3 cup of coconut milk powder to 1 cup of warm water until a thick and creamy consistency is achieved.

3.4 Methodological framework of study:

3.4.1 Sample type:

1. Control
2. Product

3.4.2 Storage Condition

1. Stored at refrigeration temperature for 7 days
2. Quality determination of both control and treatment sample maintaining 3 days interval.

3.4.3 Preparation of gel pudding sample:

Sample A

Coconut milk, sugar, agar powder were used to make jelly pudding. To prepare this sample 500 ml coconut milk, 100 gm. white sugar, 2 gm. agar powder were used.

Sample B

Coconut milk, carrot paste, sugar, agar powder were used. For preparing this sample 500 ml coconut milk, 100 gm. white sugar, 2 gm. agar powder, 107 gm. carrot paste were used**.**

Sample C

Coconut milk, carrot paste, honey, agar powder were used. For preparing this sample 500 ml coconut milk, 90gm honey, 2 gm. agar powder, 107 gm. carrot paste were used.

Sample D

Coconut milk, carrot paste, honey, agar powder were used. For preparing this sample 500 ml coconut milk, 68gm honey, 2 gm. agar powder, 107 gm. carrot paste were used.

Sample E

Coconut milk, carrot paste, honey, agar powder were used. For preparing this sample 500 ml coconut milk, 54gm honey, 2 gm. agar powder, 107 gm. carrot paste were used.

Sample F

Coconut milk, carrot paste, date paste, agar powder were used. For preparing this sample 500 ml coconut milk, 91gm date paste, 2 gm. agar powder, 107 gm. carrot paste were used.

Sample G

Coconut milk, carrot paste, date paste, agar powder were used. For preparing this sample 500 ml coconut milk, 70 gm date paste, 2 gm. agar powder, 107 gm. carrot paste were used.

Sample H

Coconut milk, carrot paste, date paste, agar powder were used. For preparing this sample 500 ml coconut milk, 55gm date paste, 2 gm. agar powder, 107 gm. carrot paste were used.

3.4.4 Formulation of carrot coconut milk gel pudding

Table 3.1 Formulation of carrot coconut milk gel pudding

Ingredients	**Sample A**	**Sample B**	**Sample C**	**Sample D**	**Sample E**	**Sample F**	**Sample G**	**Sample H**
Coconut milk	500ml	500ml	500ml	500ml	500ml	500ml	500ml	500 ml
Carrot	0g	107gm	107gm	107gm	107gm	107gm	107gm	107 gm
Sugar	100 gm	100gm	0gm	0gm	0gm	0gm	0gm	0gm
Agar	2gm	2gm	2gm	2gm	2gm	2gm	2gm	2gm
Honey			90gm	68gm	54gm			
Date						91gm	70gm	55g m

3.4.5 Manufacturing process of carrot coconut milk gel pudding:

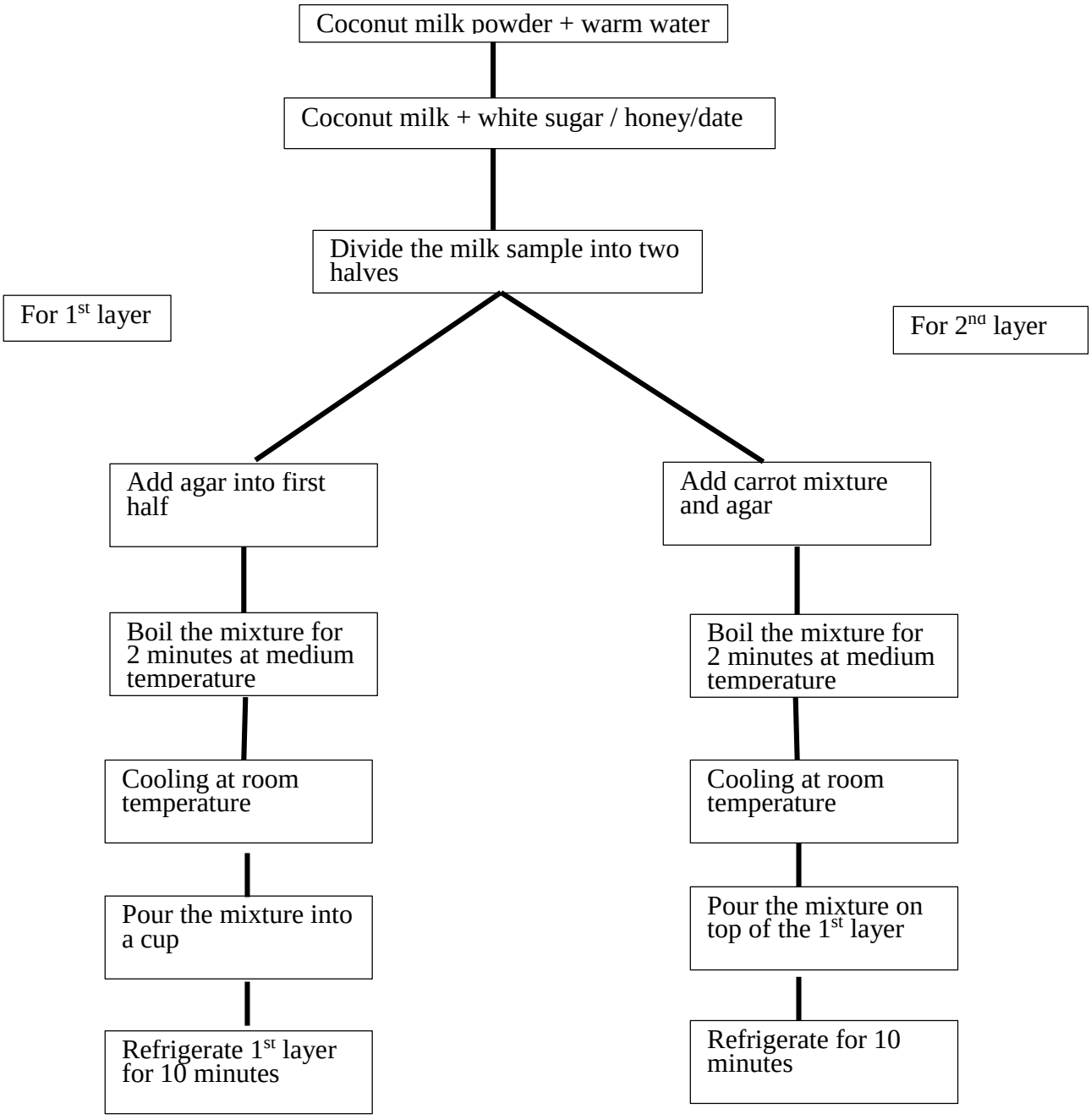


Figure 3.1: Processing steps of carrot coconut milk gel pudding

3.5 Physicochemical analysis of gel pudding:

3.5.1 Measurement of pH:

The pH scale is needed in chemistry to measure acidity or basicity of any aqueous solution.pH is defined as the concentration of hydronium ions or, more generally, the negative logarithm of the activity of the (solvated) hydronium ion. There have been international agreements to create a collection of standard solutions whose pH can serve as a benchmark for the pH scale. Primary pH standards are established using a concentration cell that incorporates transference by comparing the electromotive force (EMF) between a hydrogen electrode and a standard electrode, like silver chloride. The pH of aqueous solutions, representing their acidity or basicity, can be determined using glass electrodes and pH meters, commonly known as indicators. The hydrogen ion activity is quantified as the pH of a solution when expressed as a decimal logarithm.

3.5.2 Titratable acidity:

The acidity percentage was determined by performing titration with N/10 NaOH using phenolphthalein as the indicator to measure the level of lactic acid. In each trial, 10ml of juice was added to a 100ml volumetric flask and then diluted to 100ml with distilled water. Subsequently, 10ml of the diluted juice was titrated against N/10 NaOH, with phenolphthalein indicating the endpoint by turning the solution pink. On three separate occasions, the average titration value was recorded (AOAC, 2016).

As shown below, titratable acidity can be calculated:

(Percentage of TA) = $\frac{Titer \times N\ of\ NaOH \times 90 \times 100}{Aliquot(ml) \times 1000}$

Where,

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

N= normality of NaOH

3.6 Nutritional composition of gel pudding:

3.6.1 Moisture content:

Principle:

One of the most fundamental and usual tests in the food industry is the assessment of moisture. The moisture content of food has a direct financial impact on both the processor and the consumer because dry matter and moisture have an inverse relationship. It is considerably more important to consider how moisture affects the durability and quality of food. Using the Association of Official Analytical Chemists Method, moisture content was estimated (AOAC, 2016).

Calculation: The moisture percentage was calculated as follow-

Percentage of Moisture= [(Initial weight- final weight) ÷ Sample weight] × 100

3.6.2 Estimation of Ash content:

AOAC protocols (2016) were used to determine the ash content. Ash is an inorganic by product of decomposing organic substances. 10 grams of dried jelly were measured out using a pre-weighed crucible. It was then burned in a fire and transformed into charcoal. The charcoal was then entirely removed after being heated for four hours at a temperature of about 600 degrees Celsius in a muffle furnace. After then, the crucible was removed from the kiln. It was given time to cool in a desiccator before being weighed.

Calculation: The proportion of ash contained was calculated using the following expression.

Percentage of Ash = $\frac{w2-w1}{w} \times 100$

Where,

W1= weight of the empty crucible

W2= weight of the crucible with ash

W= weight of sample

3.6.3 Estimation of Crude fiber content:

Principle

The part of the carbohydrates in crude fiber that is not water soluble is made up of the macromolecules cellulose, hemicellulose, and lignin. This is accomplished by boiling a known quantity of fat-free food for 30 minutes in a diluted acid solution (1.25 H2SO4) and then for 30 minutes in a diluted alkali solution (1.25 NaOH). A constant volume must be maintained throughout, and the ash is then subtracted from the residue to get an estimate. The crude fiber content in this study was determined using the (AOAC, 2016) method. The waste was burned for 4-6 hours at 550-600 degrees Celsius in a muffle furnace to produce the ash.

Calculation: The proportion of crude fiber content was estimated using the formula below:

Percentage of Crude fiber= $\frac{w1-w2}{w} \times 100$

Where,

W1= weight of the crucible, crude fiber and ash

W2= weight of the crucible with ash

W= weight of sample

3.6.4 Estimation of Fat Content:

Principle:

Such food samples must be dissolved in organic solvents (chloroform, methanol), and the filtrate must then be removed in order to estimate the fat content. Following the separation of the filtrate using separating funnels, the mixture is dried for the purpose of measuring the extract and calculating the fat content. The (AOAC, 2016) techniques were provided for the Soxhlet apparatus, and they were used to determine the crude fat content of the samples.

The total amount of unrefined fat was calculated with a Soxhlet equipment. A thimble that had been sealed with fat-free cotton held the dried, weighted sample. The fat extraction tube was inserted into the Soxhlet flask using a thimble. The flask was filled with 75 mL of anhydrous ether and the fat extraction tube's top was secured to the condenser. The required content was retrieved in a maximum of 16 hours. The thimble was taken off when the separation process was finished, and the Soxhlet tube was used to distil and collect the ether. The tube would be almost full once all of the ether had been poured out. The ether was transported through a funnel and into a beaker after the volume of ether holding the sample's fat granules was drastically reduced. The flask was cleaned and filtered with ether.

The ether was subsequently evaporated in a low-temperature steam bath.

Calculation: The proportion of fat content was estimated using the formula below:

Fat percentage=$\frac{w1}{w} \times 100$

Where,

W1= weight of the extracted portion

W=weight of the sample

3.6.5 Estimation of Crude protein content:

Principle:

The amount of nitrogen present in both organic and inorganic samples is determined using the Kjeldahl method. The Kjeldahl nitrogen content is determined in order to determine the quantity of protein present in foods and beverages, as well as in meat, feeds, cereals, and forages. The Kjeldahl method is also used to figure out how much nitrogen is contained in soils, wastewaters, and various other materials. It is an accepted

approach, and several normative sources, including (AOAC, 2016), provide descriptions of it.

To calculate the nitrogen or protein content, you need to take into account the type of receiving solution and any dilution factors applied during the distillation process. The equations below use "N" to represent normality, and "ml blank" represents the volume of base required to back titrate the reagent blank if standard acid is the receiving solution. On the other hand, "ml blank" is the volume of standard acid needed to titrate the reagent blank if boric acid is the receiving solution. The equivalent equation, for which boric acid is a well-liked option for the receiving solution, is-

Nitrogen %= {(ml standard acid-ml blank) × N of acid × 1.4007} ÷ Weight of sample in gram

Protein % = Nitrogen % × 5.85 (plant origin)

3.6.6 Determination of Carbohydrate:

By subtracting total amount of moisture, ash, protein, and fat values (per 100gm) from 100, the carbohydrate content was determined. It was expressed as a percentage that was taken from 100 and subtracted to take into consideration all other adjacent factors.

Calculation: The formula for determining Carbohydrate is given below-

% CHO = 100% - %(Protein+ Fat+ Fiber+ Ash+ Moisture Content)

3.6.7 Determination of Vitamin A:

The approach used by Kumar, Ramakritinan, & Kumaraguru (2010) yielded the total carotenoids (TCC). 3.0 g of freeze-dried gel pudding were taken out using 75 ml of the 2:1:1 mixture of hexane, acetone, and ethanol for an hour at room temperature (RT; 24°C). Whatman No. 1 filter paper was used to filter the homogenate, and 100 mL of extraction solvent were added to the recovered supernatant. After that, 25 mL of water was added and rapidly shaken. After 30 minutes, the phase was separated. Organic (upper layer) and aqueous (lower layer) layers were seen. Using the following formula, the TCC was determined by measuring the organic layer's absorbance at 470 nm (de Carvalho et al., 2012):

Carotenoid content (ug g”) = [A x v (mL) x 10*] / A” x w (g)

Where A=absorbance;

v = total Extract volume;

w = sample weight;

A’™ = 2600 (B-carotene extinction coefficient in hexane).

3.7 Determination of mineral content:

In this process, the minerals from the food supply are extracted by digestion, claims AOAC (2010). After being dissolved in a 2:1 HNO3/HCIO4 acid solution, the gel was then digested. A conical flask was filled with one gram of the material, which had been weighed. To promote full digestion, the conical flask was placed on a hot plate set to 200W for 3 minutes after adding 7 ml of HNO3 and 3 ml of HCIO4. The produced solution was chilled, filtered into a 100 ml standard flask using filter paper, and then diluted with distilled water to volume. This solution was examined using the AAS method of mineral content analysis. (Humalyzer-3000, Germany's Origin)

3.7.1 Determination of Sodium (Na):

Magnesium and uranyl acetate help to dissolve the sodium into a triple salt. In an acidic solution, ferrocyanide combines with extra uranyl ions to generate a reddish tint. The amount of sodium in the sample and colour development are inversely related. Pipettes were used to add 0.02 ml of sodium standard and 1 ml of the precipitating reagent to the cuvette during the precipitation procedure. Only 0.02 ml of the sample and 1 ml of the precipitating agent were used in the cuvette. The ingredients were thoroughly combined and shook after being left to sit for 5 minutes. After that, the clear supernatant was separated using centrifugation at 2500–3000 RPM. One milliliter of acid reagent was used as the blank for the color development stage. Using a pipette, 0.02 ml of the precipitating reagent and 0.1 ml of the coloring reagent were added to the cuvette. For creating both standards and samples, a cuvette was filled with 1 ml of acid reagent, 0.02 ml of supernatant, and 0.1 ml of color reagent. After combining the components, the mixture was incubated at room temperature for 5 minutes. Within 15 minutes, the absorbance of the blank, standard, and sample was measured in comparison to distilled water. To calculate the sodium concentration in mmol/L, the sample's absorbance was multiplied by the standard absorbance at a specific value (mmol/L).

3.7.2 Determination of Potassium:

When potassium and sodium tetraphenylboron are combined, it results in the formation of a fine turbidity, specifically potassium tetraphenylboron. The extent of turbidity is inversely linked to the potassium concentration in the sample. To prepare the blank solution, 0.02 ml of deionized water and 1 ml of potassium reagent were carefully transferred into a cuvette. For the sample solution, a cuvette was filled with 1 ml of potassium reagent, 0.02 ml of potassium standard, and 1 ml of the sample extract. The

mixture was thoroughly mixed and incubate for 5 minutes to ensure proper retention. After 15 minutes, the absorbance was measured and compared to both the blank and the standard. To determine the potassium concentration in millmoles per liter (mmol/L), the ratio of sample absorbance to standard absorbance was multiplied by the concentration standard (mmol/L).

3.7.3 Determination of Calcium:

In an alkaline environment, the combination of o-cresolphthalein and calcium ions produces a violet chemical. To create a reagent blank solution, 1 mL of the working reagent was mixed with 25 L of distilled water and placed in a cuvette. For standard adjustment, 25 L of the (Ca++) standard and 1 mL of the working reagent were added separately. The sample solution was formed by combining 25 L of the sample extract and 1 mL of the working reagent. The absorbance of both the sample and the standard was measured. To calculate the calcium concentration in milligrams per deciliter, the standard concentration (mg/dL) was multiplied by the sample absorbance to standard absorbance ratio.

3.8 Microbial Analysis:

3.8.1: Aerobic Plate Count (Bacterial Plate count)

The Aerobic Plate Count can be used to estimate the bacterial population in a sample. Aerobic Colony Count (ACC), Standard Plate Count (SPC), Mesophilic Count (MC), and Total Plate Count (TPC) are additional names for the aerobic plate count (APC). The Standard Plate Count (SPC) method was used to determine the Total Viable Bacterial Count (TVC).

The test is based on the hypothesis that, when mixed with agar that provides the essential nutrition, each cell will eventually form a discernible colony. It is a generic test for organisms that grow aerobically at mesophilic temperatures (25 to 40 degrees Celsius), rather than a measurement of all the bacteria in the population. APC cannot distinguish between different bacterial species, making it impossible to use it as a measurement of organoleptic acceptability, sanitary quality, adherence with good manufacturing practices, or as a safety indication. The shelf life of the food as well as a potential change in its organoleptic characteristics can both be revealed by APC (Banwart,2012)

Requirement:

1. Agar plate count
2. Phosphate buffer saline, or PBS
3. Test tube
4. Glass bid
5. Colony count machine

Preparing the sample

The precision with which the sample was taken has a significant role in the accuracy of the analysis and interpretation of the results. The selection of data set must fairly represent the entire population. In order for the sample to accurately represent the full batch, this was accomplished by thoroughly stirring the entire batch of the product. 25 g of a jelly sample were weighed out and placed in a 250 ml flask. The sample was diluted with phosphate buffer saline that had a pH of 7.2 and a concentration of 0.6 M KH2PO4. After adding approximately 100 ml of the buffer saline to the beaker, it was thoroughly combined using a to-and-fro motion. The same buffer water was used to raise the volume to its initial level. Each and every piece of apparatus, solution, and other tool must be sterilized for a full fifteen minutes at 121 degrees Celsius.

After the sample had been prepared, it was diluted 10 times, which is equal to a 1×10-1 time's dilution, and utilized as stock solution (Andrews, 1992).

Dilution:

Using 9 ml blanks, the following series of dilutions were carried out. The first dilution, designated "a," was a 1/10 dilution (1 ml in 9 ml). This was mixed in a vortex mixer and labelled as "b." A sample of 1 ml from (a) was collected, added to the following tube, and thoroughly mixed. It was become 10^{-2} time's dilution. The final dilution factor was thus increased by a factor of 10^{-6}.

Standard plate counts

The number of microorganisms in the prepared and stored samples was calculated using an SPC. This information could be used to forecast product shelf life or serve as a gauge for food quality. Then, using a sterile pipette, 1 ml of the diluted sample was pipetted into each of the sterile empty petri dishes with the Plate count agar's nutrient agar media. Vibrations were used to combine the plates on a flat surface. After the media had set, the plates were turned over and kept in an incubator for 24 hours at 37 °C (AOAC, 1990)

Counting and Recording

After incubation, plates were selected for bacterial colony counting based on the quantity and ease of identification of colonies. Plates with overlapping, scattered, or confusing colonies were avoided. Instead, plates with clear, visible, and countable colonies ranging from 30 to 250 were chosen for further analysis.

The average colony forming units (cfu) per plate dilution factor were calculated by dividing the number of colony forming units by the weight (g) or volume (ml) of the sample. The viable bacterial count was conducted using various procedures, including sample preparation, sample dilution, standard plate counts, and the actual counting and recording of bacterial colonies.

The incubation period for these plates was set at 37 degrees Celsius, and the incubation process lasted for 24 hours (AOAC, 1990).

3.8.2 Fungal analysis in gel pudding

Media preparation procedure

The selective medium Sabouraud Dextrose Agar (SDA) is mostly used for the isolation of dermatophytes, different fungi, and yeasts. It can support the growth of filamentous bacteria like Nocardia. The pH of this medium is acidic (about 5.0), which inhibits the growth of bacteria but promotes the development of yeasts and the majority of filamentous fungi. Antibacterial agents may be used to boost the antibacterial effect. The SDA medium, which provides fungi and yeasts with a healthy source of amino acids and nitrogenous compounds, is composed of enzyme-digested casein and animal tissues. Agar with a pH of 5.6 at 25°C, 40 g of dextrose, and 10 g of mycological peptone (an enzyme digest of casein and animal tissues) are used to make 1 liter of SDA medium. After being produced in accordance with the instructions of the manufacturer, all of the media were sterilized in the autoclave for 15 minutes at 121 °C. Various selective agars are available for the cultivation and identification of mold and yeast cultures. However, most of these agars do not have stringent nutritional requirements for supporting their growth. Sabouraud Dextrose Agar (SDA) is one such agar that allows for the growth of numerous fungus strains. It is widely used due to its ability to support the growth of a wide range of molds and yeasts, making it a popular choice in microbiological laboratories for the isolation and identification of these microorganisms. We follow the steps and methods described in (Chen et al.,2000). 65 grams of the medium were initially dissolved in 1 liter of distilled water. The medium

was then thoroughly dissolved by cooking for one minute at a high temperature while stirring regularly. 15 minutes in an autoclave set at 121 °C. After cooling to about 45 and 50 degrees Celsius, the mixture was then poured into petri dishes. By streaking the material onto the medium with a sterile inoculating loop, isolated colonies were produced to process the sample. The plates were then placed upside down (agar side up) and incubated at 25–30°C with high humidity. The cultures were checked for fungal development on a weekly basis, and they were kept for one week before being judged to be negative (Aryal, 2015).

Interpretation

Following sample incubation, the plates should exhibit isolated colonies in streaked areas and dense growth in regions with abundant inoculation. While inspecting the plates, focus on identifying fungus colonies that exhibit the appropriate color and shape characteristics. It is essential to employ supplementary methods to confirm the results. Yeast colonies typically develop in cream to white hues, while molds tend to form filamentous colonies with multiple colors (Aryal, 2015).

3.9 Cost analysis:

Total cost of the ingredients is necessary to develop the carrot and coconut milk gel pudding was utilized to determine its pricing. The cost of the gel pudding per cup was determined and reported in taka.

3.10 Sensory evaluation:

For determining whether consumers would generally accept the finished product, sensory evaluation was done. A group of taste testers assessed if the developed product was acceptable to consumers. There were both teachers and students on the panel for the test, which was conducted on the grounds of CVASU. The product made from carrot and coconut milk was given to the panel of ten participants.

There were eight formulations that were encoded with samples A, B, C, D, E, F, G, and H, respectively. Without being aware of the samples' composition, the panelists all tasted them.

As asked, panelists assigned scores for the various sensory qualities of appearance, color, smell, taste, sweetness, texture, and general acceptability of gel pudding. Eight samples were given ratings from the panelists based on their opinions after tasting. Using nine point Hedonic scales, the eight samples' sensory evaluation of the qualitative

criteria (taste, appearance, color, smell, texture, sweetness, and overall approval) was conducted (Larmond, 1977).

The scale was organized in such a way that:

Table 3.2: Rating Scale for sensory evaluation

Rank	Scores
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

3.11 Statistical analysis:

For statistical analysis, data were gathered and stored on a Microsoft Excel 2013 spread sheet. Every sample was used three times. Descriptive statistics (mean and standard deviation) were used for the sensory investigation and evaluation of gel pudding. Data were sorted, coded, and recorded in the Minitab App. The next step was statistical analysis. Data on proximate, vitamin, mineral, and sensory assessment, as well as microbiological data, were examined using one-way ANOVA techniques. ANOVA is one method used to assess the importance of variation at a 95% confidence level. Using a post hoc "Tukey" test, the variation across the sample groups was determined. The statistical analysis was performed at 5% level of significant ($p \leq 0$)

Chapter 4: Result

4.1 Physiological properties of gel pudding

pH content of gel pudding is shown in table 4.1, almost all samples are significantly same. In table 4.1, highest pH found in sample A and lowest in sample F. The least value (0.20 ± 0.00) of acidity obtained in sample A, B, D and highest value (0.40 ± 0.00) found in sample F.

Table 4.1: Physiochemical properties of gel pudding

Formulation	pH	Acidity (%)
Sample A	7.23 ± 0.05^{a}	0.20 ± 0.00^{c}
Sample B	7.00 ± 0.00^{b}	0.20 ± 0.00^{c}
Sample C	6.80 ± 0.02^{c}	0.30 ± 0.00^{b}
Sample D	6.79 ± 0.01^{c}	0.20 ± 0.00^{c}
Sample E	6.80 ± 0.00^{c}	0.26 ± 0.05^{bc}
Sample F	6.60 ± 0.01^{d}	0.40 ± 0.00^{a}
Sample G	6.80 ± 0.00^{c}	0.23 ± 0.05^{bc}
Sample H	6.80 ± 0.00^{c}	0.30 ± 0.00^{b}
P-value	0.043	0.022

Legends: Means ± SD values in the same column with the same superscripts are not statistically significant (P <0.05)

Sample A- Gel pudding with white sugar (16.61%) and without addition of carrot

Sample B- Gel pudding with addition of carrot and white sugar (14.10%)

Sample C- Gel pudding with addition of carrot and honey (12.87%)

Sample D- Gel pudding with addition of carrot and honey (10%)

Sample E- Gel pudding with addition of carrot and honey (8.14%)

Sample F- Gel pudding with addition of carrot and date paste (13%)

Sample G- Gel pudding with addition of carrot and date paste (10.3%)

Sample H- Gel pudding with addition of carrot and date paste (8.54%)

4.2 Nutritional Composition

Table 4.2 gives information of the nutritional value of gel pudding, almost all sample varied considerably. The highest percentage of crude fiber

(12.88 ± 0.00^{a}) and Vitamin A (30.85 ± 0.050^{a}) was found in sample F, whereas the maximum percentage of crude protein (5.000 ± 0000^{a}) found in sample G, and crude fat 10.26 ± 0.02^{a} in sample H. The minimum level of crude fiber (2.21 ± 0.02^{h}), vitamin A (5.00 ± 0.03^{h}), crude protein (2.26 ± 0.01^{h}), was found in sample A.

Table 4.2: Nutritional composition of carrot coconut milk gel pudding

Components	**Sample A**	**Sample B**	**Sample C**	**Sample D**
Moisture	74.96 ± 0.02^{a}	61.60 ± 0.02^{e}	65.20 ± 0.26^{c}	65.1 ± 0.17^{cd}
Crude fiber (%)	2.21 ± 0.02^{g}	5.12 ± 0.02^{f}	6.08 ± 0.02^{d}	5.59 ± 0.02^{e}
Ash (%)	1.04 ± 0.005^{c}	2.17 ± 0.005^{b}	1.74 ± 0.45^{b}	1.94 ± 0.01^{b}
Crude fat (%)	9.35 ± 0.01^{b}	9.12 ± 0.01^{c}	8.05 ± 0.08^{e}	8.01 ± 0.01^{e}
Crude protein (%)	2.26 ± 0.01^{c}	3.70 ± 0.010^{a}	3.00 ± 0.00^{b}	2.98 ± 0.01^{b}
CHO (%)	12.38 ± 0.03^{d}	23.40 ± 0.03^{a}	22.00 ± 0.51^{b}	21.96 ± 0.15^{b}
Vitamin A (RAE/gm.)	5.00 ± 0.03^{h}	29.12 ± 0.02^{d}	28.95 ± 0.02^{e}	28.43 ± 0.03^{f}
Calcium (mg/gm.)	1.40 ± 0.02^{f}	1.42 ± 0.02^{f}	1.60 ± 0.02^{d}	1.50 ± 0.02^{e}
Potassium (mg/gm.)	1.71 ± 0.02^{fg}	1.66 ± 0.01^{g}	2.10 ± 0.02^{d}	1.94 ± 0.01^{e}
The Sodium (mg/gm.)	64.57 ± 0.41^{e}	65.08 ± 0.07^{d}	67.10 ± 0.02^{b}	65.90 ± 0.02^{c}

Legends: Means ± SD and values in the same rows with the same superscripts are not statistically significant (P<0.05).

Components	Sample E	Sample F	Sample G	Sample H	P-value
Moisture	64.84 $\pm 0.02^{d}$	68.17 $\pm 0.14^{b}$	68.16 $\pm 0.02^{b}$	68.16 $\pm 0.00^{b}$	0.040
Crude fiber (%)	5.13 $\pm 0.11^{f}$	12.88 $\pm 0.00^{a}$	12.67 $\pm 0.00^{b}$	10.49 $\pm 0.01^{c}$	0.040
Ash (%)	1.87 $\pm 0.005^{b}$	2.93 $\pm 0.01^{a}$	2.94 $\pm 0.07^{a}$	2.95 $\pm 0.13^{a}$	0.032
Crude fat (%)	8.50 $\pm 0.02^{d}$	10.20 $\pm 0.00^{a}$	10.20 $\pm 0.07^{a}$	10.20 $\pm 0.08^{a}$	0.041
Crude protein (%)	2.89 $\pm 0.01^{b}$	4.12 $\pm 0.03^{a}$	4.12 $\pm 0.44^{a}$	4.13 $\pm 0.18^{a}$	0.040
CHO (%)	21.89 $\pm 0.05^{b}$	14.57 $\pm 0.15^{c}$	14.56 $\pm 0.44^{c}$	14.55 $\pm 0.30^{c}$	0.027
Vitamin A (RAE/gm.)	27.9 $\pm 0.02^{g}$	30.85 $\pm 0.05^{a}$	30.44 $\pm 0.04^{b}$	29.51 $\pm 0.03^{c}$	0.007
Calcium (mg/gm.)	1.30 $\pm 0.02^{g}$	2.98 $\pm 0.02^{a}$	2.50 $\pm 0.02^{b}$	2.32 $\pm 0.02^{c}$	0.030
Potassium (mg/gm.)	1.74 $\pm 0.01^{f}$	2.83 $\pm 0.02^{a}$	2.60 $\pm 0.02^{b}$	2.33 $\pm 0.02^{c}$	0.020
Sodium (mg/gm.)	63.40 $\pm 0.02^{f}$	68.90 $\pm 0.02^{a}$	67.10 $\pm 0.02^{b}$	65.90 $\pm 0.02^{c}$	0.010

Legends: Means ± SD and values in the same rows with the same superscripts are not statistically significant ($P<0.05$).

4.3 Energy content

According to figure 4.1 control C2 had the greatest energy content (195.04 kcal/100gm).And C1 had the lowest (146.06 kcal/100g)

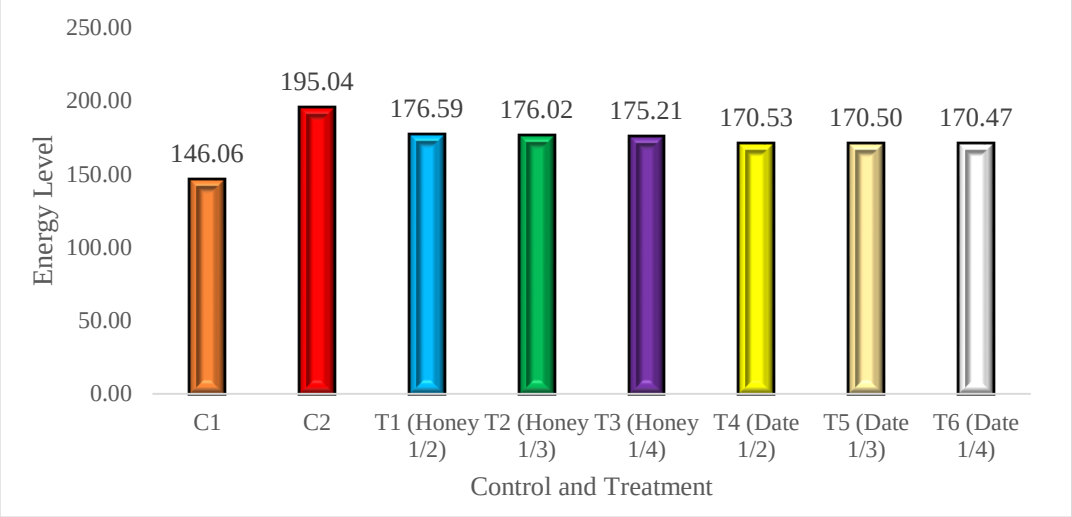


Figure 4.1: Comparison of energy content among eight sample of gel pudding

4.4 Sensory evaluation-

The greatest acceptance rate was seen in Sample B (7.10 ± 1.28^{a}) and Sample A (7.00 ± 1.88^{a}) respectively. Both of these samples were control. People are familiar with this taste. Besides, if it is seen which new sample gain more acceptance we can see that- Sample E and sample G obtained highest acceptance which is (6.40 ± 1.64^{a}) and (5.80 ± 1.61^{a}) respectively.

Table 4.3: Hedonic rating test for sensory evaluation of gel pudding

Parameters	Sample A	Sample B	Sample C	Sample D	P value
Appearance	6.8 ± 1.13^{ab}	8.0 ± 0.81^{a}	6.3 ± 1.25^{b}	6.3 ± 1.16^{b}	0.004
Color	7.3 ± 0.94^{ab}	7.9 ± 0.99^{a}	6.60 ± 1.17^{ab}	6.90 ± 0.87^{ab}	0.032
Smell	7.1 ± 1.72^{a}	7 ± 1.247^{a}	5.8 ± 1.229^{a}	6.20 ± 0.63^{a}	0.227
Taste	6.50 ± 2.12^{ab}	6.90 ± 1.44^{a}	4.60 ± 1.50^{b}	5.40 ± 0.96^{b}	0.021
Sweetness	6.90 ± 2.23^{ab}	7.00 ± 1.41^{a}	5.40 ± 1.07^{abc}	5.70 ± 1.05^{abc}	0.005
Texture	7.20 ± 1.03^{ab}	7.40 ± 1.43^{a}	5.20 ± 1.81^{c}	6.00 ± 1.56^{ab}	0.027
Overall acceptance	7 ± 1.88^{a}	7.10 ± 1.28^{a}	5.10 ± 1.52^{a}	5.70 ± 1.25^{a}	0.020

Legends: Means ± SD and values in the same rows with the same superscripts are not statistically significant ($P<0.05$)

Parameters	Sample E	Sample F	Sample G	Sample H	P value
Appearance	7.60 $\pm$ 0.96^{ab}	6.30 $\pm$ 1.25^{b}	6.80 $\pm$ 1.13^{ab}	6.80 $\pm$ 1.03^{ab}	0.004
Color	7.70 $\pm$ 0.94^{ab}	6.40 $\pm$ 1.50^{b}	6.90 $\pm$ 0.99^{ab}	6.90 $\pm$ 0.99^{ab}	0.032
Smell	6.90 $\pm$ 1.37^{a}	6.30 $\pm$ 0.82^{a}	6.50 $\pm$ 1.17^{a}	6.40 $\pm$ 1.07^{a}	0.227
Taste	5.90 $\pm$ 1.44^{b}	5.10 $\pm$ 1.28^{ab}	5.70 $\pm$ 1.33^{ab}	5.20 $\pm$ 1.61^{ab}	0.021
Sweetness	6.30 $\pm$ 1.16^{abc}	4.80 $\pm$ 1.61^{c}	5.60 $\pm$ 1.50^{abc}	4.90 $\pm$ 1.44^{bc}	0.005
Texture	6.50 $\pm$ 1.65^{ab}	5.90 $\pm$ 1.28^{ab}	6.50 $\pm$ 1.35^{ab}	5.80 $\pm$ 1.68^{ab}	0.027
Overall acceptance	6.40 $\pm$ 1.64^{a}	5.30 $\pm$ 1.25^{a}	5.80 $\pm$ 1.61^{a}	5.40 $\pm$ 1.57^{a}	0.020

Legends: Means ± SD and values in the same rows with the same superscripts are not statistically significant (P<0.05)

4.5 Microbial Analysis (SPC, Yeast and Mold)

Microbiological evaluation of experimental gel pudding is illustrated in Table 4.4. The data shows that there was no microbial growth found in sample A in 7 days of incubation. Highest bacterial colony was counted in standard plates of sample B (204×104 cfu/ml). SPC determined with sample C, D and E (honey incorporated in different quantity) showed less bacterial growth than sample F, G and H (date incorporated in different quantity). It was also observed that, among the samples formulated with honey (sample C, D and E), sample C showed least microbial development on agar plate compared to the other ones (sample D and E). No yeast and mold growth was observed during 7 days' incubation of growth plates.

Table 4.4: Microbiological evaluation of gel pudding

Formulations of jelly pudding	TVC(cfu/ml)			Yeast and mold
	0 day	3 days	7 days	7 days
Sample A	No growth	No growth	No growth	No growth
Sample B	No growth	2.62×10^{2}	204×10^{4}	No growth
Sample C	No growth	1.31×10^{2}	11×10^{3}	No growth
Sample D	No growth	1.5×10^{2}	67×10^{3}	No growth
Sample E	No growth	2.04×10^{2}	149×10^{3}	No growth
Sample F	No growth	2.32×10^{2}	123×10^{4}	No growth
Sample G	No growth	1.18×10^{2}	177×10^{3}	No growth
Sample H	No growth	1.87×10^{2}	237×10^{3}	No growth

4.6 Cost analysis

Table 4.5: Production cost of gel pudding

Heads	Taka / Kg	Quantity used g/ kg products)	Total Tk. For sample A	Total taka for sample B	Total taka for sample C	Total taka for Sample D
1) Expenditure Raw materials						
Milk	350	4000	108	108	108	108
Carrot	62	749	0	8.82	8.82	8.82
Agar powder	120	16	9.6	9.6	9.6	9.6
White sugar	116	200	11.6	11.6		
Honey	1000	212			90	64
Date	200	250				
2) Processing cost @15% of raw material			148.58	27	33.9	31.6
3)Bottling cost	144	48cup	18	18	18	18
Total production cost of per cup gel pudding			166.58	176.72	266.88	241.58

Heads	Taka / Kg	Quantity used g/ kg products)	Total Tk. For sample E	Total taka for sample F	Total taka for sample G	Total taka for Sample H
1) Expenditure Raw materials						
Milk	350	4000	108	108	108	108
Carrot	62	749		8.82	8.82	8.82
Agar powder	120	16	9.6	9.6	9.6	9.6
White sugar	116	200				
Honey	1000	212	54			
Date	200	250		18.2	14	11
2) Processing cost @15% of raw material			207.48	166.31	161.48	158.03
3)Bottling cost	144	48cup	18	18	18	18
Total production cost of gel pudding			225.48	184.31	179.48	176.03

Additionally, the amounts of milk, agar in each sample are the same.

By following the recipe, we can prepared 6 cup of gel pudding. So, the cost of gel pudding, therefore is:

Sample A per cup gel pudding is-27.76 Taka

Sample B per cup gel pudding is-29.45 Taka

Sample C per cup gel pudding is-44.48 Taka

Sample D per cup gel pudding is-40.26 Taka

Sample E per cup gel pudding is-37.58 Taka

Sample F per cup gel pudding is-30.71 Taka

Sample G per cup gel pudding is-29.91 Taka

Sample H per cup gel pudding is-29.33 Taka

Chapter 5: Discussion

5.1 Physicochemical properties of gel pudding

Fresh cow's milk has a pH of 6.5 to 6.7 (Marouf & Elmhal, 2017), which is slightly acidic, according to the literature, whereas coconut milk has a pH of 6.23. The coconut milk pH results corroborated (Aidoo et al., 2010)'s claim that plant/vegetable milk had a pH range of 6.33 to 6.97, making it moderately acidic. Honey is characteristically acidic with pH between 3.2-4.5, which is low enough to be inhibitory to several bacteria(Mandal & Mandal, 2011). Dates have a 6.0 pH level when dried. And pH level of fresh-cut carrot is around 6.0 (Silva et al., 2016) . From the table 4.1 it can be seen that sample C, D, E, F, G, and H exerts almost same pH level which is slightly acidic.

5.2 Nutritional composition of gel pudding:

During the preparation of carrot-coconut milk gel pudding white sugar, honey, dates are also added to make the gel pudding rich in carbohydrate, protein, fat, fiber and other vitamin and minerals. Proximate composition of eight different samples was shown in table no 4.2. In case of moisture content, sample A which is a control made with only with coconut milk and sugar has the highest moisture content. Moisture content of this sample is high due to the higher moisture content of coconut milk (Alyaqoubi et al., 2015). Second highest moisture was found in sample F which was made with carrot, coconut milk and dates. Dates have higher moisture content than honey and sugar. The average moisture content of 16 dried varieties is 15.2g/100gm (Al-Farsi & Lee, 2008). Although we used dry dates but for the mixing we blended the dates with water which increase the moisture content more. Honey content less moisture (Alvarez-Suarez et al., 2010) that is why moisture content is sample C,D,E is relatively lower. Moisture is an important factor in determining the shelf life and freshness of food product. Food products with higher moisture content have a short shelf life.

When compared to sample A and B, sample F has the highest crude fiber content due to higher dates in the formulation. Dates generally contain large amount of fiber (Al-Farsi & Lee, 2008),whereas honey contain 0.58±0.04% of fiber (Ogidi & Otenep, 2020). Carrot also contain significant amount of fiber 2.80 gm./100gm (Haq & Prasad, 2015) but when carrot and date mixed it yields more fiber. This is the reason why sample F has more fiber percentage.

When carbohydrate content is determined it is seen that sample B content the highest carbohydrate content than other samples. This is because white sugar contain 99.98 g of carbohydrate per 100 gm. whereas honey contain 82.4% total carbohydrate (Khan et al., 2007), dried dates contain 80.6g/100gm (Al-Farsi & Lee, 2008).This is the reason why sugar sample B has the highest carbohydrate content. But expert believes that sugar consumption is a major reason of obesity and many chronic diseases, such as type 2 diabetes(Johnson et al., 2017). Dates and honey could be used as natural sweeter(Saraiva et al., 2020) of the food products which give more health benefit.

During the determination of protein, it was seen that compare to sample A and B sample G has the highest protein content. It is because carrot contain some amount of protein such as- 0.93 gm. /100gm (Haq & Prasad, 2015)and when it is mixed with date it yields more protein. Dried date on average contain 2.14gm/100 gm(Al-Farsi & Lee, 2008).But for the honey sample the amount is lower than dates because honey hardly contain any protein roughly 0.5% proteins, mainly enzymes and free amino acids(Hasam et al., 2020).

5.3 Vitamins and minerals

According to United States Department of Agriculture (USDA) Calcium content of coconut milk is 3.7mg per cup of coconut milk powder. According to (Sharma et al., 2012) Ca content of carrot is 80mg/100 g). Honey contain 3-31mg of calcium in 100 gm(Ajibola et al., 2012).Dried dates on average contain 70.7mg of Ca in 100g of dates(Al-Farsi & Lee, 2008). Here carrot contain maximum number of Ca followed by dates and honey. This is why sample F contain more calcium because of the mixer of carrot and dates.

According to USDA, potassium content of powdered coconut milk powder is 631mg per cup or 240 gm. Carrot contain 240mg of potassium per 100 gm (Sharma et al., 2012). According to (Ajibola et al., 2012), honey contain 40-3500 mg of potassium per 100 gram. And dates contain on average 713mg of potassium per 100 gm(Al-Farsi & Lee, 2008). So, dates and carrot combined sample F contains maximum potassium content.

When compared to sample A and B it was seen that sample F (carrot +coconut milk+ dates) has the highest vitamin A content due to its components. Dates has the average vitamin A content of about 23.85µg/100gm(Al-Farsi & Lee, 2008). Carrot contain 16706 IU per 100 gm (Nagraj et al., 2020).Honey contain mainly water soluble

vitamins. Vitamins available in honey are phyllochinon, thiamin, riboflavin, pyridoxine, niacin, pantothenic acid, ascorbic acid (Hasam et al., 2020).

5.4 Microbial analysis

Dairy desserts are popular dairy food, prepared with ingredients including milk as a basic constituent. Recently, coconut milk based desserts are being more popular as many people has allergic reaction associated with dairy based food products (Savage et al., 2009). High levels of food security are possible thanks to thermal processing, however the quality of the food is thermally degraded, notably in terms of flavor and nutrients. Therefore, in this investigation, the prepared desserts underwent a 2-minute heat treatment at 90 °C. The microbial flora is significantly impacted by this treatment since heat can kill dangerous and unwanted microorganisms. To reduce the load of microbial growth, two natural ingredients with antibacterial properties (honey and date) were used in the experimental desserts ((Bizerra et al., 2012); (Taleb et al., 2016).

Table 4.4 shows that, there was no microbial growth in SPC and yeast + mold count plates of sample A. this result is in concordance with some previous studies. According to (Md et al., 2020), no microbial change in coconut milk pudding was observed after 7 days and after 14 days. Another study(Kajs et al., 1976) found that microbiological examination of coconut water aseptically removed from coconuts showed Aerobic Plate Counts of <l-30 cfu/ml. Yeast and mold counts were also found to be lower in coconut water (l-8/ml).

Bacterial growth was observed from sample B to H which were formulated with grinded carrots and some other additives. In 7 days of incubation, all the microbial values were within the range of 11×103 to 204×104 cfu/ml which were satisfactory for “Cooked foods chilled but with some handling prior to sale or consumption” according to the regulations of Microbiological Guidelines for Food (Center for food safety, 2014).

According to the results of the microbiological analysis, highest SPC number was counted in sample B as it was made with carrots and powder sugar. Carrots and powdered sugar both are rich in high energy source which promotes the growth of bacteria in incubation. In this study, we also observed an absence of yeast and mold growth in our formulated desserts enriched with honey and date. These results are in concordance with the statement of (Anyanwu, C.U, 2012) and (Abekhti A et al., 2013), who reported that honey and date contains can serve as sources of antifungal substances

against possible development of commonly found fungal species. These results also confirm the respect of aseptic conditions during the processing of the final product.

5.5 Sensory evaluation

To determine the gel pudding with highest organoleptical palatable percentage, sensory analysis of gel pudding was conducted. From sensory analysis data of table- it is seen that the variation in taste, appearance, texture, sweetness, color, smell and overall acceptability were found to be statistically insignificant at the 5%($P<0.05$) level of significance. In the sensory evaluation test sample B (carrot+ sugar+ coconut milk) and sample A (coconut milk+ white sugar) scored highest respectively(7.10 ± 1.28^{a} and 7.00 ± 1.88^{a}). But white sugar is not good for health as excessive amount of the refined sugar causes multiple diseases. On the other hand, although sample A also scored second highest acceptability but this sample do not contain any significant amount of fiber, protein, carbohydrate, vitamin A. Other than these two samples, sample E (carrot+ coconut milk+ honey) scored highest (6.40 ± 1.64^{a}) in the overall acceptability. Sample G also scored (5.80 ± 1.61^{a})almost near to sample E. It may be due to taste, smell, and appearance. Although sample C, D has more carbohydrate, protein, fat, fiber it was not preferred by panelist. Sample C had more moisture content than sample D and E. That is why texture of those samples were feeble. And due to higher honey content color of those samples were not excellent. On the other hand, although sample F were rich in carbohydrate, protein, ash, fiber and vitamin a it was scored lower due to its dark color of date. For this reason may be panelist choose sample G.

Chapter 6: Conclusion

In recent years, a significant aspect of food research has been dedicated to the development of new formulated products. Pudding, as a delicious and nutritious option, serves as an excellent choice for individuals seeking a healthy breakfast or snack. In this experiment, honey and dates were used in gel pudding as a sugar substitution to observe their effects on the nutritional qualities and sensory properties of the formulated products. This study revealed that, although energy content and sensory acceptance is higher in the sugar based products, the nutritional value was found to be significantly higher in the treatment puddings specially the one made with date (13%). Also the microbiological content was moderate according to the food safety regulations. Moreover, the cost benefit analysis indicated that, using dates as a substitute doesn't increase the cost of pudding per cup compared to the control cups. Hence, the results showed the possibility of utilizing date paste or honey to develop sweet deserts and confectioneries in a commercial basis. Furthermore, this preliminary study provides support for future research aiming at optimizing the concentration of substitute inclusion, panel test performance to observe their acceptance among people in broad spectrum and identifying the potential bioactive compounds to assess their values in health condition and different biological factors in human.

Chapter 7: Recommendation and Future Perspective

Today, malnutrition affects more than 50% of the population in our country. Given that Bangladesh has access to carrots, gel pudding may be a good supply of nutrition and energy in these circumstances. Also it can be found in every season. It has a higher commercial value and improved marketability as a result. Modern food industry can use the method in large- and medium-scale production. Based on the evidence of the investigation at hand, some suggestions and research opportunities are made below.

a) To confirm the outcomes of the experiments, the existing investigations could be improved upon.

b) The formulation might be further modified, and one could try making gel pudding using different recipes and fruit ratios.

c) Because it's simple to prepare. It can be stored for long term by adding preservatives. Additionally, from a perspective, it will help those who are economically weaker.

d) Similar studies should be conducted on other fruits, including those sold in markets off-seasonally, such as papaya and mango, sapodilla etc.

e) Modern packaging and storing techniques would be created to improve gel pudding.

f) The results will be useful from a therapeutic point since they have therapeutic value.

g) Although the sample size may be utilized for statistical comparisons of the analytical results, it is essential to exercise caution due to the limited number of samples examined. Therefore, any conclusions drawn should be considered tentative, and the findings should be validated through a larger-scale study.

h) Enough efforts should be made to provide additional nutrients to gel pudding that is sold commercially.

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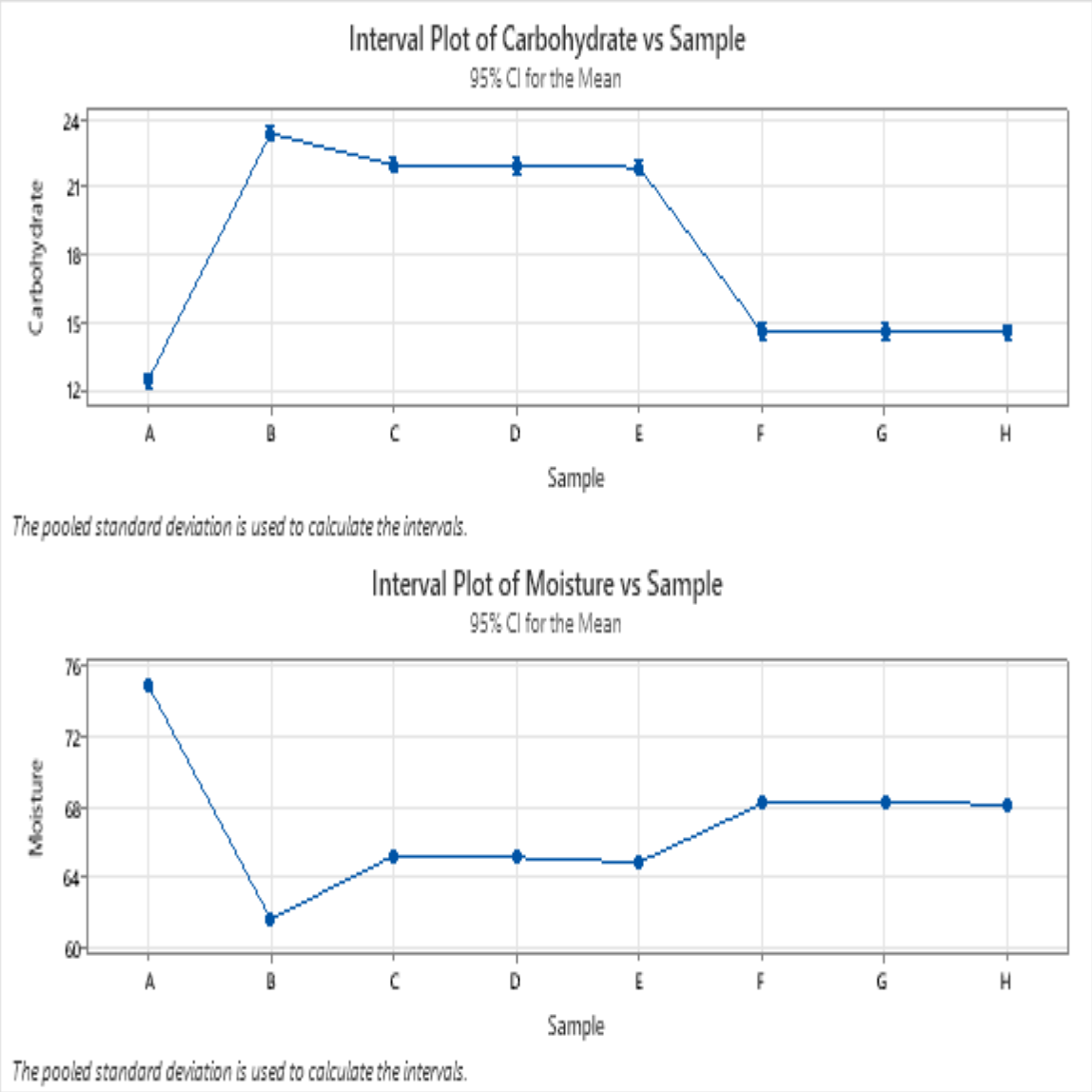
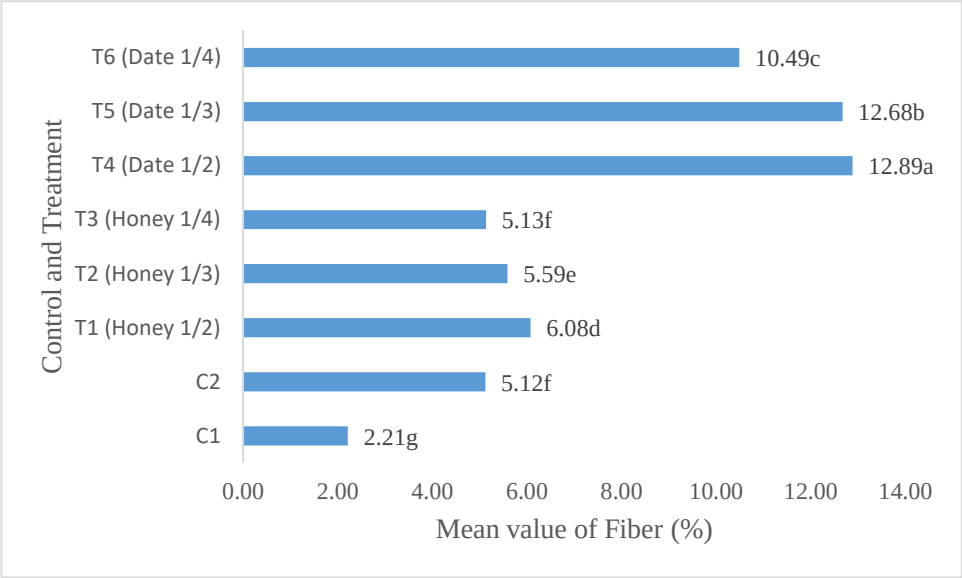
Appendices

Appendices A: Nutritional composition of gel pudding





Sample	Vitamin A	calcium	Sodium	Potassium
A	**5.0067±0.0306**	**1.4±0.02**	**64.57±0.411**	**1.71±0.02**
B	**29.12±0.02**	**1.42±0.02**	**52.407±0.514**	**1.663±0.01528**
C	**28.95±0.02**	**1.6±0.02**	**64.1±0.02**	**2.1±0.02**
D	**28.773±0.56**	**1.5±0.02**	**50.9±0.02**	**1.94±0.01**
E	**27.95±0.02**	**1.3±0.02**	**56.4±0.02**	**1.74667±0.01528**
F	**35.28±0.02**	**2.98±0.02**	**68.9±0.02**	**2.83±0.02**
G	**33.82±0.02**	**2.5±0.02**	**63.1±0.02**	**2.6±0.2**
H	**32.1±0.02**	**2.32±0.02**	**64.9±0.02**	**2.33±0.2**

Appendix B: Questionnaire for Hedonic test of gel pudding

Name of the Taster: …… Date: …….

Please taste these samples and check how much you like or dislike each one on four sensory attributes such as color, flavor, texture and overall acceptability. Use the appropriate scale to show your attitude by checking at the point that best describe your sense and feeling about the sample please give a reason for this attribute. Remember you are the only one who can tell what you like. An honest expression of your personal feeling will help us. For Taste/Flavor/Mouth feel/Appearance/Overall Acceptability. The scale is arranged such that; Like extremely =9, Like very much =8, Like moderately =7, Like slightly=6, Neither like nor dislike =5, Dislike slightly =4, Dislike moderately =3, Dislike very much =2, and Dislike extremely =1.

Here,

Sample A-Coconut milk+ Agar+ white sugar (16.61%)

Sample B- Coconut milk+ Agar + Carrot+ White sugar (14.10%)

Sample C- Coconut milk+ Agar + Carrot + Honey (12.87%)

Sample D- Coconut milk+ Agar+ Carrot+ Honey (10%)

Sample E- Coconut milk+ Agar+ Carrot+ Honey (8.14%)

Sample F- Coconut milk+ Agar+ Carrot+ Date (13%)

Sample G- Coconut milk+ Agar+ Carrot+ Date (10.3%)

Sample H- Coconut milk+ Agar+ Carrot+ Date (8.54%)

Hedonic	Appearance								Color								Smell								Taste								Sweetness								Texture								Overall							
	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
Like extremely																																																							
Like very much																																																							
Like moderately																																																						
Like slightly																																																						
Neither like or dislike																																																					
Dislike slightly																																																					
Dislike moderately																																																					
Dislike very much																																																					
Comments																																																					

Appendix D: Photo Gallery

Blended carrot

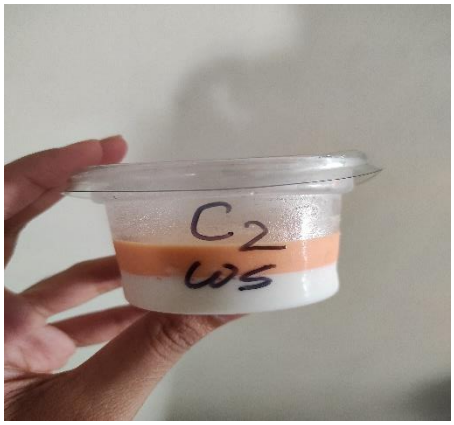
pH meter

Acidity determination

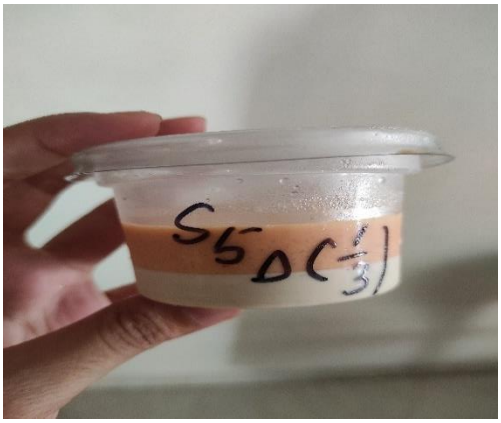
Acidity determination

pH determination

Protein determination



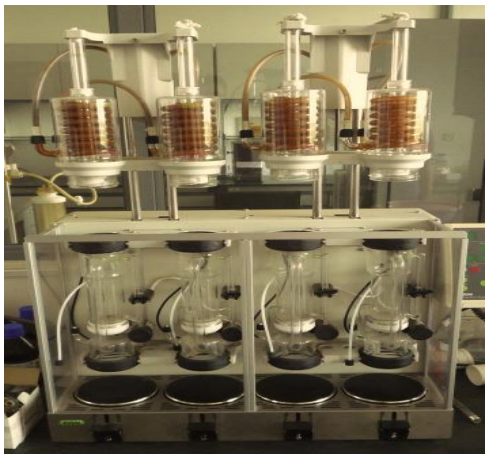
Gel pudding (Control)



Gel pudding (treatment)

Gel pudding (treatment)

Sensory evaluation



Fat determination

Crude fiber determination

Brief Biography

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