DEVELOPMENT OF A YOGURT INCORPORATING RED DRAGON FRUIT'S (*HYLOCEREUS POLYRHIZUS*) PEEL POWDER AND DETERMINE ITS QUALITY PARAMETER

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Roll No. 01/20-07

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Session: January-June 2020

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

June 2022

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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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PLAGIARISM VERIFICATION

Title of Thesis: DEVELOPMENT OF A YOGURT USING RED DRAGON FRUIT'S (*HYLOCEREUS POLYRHIZUS*) PEEL POWDER AND DETERMINE ITS QUALITY PARAMETER

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DEDICATED

TO

MY

BELOVED

PARENTS

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June 2022

Table of Contents

Authorization i

Acknowledgements v

List of Tables ix

List of figures ix

Abbreviation x

Chapter 1: Introduction 1

1.1 Objectives: 3

Chapter 2: Review of literature 4

2.1 Introduction to Dragon Fruit 4

2.1.1 Origin and geographic scope 4

2.1.2 Taxonomy of Dragon fruit 5

2.1.3 Families of Hylocereus 5

2.1.4 Nutrition of Dragon Fruit 6

2.1.5 *Hylocereus polyrhizus*'s nutritional value and therapeutic properties 6

2.1.6 Peel from *Hylocereus polyrhizus* possesses antioxidant properties 7

2.2 Yogurt 8

2.2.1 The origins of yogurt 9

2.2.2 Various yogurt varieties 10

2.2.3 Yogurt's nutritional and therapeutic benefits 10

Chapter 3: Materials and Methods 13

3.1 Study area 13

3.2 Plan of Study 13

3.3 Design of experiment 13

3.4 Sample collecting 14
3.5 Preparation of dragon peel powder 14
3.7 Yogurt processing 14
3.8 Yogurt's physicochemical analysis 15
3.8.1 Determination of pH 15
3.8.2 Titratable Acidity 15
3.8.3 Determination of Vitamin C 16
3.9 Nutritional composition of fruit yogurt 17
3.9.1 Estimation of Ash 17
3.9.2 Moisture content 18
3.9.3 Estimation of Crude Fiber 19
3.9.4 Protein analysis 20
3.9.5 Estimation of Crude Fat 21
3.10 Determination of Antioxidant capacity by DPPH scavenging method 22
3.11 Microbial Analysis: 23
3.11.1 Aerobic plate count (Bacterial plate count) 23
3.11.2 Sample preparation 24
3.11.3 Dilution 24
3.11.4 Standard plate counts 24
3.11.5 Counting and recording 25
3.11.6 Coliform Test 25
3.12 Cost Analysis 25
3.13 Sensory evaluation 25
3.14 Statistical Analysis 26

Chapter 4: Result 27

4.1 Physicochemical properties of yogurt 27

4.2 Nutritional Composition of yogurt 28

4.3 Antioxidant capacity: 29

4.4 Microbial analysis 30

4.5 Sensory analysis: 31

4.6 Cost analysis 32

Chapter 5: Discussions 34

4.2 Physicochemical properties of fruit yogurt 34

4.3 Nutritional composition of fruit yogurt 35

4.4 Antioxidant capacity: 36

4.5 Microbial 36

4.6 Sensory Evaluation 37

Chapter 6: Conclusion 38

Chapter 7: Recommendations and Future Perspectives 39

References 40

Appendices 47

Brief biography 53

List of Tables

Table 1:The following is how the scale was set up…………….…….26
Table 2: Physicochemical properties of fruit yogurt……………..27
Table 3: Nutritional composition of fruit yogurt…………………28
Table 4: Antioxidant capacity of fruit yogurt………………...….29
Table 5: Microbiological Evaluation……………………………..30
Table 6: Test for sensory evaluation of fruit yogurt…………......31
Table 7: Production cost of Fruit yogurt…………………………32

List of figures

Figure 1: Design of an experiment…………………………………..**Error! Bookmark not defined.**
Figure 2: Creating a Sample…………………………………………14
Figure 3: Yogurt processing…………………………………………15
Figure 4: Estimation of Ash…………………………………………18
Figure 5: Determination of Antioxidant capacity……………………23

Abbreviation

%	: Percentage
&	: And
ANOVA	: Analysis of variance
AOAC	: Association of Official Analytical Chemists
dl	: Deciliter
DPPH	: 2,2-diphenyl-1-picrylhydrazyl
et al	: Et alii/ et aliae/ et alia
etc	: Et cetera
G	: Gram
Kg	: Kilogramme
mg	: Miligram
TE	: Trolox equivalent
Cfu	: Colony forming unit
QE	: Quercetin equivalents
L.	: Linn
PPM	: Parts per Million
m	: Meter
spp.	: Species
µg	: Microgram

Abstract

Dragon fruit (*Hylocereus polyrhizus*) is one of the most well-liked industrial fruits in Bangladesh, which is enrich in natural antioxidants, vitamin C, and fiber. Although the dragon fruit's (*Hylocereus polyrhizus*) flesh is commonly consumed, the fruit's skin may make up to 30% to 35% of its weight is required more processing in order to raise the consumption of dragon fruit peel. The goal of the study was to produce yogurt using 2%,5% and 7% dragon fruit’s peel powder (sample B, sample C, sample D) and compare it to control yogurt (sample A) in terms of proximate analysis, sensory evaluation, microbial analysis, pH, titratable acidity, vitamin C content, and total antioxidant activity. Among these formulations, in terms of overall preferences, color, taste, and sweetness the sensory score of yogurt processed with 2% peel powder (sample B) was shown the best. Crude fiber, protein, ash, moisture, fat content were measured between the range of 14.53% to19.34%, 21.02% to 21.49%, 5.19% to 5.29%, 76.70% to 80.18%, 18.36% to 19.53% respectively. Yogurt with dragon peel powder has a significant level of antioxidant capacity. In addition, the antioxidant capacity of 2%, 5% and 7% were found 1.43±0.004 mg TA, 1.51±0.003 mg TA, 1.57±0.005 mg TA per 100 gm. respectively. A high-quality, nutrient and antioxidant-rich product was discovered when 7% peel powder was added. The pH range for the formulated samples was 4.36 to 4.41 and titratable acidity 0.18% to 0.19 %. Vitamin C percent was gradually increased from 1.17mg-1.34 mg/100g in formulated yogurt which was totally absent in control. No coliform was detected in the yogurt samples, and TVC were found in 2%, 5%, 7% samples 56.64±0.56cfu, 61.45±0.48cfu, 64.23±0.27cfu per ml respectively. The yogurt mix with additional sugar (10%) was selected as the pleased product because to the outstanding recommend rank values seen for sensory qualities. Furthermore, after seeing all attributes it can be concluded that dragon peel powder can use as a way to enhance the functional aspects, sensory assessment, and quality attributes of yogurt.

Keywords: Red dragon fruit peel powder, proximate analysis, antioxidant activity, and sensory evaluation.

Chapter 1: Introduction

Yogurt is a fermented milk product that is prepared by coagulating milk with bacteria such as *Lactobacillus bulguricus* and *Streptococcus thermophilus*, with the potential of *Lactobacillus acidophilus* (SLSI, 1989). Statistics shown that the regular market demand for yoghurt surpasses two million cups, making it one of Bangladesh's most popular dairy products (Kanakaratne, 2012).

Yoghurt is a product that could be made by blending fruit or edible fruit bits with yoghurt or cultured pasteurized milk as well as concentrated fruit beverages. It has also been noted that adding fruits or other edible components to plain yoghurt might enhance both its flavor and its therapeutic properties.

Research has shown that consuming fresh fruits and vegetables help prevent chronic conditions including cancer and cardiovascular disease that are linked to oxidative stress (Srinath Reddy and Katan, 2004, Voko et al., 2003). This is because they contain antioxidants, especially vitamin C, which has been shown to remova free radicals and prevent oxidation (Simirgiotis and Schmeda-Hirschmann, 2010).

Additionally, phenolic compounds in particular have been shown to have antimicrobial properties (Du, Olsen and McHugh, 2011). Thus, for their nutritional worth as well as for their aesthetic appeal, fruit extracts have been employed in a range of food compositions, notably dietary supplements, edible films, and coatings (Du et al., 2011).

The waste left over after commercial fruit and vegetable processing has recently drawn a lot of attention as a potential source of bioactive compounds. Researchers are striving to find uses for by-product found in functional food because of the health and technical advantages (Makris, Boskou, & Andrikopoulos, 2007).

A biological effect in the complex mixtures of extracts obtained from both edible food components and processing leftovers may be caused by a single chemical or a few classes of molecules. Extract sub-fractionation via solvent partitioning and/or chromatography may be advantageous in order to obtain pure classes of phytochemicals whose contribution to the bioactivity of the entire samples can be assessed directly (Cho et al., 2011, Roussis et al., 2008).

Due to its potential economic worth and health advantages, Dragon fruits (*Hylocereus polyrhizus)* (Weber Britton & Rose) have received a lot of attention lately. The quantity of betacyanins in the peels and flesh was measured in earlier studies (Esquivel et al., 2007, Wu et al., 2006). These rich red-purple pigments show great promise as natural coloring additives for a variety of foods due to their stable appearance over a wide pH range (Wybraniec & Mizrahi, 2002).

Additionally, recent studies have focused on their antioxidant qualities, suggesting that these pigments may provide defense against diseases associated with oxidative stress (Wu et al., 2006).

There are two traits that stand out: peels may make up to 33 % fruit weight, and nothing is known about the non-betacyanin compounds and their biological functions in this fruit. The objective of this research was to investigate the phytochemical composition, antioxidant capacity, and antibacterial activity of Dragon peel powder extracts added to yogurt. Finding potential new sources of natural antioxidants and functional meals from eatable and waste food items has garnered a lot of attention lately (khalili et al., 2009).

Dragon fruit is not as well-liked in Bangladesh as it is everywhere in the world because of its unique flavor, and high market price. Therefore, it is possible to add dragon fruit peel powder to yogurt which may increase consumer acceptability and palatability while also enabling to use the fruit's waste, which makes up around 33 percent of its total weight. Additionally, customers will have access to the alleged health benefits of dragon fruit peel. In order to make a fruit-yoghurt that included dragon fruit and define its quality standards, this study's objectives were as follows.

1.1 Objectives:

I. To produce a yogurt that incorporated with red dragon fruit's peel powder.

II. To determine and compare the prepared yogurts proximate analysis, sensory qualities, pH, titratable acidity, antioxidant activity, vitamin C content, and microbiological characteristics with control.

III. To evaluate the overall acceptability of the developed yogurt.

Chapter 2: Review of literature

The food items made from a range of crops that are most often eaten are fruits. An enormous quantity of waste is produced just by processing halt results; it makes up between 25 and 30 % of the final output. Pomace, peels, rind, and seeds are some of the most typical household trash and are probably loaded with beneficial bioactive chemicals and combinations of various components. The food business uses bioactive ingredients to improve probiotic foods, nutritious ready-to-eat films, and remarkable industries for priceless goods. A novel method of exploitation involves turning low-cost waste agricultural wastes into a value-added product. Similar to the processing of horticulture crops, output has rapidly expanded to meet the rising demand due to the rise in weight loss plan behavior and the expanding population.

2.1 Introduction to Dragon Fruit

A tropical fruit from the Cactaceae family of cactus, the dragon fruit (*Hylocereus polyrhizus*) is sometimes referred to as red pitaya. Fruits are a great source of vitamin C and also water-soluble fiber (Ruzainah et al. 2009).

The dragon fruit produced by the *Hylocereus cactus*, sometimes referred to as the Honolulu queen, that blooms at night. The natural habitats of this plant are in Southern Mexico and Central America. Today, it is cultivated all over the world. Some of the names given to it are strawberry pear, pitaya, and pitahaya. The name comes from the two most common kinds' vivid red skin and their green scales, which resemble dragon scales (Shirzad et al., 2012). Customers' interest has been sparked by the dragon fruit's abundance in micronutrients and its striking color.

2.1.1 Origin and geographic scope

Although its exact origin is unknown, the dragon fruit is most likely a native of Central America. According to Blancke, it is also known as pitahaya in Mexico and pitaya roja in Central America and northern South America (Tropical Fruits and Other Edible Plants, 129). A variety of tall cacti with blooming fruit are referred to as pitahayas in Spanish.

Over a century ago, the French introduced the fruit to Vietnam (Robert E. Paull and Odilio Duarte, 2012).

Dragon fruit accounts for 55 percent of Vietnam's total fruit export revenue, making it the world's largest exporter, according to figures from 2013. (Doanh et al., 2014). For instance, attempts to cultivate the fruit have been made in Thailand, Israel, northern Australia, southern China, the Philippines, and Hawaii (Doanhet al., 2014).

2.1.2 Taxonomy of Dragon fruit

Domain: Eukarya

Kingdom: Plantae

Phylum: Magnoliophyta

Class: Magnoliopsida

Order: Caryophyllales

Family: Cactaceae

Genus: Hylocereus

Species: *Hylocereus polyrhizus*

2.1.3 Families of Hylocereus

Despite having an odd appearance, dragon fruit has tastes that are like to other fruits. Regarding taste, it has been likened to a somewhat sweet cross between a kiwi a pear. The fruit of several types of cactus has been described as

• White dragon fruit (*Hylocereus undatus*),

• Red and *H. polyrhizus*, or polyrhizus (*H. polyrhizus*)

• Yellow-colored Selenicereus megalanthus (Nerd et al., 2002).

2.1.4 Nutrition of Dragon Fruit

Dragon fruit is often taken either raw or juiced. As a consequence, a notable byproduct of dragon fruits is peel. The peels are thought to have some antioxidant properties because of their color. Pitaya peel makes up 32% of the total fruit, which is now thrown away. Significant quantities of pectin, betacyanin pigment, and total dietary fiber were all found. A good IDF to SDF ratio was seen in the peel. Thus, fiber, pectin, and natural coloring might all be obtained from pitaya peel (Jamilah et al., 2011). As a consequence, the pulp and peels may both be employed in the food and drug sectors (Ruzlan et al., 2004).

A 6-ounce serving of dragon fruit cubes has:

- 0 grams of fat
- 2 grams of protein.
- 5.0 g of fiber
- 13 grams of sugar
- 4 milligrams of vitamin C;
- 100 international units (IU) of vitamin A
- 31 mg of calcium
- 68 milligrams of magnesium
- 0.1 milligrams of iron

2.1.5 *Hylocereus polyrhizus's* nutritional value and therapeutic properties

1. The Cactaceae plant *Hylocereus polyrhizus* is often referred to as red pitaya or dragon fruit in its native region. Around the world, the fruit is widely cultivated, notably in Malaysia, Vietnam, Thailand, Taiwan, and other nations. The fruit has a crimson peel covered in huge scales and a red flesh with edible black seeds.

2. The fruit is enrich in lycopene and vitamin C. A decreased risk of cancer, heart disease, and blood pressure has been associated with lycopene (Bellec et al., 2006, Zainoldin and Baba, 2009). Furthermore, linoleic and linolenic acids, in particular, are abundant in the seeds of *H. polyrhizus* and *H. undatus* (Ariffin et al., 2009).

3. Tolerance to stomach acid conditions, partial resistance to human salivary -amylase, and the capacity to promote the growth of lactobacilli and bifidobacteria were among the prebiotic properties of *H. polyrhizus* oligosaccharides (Wichienchot et al., 2010). According to (Nurmahani et al. 2012), *H. polyrhizus* chloroform extracts were effective in killing both Gram-positive and Gram-negative germs.

4. Despite its widespread usage, there is a paucity of toxicological evidence about the safety of repeated exposure to *H. polyrhizus* fruit. In order to examine the possible toxicity of the *H. polyrhizus* fruit after a single oral dosage and a 28-day repeated oral dose in Sprague-Dawley rats, a toxicological research was carried out as part of a safety review of the fruit

2.1.6 Peel from *Hylocereus polyrhizus* possesses antioxidant properties

Dragon fruit is a great source of antioxidants. These compounds shield your cells from free radicals, unstable molecules linked to aging and chronic illnesses. Some of the most significant antioxidants present in dragon fruit pulp include the following:

- Betalains have been demonstrated to prevent "bad" LDL cholesterol from being oxidized or destroyed. They are the dark red pigments that may be found in the pulp of red dragon fruit.

- Hydroxycinnamates: Both in test tubes and on animals, it has been shown that this group of compounds possesses anticancer capabilities.

- Flavonoids: A large, diverse class of antioxidants known as flavonoids has been associated to enhanced brain function and a decreased risk of heart disease.

Due to its reddish-purple color, economic importance as a food item, and health advantages, dragon fruit has lately increased in popularity (Wybraniec and Mizrahi, 2002). Red-fleshed dragon fruits contain the reddish-violet pigment betacyanin. The primary bioactive component of red dragon fruit, betacyanin, has undergone significant chemical research (Wybraniec et al., 2001).

An antioxidant with the ability to scavenge free radicals is known as betacyanins, which are linked to N-heterocyclic compounds. According to a research, white dragon fruit (*Hylocereus undatus*) varieties had lower antioxidant activity than red dragon fruit (*Hylocereus polyrhizus*) cultivars (Chemah et al., 2010).

2.2 Yogurt

According to the Codex Alimentarius, Milk and Milk Products. Second Edition. FAO/OMS, (2011), yogurt is a milk product produced through the fermented of milk-specific bacteria that must be present in large quantities and be both active and live (*Lactobacillus delbrueckii* subsp. *bulgaricu*s and *Streptococcus thermophilus*).

Many cultures across the world rely heavily on yogurt, which has its roots in Western Asia and the Middle East. The Turkish word "yourmak," which means "to thicken, coagulate, or curdle," is supposed to have been the source of the word "yogurt" (Fisberg and Machado, 2015). Historical texts mention milk being carried by nomad herders in animal hide pouches. *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, particularly, are added to heated milk to create yogurt, which is then allowed to rest at a warm temperature (110-115°F) for several hours. The fermentation of milk by natural enzymes in pouches carried close to the body, which produced enough body heat to do so, evolved in yogurt. Different types of bifidobacteria and lactobacilli may be introduced. Bacteria convert lactose, a sugar contained in milk, to lactic acid, which thickens the milk and gives it a peculiarly acidic taste.

Yogurt and health are mentioned as early as 6000 BCE in Indian Ayurvedic medical texts. Bulgarian researcher Stamen Grigorov identified Lactobacillus bulgaricus bacillus, a strain of bacillus bacteria that isn't ordinarily present in the human stomach and is responsible for yogurt fermentation. He also investigated the effects of lactic acid on health.

Today, yogurt comes in a variety of tastes, including plain, with fruit, and with desserts. Stabilizers and thickeners like pectin and gelatin may be used to give food a richer taste and thicker texture.

People with lactose intolerance may be able to consume some yogurt since it contains less lactose than dairy products. During fermentation, microorganisms transform lactose into lactic acid. Another choice is lactose-free yogurt made from plants.

2.2.2 The origin of yogurt

An ancient food is yogurt. The earliest evidence of it was found during the Neolithic era, between 10,000 and 5,000 BCE, nomadic people were settling into a new way of life was only starting to give rise to sedentary lifestyles. At the period, it was also becoming common to domesticate milk-producing animals including cows, goats, buffalo, yaks, and camels.

In the Middle East, though, herders constructed milk-transport bags out of animal intestine. As a consequence, milk came into contact with digestive enzymes, causing it to curdle and sour. In some respects, the original yogurt was this form of milk since it was simpler to carry. Additionally, it's possible that these modifications to milk structure had a role in the modern understanding that dairy products may be kept fresh for a long time.

Yogurt has been consumed worldwide for countless centuries. King Francois the 1st of France introduced yogurt to Western Europe for the first time in the 16th century after receiving it from a Turkish doctor as a treatment for acute diarrhea (Fisberg et al,. 2015).

Before anybody knew about bacteria, starter cultures converted the lactose in milk to lactic acid, protecting it from illnesses. To bring about this alteration, fresh milk was infected with small quantities of sour milk.

Early in the 20th century, yogurt production for commercial marketing started. The first yogurt plant in France was established in 1932 by Daniel Carasso. Yogurt was first marketed in pharmacies because to the increasing interest in its conceivable health benefits. Yogurt is a mainstay in many people's diets across the globe and is now largely recognized as a healthy food (Fisberg et al., 2015)

2.2.4 Various yogurt varieties

There are several varieties of yogurt available, each with a unique production method and ingredients that may be added to plain yogurt either before or after fermentation:

- The kind of milk used—whole, semi-skimmed, or skim determine the final fat content of yogurt. For stirred-style yogurt, milk is fermented in a fermentation tank. After fermentation, the components are combined. After the mixture has been chilled and fruit or flavorings have been added, the food may then be packed and refrigerated.
- For French-style yogurt, often referred to as set-style yogurt, the milk is fermented before being combined with other ingredients (fruit preparation, sugar, flavoring, etc.) and packed. After that, the product is cooled and kept at refrigerator temperatures for storage.
- Yogurt used for drinking is stirred yogurt with a small amount of total solids that has been homogenized to reduce viscosity. After that, the substance is colored, flavored, and sweetened before being put into bottles.

2.2.5 Yogurt's nutritional and therapeutic benefits

1. Yogurt contains two essential nutrients: protein and calcium. However, a large portion of research on the health advantages of yogurt concentrates on its live bacterial component, which is also present in kefir, kimchi, and sauerkraut (Marco et al., 2017)

2. With excellent digestion and a high in essential amino acids, yogurt is a high-quality protein source. Yogurt's proteins are also simpler to digest than those in ordinary milk. This could be as a result of the fermentation process, which

reduces the minute fragments (Savaiano and Hutkins, 2020). A variety of fatty acids are also present in yogurt (Lordan et al., 2018)

3. Yogurt contains vitamins and minerals (calcium and potassium) (Williams et al., 2015). Additionally, it contains magnesium, whose levels in milk throughout lactation are generally stable with very minor fluctuations (12 mg per 100 g) (Haug et al., 2007).

4. The necessity of maintaining a healthy lifestyle by consuming nourishing meals and drinks is becoming more and more recognized in today's society. A wholesome beverage is yogurt, for instance. Streptococcus thermophilus and Lactobacillus bulgaricus are two separate bacterial cultures used to make yogurt, which is a fermented milk product (Corrieu and Béal, 2016).

5. Increased lactose absorption, decreased lactose intolerance, antimicrobial activity, better protein and fat digestion, and immune system stimulation are just a few of the health advantages of yogurt (Jeantet et al., 2008).

6. The popular fermented dairy product is yogurt, which offers several health advantages. It contains lactic probiotic microbes, is simple to digest, and is very nutrient-dense. Yogurt is said to be beneficial for reducing gut inflammation, bowl issues, and cholesterol levels (Jaster et al., 2018).

7. Based on taste, there are three categories of yogurt: plain, fruit, and flavored. Based on its textural characteristics, yogurt may be categorized as set, stirred, or sipping yogurt. The primary distinction between stirred and set yogurt is that the latter has to be stirred or agitated after the production process. Yogurt products now include a variety of food additives to increase their taste and nutritional value for customers (Tamime & Robinson, 2007).

8. Plain yogurt is promoted as a healthy dairy product, it is deficient in dietary fiber (Tseng & Zhao, 2013). Yogurt is a great choice for use in this research as a dietary fiber supplement because of this. This method has been utilized in earlier

research to add pineapple peel, passion fruit peel, pomegranate peel extracts, and orange fibers to yogurt (El-Said et al., 2014; Garca-Pérez et al., 2005; Sah et al., 2016; Vieira et al., 2015).

9. Dragon fruit flesh contains 8 to 9 g of vitamin C per 100 g, compared to 9.4 mg of vitamin C in the fruit's skins (Panjuantiningrum et al., 2019). The peels of the super red dragon fruit include phenolics, alkaloids, terpenoids, and flavonoids (Fajriani et al., 2013). The ultra-red dragon fruit is rich in antioxidants in both the meat and the peel. The super red dragon fruit peels should be developed as a natural antioxidant source since their antioxidant activity is greater than that of the fruit meat. (Wu et al., 2006)

10. Dragon fruit peels will thereby enriches the yogurt's antioxidant content when added. Super red dragon fruit meat is used as an extra material in the Sari and Rohmah study to manufacture nuggets, while super red dragon fruit flesh is used in the Wahyuni research to make jenang (Wahyuni et al., 2012). (Sari and Rohmah, 2014).

11. All throughout one's life, bone health is crucial. Even yet, the two key phases of life—youth and old age—require individuals to take special care of their bones.Protein, calcium, vitamin D, and potassium are all abundant in yogurt and are all vital for healthy bones. Additionally, probiotics and the live bacteria included in yogurt may aid in promoting calcium absorption and bone health (Drewnowski et al., 2018)

12. Yogurt eating on a regular basis has been associated with improved bone health in kids and teens (Rizzoli and Biver , 2017). One yogurt was added to the regular preschool diet of children for 9 months, five days a week, as part of a research to determine the effects of a yogurt supplementation among Chinese children. According to this research, kids who consumed more yogurt grew taller, gained more weight, and developed their bones more densely than kids who did not (Neville et al., 2014)

Chapter 3: Materials and Methods

3.1 Study area

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

3.2 Plan of Study

From January through May 2022, this research was carried out.

3.3 Design of experiment

Dragon fruit was first collected. Once the samples were gathered, then after collecting, cutting and drying process Dragon peel turned into powder. After that, yogurt was made using this powder. For each product category (A=control, B=formulated with 2%, C=formulated with 5%, D= formulated with 7% Dragon peel power), consumer acceptance tests were undertaken. After processing, the quantities of vitamin-C and antioxidant activity were measured, along with the yogurt's proximate composition (moisture, ash, crude fat, protein, and crude fiber), p^H, acidity, and titratable acidity for each product category. On one of the controls, a comparable analysis was perform.

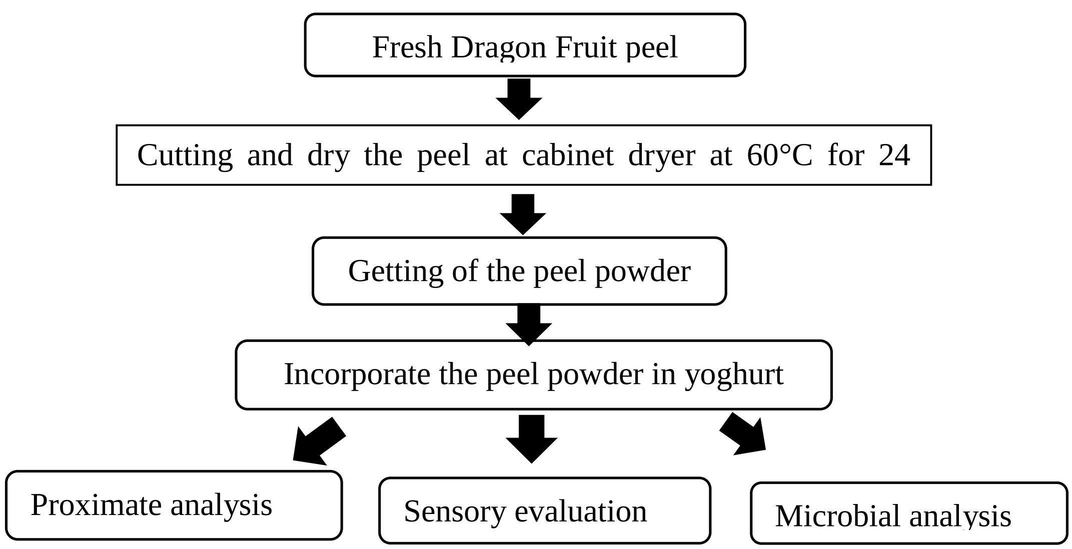

Figure 1: Design of experiment

3.4 Sample collecting

Samples of milk and dragon fruit were obtained from Supermarkets in the Chattogram Khulshi area. As soon as the samples were collected, they were placed in the refrigerator to maintain their freshness and protect them from any degradation

3.5 Peel powder preparation

The Dragon fruits were professionally cleaned to get rid of sand and other dirt. The stem was then cut into pieces that were 4 to 5 inches long and dried for around 24 hours at 60°C in a cabinet drier. To get rid of any remaining debris, the powdered sample was run through a fine (2 mm mesh) filter. Before usage, the finely ground substance was stored in plastic containers with labels.

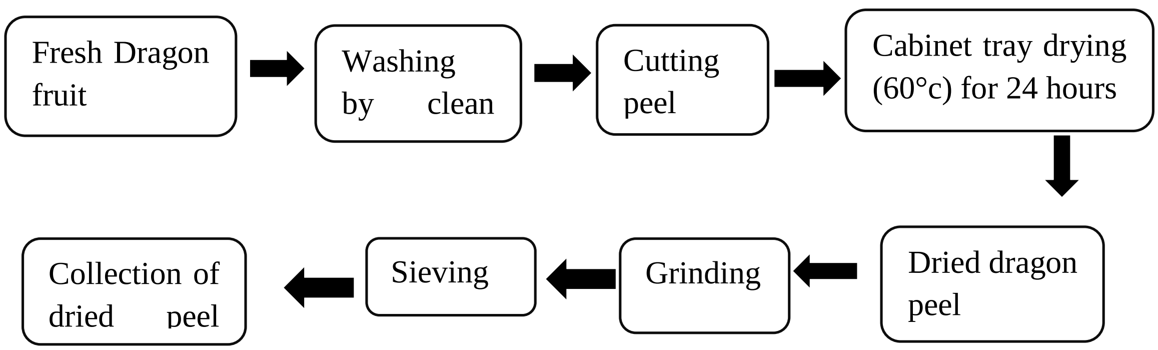

Figure 2: Peel power preparation

3.7 Yogurt processing

The nutritional value and sensory qualities of the manufactured yogurt were tested after heating the milk to pasteurization temperature with the addition of 10% sugar, allowing it to cool to room temperature, and then combining in the peel powder in three formulation ratios with control.

Sample A= Control (without peel powder)

Sample B= yogurt containing 2% peel powder

Sample C= yogurt containing 5% peel powder

Sample D= yogurt containing 7% peel powder

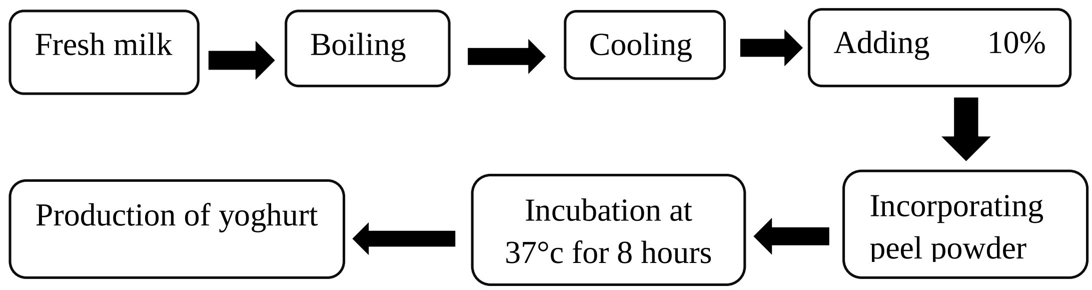

Figure 3: Yogurt processing

3.8 Yogurt's physicochemical analysis

AVOC (2016) procedures were used to test the following properties in fresh samples: pH, acidity, titratable acidity, ash, crude fiber, crude fat, and protein. These samples also underwent proximate analysis, Vitamin C analysis, and antioxidant analysis

3.8.1 Determination of pH

In chemistry, an aqueous solution's pH serves as a gauge for how acidic or basic it is. In technical language, pH is most referred to as a measure of hydronium ion concentrations. pH is the negative logarithm of the activity of the (solvated) hydronium ion. The difference between a hydrogen electrode and a standard electrode, such as the silver chloride electrode, is monitored in a concentration cell with transference to ascertain the fundamental pH standards. You can use a glass electrode, a pH meter, or indicators to check the pH of aqueous solutions. pH is the reciprocal of the hydrogen ion activity in a solution expressed as a decimal logarithm. (McClements and Decker,2010)

3.8.2 Titratable Acidity

The percentage of acidity in terms of anhydrous citric acid was determined by titrating against N/10 NaOH with phenolphthalein indicator. 10ml of sample was added to a volumetric flask with a capacity of 100ml, which was then filled with distilled water. From there, the volume was raised to 100ml, and 10ml of the diluted sample was titrated against N/10 NaOH using phenolphthalein as an indicator. The conclusion of the titration is indicated by the pink hue. After titration was reported three times, average value was taken (AVOC, 2016).

As shown below, titratable acidity may be calculated:

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

Where

TV = Sample titer value in milliliters

W = Sample size for the test, measured in milliliters

Citrus fruit has a citric acid factor of 0.0064 and malic acid of 0.0067

3.8.3 Determination of Vitamin C

The market-reducing properties of vitamin C are the foundation for its chemical assay. The capacity of vitamin C to decrease the dyes 2, 6-dichloride phenol indophenols is often used to evaluate it in plant or animal extracts. The color pigment in this case converted vitamin C into dehydroascorbic acid. The dye is generated into a colorless molecule at the same moment. S that the endpoint of the reaction can be easily determined. Since oxidized Vitamin C, which is virtually destroyed during testing and grinding, may contribute excess into plant products, rapid excretion and filtration are desirable. The use of metaphosphoric acid in the extraction procedure causes oxidation. The most exact result will come from an extremely acidic solution. In one minute, the titration ought to be accomplished. When dissolved in water, the dye turns blue. When lowered in an acidic solution, it completely loses its color. (AOAC, 2016).

Reagent requirement

Solution for Dye

1. 260 milligrams of colorant (2, 6-dichlorophenol indophenols)

2. Distilled water and 210 mg of $NaHCO_3$ in 100 ml.

Concentration of metaphosphoric acid (3%)

1. Metaphosphoric acid (15/7.5 mg).

2. Glacial acetic acid is diluted with distilled water to make 500/250 ml from 40/20 ml.

Ascorbic acid mixture as is customary 500 ml of metaphosphoric acid solution was mixed with 50/25 mg of crystalline ascorbic acid.

Procedure

The burette was filled with a dye solution. Then, a conical flask was filled with 5 mL of vitamin C solution. Drop by drop, dye was added to the conical flask, which was placed beneath the burette. When a pink tint developed, remained for 20 seconds, and then disappeared, the titration was complete. At least three readings were taken. An ascorbic acid solution with an unknown concentration was treated using the same procedure. The result was expressed as a percentage of milligrams (mg percent).

3.9 Nutritional composition of yogurt

3.9.1 Estimation of Ash

All of the mineral components are mixed in the ash fraction. Knowing the amounts of several different substances would be more helpful. However, it does permit the estimation of contamination and the calculation of Nitrogen-Free-Extract (by difference) from dry matter (see below) (due to too much soil or too much salt applied).

This technique comprises weighing the ash after oxidizing an entire material sample that was weighed. It may be used to produce low-carb fish, fish products, and other things.In addition to melting and fusing solid materials, high temperatures may cause the volatilization of several elements (especially K, Na, Cl, and P)

Procedure

To begin, a vacant crucible was thoroughly cleaned and dried in a hot air furnace. It was placed in desiccators and allowed to cool before being weighed. Weighing 2-5 grams of the sample and placing it in the crucible it was allowed to burn until the sample was completely smoke-free. The crucible was cooled and placed in the muffle furnace for 6-8 hours at 550-600°C. When white ash is formed, the procedure is complete. It was chilled to 150°C before being placed in a desiccator. The weight was taken when it had cooled to a pleasant warm temperature.

5-10gm sample placing in crucible

⬇

Burned it up to smoke

⬇

Cooled the sample and transferred it to muffle furnace

⬇

Flamed out it at 550-600^{0}C for 6-8 hours until white ash

⬇

Cooled it at 150^{0}C and transferred it to the desiccator

⬇

Weighted the sample at mild warm

Figure 4: Estimation of Ash

The formula below was used to determine the ash content

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

Where W= weight of the crucible with ash

W_1 = weight of the empty crucible

W_2 = weight of the sample

3.9.2 Moisture content

One of the most crucial and frequently used metrics in the preparation and testing of meals is moisture monitoring. The moisture content of food has direct economic significance for both the processor and the consumer since the amount of dry matter in a serving of food is inversely linked to the amount of moisture it contains. On the other hand, moisture has a much greater effect on the consistency and quality of food. The moisture content was determined using a technique advised by the Association of Official Analytical Chemists (AOAC, 2016)

Calculation:

Following is how the percentage of moisture was determined:

$$\% \text{ Moisture} = \frac{w-w1}{w} \times 100$$

W= weight dry sample

W_1 **=** weight of dried matter

3.9.3 Estimation of Crude Fiber

Principle:

Cellulose, hemicellulose, and lignin make up the majority of crude fiber, the portion of carbohydrates that is insoluble in water. It is estimated by first boiling a known amount of fat-free food for 30 minutes in a weak acid solution (1.25 percent H_2SO4), followed by 30 minutes of constant volume boiling in a weak alkali solution (1.25 percent NaOH), and then deducting the ash from the residue that is left over. The crude fiber was calculated using the AOAC method (2016). The rest was then heated to 550–600°C and burned for 4-6 hours in a muffle furnace, turning it into white ash.

Calculation: Calculation of the crude fiber percentage as follows:

$$\% \text{ Crude fiber} = \frac{w-w1}{w2} \times 100$$

Where,

W= Weight of crucible, crude fiber and ash

W1=Weight of crucible and ash

W2= Weight of sample

3.9.4 Protein analysis

Protein content was determined by following AOAC (2000) method 2.049. Following was the course of events:

Reagent required

i) Concentrated sulphuric acid (nitrogen-free) 20 ml

ii) Digestion mixture:

• Potassium sulphate: 100gm

• Copper sulfate: 10 g

• Selenium di-oxide: 2.5g properly homogenized in a mortar and stored in a dry location.

iii) Boric acid solution: 2% solution in water

iv) Alkali solution: 400g of sodium hydroxide should be diluted to 1 liter of water.

v) Mixed indicator solution Bromocresol: 0.1g and methyl red-2g dissolved in 250 ml

Ethyl alcohol.

vi) Standard HC1: 0.1N

Procedure

Accurately weighing 5g of the digesting mixture, it was then transferred to a dry, 300ml Kjeldahl's flask. The appropriate amount of sample (1g for each) was added to the flask. Twenty milliliters of sulphuric acid were added, heated slowly until froth subsided, and then simmered fast. After 15-20 minutes, the solution became clear, and another 45 minutes were spent heating it. After cooling, 500 ml—the entire amount—was quantitatively transferred to a 1-liter round-bottom flask by adding 100 ml of water. A little amount of sodium hydroxide solution was gently added to the side to create cupric hydroxide precipitation. The steam trap and condenser were readily connected to the flask after that. Then, 50 ml of the boric acid solution, 50 ml of distilled water, and 5 drops of the indicator solution were added to a 500 ml conical receiving flask. A 250 ml quantity of distillate was collected after the condenser was placed and the distillation was performed for 4 to 5 minutes. After that, 0.1 N hydrochloric acids were used to titrate the contents of the receiving flask, and a brown coloring served as an indicator of the finish point. Additionally, a reagent blank was found and subtracted from the titration. One gram of nitrogen is equal to one milliliter of hydrochloric acid at a concentration of 0.1N. The percentage of protein from nitrogen was calculated using a protein conversation factor. To calculate the percentages of nitrogen and protein, use the equation below:

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

Here,

Ts = Titre volume of the sample (ml)

Tb= Titre volume of the blank (ml)

Protein (%) = Nitrogen% x Protein factor

3.9.5 Estimation of Crude Fat

Principle:

Food samples are dissolved in organic solvents (such as methanol or chloroform) before being filtered to separate the filtrate. Dividing the filtrate into funnels, drying the resulting mixture to determine the extract, and then calculating the fat content. AOAC (2016) protocols were used to analyze the samples' crude fat content using a soxhlet instrument.

Calculation

The amount of crude fat was measured using a Soxhlet apparatus. A thimble was used to contain the weighted, dried sample, and fat-free cotton was used as the plug. The fat extraction tube of the Soxhlet flask was inserted using the thimble. 75 mL of anhydrous ether were put into the flask, and the head of the fat extraction tube was fastened to the condenser. The material was extracted over the course of at most 16 hours. The thimble was taken off once the separation was finished, and the Soxhlet tube was used to distill and collect most of the ether. The tube would be almost full when the ether was poured out. A funnel was used to transmit the ether carrying the sample's fat granules into a beaker once the volume of ether holding them had been attained at a very small volume. The flask was properly cleaned and filtered with ether. The ether was then vaporized over a low-temperature steam bath.

The formula following is used to calculate the amount of fat in the test:

$$\text{Fat \%} = \frac{weight\ of\ the\ extract}{weight\ of\ the\ sample} \times 100$$

3.10 Determination of Antioxidant capacity by DPPH scavenging method

Getting ready the extract A Felcon tube was used to hold a 1 gram sample that was collected. The mixture was then given 10 mL of 100 percent methanol and allowed to stand for 72 hours. A four-hour respite was followed by continuous straining. After 72 hours, the samples were filtered, and methanoic extracted was found. Methods the DPPH assay, which would have been constantly improved from Azlim et al., was used to assess the transportation of the samples' antioxidants (2010). 6 milligrams of DPPH were dissolved in 100 mL of pure methanol to create a methanoic DPPH solution. Then, 1 ml of methanoic extracts was combined with 2 ml of DPPH solution. The solution was gently shaken, then let to stand for 30 minutes at room temperature in the darkened. A UV-VIS spectrophotometer was used to evaluate the transmittance at 517 nanometers (UV-2600, Shimadzu Corporation, USA). Methanol would be used as a reference and 1 mL of methanol plus 2 mL of DPPH solution as either a blank. The diffusing mobility of the samples was determined by comparing the intensity of the samples with that of the DPPH test solution.

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.

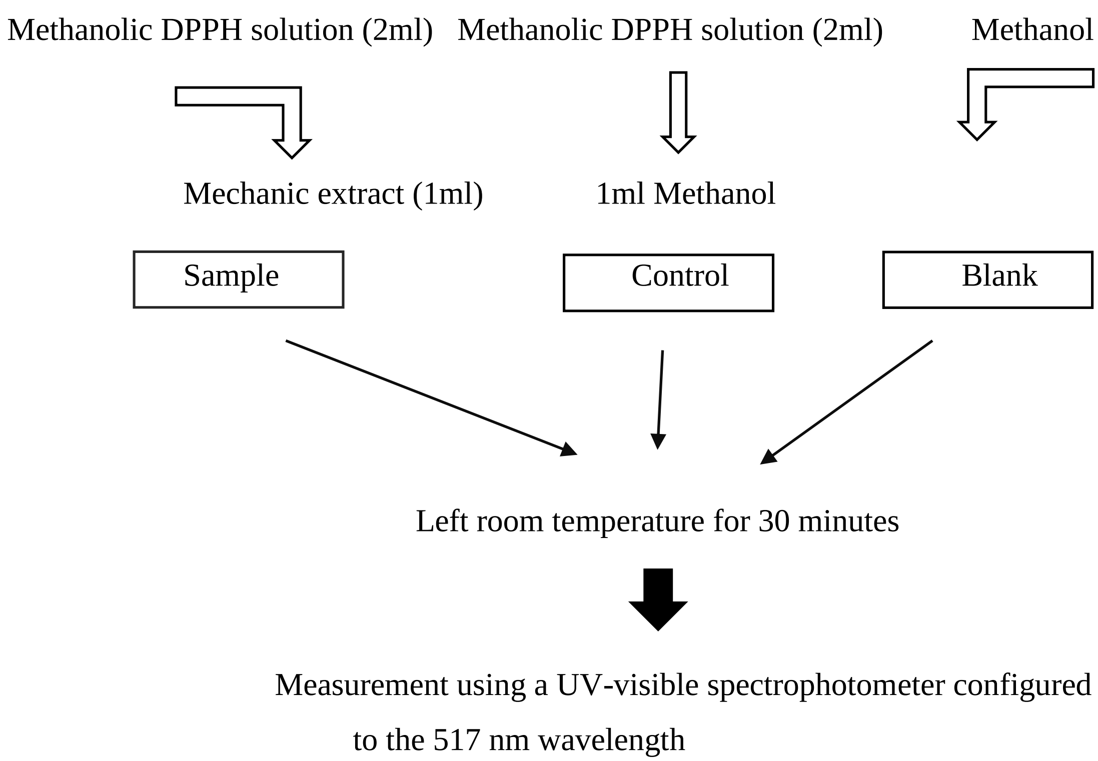

Figure 5: Determination of Antioxidant capacity

Calculation

Through using following formulae, extracts' antioxidant capacity based on their DPPH free radical scavenging mobility was computed.

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

3.11 Microbial Analysis:

3.11.1 Aerobic plate count (Bacterial plate count)

The aerobic plate count is a measure of the bacterial population that was used on a sample. Other names for the aerobic plate count (SPC), total plate count (TPC), and mesophilic count are standard plate count and aerobic colony count, respectively (APC). The Typical Plate Count (SPC). A certain method was used to determine the total number of bacteria that were viable (TVC). The test is built around the idea that each cell will grow into a clear colony when combined with agar that contains the necessary nutrients.

The entire bacterial habitat is not considered; rather, it only assesses microorganisms that can thrive aerobically at mesophilic temperatures (25 to 40°C). APC can be used to evaluate overall acceptability acceptability, hygienic quality, compliance with good specifications, and as a safety indicator even if it is unable to differentiate between different bacterial species. APC can offer details about a food's prolonged storage or predicted organoleptic improvement (Banwart, 2012).

3.11.2 Sample preparation

The methodology used to gather the sample has a significant impact on the accuracy of the analysis and interpretation of the results. The sample ought to be a true representation of the total volume. Because of this, the material was thoroughly blended to ensure that the sample was accurate for the current batch of items. In a 250 ml conical flask, 25 g of this mixed thoroughly yogurt were placed. To dilute the samples, phosphate buffer saline (0.6 M KH2PO4 at pH 7.2) was utilized. The pipette received 100 mL of buffered saline, which was then extensively agitated while moving back and forth. With almost the same buffer water, the volume being covered. To sanitize all of the equipment, solutions, and other supplies, they must always be heated to 1210 C for 15 minutes. The created sample was then used as a stock solution after being diluted to 10 times its original concentration (1-10-1 dilution) (Andrews et al., 1992).

3.11.3 Dilution

The following dilutions were created using 9 ml blanks. First, a dilution was made (1 ml in 9 ml) (b). This was mixed in a vortex mixer (c) The next tube received 1 ml from (b), which was nicely mixed. It was 10-2 times less concentrated. In this way, the dilution was raised to 10-6.

3.11.4 Standard plate counts

An SPC was used to estimate the number of microorganisms present in the prepared and stored samples. This information may be used to make forecasts about product shelf life or as indications of food quality1 cc of the dissolved material being pipette into any of the sterile empty petri dishes with nourishing agar medium (Plate count agar) at 45°C using a pipette. The dishes were pushed together on a horizontal surface. The plates were switched over rather than incubated in an incubator for 24 hours at 37 °C after the media had formed. (AOAC, 1990).

3.11.5 Counting and recording

The number of colonies and the simplicity with which they could be counted were taken into consideration while selecting the incubated plates for bacterial colony counting after incubation. The plate with separated, overlapping, and confusing colonies was decided to avoid. Plates having colonies that ranged in size from 30 to 250 that were colorful, unique, and countable were selected. The typical colony forming unit (cfu) plate diluting ratio is cfu/g or ml. Testing procedure, sample dilution, standard plate counts, along with measuring and storing, were all used in the viable total bacterial. Incubation took place for 24 hours at 37°C. (AOAC, 1990).

3.11.6 Coliform Test

i. From the test solution, 10ml, 1ml, and 0.1ml of the solvent were drawn. After that, combine with the LST broth solutions in turn in each of the three separate bottles of LST broth using Durham tubes.

ii. For growth, these broth bottles were kept in an incubator for 24 hours at 37 degrees Celsius.

3.12Cost Analysis

Based on the overall cost of the ingredients needed to manufacture the yogurt, the cost of the fruit yogurt using peel powder as its premise was calculated. The total was displayed in taka, and the price per yogurt cup was determined

3.13 Sensory evaluation

Sensory evaluation was used to gauge the overall level of customer satisfaction with the finished product. A taste-testing panel assessed the generated good's commercial acceptance. On the CVASU campus, a panel test was conducted. There were 10 untrained panelists in all, and that each received the product. Three distinct formulae were encoded beginning with Samples A, B, and C. Without being told what they were doing, the panelists sampled the three samples. Each yogurt sensory quality, including look, color, taste, consistency, taste, sweetness, and overall acceptance, was assessed by the panelists. This strategy clearly implies characteristics that a high-quality product should have, even if it obviously does not match real customer perception (Sing et al., 2008). They evaluated each of the four things they tested individually. Using nine-point Hedonic measures, sensory assessment of the four samples' qualitative qualities (taste, appearance, flavor, mouth feel, sweetness, and overall acceptability) was carried out (Larmond et al., 1977).

Table 1: The following is how the scale was set up:

Ranks	Score
Like very much	5
Slightly like	4
Neither like nor dislike	3
Dislike slightly	2
Dislike very much	1

3.14 Statistical Analysis

Data were determined and saved on a Minitab 19 spread sheet to evaluate statistical analysis. For each sample, three replicates were employed. Descriptive statistics (mean and standard deviation) were conducted to analyze the proximate composition and sensory evaluation of fruit yogurt. After that, statistical analyses were performed. One-way ANOVA protocols were used to determine the major degree of variation for data on proximate composition, antioxidant properties, and sensory evaluation at the confidence interval of 95%. To find variation within the sample groups, a post hoc "Tukey" test was being used. A significance level of 5% was used for the statistical analysis ($p \leq .05$).

Chapter 4: Result

4.1 Physicochemical properties of yogurt:

P^H of fruit yogurt is an important factor for optimum condition. In table, lowest (4.3600±0.0361%) pH found in sample B and highest (4.7333±0.0577%) in sample A. The maximum value (0.189000±0.001000%) of acidity obtained in sample D and the least value (0.164667±0.001528%) found in sample A. there is no vitamin C found in sample A and the highest value found in sample D (1.34333±0.02 mg/100g) .

Table 2: Physicochemical properties of yogurt

Sample	P^H	Tritratable Acidity	Vitamin C(mg/100g)
A	4.7333±0.0577[a]	0.164667±0.001528[b]	0.000[c]
B	4.3600±0.0361[b]	0.188000±0.001000[a]	1.17333±0.01[b]
C	4.3833±0.0289[b]	0.188667±0.000577[a]	1.34000±0.01[a]
D	4.4167±0.0289[b]	0.189000±0.001000[a]	1.34333±0.02[a]

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

Sample A – yogurt from plain milk without adding dragon peel powder

Sample B – yogurt with 2% peel powder

Sample C – yogurt with 5% peel powder

Sample D – yogurt with 7% peel powder

4.2 Nutritional Composition of yogurt

The nutritional value of yogurt is displayed in table (3); nearly all samples varied significantly from the result of one way ANOVA analysis. The largest percentages of crude fat (19.5333±0.02%) found in samples B and crude protein (21.07330±07 percent), crude fiber (19.3433±0.03%) were found in D. The samples A, D, and C had the lowest amounts of crude fiber (14.53000±0.02%), crude fat (18.3600±0.01%), and crude protein (21.0233±0.04%) correspondingly.

Table 3: Nutritional composition of yogurt

Sample	Moisture (%)	Crude Protein (%)	Fat (%)	Ash (%)	Crude Fiber (%)
A	78.06533 ± 0.04^{C}	21.4967 ± 0.02^{a}	19.4800 ± 0.01^{b}	5.19333 ± 0.01^{b}	14.5300 ± 0.02^{d}
B	76.7067 ± 0.03^{d}	21.0500 ± 0.05^{b}	19.5333 ± 0.02^{a}	5.28000 ± 0.01^{a}	18.3700 ± 0.01^{c}
C	79.3000 ± 0.02^{b}	21.0233 ± 0.04^{b}	18.5600 ± 0.01^{c}	5.29000 ± 0.01^{a}	18.4367 ± 0.01^{b}
D	80.1867 ± 0.02^{a}	21.0733 ± 0.07^{b}	18.3600 ± 0.01^{d}	5.29333 ± 0.01^{a}	19.3433 ± 0.03^{a}

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

4.3 Antioxidant capacity:

From the table, it was observed that antioxidant capacity was significantly highest (1.57567±0.0051 mg TE/100 g) in sample D and significantly lowest (1.30433±0.003 mg TE/100 g) in sample A.

Table 4: Antioxidant capacity of yogurt

Sample	Antioxidant capacity (mg/100g)
A	1.30433 ± 0.00306^{d}
B	1.43767 ± 0.00404^{c}
C	1.51900 ± 0.00361^{b}
D	1.57567 ± 0.00513^{a}

Legends: Means ± SD and within the column bearing different superscripts (a, b) are not significantly different (P< 0.05).

Sample A – yogurt from plain milk without adding dragon peel powder

Sample B – yogurt with 2% peel powder

Sample C – yogurt with 5% peel powder

Sample D – yogurt with 7% peel powder

4.4 Microbial analysis

The total number of live cells (microorganisms) present in the prepared fruit yogurt was determined by TVC of a yogurt sample. Due to the inclusion of peel powder, which may increase the amount of acidity thus fruit yogurt's TVC was greater in type A than the other (B, C, and D) samples of yogurt (A type yogurt). As a result, it was thought that any kind of yogurt made from dragon peel powder was safe for ingestion.

The hazardous bacteria known as coliform is often found in nature and may result severe diarrhea. In every kind of prepared yogurt sample, TCC was zero. As advised by Bangladesh Standards Testing Institute, the final goods should contain coliform fewer than 10cfu/ml (BSTI). However, in this investigation, the coliform count of every kind of prepared yogurt sample remained zero, as shown in Table 5. Four prepared yogurt samples (A, B, C, and D) were deemed to be safe for ingestion as a result.

Table 5: Microbiological Evaluation

Sample	TVC (cfu/ml)	Coliform
A	65.17 ± 1.15^{a}	0
B	56.64 ± 0.56^{d}	0
C	61.45 ± 0.48^{c}	0
D	64.23 ± 0.27^{b}	0

Legends: Means ± SD and within the column bearing different superscripts (a, b) are not significantly different (P< 0.05).

4.5 Sensory analysis:

All of the sensory attributes evaluated showed no statistically significant difference (p>0.05). Sample A got the highest acceptance rate of all the parameters. When compared to the other tests, sample C had the lowest acceptability rating**.**

Table 6: Test for sensory evaluation of yogurt

Sample	Color	Taste	consistency	smell	Overall Acceptability
A(control)	4.50±0.52^{b}	3.13±0.45^{c}	2.98±0.32^{c}	3.10±0.45^{ab}	3.32±0.21^{c}
B (2%)	4.40±0.52^{b}	4.30±0.68^{a}	4.40±0.52^{a}	3.90±0.57^{a}	4.50±0.53^{a}
C (5%)	4.40±0.52^{b}	3.90±0.57^{ab}	3.70±0.68^{b}	3.80±0.42^{a}	4.00±0.67^{ab}
D (7%)	5.00±0.32^{a}	3.50±0.52^{b}	3.30±0.48^{b}	3.30±0.48^{b}	3.80±0.42^{b}

Legends: Means ± SD and within the column bearing different superscripts (a, b) are not significantly different (P< 0.05).

4.6 Cost analysis

Table 7: Production cost of yogurt

Heads	Tk./Kg	Quantity used(g/1kg products)	Total Tk (Formulation 2%)	TotalTk (Control)
1)Expenditure				
Raw materials				
Peel powder	215	20	53.75	00.00
Sugar	80	10	80.00	80.00
Milk	70	1000	70.00	70.00
Culture	95	02	2.00	2.00
Sub total			205.75	152.00
2) Processing cost @ 15% of raw material			30.56	22.80
3) Packaging cost 10 pieces cup		2 Tk./piece	20.00	20.00
Total production cost of 1kg of fruit yogurt			**256.31**	**194.80**

By following this recipe, we can prepared 10 cup of yogurt from 1 kg milk. So, price of per cup is:

Control per cup yogurt is =**194.80/10** taka

=**19.48** taka

Formulation per cup fruit yogurt is = **256.31/10** taka

=**25.63** taka

Chapter 5: Discussions

4.2 Physicochemical properties of yogurt

The pH of yogurt is critical for optimal performance. Low pH in food also inhibits microbial development. In this investigation, sample B had the lowest pH (4.36) and sample A had the highest (4.73).

All of the results are in the range of 4.5-5.5; Ashaye and Adeleke also found similar results (2010). The considerable fluctuation in pH value could be due to different percentages of peel powder providing varied pH values (Morales-Cabrera et al., 2013).

The pH value of all samples varied significantly, ranging from 4.3 to 4.7, and these values were within the permitted range for regular yogurt, as shown in the table. Fruit yogurt has a pH of 4.5, according to (Broomes et al. 2010).

The presence of insufficient acid content is one of the most prevalent causes of yogurt failure and long-term storage. When the yogurt has settled enough, the pH value should be measured.

If the pH is higher than the optimal 6, the storage time decreases; it becomes 2-3 days, with a maximum of 7 days. Citric acid might be added commercially at the required amount to lower the pH to the range of 4.2 to 4.5, with a pH of 4.7-5.0 being the optimum. By adding the citric acid towards the conclusion of the boiling process, you may be able to achieve greater pH control. The pH can be changed to get the best possible storage time, as well as to control or modify the rate of setting (Eke-Ejiofor and Owuno, 2013).

Almost all of the samples in this investigation showed no significant change in total titratable acidity content of yogurt. The highest acidity value (0.18%) was identified in sample D, while the lowest value (0.16%) was recorded in sample A. Acidity could be caused by the presence of lactic acid in the environment. The titratable acidity of yogurt below the range of optimal acidity in this study was (0.6–0.8%). According to (Shah et al., 2015) the result is satisfactory because the higher the acidity, the more acidity taste will be discovered in the yogurt.

4.3 Nutritional composition of yogurt

When dragon fruit peel powder is mixed with milk to make yogurt, it delivers essential elements such as protein, fat, fiber, and vitamins. Four different types of yogurt were shown to have similar compositions. Sample B had a lower moisture content than control sample A, whereas samples C and D had a higher moisture content than control sample A. It could be because various percentages of peel powder are added during processing for different types. According to (Siddiqui et al., 2015), peel powder holds the moisture of products, resulting in a moisture or water percentage in the product.

Moisture is a significant component that affects product shelf life and freshness. Foods with a high moisture content have a shorter shelf life. Ashaye and Adeleke (2009) estimate that the moisture level of peel enhance yogurt is between 75 and 80 percent. Due to storage conditions and the amount of peel utilized during preparation, the moisture level of fruit yogurt can vary (Broomes and Badrie, 2010).

When compared to control sample A, sample B had the greatest value of crude fiber (19.34%), crude fat (19.53%), and crude protein (21.05%), while sample D had the highest ash level (5.29%). Dragon fruit peel is high in nutritional composition, particularly dietary fiber, according to Ismail et al., (2008). The ash content in food products indicates the mineral composition of the food (khan et al., 2012). (Mordi et al.,2011) reported that another fruit peel powder added in yogurt had a better nutritious content in this investigation.

For life to exist, ascorbic acid is required. Samples C and D of dragon fruit peel powder had higher vitamin C content (1.34) and (1.343) mg/100g, respectively, than the other samples. It could be the result of a lengthy heat treatment during processing. According to (Martinsen et al., 2020) high processing temperatures reduced ascorbic acid concentration. The ascorbic acid concentration in red and yellow dragon peel powder ranged from 1.9 mg/100 gm. to 2 mg/100 gm. (Ashaye and Adeleke, 2009).

According to (Martinsen et al., 2020) high processing temperatures reduced ascorbic acid concentration . Consumption of vitamin C-rich fruits has been linked to a lower risk of cardiovascular disease and obesity (González Molina et al., 2010). Because the human body is unable to produce these nutrients, they must be supplemented by dietary intake of fruits and vegetables (Leong and Oey, 2012).

4.4 Antioxidant capacity

The antioxidant capacity of all of the tests varies significantly. DPPH was a common substrate for assessing antioxidant activity, especially in the study of biological and chemical substances' ability to scavenge free radicals. Sample D demonstrated a higher antioxidant capacity (1.57 mg TE/100 g) than control sample A. This could be due to the strong antioxidant content of the Dragon fruit peel, which contains 2.67 mg of TE per 100 g. (Mohamed and colleagues, 2007). According to (Ogutu et al., 2007) a high peel content improves antioxidant capacity. Heat and pH alter the antioxidant content of peel powder and its product (Wu et al., 2018), although 65% antioxidant capacity was maintained after processing fruits peel into yogurt (Ceron et al., 2014).

4.5 Microbial

Total viable counts for yogurt's A, B, C, and D kinds were 65.17×10^4, 56.64×10^4, 61.45×10^4, and 64.23×10^4 per gm. respectively. The statistical analysis showed that the samples differed significantly from one another. According to this information, incorporating peel powder to the solution increased the number of viable cells overall. The findings of this study corroborate Rahman's (1998) findings, which stated that the average total viable count of yogurt drinks was 120.22(2.51) 10^4/g ,The present results agree from those of (Nahar et al. 2007), who found that the typical total viable count per gram of yoghurt experiment was 75×10^4. None of the yogurt sampled contained any coliform bacteria. The existence of coliform bacteria indicates unhygienic yogurt making conditions. The absence of coliform counts in this experiment may be attributed to the sanitary practices used in the gathering of milk and yogurt production as well as the use of an effective bacterial culture.

4.6 Sensory Evaluation

The highest organoleptic ally suitable proportion of yogurt was determined through sensory analysis of all yogurt samples. According to the sensory analysis data in Table (6), fruit yogurt containing 2% peel powder that is sample A has the highest overall acceptance of 4.50. It could be because of how the food tastes, how consistent it is, and how it looks. Sample B's acceptable sensory level was the most similar to the values of samples A and C. The composition of the peel % contained in yogurt has an impact on the mouth feel score. With an increase in the amount of peel powder in the yogurt, the texture score declined. (Basu et al., 2010) reported a similar proclivity. In the hedonic rating scale, the highest mean acceptability score of 4.50 in sample B denoted "Like Very Much." Fruit yogurt with 2% peel powder in both varieties was shown to have a superior organoleptic ally than other compositions, according to the current study. Yogurt made from peel powder received great sensory grades. Fruit yogurt made from peel powder and kept at room temperature for four days is still acceptable (Ashaye et al., 2009).

Chapter 6: Conclusion

Because of its nutritional benefits, yogurt is a popular food product in ready-to-eat dishes. In this investigation, it was discovered that fruit-yogurt made from dragon peel powder has the highest sensory acceptance. Yogurt was subjected to a physicochemical test, which revealed substantial differences. Yogurt provided a rich source of protein, fat, and vitamins in the short term. It is classified as a functional food since it contains a high concentration of phytochemicals such as antioxidants. Commercial fruit yogurt was not tasted in the current investigation due to its unavailability in local markets. The nutritional outcomes were determined to be satisfactory, which helps to improve the health status. Due of its low cost and ease of use, that method can be advantageous to consumers. This study predicts a bright future for the production of yogurt in Bangladesh using powdered dragon fruit peel, to the benefit of producers, processors, and buyers. Additionally, it is important to remember that exporting goods that meet the highest international standards might bring in foreign currency and benefit Bangladesh's economy. Trials with different forms of fruit waste for the development of yogurt require additional investigation with other crucial elements.

Chapter 7: Recommendations and Future Perspectives

More than 50% of people in Bangladesh are undernourished; in this situation, yogurt, which is commonly available throughout the country, could be a great source of nutrients needed. We have found some promising results in the area of making fruit yogurt from leftover fruit. Its commercial potential and marketability have also increased. The transition from intermediate to big scale production is one that contemporary food businesses can use. Based on the findings of the investigation at hand, the following suggestions and research projects are made.

a) The current research could be expanded upon to find more accurate experimental results with large amounts of sample size.
b) The mixture might be further altered, and you could experiment with making fruit yogurt using different recipes and fruit ratios.
c) Because it is simple to cook and advised to prepare it throughout the fruit season when it is simple to purchase. This will benefit those who fall under the economically weaker part from an economic standpoint.
d) Similar studies ought to be carried out on other marketable fruits, such as papaya and mango.
e) For the improvement of storage conditions, modern packaging and storage conditions will be devised.
f) Because the research has medicinal significance, it will be beneficial from a therapeutic standpoint.
g) Even if statistical comparisons between the analytical data might be made using the sample size. Due to the limited number of samples that were examined, our conclusion should be treated with caution, and the findings need to be verified in a bigger study.
h) Sufficient initiatives should be done to add more nutritional value to commercially marketed yogurt.

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Appendices

Appendices 1: pictorial presentation of processing of yogurt

Dragon fruit

Washing

Dragon peel

Cutting

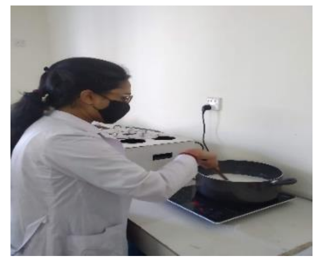
Drying at cabinet dryer

Dry peel

Grinding

Incubation

Mixing peel powder



Boiling milk

Final product

Appendices 2: laboratories activities





Determination of Antioxidant activity


Crude fiber determination

Weighting of yogurt

Ash determination


Protein determination

PH measurement

Determination Vitamin C

Sensory evaluation

Appendix C: Questionnaire for yogurt

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 very much = 5, Slightly like = 4, Neither like nor dislike = 3, Dislike slightly = 2, Dislike very much = 1

Here,

Sample A – yogurt with 2% peel powder

Sample B – yogurt with 5% peel powder

Sample C – yogurt with 7% peel powder

Hedonic scale	Flavor			Mouth feel			Sweetness			Appearance			consistency			Overall Acceptability		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Like very much																		
Slightly Like																		
Neither like or dislike																		
Dislike slightly																		
Dislike very much																		
Comments																		

Brief biography

Bithi Rani Sarker completed B.Sc. (Hon's) in Food Science and Technology from the Faculty of Food Science and Technology of Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram, Bangladesh with CGPA 3.54 out of 4.00. Now, she is a candidate for the degree of MS in Applied Human Nutrition and Dietetics under the Department of Applied Food Science and Nutrition, CVASU. She has immense interest to work on the development of a yogurt incorporating red dragon fruit's (*Hylocereus polyrhizus*) peel powder and determine its quality parameter.