PROCESSING OF A VALUE-ADDED DRAGON FRUIT DEHYDRATED R.T.E. BAR USING A MULTI-HEAD SOLAR PANEL DRYER

A Project Report

By

Rifa Binta Zakir

ID: 191-34-867

Submitted to the Department of Nutrition and Food Engineering for the partial fulfillment of Bachelor degree in Nutrition and Food Engineering

Supervised By

Dr. Md. Bellal Hossain

Professor

Department of Nutrition and Food Engineering

Faculty of Health and Life Science (FHLS)

FACULTY OF HEALTH AND LIFE SCIENCE (FHLS)

DAFFODIL INTERNATIONAL UNIVERSITY

September 2024

APPROVAL

This project titled "**Processing of a value-added Dragon Fruit Dehydrated RTE Bar Using a Multi-Head Solar Panel Dryer",** submitted by **Rifa Binta Zakir** to the Department of Nutrition and Food Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfilment of the requirements for the degree of B.SC. in Nutrition and Food Engineering and approved as to its styled and contents. The presentation has been held on June, 2024.

EXAMINING COMMITTEE

Chairman of the Board _____

External Member _____

Internal Member 1 _____

Internal Member 2 _____

_____

Dr. Nizam Uddin
Associate Professor & Head
Faculty of Health and Life Sciences
Nutritional and Food Engineering
Daffodil International University

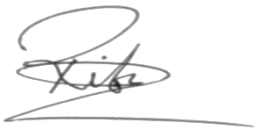
DECLARATION

I hereby declare that; this project has been done by me under the supervision of **Dr. Md. Bellal Hossain,** Professor, Department of NFE, Daffodil International University. I also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

Supervised By:

Professor Dr. Md. Bellal Hossain
Professor
Department of Nutrition and Food Engineering
Daffodil International University

Submitted By:



Rifa Binta Zakir
191-34-867
B.SC in Department of Nutrition and Food Engineering
Daffodil International University

ACKNOWLEDGEMENT

First, I express my heartiest thanks and gratefulness to almighty for his divine blessing makes me possible to complete the final year project successfully. I really grateful and wish our profound our indebtedness to **Dr. Md. Bellal Hossain, Professor,** Department of Nutrition and Food Engineering, Daffodil International University.

His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts and correcting them at all stage have made it possible to complete this project.

I would like to express my heartiest gratitude to **Dr. Nizam Uddin, Associate Professor and Head,** Department of NFE, for his kind help to finish my project and also to other faculty member and the staff of NFE, Daffodil International University. I would like to thank to my entire course mate in Daffodil International University. Finally, I must acknowledge with due respect the constant support and patients of my parents.

ABSTRACT

Dragon fruit is an emerging super-exotic fruit, known for being rich in water-soluble fibers and antioxidants. This study aimed to develop dragon fruit leather and assess its nutritional and sensory properties. The nutritional analysis of dragon fruit showed 16% total soluble solids (TSS), 2.34% ash, 3.4% fat, 2.2% protein, a pH of 4.5, and 8.56% moisture respectively. Sensory evaluations were conducted to assess the attributes of dragon fruit bar. For color, 28 out of 30 participants liked it extremely, 25 liked it very much, 12 liked it moderately, and 3 liked it slightly. For flavor, 28 participants liked it extremely, 25 liked it very much, 11 liked it moderately, and 4 liked it slightly. For texture, 22 participants liked it extremely, 20 liked it very much, and 3 liked it moderately. For taste, 25 participants liked it extremely, 20 liked it very much, and 3 liked it slightly. Overall, 78% of participants liked the dragon fruit Bar extremely, 20% choice very much, and 2% moderately.

Keyword: *Dragon, Fruit, Leather, Composition, sensory quality, evaluation*

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER: One

INTRODUCTION

1.1 Introduction

Dragon fruit, is cruciferous and highly nutritious, distinctive hot sessional fruit that belongs to the genera *Hylocereus* and *Selenicereus*. Originating from Central America, this exotic fruit extensively cultivated in muddy soil and subtropical areas across the Universe. Dragon fruit is highly regarded for its striking appearance, featuring bright pink or yellow skin with green scales, and its vibrant, speckled flesh, which can be white, red, or purple. In addition to its eye-catching colors, dragon fruit is celebrated for its refreshing and mildly sweet taste, making it a popular choice for both culinary and health purposes.

Figure 1: Dragon cultivation

Dragon fruit is a tropical fruit renowned for its unique appearance and delightful taste. It features bright pink or yellow skin with a distinctive scaly texture, making it easily recognizable. The flesh inside can vary in color, typically being either white or red, and is speckled with small black seeds. In terms of taste, dragon fruit offers a mild flavor that combines elements of kiwi and pear, with a texture that resembles a blend of kiwi and melon.

There are several varieties of dragon fruit, each with its own distinct characteristics. The most common varieties have either white or red flesh, though some cultivars can also have yellow or pink skin. These variations not only add to the fruit's visual appeal but also contribute to its popularity across different regions.

Beyond its appealing taste and texture, dragon fruit is a nutritional powerhouse. The fruit having food grade fiber, which benefits digestion and overall biological activities. It is also contains antioxidants, which protect the free radicals in human cell , and provides trace elements such as Ca, Fe, and P etc.

1.2 Health Benefits of Dragon fruit

Dragon fruit, or pitaya, is a nutrient-dense tropical fruit with several notable health benefits:-

Dragon fruit is rich in antioxidants, including vitamin C, Betalains, with carotenoids, which help to control free radicals, related mental stress, and potentially lower the risk of acute diseases like CVD and cancer while supporting healthy, radiant skin. The high amount of ascorbic acid content also boosts the immune system by increasing blood cell production, helping the body fight infections. Additionally, the dietary fiber in dragon fruit promotes regular bowel movements, prevents constipation, and supports a healthy gut microbiome, contributing to digestive health.

Figure 2: Fully ripe dragons

Dragon fruit helps regulate blood sugar levels with its fiber and antioxidants, aids in weight management by being low in calories and high in fiber, making it a satisfying, healthier alternative to sugary snacks, and promotes healthy skin through vitamin C's role in collagen production.

Figure 3: Dragon Fruits

Dragon fruit supports bone health with essential minerals such as calcium, iron, and phosphorus, which contribute to strong bones and the production of red blood cells. Its high water content aids in maintaining hydration, which is vital for various bodily functions. Additionally, preliminary studies suggest that the antioxidants in dragon fruit may have potential anti-cancer properties, although further research is needed

1.3 Objectives

- Create fruit ready to Eat Bar from locally grown dragon fruit.
- Evaluate the nutritional content of the fruit bars.
- Examine the phytochemical properties of the product.
- Assess the sensory quality of the fruit bars.

CHAPTER: TWO

Literature Review

Historical review:

Dragon fruit, scientifically known as *Hylocereus undatus*, is a tropical cactus fruit native to Central America, including Mexico and Guatemala. Also referred to as pitaya or pitahaya, it has been cultivated in its native region for centuries. The fruit has significant cultural importance in Asia, symbolizing prosperity and good luck, while in Central America, it has been used in traditional medicine. European explorers introduced dragon fruit to Asia in the 19th century, where it gained popularity in countries such as Vietnam, Thailand, and Malaysia. Botanically, it is a climbing cactus with aerial roots and large, fragrant flowers that bloom at night and are pollinated by bats or moths. The fruit matures in 30 to 50 days and has a colorful skin with white or red flesh and tiny black seeds. Key varieties include the white-fleshed *Hylocereus undatus* and the red-fleshed *Hylocereus costaricensis* or *Hylocereus polyrhizus*. Today, dragon fruit is grown globally in regions like Vietnam, Thailand, Malaysia, the Philippines, Israel, and parts of the U.S. Its attractive appearance, nutritional benefits, and adaptability have made it a popular commercial crop. The growing interest in exotic fruits and healthy diets has further increased its demand, leading to its expansion into new growing areas.

Specific literature review:

Fruit leather, commonly referred to as a fruit bar or fruit slab, is a dehydrated fruit-based treat celebrated for its chewy texture and robust flavor (Diamante et al., 2014). This snack is naturally low in fat, yet high in fiber and carbohydrates, making it a favorite among consumers (May, 2014; Diamante). Its lightweight nature further enhances its convenience for both storage and transport (Diamante et al., 2014).

Rich in vitamins, proteins, minerals, and other essential nutrients, fruits play a crucial role in the diet by boosting immunity (December, 2020). Fruit leathers, crafted from dried sheets of fruit pulp, possess a soft, rubbery texture and a sweet taste. They can be made from either single or mixed fruit varieties, serving as a convenient alternative to traditional boiled sweets (Ayotte, 1980; Diamante et al., 2014).

The process of making fruit leather involves dehydrating fruit puree into a leathery sheet, offering a convenient and economical substitute for fresh fruit, while also providing various nutritional benefits (Raab & Oehler, 1999). Various drying methods—such as sun drying, oven drying, cabinet drying, or using a dehydrator—can be employed, each impacting the final product’s quality and characteristics (Raab & Oehler, 1999). While sun-drying may lead to discoloration and hygiene concerns, hot air drying is more efficient and improves the overall quality (Maskan et al., 2002).

During the drying process, fruit leather undergoes changes like shrinkage, puffing, and crystallization. These changes are accompanied by chemical and biochemical reactions that can affect the product's color, texture, and odor, either positively or negatively (Huang & Hsieh, 2005; Gujral & Brar, 2003). Modern dehydrators and advanced drying techniques

allow for the year-round production of fruit leather, catering to consumer demand. Commercial packaging plays a crucial role in extending the shelf life and preserving the product's sensory properties and physicochemical characteristics (Irwandi et al., 1998).

To prepare fruit leather, ripe fruits are washed, their pulp is extracted and heated, and then dried on aluminum trays. Adding sugar (up to 10%) and other ingredients before drying helps achieve the desired moisture content of 14.5% (Roy & Singh, 1979; Singh & Chaurasiya, 2014). Various fruits, including apples, berries, and kiwifruit, are commonly used to produce fruit leathers, which are popular snacks (Huang & Hsieh, 2005; Tiwari, 2019).

Blending different fruit pulps to create fruit leather can enhance its nutritional qualities, sensory attributes (such as color, texture, and flavor), and storage stability (Tiwari, 2000; Tiwari, 2019). Additionally, dehydrated fruit pulp can be rehydrated to create ready-to-serve juice (Nanjundaswamy et al., 1976).

In summary, fruit leather—also known as fruit rolls or fruit roll-ups—has gained popularity as a healthier alternative to other confectioneries. Its appeal has grown significantly over the past decade, largely due to its perceived health benefits. While mass-produced fruit leathers are widely available, they can also be easily made at home, offering a convenient and natural alternative to high-salt, high-sugar, and high-fat junk foods.

Recent research by Delgado and Gómez (2021) indicates that the maturity of dragon fruit significantly impacts the physicochemical properties of its puree. Their findings suggest that ripe dragon fruit exhibits higher total soluble solids and improved texture compared to less mature fruit, emphasizing the importance of selecting appropriately ripe fruit to ensure optimal quality in processed products like dragon fruit bars.

Xu and Zhang (2023) have highlighted advancements in mechanization techniques for extracting dragon fruit pulp, noting that these methods significantly enhance efficiency and yield compared to traditional manual processes. Their study underscores the importance of fine-tuning extraction parameters to maintain the high nutritional quality and sensory attributes of the dragon fruit pulp while also reducing labor costs and minimizing waste.

Patel and Sharma (2022) conducted a comparative study on the effects of freeze-drying versus hot air drying on the quality of dragon fruit bars. Their research revealed that freeze-drying preserves the color and nutritional content of the bars more effectively than hot air drying. Although freeze-drying maintains higher levels of antioxidants and vitamins, hot air drying is more cost-effective and time-efficient, making it a viable alternative for large-scale production due to its lower operational costs.

Lin and Wang (2024) explored the influence of various sugar and preservative types on the shelf life and sensory quality of dragon fruit bars. Their study found that different sugars, such as sucrose and high-fructose corn syrup, significantly affect the texture and sweetness profile of the bars. The use of preservatives like potassium sorbate and sodium benzoate was also found to extend shelf life, though the choice of preservative had a notable impact on flavor and overall sensory attributes. This research highlights the need to optimize formulation ingredients to balance preservation and sensory quality in dragon fruit bars.

Lee and Choi (2023) emphasized the importance of advanced packaging technologies in extending the shelf life of fruit-based snacks, particularly dragon fruit bars. Their study shows that innovative packaging solutions, such as vacuum-sealed pouches and modified atmosphere packaging, can significantly reduce oxygen and moisture exposure, thereby preserving the quality and freshness of the product. Proper packaging not only enhances the longevity of dragon fruit bars but also maintains their sensory attributes, such as flavor and texture, which are crucial for consumer satisfaction.

Finally, Sharma and Kumar (2024) evaluated dragon fruit bars for their nutritional content and sensory attributes to assess their market potential. Their study revealed that these bars are rich in essential vitamins and minerals, making them an appealing healthful snack option. Sensory evaluations indicated high consumer acceptance due to their unique flavor and appealing texture, positioning them favorably in the market for health-conscious consumers. This research suggests that dragon fruit bars have the potential to serve as a nutritious alternative to traditional snacks, with their nutritional benefits and sensory qualities supporting their growing popularity.

CHAPTER: THREE

MATERIALS AND METHODS

3.1 Materials

Red dragon fruits were sourced from a local market and promptly transported to the laboratory for analysis. To ensure consistency and reduce biological variability in the study, a careful selection process was undertaken. During this process, fruits were closely examined, and any that exhibited signs of disease, damage, or other abnormalities were excluded from the sample. This approach helped maintain the integrity and reliability of the subsequent analyses.

Sugar: Sugar is added to enhance the sweetness of the fruit bars, balancing the tartness of dragon fruit and improving overall flavor. It also acts as a preservative by reducing the water activity in the bars, which helps in extending shelf life, collected from local market.

Rice Starch: Rice starch serves as a thickening agent and binder in the fruit bars. It helps in achieving the desired texture and consistency, ensuring that the fruit bars hold together properly during processing and handling, managed and processed using grinder.

Glycerin: Glycerin is used to retain moisture in the fruit bars, preventing them from becoming too dry and brittle. It also helps in maintaining the softness and chewiness of the bars, contributing to a pleasant mouthfeel, collected from Mitford Market.

Citric Acid: Citric acid acts as an acidulant, which helps in balancing the flavor profile of the fruit bars by adding a tart note. Additionally, it acts as a preservative by lowering the pH, which inhibits the growth of microorganisms and helps in prolonging shelf life, arranged from Bongo chemical company, Chittagong, Bangladesh.

Sodium Benzoate Sodium benzoate is used as preservative that helps to control microbial growth and spoilage of food products. By inhibiting the growth of bacteria, yeast, and molds, it ensures that the fruit bars remain safe to eat and maintain their quality over time, purchased from Mitford which manufactured by German.

3.2 Formulation

Tab 1: List of ingredients and formulation of dragon fruit bar

Ingredients	Amounts
Red Dragon fruit pulp	900g
Rich Starch	54g
Sugar	36g
Sodium Benzoate	0.5g
Citric acid	2g
Xanthan gum	2.7g
Glycerol	10ml

3.3 Procedures:

First the raw materials were collected from the local market of Dhaka. Fresh red dragons were selected and washed with safe potable water for the removal of dirt. After that, dragons were cut using a sharp knife and chopping board. Dragon cuts were then put in Sause pan for heating for the inactivation of enzymes. After heating those were put in an electric blender machine for blending. When blending is done, the mixture was filtered using a muslin cloth or net. The dragon pulp production is complete already, now the pulp is heated for 20mins in stove. At the time of heating all other ingredients; mustered oil, sugar, sodium benzoate, citric acid, rice starch, xanthan gum was added gradually into the heated dragon pulp. After the cooking was done, the Sause pan was removed from the stove and let it cool down in a tray. Before the paste was transferred to a tray, glycerol was spread over the surface of the tray. The paste was dried in the oven at 55°C for 12-15 hours. Finally, the product was cooled and packaged, and stored at room temperature. The dragon bar was ready to eat.

Figure 4: Fresh raw dragons

Figure 5: Freshly cut dragons

Figure 6: All ingredients

Figure 7: Dragon bar

Figure 8: Dragon bar final product

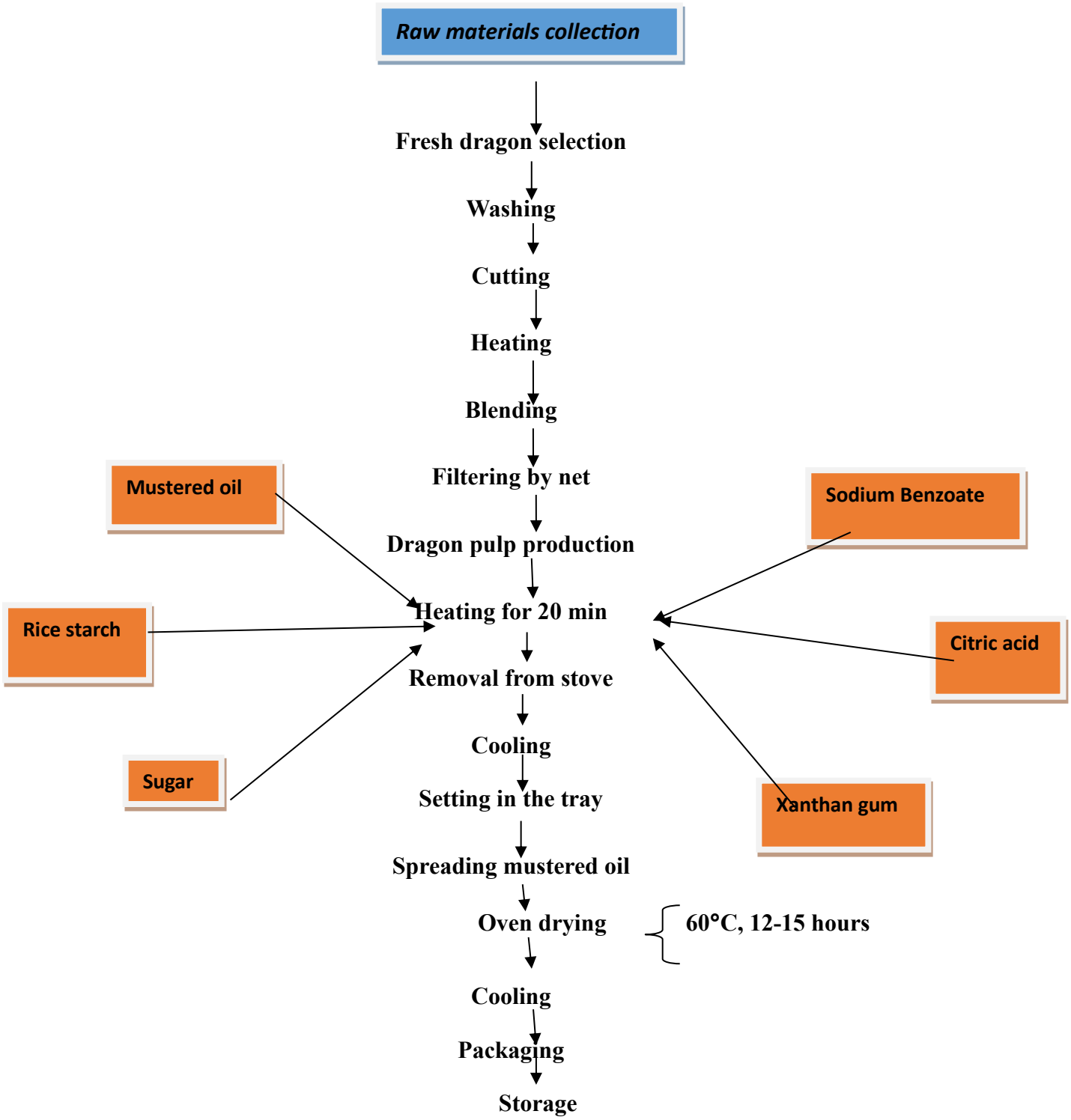


Figure 9: Flowchart of dragon bar production process

3.4 Methods for determination of Nutritional properties

3.4.1 Determination of Moisture Content

Principle

The objective of this procedure is to determine the moisture content of a material, which is the amount of water present within the sample, expressed as a percentage. Moisture content affects the physical properties and shelf life of the product.

Apparatus:

- Digital moisture analyzer
- Spatula

Procedure:

- Place approximately 2 grams of the sample on the pan of the moisture analyzer.
- Close the upper cover of the analyzer and set the temperature to 120°C.
- Wait for the analyzer to signal completion with a beep.
- Once the beep sounds, record the moisture content reading displayed on the analyzer.

Precautions:

- Be cautious when placing the sample on the pan to avoid spills.
- Ensure the temperature is set correctly before starting the analysis.
- Wear gloves to maintain sample integrity and personal safety.
- Carefully record the moisture content reading.
- The duration of the analysis may vary depending on the type of sample being tested.

3.4.2 Determination of Fat Content Using the Soxhlet Extraction Method

Principle

The aims is to determine the fat content in food items, which is a key aspect of proximate analysis. The Soxhlet Extraction Method is employed to accurately measure the total fat content of the sample.

Reagents & Materials:

- 95% n-Hexane
- Balance machine
- Filter paper and cotton
- Cellulose thimble
- Hot air oven
- Soxhlet apparatus

Procedure:

Step 1: Preparation of Thimble

i. Prepare a thimble using filter paper.
ii. Weigh the thimble on a balance machine and tare the weight to zero.

Step 2: Sample Preparation

i. Remove the thimble from the balance machine.
ii. Add approximately 5 grams of the sample into the thimble and record the weight.
iii. Place a piece of cotton in the thimble to cover the sample, then fold the thimble to secure it.
iv. Mark the thimble with a sample identification number.
v. Insert the prepared thimble into a cellulose thimble.
vi. Weigh a cleaned and dried flat-bottom flask on the balance machine and record the weight.

Step 3: Fat Extraction

i. Set up the Soxhlet extraction unit with the sample inside.
ii. Add a sufficient amount of n-Hexane to the extraction unit.
iii. Run water through the condenser of the Soxhlet extraction unit.
iv. After 6 hours, stop the extraction process.
v. Place a funnel on a glass bottle and remove the thimble to collect the waste n-Hexane.
vi. Collect any remaining n-Hexane from the thimble and flask through condensation.
vii. Rotate the flask to evaporate any excess n-Hexane.

Step 4: Final Weighing

i. Place the flask in a hot air oven set to 110°C for 30 minutes to remove any residual moisture and n-Hexane.
ii. After drying, transfer the flask to a desiccator to cool for 20 minutes.
iii. Weigh the cooled flask containing the extracted fat and record the final weight.

3.4.3: Procedure for pH determination

Aims

To measure the pH level of a given solution, which indicates its acidity or alkalinity.

Apparatus and Materials:

i. pH meter
ii. pH buffer solutions (usually pH 4.0, 7.0, and 10.0)
iii. Distilled water
iv. Beaker or sample container
v. Stirring rod (optional)
vi. Tissue paper or lint-free cloth

Procedure:

1. **Calibrate the pH Meter:**
    i. Turn on the pH meter and allow it to warm up if necessary.
    ii. Rinse the pH electrode with distilled water and gently blot it dry with tissue paper.
    iii. Immerse the electrode in the pH 7.0 buffer solution and adjust the meter to read pH 7.0.
    iv. Rinse the electrode with distilled water and repeat the calibration using pH 4.0 or pH 10.0 buffer solutions, depending on the expected pH range of your sample.
2. **Measure the pH of the Sample:**
    i. Rinse the pH electrode with distilled water and blot it dry.
    ii. Immerse the electrode in the sample solution.
    iii. Stir the solution gently with a stirring rod if necessary to ensure even distribution of the ph.
    iv. Wait for the pH meter to stabilize and display a constant reading.
    v. Record the pH value shown on the meter.
3. **Clean the pH Electrode:**
    i. After measuring, rinse the electrode with distilled water.
    ii. Blot the electrode dry before storing it according to the manufacturer's instructions.

3.4.4 Brix Estimation

Aims

To measure the Brix level, which indicates the sugar content in a liquid solution, typically used for fruit juices, syrups, and other sugary liquids.

Apparatus and Materials:

i. Refractometer (handheld or digital)
ii. Distilled water
iii. Sample solution (e.g., fruit juice, syrup)
iv. Tissue paper or lint-free cloth

Procedure:

1. **Calibrate the Refractometer:**
    i. If using a handheld refractometer, open the cover plate and place a few drops of distilled water on the prism.
    ii. Close the cover plate and look through the eyepiece to ensure the scale reads 0.0 Brix. Adjust the calibration screw if necessary.
    iii. For digital refractometers, follow the manufacturer's instructions for calibration, usually involving a similar step with distilled water.
2. **Prepare the Sample:**
    i. Clean the prism surface with distilled water and dry it with tissue paper.
    ii. Place a few drops of the sample solution onto the prism of the refractometer.
3. **Measure the Brix Level:**
    i. Close the cover plate to spread the sample evenly across the prism (for handheld refractometers).
    ii. Look through the eyepiece and read the Brix value where the light and dark boundary line crosses the scale.
    iii. For digital refractometers, simply press the "measure" button to display the Brix value.
4. **Record the Brix Value:**

- Note the Brix value, which represents the percentage of sugar by weight in the sample.

5. **Clean the Refractometer:**
    - After measurement, clean the prism with distilled water and dry it thoroughly before storing the refractometer.

3.4.5 Determination of Protein

Principal

To determine the protein content of a dehydrated fruit bar, the Kjeldahl method is used. Here's a step-by-step guide using the Kjeldahl method, which is a standard procedure for nitrogen determination, and thus protein estimation.

Materials Needed:

- Sample of dehydrated fruit bar
- Kjeldahl digestion apparatus
- Sulfuric acid (HCl)concentrated
- Catalysts (copper sulfate ($CuSO_4$) and potassium sulfate (K_2SO_4))
- Sodium hydroxide (NaOH)
- Boric acid solution
- Standard acid solution (HCl)
- Indicators (Methyl Red)
- Distillation apparatus
- Titration setup

Procedure

The procedure for determining the protein content of a dehydrated fruit bar involves several steps. First, weigh out 1.0 gram of the sample, then digest it in a Kjeldahl flask using concentrated sulfuric acid and a catalyst ($CuSO_4$ and K_2SO_4) until the solution is clear, converting nitrogen to ammonium sulfate. After cooling, neutralize with sodium hydroxide and distilled the released ammonia into a boric acid solution. The trapped NH_3 then titrated using standard HCl acid using an indicator to detect the endpoint.

The nitrogen content is calculated using the volume of acid consumed in the formula Nitrogen percentile calculation.

Result:

The protein content is determined by multiplying the nitrogen percentage by 6.25.

Figure 10: Titration preparation

3.4.6 Ash determination

Aims

Ash determination of a dehydrated dragon fruit bar uses the dry ashing method, which incinerates organic material at high temperatures to leave inorganic residues (ash).

Materials:

- Dehydrated dragon fruit bar
- Analytical balance
- Muffle furnace
- Crucibles (porcelain/silica)
- Desiccator
- Tongs

Procedure:

1. Crucible Preparation: Clean, dry, and preheat the crucibles at 550°C for 1 hour. Cool in a desiccator and weigh (W_1).
2. Sample Preparation: Weigh 2–5 grams of the ground sample into the crucible and record the weight (W_2).
3. Ashing: Place the crucible in the muffle furnace at 500–600°C for 4–6 hours until the sample turns light grey/white.
4. Cooling: Remove the crucible, cool it in a desiccator, and weigh the ash (W_3).

5. **Calculation of result:**

   Ash content (%) = $\{(W_3 - W_1)/W_2\} \times 100$

3.4.7 Microbial Assay

Principal

The pour plate method is widely used to count colony-forming bacteria in a liquid sample. In this method, a fixed amount of inoculum (typically 1 ml) is transferred to the center of a sterile petri dish using a sterile pipette. Approximately 15 ml of molten, cooled agar is then poured into the dish over the inoculum and mixed thoroughly. After the agar solidifies, the plate is inverted and incubated at 37°C for 24-48 hours. Bacteria grow both on the surface and within the medium; colonies within the medium tend to be smaller and may merge, while surface colonies resemble those on a streak plate. Each visible colony corresponds to a "colony-forming unit" (CFU).

Materials and Equipment:

- Test sample
- Plate count agar
- Hot water bath (maintained at 45°C)
- Sterile petri dishes
- Bunsen burner or flame source
- Colony counter with magnifying glass
- Incubator
- Biological safety cabinet
- Spatula
- Analytical balance
- Sterile capped test tubes (16 x 150 mm)
- Autoclave
- Pipettes (various sizes)
- Sterile pipette tips

Preparation of sample by serial dilution:

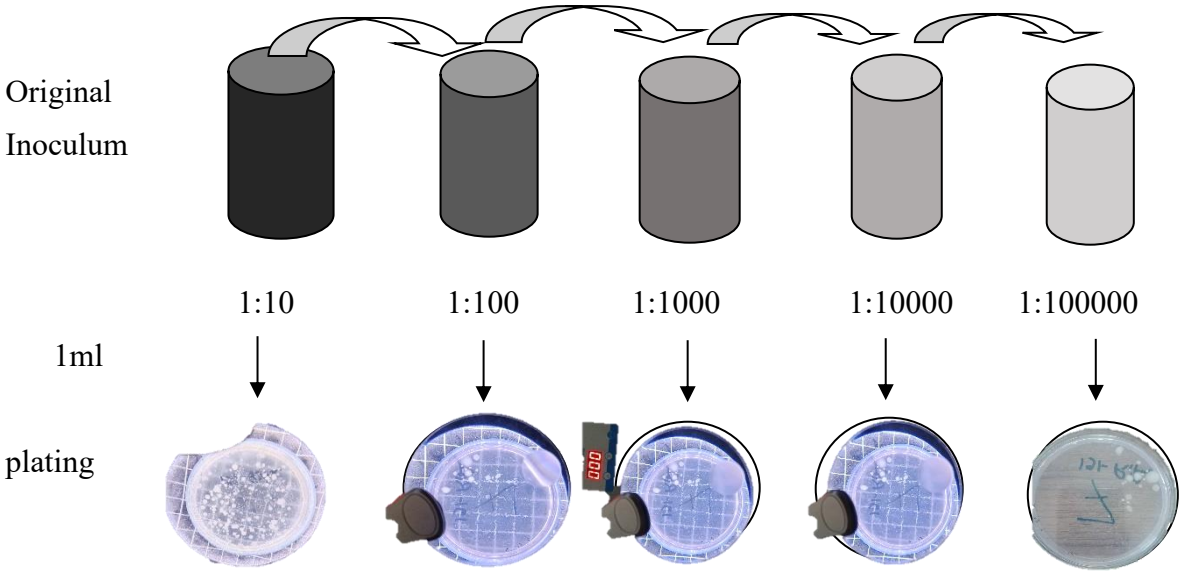


Figure 11: Preparation of sample by serial dilution

Pour Plate Method - Paraphrased Procedure:

1. Labeling: Mark the bottom of a sterile petri dish with essential details such as your name, date, type of medium, organism, and dilution factor if needed.
2. Serial Dilutions (Optional): If using serial dilutions, prepare them carefully to achieve 30–300 CFU per plate. This step prevents overcrowding of colonies.
3. Agar Preparation: Collect 18 ml of pre-sterilized agar in a test tube. Melt the agar in a steamer for 30 minutes, then maintain it at 55°C in a water bath until ready. Before pouring, transfer the agar to a heat block set at 48°C for 10 minutes to prevent bacterial death or lumpy solidification.
4. Sample Preparation: Prepare the sample using either a broth culture or a cell suspension from colonies in buffer or saline. Plate 0.1–1.0 ml of the sample, possibly from a dilution series.

5. Aseptic Technique: Using sterile techniques, open the petri dish, dispense the sample into the center, and close the lid immediately to avoid contamination.
6. Sample Transfer: Carefully transfer the sample using a serological or micropipette, ensuring no spillage from the plate.
7. Pouring Agar: Sterilize the rim of the agar tube by flaming it. Pour the agar over the sample in the petri dish and gently swirl to mix.
8. Solidification: Let the agar fully solidify before turning the plate upside down.
9. Incubation: Invert, seal, and incubate the plate at 37°C for 24–48 hours.

Calculation:

$$\text{CFU} = \frac{\text{No. of colonies} \times \text{total dilution factor}}{\text{Volume of culture plated in ml.}}$$

3.5 Nutritional properties

The nutrition facts for a serving of 100 grams of ripe dragon fruit (FAO):

Table 2: Nutritional properties of dragon fruit

Nutrient	Amount
Protein	0.36g
Fat	o.14g
Carbs	15g
Water	87g
Fiber	3g
Calcium	8.5mg
Iron (Fe)	1.9mg
Phosphorus	22.5mg
Energy in Kcal	57

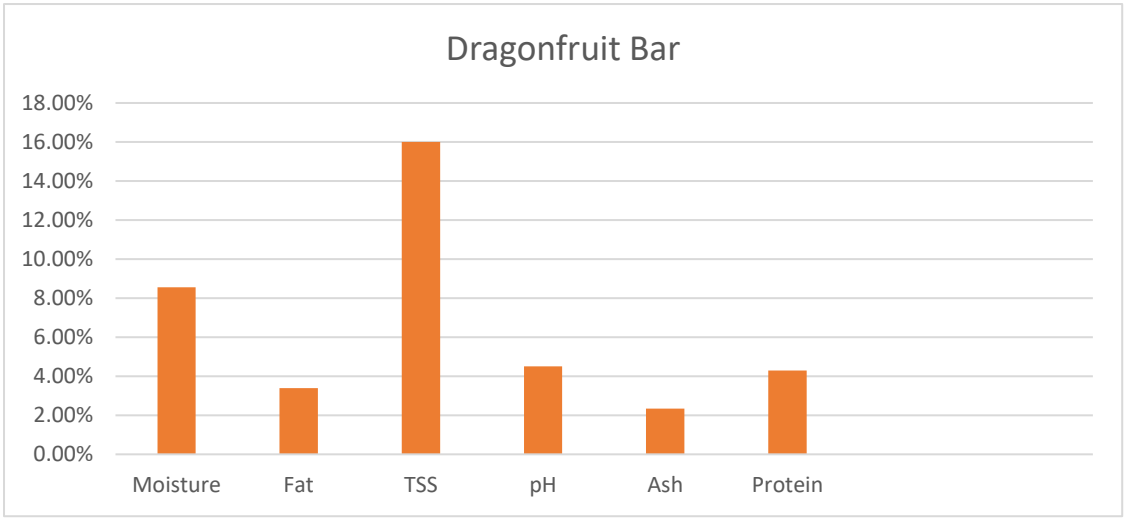


Fig 12: Nutritional properties of dragon fruit Bar

CHAPTER: FOUR

Results & Discussions

The dehydrated dragon fruit bar was developed in the Nutrition and Food Engineering Laboratory at FHLS, Daffodil International University, DSC, Ashulia, Dhaka. Its nutrient composition and overall sensory acceptance were then assessed

The composition of dehydrated Dragon fruit Bar is shown in the table 3.

Table 3: Nutritional value

Nutrients	**Amounts (%)**
Moisture	8.56%
Ascorbic Acid in mg	0.017 %
P^H	4.5%
Ash	2.34%
TSS	16%
Protein	2.2%
CHO	80.0%
Fat	3.4%
Betalains in mg	0.45%
Microbial Load (cfu/100g)	$3X10^6$
Energy in Kcal/100 gm	358

- **Moisture content:** Dragon fruit leather contains around **8.56%** moisture, contributing to its chewy texture and prolonged shelf life.
- **Brix (TSS) content:** The total soluble solids (TSS) content, often measured in brix percentage, is **16%.** This indicates a high concentration of natural sugars in the fruit leather, enhancing its flavor and sweetness.
- **Fat content:** The fat content of dragon fruit leather **is 3.4%,** which aligns with its low-fat profile, making it a healthier snack option.

- **pH:** The pH level of **4.5** falls within the general pH range of dragon fruit, ensuring the product's stability and safety.

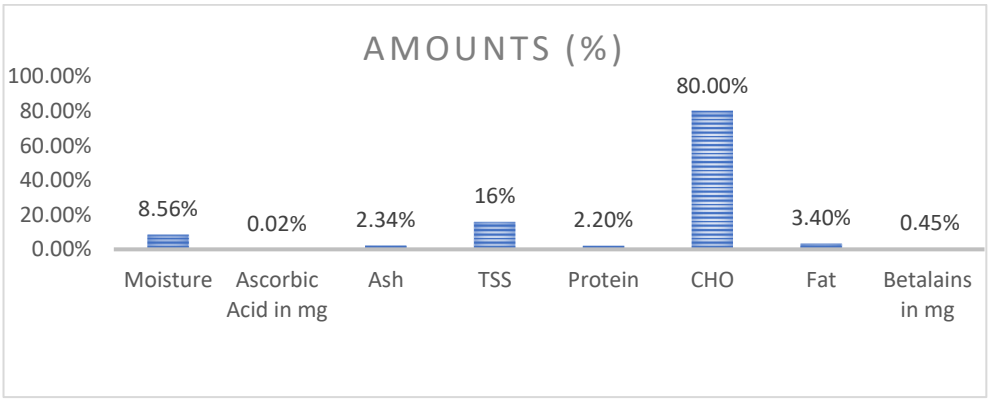


Figure-13: **Composition of dry Dragon Fruit Bar**

- **Ash:** Dragon fruit leather contains **2.34%** ash, representing the mineral content derived from the fruit and other ingredients used in its preparation.
- **Microbial analysis:** The microbial content of **3X10^6 *cfu*/100 g** indicates the level of microorganisms present in the fruit Bar, which is crucial for assessing its safety and shelf stability.
- **Protein:** Dragon fruit leather contains **2.20%** protein, contributing to its nutritional value and making it a satisfying snack option.

4.1 Product acceptance (Sensory Evaluation)

1.4.1 The following discussion addresses participant feedback on sensory evaluation, focusing on the product's sensory parameters, including color, flavor, taste, texture, and overall acceptability.

4.2 Taste

The Ready to Eat Dragon Fruit Bar was generally well-received for its taste. A substantial majority of participants, 25 out of 30, expressed satisfaction with the flavor. This positive feedback indicates that the taste of the bar resonated well with the participants, demonstrating its effectiveness in this sensory aspect.

4.3 Texture

The sensory evaluation of the ready-to-eat dragon fruit bar highlighted several positive attributes regarding its taste. Participants observed that the textural quality of the bar was

particularly promising, significantly enhancing its overall sensory appeal. The texture was described as satisfying and well-suited to the product, which contributed to a more enjoyable eating experience. Additionally, participants rated the bar very favorably in terms of taste, placing it in the “like extremely” category. This rating indicates a high level of approval and enjoyment. The flavor profile of the dragon fruit bar was perceived as both distinctive and pleasant, meeting consumer expectations for a sweet and fruity treat. The combination of a favorable texture and appealing taste contributed to the high level of satisfaction reported by participants.

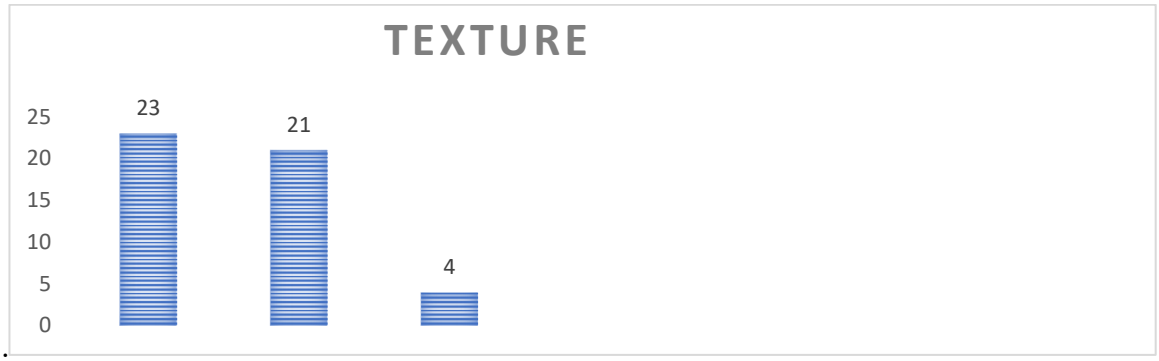


Figure 14: Textural properties of dragon fruit Bar

4.4 Flavor

The flavor of the dragon bar was enjoyable. They were very popular among the participants.

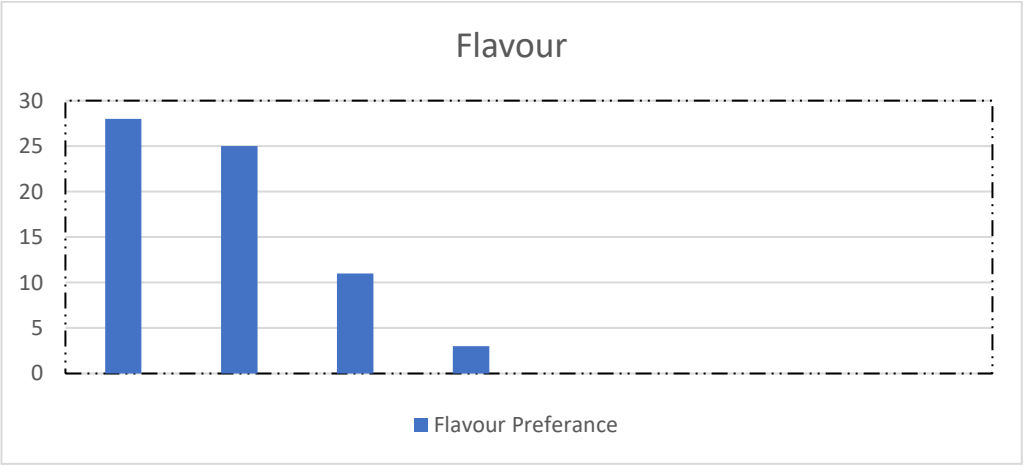


Figure15: Flavor of dragon fruit Bar

4.5 Color

The color acceptability of the dragon Bar is shown in the Figure

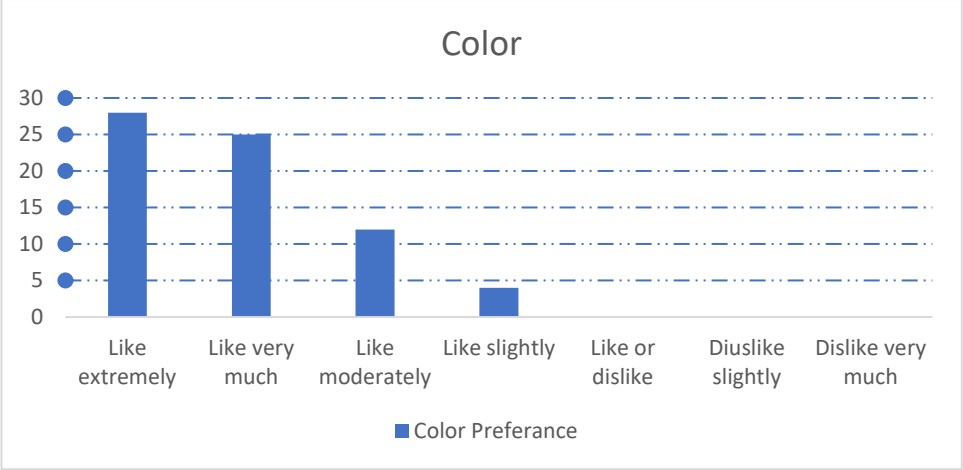


Figure16: Color of dragon fruit Bar

4.6 Overall Acceptability

The participants widely regarded the sensory qualities of the dragon leather as exceptional. An impressive 78% rated the product as "extremely favorable," 20% found it "very pleasing," and only 2% deemed it "moderately enjoyable." Notably, none of the participants expressed any negative feedback or dislike for the product.

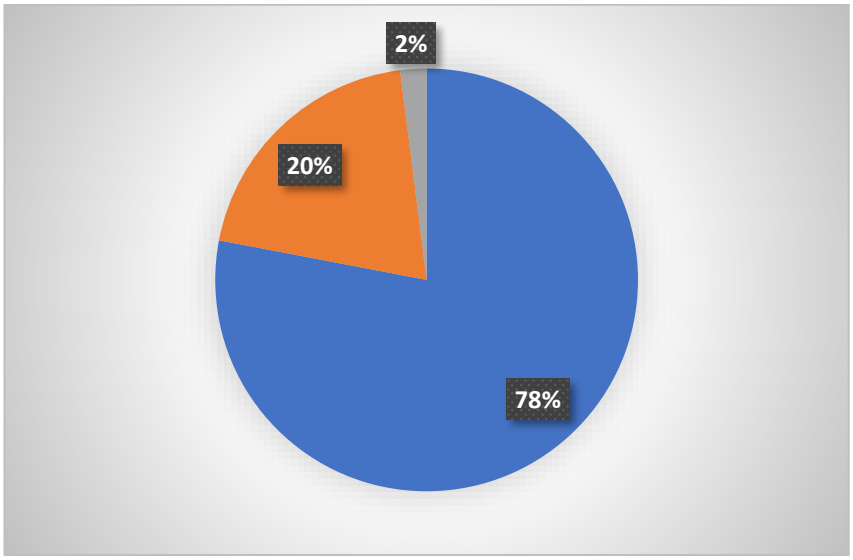


Figure 17: Overall acceptability of the dragon fruit Bar

Discussions

This discussion integrates findings from the literature review with the results obtained in this project to highlight the significance and potential of dragon fruit bars as a nutritious snack alternative. The literature consistently shows that fruit leathers are naturally low in fat and high in carbohydrates and fiber, making them a preferred choice among health-conscious consumers (Diamante et al., 2014; May, 2014). The dragon fruit bar developed

in this project aligns with these findings, featuring a low fat content of 3.4% and a high carbohydrate content of 80%. This nutritional profile caters to consumer preferences for low-fat, high-energy snacks that provide sustained energy release, as noted by Sharma and Kumar (2024). Furthermore, fruits, including dragon fruit, are known to be rich sources of vitamins, minerals, and other components essential for immune development (December, 2020). The dragon fruit bar reflects these nutritional benefits with a balanced proximate composition that includes 2.2% protein and 2.34% ash content. These findings are consistent with the literature, which emphasizes the nutritional richness of fruit leathers made from various fruit varieties (Huang and Hsieh, 2005; Tiwari, 2019). Additionally, the dragon fruit bar's ascorbic acid and betalain content enhances its appeal as a health-promoting snack, contributing valuable antioxidants and essential vitamins (Patel and Sharma, 2022).

The moisture content of the dragon fruit bar, recorded at 8.56%, is a crucial factor in its quality, as it helps prevent microbial growth while maintaining a desirable texture. This aligns with the literature on fruit-based snacks, which emphasizes the importance of moisture control in preserving product quality and safety (Irwandi et al., 1998). The controlled drying process used in the production of the dragon fruit bar effectively balances moisture retention with shelf stability, ensuring a chewy texture that is appealing to consumers while also minimizing the risk of spoilage.

Sensory evaluation results show a high level of consumer acceptance for the dragon fruit bar, with 78% of participants liking it extremely and 20% liking it very much. This positive reception underscores the potential market success of the product, aligning with the findings of Sharma and Kumar (2024), who reported high consumer satisfaction for dragon fruit-based snacks due to their unique flavor and appealing texture. The favorable sensory attributes of the dragon fruit bar, including taste, texture, flavor, and color, further enhance its attractiveness to consumers, making it a strong contender in the health food market.

The role of packaging in extending the shelf life of fruit-based snacks is well-documented in the literature (Lee and Choi, 2023). Although this project did not specifically explore packaging technologies, future research could focus on innovative packaging solutions to further enhance product stability and shelf life. According to Lee and Choi (2023), using advanced packaging techniques like vacuum-sealed pouches or modified atmosphere packaging can greatly minimize exposure to oxygen and moisture, thereby preserving the quality and freshness of dragon fruit bars.

In conclusion, the dragon fruit bar developed in this study demonstrates a strong alignment with the existing literature on fruit leather products. Its balanced nutritional profile, favorable sensory attributes, and potential for shelf stability make it a compelling snack option for health-conscious consumers. Future research should explore optimizing production methods and packaging technologies to maximize product quality and extend shelf life.

CHAPTER: FIVE

Conclusions

The development of dragon fruit bar represents an innovative approach to incorporating exotic fruits into snack products, offering consumers a tasty and nutritious alternative to traditional confections. Dragon fruit, with its rich nutritional profile, including water-soluble fibers and antioxidants, makes it an excellent candidate for a unique and healthful fruit leather.

Sensory evaluations of the dragon fruit leather demonstrated high levels of satisfaction among participants, particularly concerning color, flavor, texture, and taste. Most participants expressed extremely positive or very high levels of liking for these sensory attributes, highlighting the product's appeal as a snack option. The overwhelmingly positive feedback suggests that dragon fruit leather has strong potential to be well-received by consumers seeking both nutritional benefits and enjoyable snacking experiences.

In conclusion, the development of dragon fruit leather offers an exciting opportunity in the realm of fruit-based snacks. With its favorable nutritional composition and appealing sensory attributes, dragon fruit leather shows great promise as a desirable addition to the fruit leather market.

CHAPTER: SIX

References:

1. Ariffin, A. A., Bakar, J., Tan, C. P., Rahman, R. A., Karim, R., & Loi, C. H. (2009). Essential fatty acids of Pitaya (dragon fruit) seed oil. *Food Chemistry, 114*(2), 561-564.
2. Gujral, H. S., & Brar, S. S. (2003). Effect of hydrocolloids on the dehydration kinetics, color, and texture of mango leather. *International Journal of Food Properties, 6*, 269-279.
3. The Pharma Journal. (2023). *Vol. 12, Issue 7, Part N*. Retrieved from https://www.thepharmajournal.com/archives/2023/vol12issue7/PartN/12-7-95-597.pdf
4. ResearchGate. (2020). *Development of Mixed Fruit Leather Using Five Tropical Fruits*. Retrieved from https://www.researchgate.net/publication/344388164_Development_of_Mixed_Fruit_Leather_Using_Five_Tropical_Fruits
5. Delgado, A., & Gómez, J. (2021). Impact of fruit maturity on the physicochemical properties of dragon fruit puree. *Journal of Food Science and Technology, 58*(3), 1150-1159.
6. Xu, Y., & Zhang, M. (2023). Mechanization and optimization of pulp extraction in dragon fruit processing. *Food Processing & Technology, 14*(2), 167-179.
7. Patel, S., & Sharma, S. (2022). Comparative study of freeze-drying and hot air drying on the quality of dragon fruit bars. *International Journal of Food Science & Technology, 57*(5), 2358-2370.
8. Lin, J., & Wang, S. (2024). Effect of sugar and preservative types on the shelf life and sensory quality of dragon fruit bars. *Food Chemistry, 380*, 132-140.
9. Lee, K., & Choi, S. (2023). Innovative packaging solutions for extending the shelf life of fruit-based snacks: A case study of dragon fruit bars. *Packaging Technology and Science, 36*(1), 45-59.
10. Sharma, P., & Kumar, A. (2024). Nutritional and sensory evaluation of dragon fruit bars and their market potential. *Journal of Nutritional Science, 13*(2), 89-101.

PROCESSING OF A VALUE-ADDED DRAGON FRUIT DEHYDRATED R.T.E. BAR USING A MULTI-HEAD SOLAR PANEL DRYER

ORIGINALITY REPORT

12%	7%	4%	7%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Florida A&M University Student Paper	1%
2	Submitted to University Tun Hussein Onn Malaysia Student Paper	1%
3	thesciencenotes.com Internet Source	1%
4	Submitted to Hertford Regional College Student Paper	1%
5	www.ijcmas.com Internet Source	1%
6	Submitted to United Colleges Group - UCG Student Paper	1%
7	psasir.upm.edu.my Internet Source	<1%
8	Submitted to Higher Education Commission Pakistan Student Paper	<1%

9	www.tandfonline.com Internet Source	<1 %
10	K. P. Asha Rani, S. Gowrishankar. "chapter 17 Pathogen Detection in Dragonfruit With Transfer Learning and Fine-Tuned Keras Models", IGI Global, 2024 Publication	<1 %
11	Lemuel M. Diamante, Xue Bai, Janette Busch. "Fruit Leathers: Method of Preparation and Effect of Different Conditions on Qualities", International Journal of Food Science, 2014 Publication	<1 %
12	Siddiq, Muhammad, and Muhammad Nasir. "Dragon Fruit and Durian", Tropical and Subtropical Fruits Postharvest Physiology Processing and Packaging, 2012. Publication	<1 %
13	Submitted to Cheadle & Marple Sixth Form College Student Paper	<1 %
14	Submitted to Monash University Student Paper	<1 %
15	microbeonline.com Internet Source	<1 %
16	Submitted to British School of Brussels Student Paper	<1 %

17	healthdocbox.com Internet Source	<1 %
18	www.agriculturejournals.cz Internet Source	<1 %
19	www.torrinomedica.it Internet Source	<1 %
20	C. S. Arinzechukwu, I. Nkama. "Production and Quality Evaluation of Fruit Bars from Banana (Musa sapientum) and Cashew (Anacardium occidentale) Apple Fruit Blends", Asian Food Science Journal, 2019 Publication	<1 %
21	Tania Khatun, Md. Asraful Sharker Nirob, Prayma Bishshash, Morium Akter, Mohammad Shorif Uddin. "A comprehensive dragon fruit image dataset for detecting the maturity and quality grading of dragon fruit", Data in Brief, 2023 Publication	<1 %
22	Submitted to Fiji National University Student Paper	<1 %
23	Sindhu U. Mukthamath, Ruchira Raychaudhuri, Mamatha Ballal, Kalyana C Pentapati, Krishnaraj Somayaji Shirur, Srinivas Mutalik. "Novel nano-cubosomal chlorhexidine for endodontic irrigation:	<1 %

	Development, characterization, and performance evaluation against E. faecalis and streptococcal biofilms in human extracted teeth", Journal of Applied Pharmaceutical Science, 2024 Publication	
24	Submitted to The Brooke House Sixth Form College Student Paper	<1 %
25	Submitted to Taylor's Education Group Student Paper	<1 %
26	www.wickedspatula.com Internet Source	<1 %
27	sutir.sut.ac.th:8080 Internet Source	<1 %
28	Md. Meraj Ansari, Yunji Heo, Kyoungtag Do, Mrinmoy Ghosh, Young-Ok Son. "Nanocellulose derived from agricultural biowaste by-products: sustainable synthesis, biocompatibility, biomedical applications, and future perspectives: a Review", Carbohydrate Polymer Technologies and Applications, 2024 Publication	<1 %
29	dspace.daffodilvarsity.edu.bd:8080 Internet Source	<1 %
30	hdl.handle.net Internet Source	<1 %

31	www.agrifoodmagazine.co.in Internet Source	<1%
32	Kirti Jalgaonkar, Manoj Kumar Mahawar, Bhushan Bibwe, Pankaj Kannaujia. " Postharvest Profile, Processing and Waste Utilization of Dragon Fruit (.): A Review ", Food Reviews International, 2020 Publication	<1%
33	gastroscan.ru Internet Source	<1%
34	link.springer.com Internet Source	<1%
35	www.thepharmajournal.com Internet Source	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		

PROCESSING OF A VALUE-ADDED DRAGON FRUIT DEHYDRATED R.T.E. BAR USING A MULTI-HEAD SOLAR PANEL DRYER

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

PAGE 15

PAGE 16

PAGE 17

PAGE 18

PAGE 19

PAGE 20

PAGE 21

PAGE 22

PAGE 23

PAGE 24

PAGE 25

PAGE 26

PAGE 27

PAGE 28

PAGE 29

PAGE 30

PAGE 31

PAGE 32