Chapter 1: Introduction

1.1 General feature

Health is the most precious treasure for all of us. To protect our health, we need to pay attention to our diet. A balanced and healthy diet is a big plus in many aspects of life. This has a positive impact on both mental and physical health and plays an important role in a person's success. The importance of leading healthy lifestyles is rising among people all over the world (Skerrett & Willett, 2010). Consequently, it might have an impact on both what and how people eat. Consumers today place a high value on the sensory aspects of food, such as flavor, texture, and appearance. Nutritional evaluation of consumed food may influence consumers' food choices in addition to sensory attributes. The value of wholesome, nutritious food has also increased among consumers. Fresh fruits and processed fruit products are the finest option to satisfy their requirement for consumption. Vegetables and fruits, which are among the perishable goods, play a significant role in human diets. A diet high in fruits and vegetables can lower blood pressure, lessen the risk of heart disease and stroke, lower the risk of some types of cancer, avoid eye and digestive disorders, and improve blood sugar levels (Harvard T.H. Chan School of Public Health, 2023). Due to their great nutritional value, they significantly contribute to human well-being in terms of nutrition. They are a more reliable and affordable supply of foods that are protective. The national situation will significantly improve if they can be made available for human use year-round in fresh or preserved form. Food security, both in terms of food and nutrition, is improved by processed foods (Cole, Augustin, Robertson, & Manners, 2018). Many food companies have created fruit supplements such juice, fruits bar, fruit drinks, jam, jelly, fruit-based desserts with milk, fruit powder, etc. to give essential nutrients.

Wood Apple is a rare species of tree that is indigenous to the Indian subcontinent and Southeast Asia. It is also referred to by the common names bael (or bili or bhel), Bengal quince, golden apple, Japanese bitter orange, stone apple, or wood apple. As a naturalised species, it can be found in India, Bangladesh, Sri Lanka, and Nepal (Wikipedia, 2023). Bael fruits are high in beta-carotene, protein, riboflavin, vitamin C, vitamin B1 and B2, thiamine, riboflavin, niacin, and carotene. They also contain a lot of minerals like calcium, potassium, fiber, and good fats. (Netmeds.com, 2023). These fruits are also usedfor their medicinal and therapeutic properties for thousands of years.

They are also popular for their antioxidant, anti-inflammatory, and laxative properties. Each nation has its own unique methods for utilising bael fruit in relation to food. For instance, the ripe fruit is consumed raw and is also made into nectar, squash, sherbet, jam, and marmalade.

A species of Cucumis called Cucumis melo, sometimes called Bangi or Muskmelon, has given rise to numerous cultivated varieties (Wikipedia, 2023) . The flesh may be sweet or mild, musky or not, and the rind may be smooth (e.g., honeydew melon), ribbed (e.g., European melon), wrinkled (e.g., cassava melon), or reticulated (e.g., cassava melon). : cassava melon), or reticulated (e.g. cassava melon). Consuming muskmelons is linked to potential health advantages for humans because they include naturally occurring vitamins, minerals, and pigments that have anti-oxidant, anti-inflammatory, and anti-diabetic effects (Ismail et al., 2010) (Bindu, Sharma, Manan, & Kaur, 2023). Fruits are full of vitamins and minerals and can be used to cure a variety of illnesses, including dermatitis, kidney problems, coughing, bilious diseases, hot liver inflammation, liver and bile obstruction, and hidden hunger (micronutrient deficit). The ripe muskmelon fruit is eaten raw and is also made into juice, jam, and jelly, among other things.

Energy, vitamins, minerals, and dietary fibre are all found in fruits. Fruit bars would be a convenient dietary selection to benefit from the health benefits of fruits because all nutrients are concentrated, giving them a significantly larger nutritional value than fresh fruits (Orrego, N.Salgado, & Botero, 2013). Consumers favor fruit bars with better taste and suitable textural characteristics, which may be achieved by balancing the components, selecting the right production steps, and managing the product's final moisture level. Fruit pulps, fresh or dried fruit, sugar, binders, and a number of minor ingredients can all be combined to make fruit bar preparations. Due to fast urbanization in the world, importance of off season and readymade healthy food is increasing at a faster rate. Fruit bar is readymade food products, whose importance will increase rapidly in recent future. The main benefits of producing fruit bars are to control postharvest deterioration by drying fruit and preserving it. Producing fruit bars from ripe or slightly overripe fruits that are unfit for fresh consumption would allow businesses to meet consumer demand when the market is slow. Fruit bars are also significant providers of nutrients and carbs in addition to this. It is conceivable that

eating fruit bars will help lower the chance of developing various diseases given the variety of bioactive compounds found in fresh fruits that are maintained in them.

1.2 Aims & Objectives

General objective

The aim of the research was to develop a high-quality fruits bar with bioactive compounds.

Specific Objectives

- To compare the nutritional and bioactive components of fruits bar using different sweetener's.
- To compare organoleptic and sensory properties of fruits bar.
- To assess the microbiological properties.

Chapter 2: Review of Literature

2.1 Wood apple (Limonia acidissima)

Wood Apple (*Limonia acisdissima*) tree is one of the medicinal plant belongs to the genus of ‘ Limonia’ in the family of ‘Rutaceae’ which is a natural sources of antioxidant. The plant's roots, fruits, bark, and leaves are among its valuable parts and are utilised for a variety of therapeutic applications (Pandey, Satpathy, & Gupta, 2014). the subtropical fruit known as "Bael" or Aegle marmelos. Bael is called several things in different languages, including Bel in Spanish and Assamese, Matoom in Thai, Vilva marum in Tamil in India, and Be Li in Sinhalese (Sarkar, Salauddin, & Chakraborty, 2020). In addition to Sri Lanka, Pakistan, India, Burma, Thailand, and the majority of Southeast Asian nations, it is grown all across Bangladesh.

Fig 2.1: Wood-apple fruit

Taxonomical classification

Kingdom: Plantae

Divison: Magnoliophyta

Class: Magnoliopsida

Sub-class: Rosidae

Order: Sapindales

Family: Rutaceae

Genus: Aegle

Species: *A.marmelos*

2.1.1 Nutritional Value of Wood-apple

The fruit's peel is a highly tough shell that ranges in colour from green to brown according on the degree of ripeness. The yellow or orange edible pulp has a boiled pumpkin-like appearance and tastes slightly sweet. It also has a distinctive floral, terpene-like scent that is quite fragrant and delightfully flavoured. Mucilage, a translucent, slimy substance, surrounds the seeds. Numerous useful and bioactive substances, including carotenoids, phenolics, alkaloids, coumarins, flavonoids, terpenoids, and other antioxidants, are present in the bael fruit pulp and may protect us against chronic diseases (Lakht-e-Zehra, Saleem, Soomro, Afzal, & Naqvi, 2015). Mucilage and pectin, two types of soluble and insoluble dietary fibre, make up the majority of the total amount of dietary fibre in this fruit. It also contains a variety of vitamins and minerals, including as calcium, phosphorus, vitamin C, vitamin A, thiamine, riboflavin, and niacin (Bhardwaj & Nandal, 2015). As a result, the bael fruit may suggest that it is one of the key plants utilised in traditional indigenous medicine. There are countless examples of its application in conventional medicine.

Nutrient	Value per 100 gm
Energy	134.0 kcal
Carbohydrates	18.1 g
Proteins	7.1g
Fats	3.7g
Calcium	130mg
Iron	0.6mg
Vit C	3.0mg

Table 2.1- Nutritional composition of Wood-apple

2.1.2Various proved therapeutic values of Wood-apple:

1. Ant Diabetic Activity: Upadhya S. et al. (2004) used alloxan-induced diabetes in male albino rats to test the hypoglycemic and antioxidant effects of an aqueous extract of Aegle marmelos leaves, and they suggested that AML may be helpful in the long-term control of diabetes (Ismail, 2009).

2. Hepatoprotective activity: Aegle Marmelos leaf extract was used by Singanan et al. (2007) to treat alcohol-induced liver damage in albino rats and they reported that the treatment had excellent hepatoprotective benefits (Snganan, Singanan, & Begum, 2007).

3. Antimicrobial Activity: Shigella boydii, Sonnei, and Flexneri were the several intestinal infections that Maheshwari et al. (2009) tested on ethnochemical extract of dried fruit pulp of Aegle Marmelos against, and they proposed that specific phytochemicals including Phenols, Tannins, and Flavonoids were effective against all. In agreement, it was also tested for Aegle Marmelos' positive bactericidal properties on a variety of harmful bacteria, including Salmonella typhi, Pseudomonas aeruginosa, Aeromonas hydrophyla, and Vibrio sp. (Mujeeb, Bajpai, & Pathak, 2014).

4. Analgesic anti-inflammatory, & antipyretic Activity: The antiinflammatory, antipyretic, and analgesic activities of a serial extract of Aegle marmelos leaves were presented by Arul et al. in 2005. They also demonstrated that the majority of the extract significantly inhibited the carrageenan-induced paw oedema and cotton-pellet granuloma in rats. By reducing the early and late phases of mice's paw-licking behaviour, the extracts also demonstrated significant analgesic efficacy. The majority of the extracts also significantly reduced the rats' hyperpyrexia.Similar to this, Aegle mannelos' aqueous extract was tested for anti-inflammatory activity using a rat paw oedema model by Ghangale G. R. (2008), who similarly suggested that the plant has anti-inflammatory properties. At dose levels of 200 and 300 mg/kg, Shankharananth V. (2007) showed that methanolic extract of leaves from Aegle marmelos has considerable analgesic effect on acetic acid induced writhing and tail flick test in mice.

5. Anticancer Activity: Leticia V. and Costa L. (2005) examined the anticancer potential of traditional Bangladeshi medicine and tested extracts of Aegle marmelos for cytotoxic activity using the MTT assay with tumour cell lines, the sea urchin eggs assay, and brine shrimp lethality assay.According to research by Maithy, Bandyopadhyay, and Mishra, a pure compound from the bael plant is physiologically active against a number of serious disorders, including cancer..

6. Radioprotective Activity: By subjecting mice to various doses of gamma radiation, Jagetia GC and Venkatesh P (2005) investigated the radioprotective impact of Aegle marmelos extract. They discovered that oral administration of the extract increased

radiation tolerance by 1.6 Gy. Intestinal mucosa, colony-forming units in the spleen, and peripheral blood were studied for radiation-induced changes. It was found that Aegle marmelos extract significantly lessened the harmful effects of radiation on the mouse's intestine and bone marrow (Jagetia, Venkatesh, and Baliga, 2004).

7. Anti thyroid Activity: Scopoletin (7-hydroxy-6-methoxy coumarin), which was isolated from the leaves of Aegle marmelos, was examined for its ability to control hyperthyroidism by Panda S. and Kar A. in 2006. It was shown that administering scopoletin to levothyroxine-treated rats resulted in a reduction in the amount of serum thyroid hormones (1.00 mg/kg, p.o. for 7 days). Additionally, it was demonstrated that scopoletin had better therapeutic effect than the common antithyroid medication, propylthiouracil (Panda and Kar 2006).

8. Toxicity Studies: The toxicity of the complete alcoholic, total aqueous, whole aqueous, and methanolic extracts taken from the leaves of A. marmelos was examined in experimental rats by Veerappan A et al. in 2007. When A. marmelos extracts were given intraperitoneally for 14 days straight at a concentration of 50 mg/kg body wt, no histological alterations were seen. According to the gathered data, A. marmelos leaf extracts have a good margin of drug safety (Alhorani, et al. 2022).

9. Other reported medicinal values: According to Das, Ghosh, and Sen (2002), an aqueous extract of the Aegle marmelos fruit inhibits the outer membrane protein C of enteropathogenic Escherichia coli. In addition to these actions, reports have been made of insecticidal, anti-lipid peroxidative, and antioxidant properties.

2.2 Muskmelon (Cucumis melo)

The Cucurbitaceae family includes Cucumis melo L. (Reticulatus group), also known as cantaloupe or muskmelon. The fruit cucumis melo L., which is widely regarded, has numerous advantages for human health. According to Lester (2008), this fruit's sweetness (or sugar content), flavour, scent, texture, and more recently, its abundance in phytonutrients, all influence consumer liking for it. In addition to being highly popular with consumers, cucumbers are also a very healthy food option because they are high in ascorbic acid, carotene, potassium, folic acid, and a variety of other bioactive chemicals that are beneficial to human health (Menon, Rao, & V, 2012).

Fig 2.2- Cucumis melo

Taxonomical Classification

Kingdom - Plantae Plants

Division - Magnoliophyta

Class - Magnoliopsida

Order - Cucurbitales

Family - Cucurbitaceae

Genus - Cucumis

Species - Cucumis melo Linn

2.2.1 Nutritional value of muskmelon

Cucumis melo (muskmelon) is round or oblong in shape, weighs 450-850 g, frequently more than a kilo, and has a diameter of 4.5 to 6.5 in. Internally, the flesh can be orange-yellow to salmon in colour, has a soft consistency, is juicy, and has a sweet, musky perfume that is most noticeable in fully ripe fruits. Muskmelon has a 90% water content, 8% carbohydrate content, 0.8% protein content, and 0.3% fat content (Manchali and Murthy 2020). One hundred grammes of muskmelons has 34 calories (kcal) and 2020 mg of the provitamin A orange carotenoid, -carotene. The fruit is a rich source of polyphenols and flavonoids including zea-xanthin and cryptoxanthin, as well as modest amounts of potassium, manganese, and B-complex vitamins like niacin, pantothenic

acid, and vitamin C. Cucurbitacin B and E, which reduce inflammation, are also abundant in the fruit. Cantaloupe guards against excessive inflammation and oxidative stress. The blood levels of people who consume a lot of cantaloupe also have lower levels of C-reactive protein (CRP). According to the USDA database 100gm of muskmelons contain following nutrients-

Nutrient	Value per 100 gm
Energy	34kcal
Carbohydrates	8.16g
Fats	0.9g
Fiber	0.19g
Potassium	267mg
Iron	0.21mg
Vit C	36.7mg

Table 2.2- Nutritional composition of Muskmelon

2.2.2 Health benefits of muskmelon

1. Rich Antioxidant Content: Muskmelon contain a range of antioxidants including-

Selenium is an important trace element that is needed for hormonal balance, immune protection and counteraction of free radicals, improving blood circulation (Kang, et al., 2022)Beta carotene, which is converted into vitamin A. The latter is important for vision, the immune system and healthy red blood cells.Vitamin C is one of the most powerful antioxidants known to date, key to immunity, skin health and more.Choline, which contributes to normal cholesterol levels in the body and supports nervous and muscle function (Bernillo, et al., 2022).

2. Potential beneficial effect in Asthma

According to research on animals, eating a lot of the antioxidant beta carotene, which is a type of vitamin A, may help people avoid developing asthma later in life. Fruits that are yellow or orange, such melons, peppers, and carrots, contain beta carotene. 3,580 micrograms of beta carotene are present in one cup, or 177 grams, of melon slices.

A 2010 study found that persons with asthma who got choline, another antioxidant found in melon, as part of their treatment experienced a reduction in inflammation (Farfour, et al. 2010) .

3.Potential anticancer properties

Melons include beta carotene, tocopherol, and other antioxidants that can help stop oxidative stress from damaging cells. According to research (Zhang et al., 2020), consuming supplements containing these and other antioxidants can lower the risk of developing lung, prostate, and other cancers. According to additional evidence, dietary fibre also provides defence against colorectal cancer (Ahrolovich, Madiyarovich, & Halimova, 2020).

4.Helps to maintain normal blood pressure

Cucumis melons' choline, fibre, potassium, and vitamins C and C improve heart health. Blood pressure can be lowered by eating foods high in potassium (Aluko, 2020). To maintain normal cardiovascular function, the American Heart Association (AHA) advises that an average adult ingest 4,700 mg of potassium daily.

2.3 Honey and Its application to processed fruit items

Honey, which differs from other sweeteners in that it has not been refined like white cane sugar and sugar beets, is a sweet and natural substance manufactured by bees, particularly those of the species Apis mellifera (hammer and Locher 2022). Blossom honey is obtained by bees by collecting nectar from blossoms. There is no need for preservatives, which are widely used in industrial manufacturing. According to Steeg et al. (1988), sugars—particularly fructose and glucose—make up the majority of honey's constituents. Other elements from the floral source where the bee obtains the nectar, such as water and free amino acids, are also present, but in lesser quantities and with different honey types. The one that is most common is proline. The three primary enzymes found in honey are invertase, amylase, and glucose oxidase. Additionally present are phosphatase and catalase . The organic acids that give honey its particular flavor and preserve its extraordinary durability against microbes include formic, acetic, butyric, oxalic, lactic, succinic, folic, malic, citric, and glycolic (Sato and miyata, 2000). Honey lacks fat and fiber, and their effects are very minor in compared to those of inorganic minerals and vitamins. When honey is ingested in moderation, the body has

enough time to transition to the process of removing sugars since the conversion of levulose into sugar occurs at a considerably slower rate than is necessary. The powerful stimulating properties of honey are only one of its many qualities; 100 grams of honey have 330 kcal in them (Sahlan, et al. 2019).

It is perfect for athletes since it promotes quick recovery from strenuous activity and covers symptoms of fatigue. It is also recommended for the elderly and the exhausted. The food needs of the people are varied; many of them want new tastes, colors, and fragrances. Given that jelly is not necessary for some innovative products, like cranberry, honey can be used in place of sugar, which has a very large market potential.

2.4 Sugar

Sucrose, sometimes known as "sugar," is a crystalline carbohydrate with a sweet flavor and a caloric content of 4K per gram (Oostenbach, et al. 2022). Beet and cane are the two primary sources of sugar, but it can also be found in a wide range of other foods, including fruits, vegetables, honey, corn syrup, and so on (Erdat et al., 2007). Despite the fact that sugar's main purpose in food is to enhance flavor, it also has a considerable impact on the dish's color, texture, and fermentation, making it more perishable. Due to the connection between rising rates of obesity, cardiovascular disease, and type 2 diabetes and increased sugar intake, food organizations have published tight guidelines for determining how much sugar an individual should consume.

2.5 Date

The date palm is a species of Phoenix dactylifera. Dates are a type of plant in the Arecaceae family of palms that are cultivated primarily for their mouthwatering fruitiness. The species, which is frequently grown as a plant in South Asia, the Middle East, and northern Africa, has naturalised in many tropical and subtropical regions of the world. The typical member of the genus Phoenix, which includes 12–19 distinct species of wild date palms, is P. dactylifera (Krueger, 2018). According to Al Farsi and Lee (2008), the fruit is a rich source of energy, with 100 grams of flesh providing roughly 314 kcal (Al-Farsi and Lee 2008).

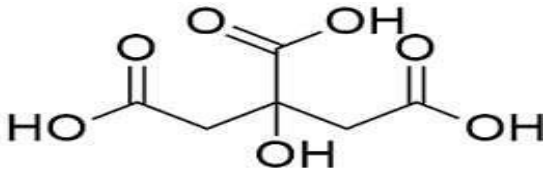
Dates typically include less than 1% fat, 2% protein, and 21% water, with 75% of their calories coming from carbohydrates (63 percent sugars and 8% dietary fiber).

One date has 1,180 kJ (280 kcal) of nutritional energy, making it a reasonable source of energy. sources of vitamins, dietary minerals including magnesium and potassium,

pantothenic acid (10–19% of the Daily Value), and other trace amounts of micronutrients. According to Yasawy (2016), dates have a sugar content of around 55 percent glucose, 45 percent fructose, and very little sucrose.

2.6 Citric Acid

Citrus fruits naturally contain citric acid, also known as 2-hydroxy-propane1 and 2-tricarboxylic acid ($C_6H_8O_7$.H2O). Citrus acid is an organic acid produced by the Krebs cycle in live cells and gets its name from the Latin word for citrus (Swain et al., 2012).Pure citric acid is tasteless, odorless, and colorless and is solid at room temperature, according to a review by Angumeenal et al. (2013). One of the most significant commercially value-added products is citric acid (CA), a Krebs cycle intermediate used in the food processing industry (70%), the pharmaceutical industry (12%), and other industries (18%)(El-Hussein et al., 2009; Yalcin et al., 2010). It is also thought of as a chemical that is non-toxic, tasty, and generally accepted as safe (GRAS). Citrus fruits including grapes, oranges, limes, lemons, and tangerines contain citric acid naturally. Citric acid is a typical food additive because of its preservative, acidifying, antioxidant, emulsifying, and buffering properties. As a result, citric acid is frequently utilized as a basic ingredient in a range of foods. It is a beneficial ingredient that is generally liked worldwide for daily consumption.



Citric acid

2.7 Starch

Starch or amylum is a polymeric carbohydrate composed of many glucose units joined together by -(14)-D glycosidic bonds. This polysaccharide is produced by the majority of green plants as a way to store energy. It is the most common carbohydrate in the diets of people all over the globe and is found in substantial quantities in a variety of everyday foods, including wheat, potatoes, maize (corn), rice, and cassava. White, tasteless, odorless, and insoluble in alcohol or cold water, pure starch is a powder. It is composed of the linear and helical amylose molecules, as well as the branching amylopectin

molecule. Depending on the plant, starch normally contains 20 to 25% amylose and 75 to 80% amylopectin by weight. In the food business, starch is a food ingredient that may be used to regulate the consistency, stability, and texture (soups and sauces, fruitsbar), prevent the gel from breaking down during processing, and lengthen the shelf life of different products.

2.8 Fruits bar

Vitamins, minerals, and dietary fiber are all found in fruits, which also provide energy. The time needed to prepare them and their high perishability are two obstacles to boosting the intake of fruits and vegetables. A good, practical, and superior alternative may be achieved by processing these high-value foods into fruit bars or fruit leather.Fruit bars are products made from a mixture of fruit purees or pulp from ripe pulpy fruit, sugar or other nutritive sweeteners, and additional ingredients and additives chosen for the product. The mixture is then dried to produce a sheet that can be cut to the appropriate shape and size. The specification for fruit bar are moisture less than 20.0%, total soluble solids less than 75.0 %, fruit content not less than 25.0 % and yeast & mould count positive in not more than 100 count/gm as per 'Food Safety and Standard Authority of India' (FSSAI, 2010). Fruit bars are dehydrated fruit product with low water activity and low moisture content (15-25%), high sugar content as well as concentration of natural acidity making its pH low. Fruit bars can also serve as a good matrix for prebiotics to be added, according to other research.

2.9 Conclusion

Fruit bars are renowned for their great nutritional and energetic benefits cause it has a long shelf life and is a concentrated, dehydrated product. Various fruit bars exist, anyone can eat it because it is a tasty, healthy food with good nutrition. It can supply the necessary dietary fiber, vitamins, minerals, and other bioactive substances that promote human nutrition and is appropriate for usage as 'food on the go' due to its portability.

Chapter 3: Materials and Methods

3.1 Study area:

Departments of Applied Human Nutrition and Dietetics, Animal Science and Nutrition, Biochemistry, Poultry Research and training center (PRTC) at Chattogram Veterinary and Animal Sciences University (CVASU) were responsible for carrying out the experiment. Beginning on January 1, 2023, and ending on June 2o, 2023, experiments lasted for a total of six months.

3.2 Collection of samples:

Fresh muskmelon and bael were collected from the local market of Chattogram City Corporation. In order to formulate Jam, additional materials were purchased from the neighborhood store. These included sugar, honey, and dates. Additional components for the experiments, such as starch and citric acid, were retrieved from the stocks that the laboratory maintained.

Figure 3.1 : Study area

3.3 Materials & Apparatus required

Materials required

- Wood Apple
- Muskmelon
- Starch
- Citric acid
- Sugar

Apparatus required

- Shallow pans
- Stainless steel knife
- Chopped board
- Balance
- Blender
- Electric oven
- Thermometer

3.4 Experimental design

After gathering all of the components, fruits pulp of wood apple & muskmelon and sweeteners were used to create fruits bars. Three distinct fruits bar were made with three distinct sweeteners. The proportions and constituents of jams A, B, and C are shown in Table 3.1. After processing of fruits bar the proximate composition of fruit bar included moisture, ash, crude fat, protein, crude fiber, and carbohydrates- was determined. Moreover the each category of food was assessed for its nutrient content, bioactive ingredients (total antioxidants capacity, total polyphenol capacility,total flavonoids),shelf life, consumer acceptability and total cost analysis was also done.

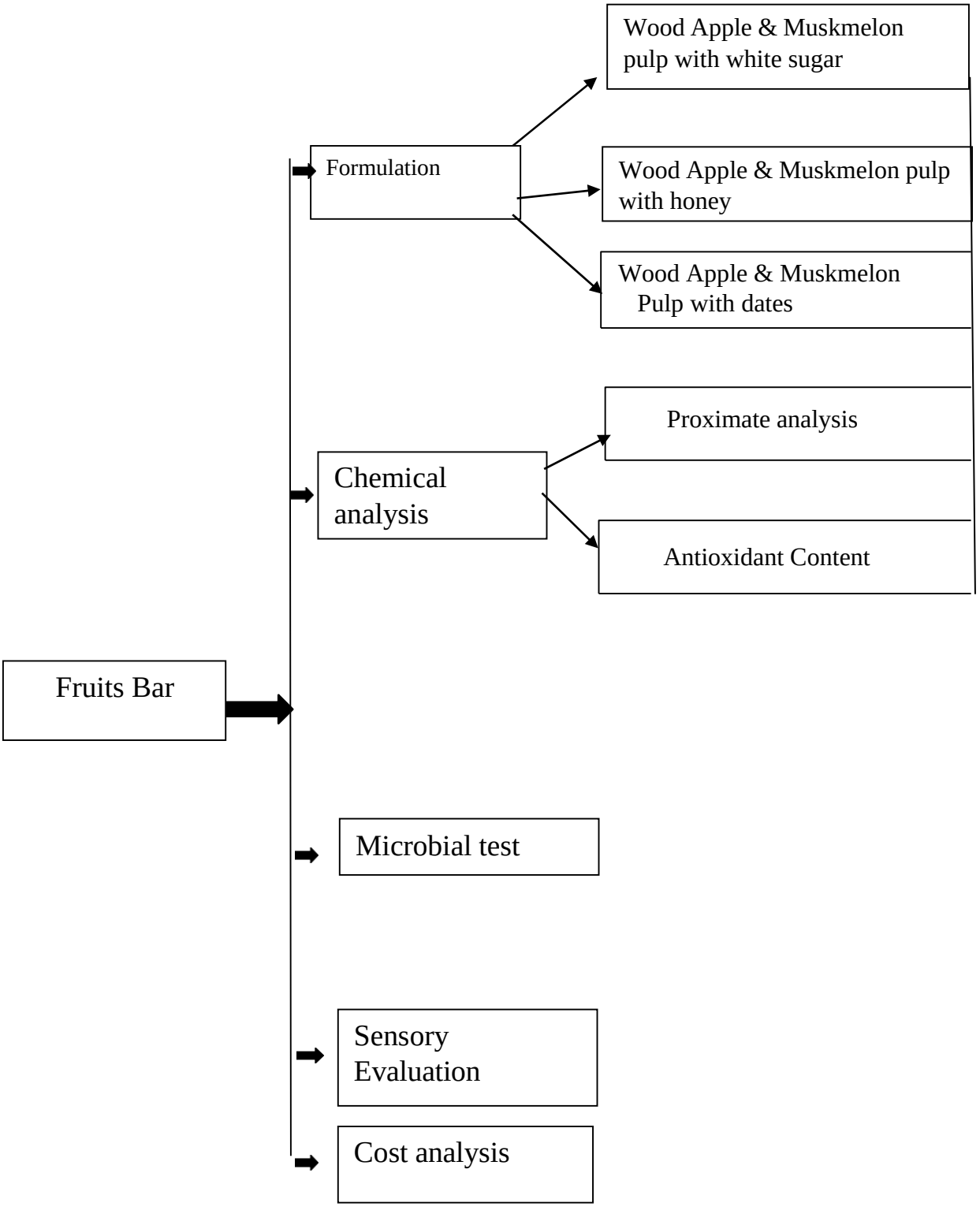


Figure 3.2: Study design

Table 3.1: Ingredients & composition of experimental fruit bar

Ingredient	A & D (woodapple & muskmelon pulp with sugar)	B & E (woodapple& muskmelon pulp with Honey)	C & F (woodapple & muskmelon pulp with dates)
Wood apple pulp	40 gm	40gm	40 gm
Muskmelon pulp	40gm	40gm	40 gm
Sweeteners	17gm	12.75 ml	22 gm
Starch	2.5 gm	2.5 gm	2.5 gm
Citric acid	0.5 gm	0.5 gm	0.5 gm

3.4 Preparation of fruit bar

Wood apple & muskmelon fruits were washed & sanitized in chlorinated water (100 ppm), peeled & seeds were removed. Then fruits pulp were extracted .In an electric blender both of the fruits pulp processed in separately because the formation of fruit leather required blended fruit puree. The processed fruit pulp was measured and weighed on a balance. The entire wood apple & muskmelon pulps were divided into 3 portions for the preparation of three different sample. Mixed pulp was heated for 10 minutes at 80 ºC . Then sugar , citric acid & starch was added. The mixture was heated with continuous stirring till it reached to 68 º degree brix. When the mixture reached to 68 º brix then it was spreading in a oil coated tray upto 0.5 cm thickness and dried in a cabinet drier for a maximum 16 hours at a constant temperature 60 ºC .After drying the sheet was cut into rectangular pieces of 3*0.5 cm size. High density polythene bags were used to package & preserve the fruits bar Departments of Applied Human Nutrition and Dietetics, Animal Science and Nutrition, Biochemistry, Poultry Research

and Training Center (PRTC) at Chattogram Veterinary and Animal Sciences University (CVASU) were responsible for carrying out the experiment. Beginning on January 1, 2023, and ending on June 2o, 2023, experiments lasted for a total of six months.

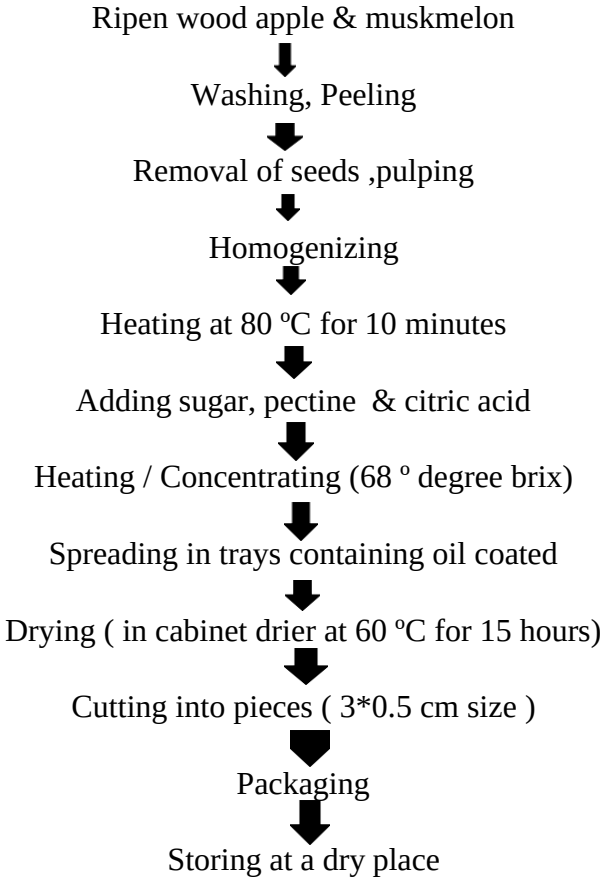


Fig 3.3 - Process flow sheet for the preparation of Fruits bar

3.5 Physicochemical analysis of fruits bar

The AOAC 2016 method was used to analyze pH , acidity, titrable acidity, moisture, protein, fat, fiber, and ash content of woodapple & muskmelon fruits bar samples. Additionally, total flavonoid and total polyphenol content, as well as antioxidant capacity, Vitamin C were measured in these samples.

3.5.1 Total Soluble Solids

Total soluble solids were measured using an Atego RX 1000 digital refractometer, and the results were represented as a percentage of soluble solids (Brix) in line with AOAC standards.

3.5.2 Titrable Acidity

Distilled water was used to dilute 10 ml of juice to 100 ml in a volumetric flask. In order to titrate 10 ml of the diluted juice against N/10 NaOH, phenolphthalein was used as an indicator. The arrival of pink colour signifies the titration's endpoint. Three reports of the titration were made, each of which included the average value (AOAC 2016).

$$\text{Titratable acidity (\%)} = \frac{\text{T.V} \times \text{Factor}}{\text{W}}$$

Where, TV = Titer value of the sample in ml

W = Quantity of the sample taken for the test in ml Factor - Citric acid: 0.0064 (Citrus Fruit); Malic Acid: 0.0067

The negative logarithm of the amounts of hydronium ions is typically used to express pH. To determine the primary pH standards in a concentration cell with transference, the potential difference between a hydrogen electrode and a standard electrode, such as the silver chloride electrode, is measured. The pH of aqueous solutions can be measured with a glass electrode and a pH metre, or indicators can be used instead (McClements and Decker, 2010).

3.5.3 Determination of Vitamin C

Chemically assay of the Vitamin C depends on the market reducing properties of the Vitamin C. Generally, Vitamin C is determined in plant or animal extract by its reducing action on the dyes stuff 2,6-dichloride phenol indophenols. In this matter, Vitamin C oxidized by the color dye to the dehydroascorbic acid. Concurrently, the dye is converted into the colorless compound. So that the endpoint of the reaction may be easily determined. Rapid excretion and filtration are desirable. Oxidation is presented by the use of meta- phosphoric acid during extraction. Strongly acidic solution will provide most accurate result. The titration should be finished in one minute. In aqueous solution, the dye is blue, pink in an acidic solution, and colorless when totally reduced (AOAC 2016).

Reagent requirement

Dye Solution

260 mg of dye (2,6-dichlorophenol indophenols)

210 mg of NaHCO3 dissolved in 100 ml of distilled water.

Metaphosphoric acid solution (3%)

15/7.5 mg of Metaphosphoric acid.

40/20 ml of glacial acetic acid is diluted with distilled water to get 500/250 ml solution

Standard ascorbic acid solution

500 ml/250 ml of a solution of metaphosphoric acid and 50/25 mg of crystalline ascorbic acid were combined.

Procedure

In the burette, the dye solution was taken. Then, in a conical flask, 5 mL of Vitamin C solution was then added. The dye was added drop wise to the conical flask by using a burette. After the pink color appeared and lasted for 20 seconds before fading, the titration was complete. At least three separate readings were taken. A similar procedure was used with a solution of ascorbic acid, the concentration of which was unknown. Mg %, or milligram percentage, was used to represent the outcome.

3.6 Proximate analysis of fruits bar

3.6.1 Determination of moisture content

The hot air oven drying procedure, as defined in (AOAC 1990), was used to assess the sample's moisture content. In an analytical balance, 3 g of sample and an empty crucible were weighed. The sample was taken inside the crucible and dried for 12 hours at 105 degrees in a hot air oven. The crucible was then taken out and put into a desiccator to cool to room temperature. The weight and value of the sample's crucible were recorded. This process is repeated for several times until a constant weight shows by the sample.

Calculation: The percent of moisture was calculated as follows,

$$\%\ Moisture = \frac{W - W1}{W} \times 100$$

W= Weight of fresh/dry sample, W1= Weight of dried sample.

3.6.2 Determination of Ash content

The mineral components are completely mixed up in the ash fraction. With this technique, all organic material is burned to oxidise it, and the weight of the ash that

remains is calculated. Weighted the empty crucible initially. A sample of around 2 to 5 g was placed in the crucible. The crucible was then placed in the muffle furnace's chamber for ignition at 550° C for 6-8 hours, producing ash that was grey in colour. The crucible was removed from the muffle furnace and cooled in desiccators after that. The final weight of sample with crucible was taken.

Calculation: The ash content was calculated by following expression,

$$\% \, Ash = \frac{W - W1}{W2} \times 100$$

W= Weight of Crucible and ash, W1= Weight of crucible, W2= Weight of sample.

3.6.3 Determination of protein

Nitrogen content estimation is done by Kjeldhal method. The protein content of food stuff was obtained by estimating nitrogen content of the material and multiplying the nitrogen factor by 6.25 .

Digestion

Ammonia was produced during the digestive process by the breakdown of protein and other nitrogen-containing substances. A digestive tube was filled with a weighted sample weighing around 0.5 gm. 4 gm of this catalyst, which was made up of 63 gm of potassium sulphate and 7 gm of copper sulphate, was introduced to the digestive tube. A 10ml conc. H_2SO_4 solution was then added to the mixture. The digestion tube was then inserted into the digestion machine and left there for 30 minutes to digest. The digestion tube was cooled for 30 minutes at room temperature.

Distillation

After cooling, 25 ml of 40% NaOH and 50 ml of distilled water were added. In the conical flask of the distillation unit, 10 ml of 2% boric acid was introduced together with 3 drops of green bromocresol. The receiving solution was added to the distillation unit together with the cooled tube. The tube was automatically filled with 100 ml of

40% NaOH. For three minutes, the distillation process was carried out. At the conclusion of the procedure, the receiving solution turned green.

Titration

The most common method of determining the amount of nitrogen is titration of ammonia with a standard solution of HCL in the presence of mixed indicator. The receiving solution was titrated with N/10 HCL solution until turn into light pink color.

Calculation: Percentage of nitrogen and protein calculated by the following formula,

$$\%\ Crude\ Protein = \frac{A \times\ B \times 0.014}{W} \times\ 6.25 \times 100$$

A= Volume of standard N/10 HCL solution, B= Normality of standard HCL, W= Weight of the sample.

3.6.4 Determination of fat content

The amount of fat was calculated using the Soxhlet device. Chillers 1 and 2 of the Soxhlet equipment were turned on in that order. The work had already begun when the temperature fell below 12°C. Beakers were weighed and tagged based on their empty weight. A sample of 2.0 grams was placed on thimble paper. The thimble paper was then placed beneath the magnetic holder by a magnetic ring, which was used to raise it. In a beaker with a label, 80–100 ml of diethyl ether were taken. Under the condenser, solvent-filled beakers were screwed, and the stopcock was opened vertically. The extraction beaker was then placed in the burner by the lift lever handle after the thimbles had been lowered into the beaker. The machine was turned on, heated to boiling temperature (100°C), and allowed to boil for 20 minutes. The reflux stopcock was closed when the thimbles were raised and 20 minutes had passed. Once more, waited for the solvent to evaporate for around 10-15 minutes. The lever was raised, turned off, and the extraction beaker was then taken. The extraction beaker was then placed in a hot air oven set at 105°C for 30 minutes, cooled at a desiccator, and its weight was measured.

Calculation: The percent of fat was expressed as follows,

$$\%\ of\ Ether\ extract = \frac{A - B}{W} \times 100$$

A= Weight of the flask with ether extract, B= Weight of the flask, W= Weight of the sample.

3.6.5 Determination of fiber content

First, the crucible's weight was determined, and then a 2gm sample was added to the crucible. The fiber analyzer was then used to set the filter. Each sample was cooked in 150 cc of sulfuric acid (1.25%) for 30 minutes before chilling for a few minutes. then an antifoam agent, 3-5 drops of n-octanol, are added. Three times, 30 ml of hot, distilled water were used to wash each sample. Once more, the sample was heated for 30 minutes in 125 ml of sodium hydroxide (1.25%) before chilling for a few minutes. Each sample was also cleaned three times with 30 cc of hot, distilled water. Once more, the sample was heated in 125 ml of sodium hydroxide (1.25%) for 30 minutes before cooling down for a few minutes. Additionally, each sample was rinsed three times with 30 cc of hot, distilled water. The sample was cleaned once with 30 ml of regular distilled water, followed by three times in the condenser chamber with a 1% HCL solution. Sample was maintained at 105°C for 1 hour in a hot air oven. The material was then dried out in a desiccator and weighed. Additional samples were held at 550°C for three hours in a muffle furnace. After 30 minutes in the desiccator, the crucible's ultimate weight was recorded.

$$\%\ of\ Crude\ fibre = \frac{W - W1}{W2} \times 100$$

W= Weight of crucible, crude fiber and ash, W1= Weight of crucible and ash,

W2= Weight of sample.

3.6.6 Determination of total carbohydrates

Calculating the difference of Nitrogen Free Extractive (NFE) allowed for the determination of the carbohydrate content. The amount of carbohydrates in an object may be calculated by subtracting the total of the values for moisture, ash, protein, and fat from 100 (per 100 gm) (AOAC, 2012).

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

3.6.7 Determination of energy content

By multiplying the values for crude protein, crude fat, and crude carbohydrate by the appropriate Atwater factors (4 Kcal, 9 Kcal, and 4 Kcal), the energy content (kcal/100g) was obtained.

It is expressed as: Energy value (Kcal/100 gm) = (Protein× 4) + (Fat× 9) + (Total CHO×4)

3.7 Determination of mineral content:

Mineral contents were determined by using biochemical analyzer (Humalyzer 3000). Commercially available biochemical kit (Randox®) was used for biochemical assay.

3.7.1 Sample preperation:

Samples weighing 1g were placed in a digestion vessel. Next, 3 mL of 30% H_2O_2 and 7 mL of HNO_3 were added. The containers were then secured in holders and sealed. The vessel holder was then placed in a microwave oven and exposed to predetermined program settings for 3 minutes at 250 watts, 5 minutes at 630 watts, 22 minutes at 500 watts, and 15 minutes at 0 watts. After that, take the digesting containers out of the microwave and let them cool completely before opening. After that, the vessel was opened and the contents were washed into the container. It was filtered using a filter paper, transferred to a volumetric flask (100 ml), and adjusted to the correct volume for use in determining the mineral contents.

3.7.2 Calcium (Ca) determination

Calcium ions and O-Cresolphthalein interact to form a violet complex in an alkaline medium. To create the reagent blank solution, a cuvette was filled with 1 ml of the working reagent and 25 L of distilled water. 25 L of the (Ca++) standard and one milliliter of the working reagent were added for the standard. 1 ml of the working reagent and 25 L of the sample extract were combined to create the sample solution. The absorbance of the standard and the sample was determined. The sample absorbance was multiplied by the standard concentration (mg/dl), and the result was the calcium concentration in mg/dl (Akther et al., 2020).

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3.7.3 Potassium (K) determination

When potassium and sodium tetraphenylboron mix, a fine turbidity of potassium tetraphenylboron is produced. The sample's turbidity and potassium concentration are inversely correlated. The blank solution was made by pipetting 0.02 ml of deionized water and 1 ml of potassium reagent into the cuvette. A total of 0.02 milliliters of potassium standard, 0.02 milliliters of sample extract, and 1 milliliter of potassium reagent were put into the cuvette. These finished an incubation time of the retention duration for 5 minutes after mixing. In contrast to a blank, the absorbance of the standard and sample were measured after 15 minutes. By dividing the sample absorbance by the reference concentration (mg/dl), the potassium concentration was estimated in mg/dl.

3.7.4 Magnesium (Mg) determination

The technique is dependent on a particular interaction between magnesium and calmagite, a metallochromic indicator, at an alkaline pH, which leads to a change in the complex's absorption spectrum range. The sample's magnesium content directly influences how strong the cromophore is. One milliliter of the reagent was taken and put in a cuvette to create the reagent blank solution. In a cuvette, the preparation sample solution was created by mixing 10 mL of sample extract with 1 mL of reagent. The standard solution was made by adding one milliliter of reagent and ten milliliters of a magnesium standard to a cuvette. After mixing, the cuvettes should rest for two minutes at room temperature. The 520 nm absorbance of the sample and the standard was measured and contrasted with the reagent blank. By dividing the sample absorbance by the reference concentration (mg/dl), the amount of magnesium in the blood was calculated in mg/dl.

3.7.5 Iron (Fe) determination

The transferring-iron complex separates from the iron in a moderately acidic medium. The released iron was transformed into the bivalent state using ascorbic acid. Ferrous ions create a colourful complex when combined with ferrozine. The sample's iron content has a direct relationship with the results' colour intensity. The blank solution was made by adding 1 ml of reagent to the cuvette using a pipette. For the creation of the standard, 1 ml of reagent and 200 L of standard were added. 200 L of sample extract and 1 ml of reagent were added to create the sample solution. The sample solution was then incubated at room temperature for 10 minutes after mixing. Iron concentration was

calculated using the standard and sample absorbance measurements in relation to a blank.

3.8 Antioxidant capacity determination

The produced sample's antioxidant activity was assessed based on its ability to neutralize the stable free radical DPPH (22-Diphenyl-1-picrylhydrazyl). With a small modification, the technique published by Azlim et al. (2010) was used to assess the extracts' antioxidant capability.

Extract Preperation

In a falcon tube, a 1 gram sample was obtained. Then, 10 ml of 100% methanol was added, and the mixture was left for 72 hours. After a 4-hour break, continuous straining was performed. Filtrate was gathered after 72 hours, and methanoic extract was discovered.

Procedure

Extract stock solutions were diluted in methanol to concentrations of 0.50, 1.00.1, 0.50, 2.00, and 2.50 mg/ml. 6.0 mg of DPPH were dissolved in 100 ml of pure methanol to create the DPPH solution. After mixing the methanolic DPPH solution (2 ml) with 1 ml of each extract solution at a varied concentration for 30 minutes, the absorbance was measured at 517 mm. The control was made by mixing 2 ml of DPPH solution with 1 ml of metunol. Trolox was employed as the norm. Expressed in milligrams of Trolox equivalents (TE) per gram of extracts (mg TE2), antioxidant capacity based on the DPPH free radical scavenging activity of extracts was estimated.

3.9 Microbial analysis

In a falcon tube, a 1 gram sample was obtained. Then, 10 ml of 100% methanol was added, and the mixture was left for 72 hours. After a 4-hour break, continuous straining was performed. Filtrate was gathered after 72 hours, and methanoic extract was discovered.

Fungal analysis media preperation

The selective medium Sabouraud Dextrose Agar (SDA) can support the development of yeasts, dermatophytes, different fungi, and filamentous bacteria including Nocardia.

While bacterial growth is inhibited by the medium's acidic pH (about 5.0), yeast and the majority of filamentous fungus are encouraged to proliferate. Antibacterial substances can be used to boost the potency of antibacterial substances. A rich supply of amino acids and nitrogenous substances for the development of fungi and yeasts, SDA medium is an enzymatic digest of casein and animal tissues. For 1 liter of SDA medium, 10 g of Mycological Peptone (an enzyme digest of casein and animal tissues), 40 g of Dextrose, and 15 g of Agar with a pH of 5.6 at 25 0C are employed. All media were prepared in accordance with the manufacturer's instructions and autoclaved at 121°C for 15 minutes to achieve complete sterilization. Most selective agars do not have strict nutritional requirements for growth, despite the fact that there are many of them available for the creation and detection of mold and yeast cultures. Numerous different fungal strains may thrive on Sabouraud Dextrose Agar. We employ the procedures and approaches mentioned by Chen and Gu (2000), FSSAI (2012), and APHA (1996).

Procedure for media preperation

The medium was first dissolved in 1 litre of sterile water using 65 g. To completely dissolve the medium, it was heated for one minute while being constantly swirled. 15 minutes in an autoclave set at 121 °C. The liquid was put into petridishes after cooling to between 45 and 50 degrees. To create isolated colonies, the substance was streaked across the medium using a sterile inoculating loop. The agar side of the plates were then incubated at a humid 25–30°C temperature. Cultures were checked for fungal development on a weekly basis, and they were kept for 4-6 weeks before being certified negative (Aryal, 2015).

Interpretation

After the advised incubation, the plates should show solitary colonies in regions with streaks and confluent development in parts with heavy inoculation. On the plates, look for fungi that have the normal form and colouring. The outcomes should be verified using additional steps. The colour of yeast colonies can range from creamy to white. Moulds will appear as clusters of coloured filamentous development (Aryal, 2015).

TVC-Test

The Chattogram Veterinary & Animal Sciences University's poultry Research & Training Centre (PRTC) performed a microbial test on the material. The TVC test gives

a quantifiable result when microorganisms including bacteria, yeast, and mold are present in a sample. The count really refers to the number of colony forming units (cfu) present in the sample at a rate of one gram or one ml, to be precise. By plating culture dilutions until 30-300 colonies are visible on a single plate, a TVC is produced. A high TVC count is often correlated with poor quality.

Materials

a. Diluents: The diluent that is advised for general use is the peptone saline solution, which includes 0.1% peptone and 0.85% salt chloride in distilled water. The solution is called maximum recovery diluents (MRDs).

b. Food sample

c. Cotton

d. Pipette

e. Glass spreader

f. Incubator

Procedure

The 50 gram sample was divided into a series of test tubes, each holding 9 ml of diluents, and then homogenized in 450 ml of diluents before being put into suspension in a beaker. 1 cc of the original sample was transferred to and well mixed in test tube number 1. From the first test tube, one milliliter was transferred to the second, and so on until the last test tube, where one milliliter was removed for disposal. Each test tube had three PCA medium-filled petri plates taken from it. After that, slowly transfer 0.5 ml of the liquid from each test tube to the corresponding petri plate. There was a pipette required for every tube. Use the test tube tips gently when contacting the medium. Using a glass spreader, diluted samples should be applied to the media's surface. The petri dishes were marked with the sample number and date and kept in the incubator upside down at 37°C for two to three days. Beginning the day following incubation and continuing for up to three days, the colonies were monitored. The 30-300 plate colonies that were counted should be considered, and the other colonies should be discarded. Three petri dish colonies from each tube are totaled and given an average size.

Calculation

The average count will be multiplied to that multiplying factor which results the number oforganisms.

If in dilution 10^3 dilution average count is 46 then

CFU will be $46*10^{\wedge 3}$/0.5 ml of sample

= $2*46*10^{\wedge 4}$/ml sample

= $92*10^{\wedge 4}$/ml sample

The price of the fruit bar, which uses the fruits wood apple and muskmelon as its base, was computed based on the total cost of the ingredients required to make the product. The entire amount was shown in taka, and the cost per 10gm was calculated.

3.10 Sensory evaluation

Sensory testing was done to make sure the finished product was fully accepted possible by the client. A group of tasters judged how suitable the developed product was. The panel test was held on the CVASU campus, and both university staff and students served on the panel. The item was distributed to a panel of 15 people. Three formulations that were each tagged with a distinct sample (A, B, C, D, or E) were sampled by the panelists. For the participants' suitable scores, the sensory characteristics of the bar's appearance, color, flavor, texture, and overall acceptance were sought. Even while it might not be a reliable predictor of consumers' attitudes about a product, this technique does stress features. Five samples were tested, and evaluations were made in light of the comments. Using nine-point Hedonic measures, sensory evaluation of the five samples' qualitative characteristics (taste, color, flavor, consistency, and overall acceptability) was carried out (Larmond, 1977).

The scale was set up in such a way that: Like extremely =9, Like very much =8, Like moderately =7, Like slightly=6, Neither like nor dislike =5, Dislike slightly =4, Dislike moderately =3, Dislike very much =2, and Dislike extremely =1.

3.11 Statistical analysis

A Microsoft Excel 2013 spreadsheet was used to collect and store the data for statistical analysis. Three times each were used for all samples. Descriptive statistics (mean and

standard deviation) were computed for the sensory assessment of Pomegranate jelly and immediate composition. With the aid of Minitab, data is arranged, coded, and recorded. Following that, statistical analysis was carried out. The One-way ANOVA approach was used to examine significant levels of variation at the 95% confidence interval for data on proximate composition, phytochemicals, antioxidant capacity, and sensory assessment. A Tukey test was used to determine how much variance there was between the samples. The analysis employed a 5% ($p<0.05$) significance threshold.

CHAPTER 04: RESULTS

4.1 Physicochemical properties of fruits bar

4.1.1 pH, Acidity and TSS

pH of fruits is an important factor for optimum bar condition. In table 4.5, lowest (3.00±0.02) pH found in sample C and highest (3.93±0.01) in sample A. TSS (total soluble solids) was highest (78.89^{o}B) in sample C and lowest in (78.61^{o}B) in sample E. The highest value (0.421±0.01%) of acidity was observed in sample A while the lowest value (0.403±0.01%) was obtained in sample B.

Table 4.1: Physicochemical analysis test result of fruits bar

Sample	pH	Acidity	TSS(°B)
A	3.93±0.02^{b}	0.421±0.01^{b}	78.62±0.01^{c}
B	3.02±0.02^{a}	0.403±0.01^{a}	78.67±0.01^{a}
C	3.00±0.02^{a}	0.410±0.02^{a}	78.89±0.01^{a}
D	3.81±0.02^{c}	0.427±0.01^{c}	78.65±0.01^{b}
E	3.09±0.01^{b}	0.408±0.02^{b}	78.61±0.01^{c}
F	3.09±0.01^{c}	0.415±0.01^{c}	78.60±0.01^{b}
P value	0.01	0.02	0.03

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

Sample A= Wood-apple and muskmelon fruits bar using sugar

Sample B = Wood-apple and muskmelon fruits bar using honey

Sample C= Wood-apple and muskmelon fruits bar using dates

Sample D= Wood-apple and muskmelon fruits bar using sugar

Sample E= Wood-apple and muskmelon fruits bar using honey

Sample F = Wood-apple and muskmelon fruits bar using dates

4.2 Proximate analysis of fruits bar

One way ANOVA (Analysis of Variance) test was conducted to see the overall mean differences of values for different parameter of fruits bar treated with sugar and honey and comparison with dates.

Table 4.2 Proximate analysis of Fruits bar

Parameters (%)	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F
Moisture	20.76 ±0.01^{a}	25.70 ±0.02^{cd}	20.70 ±0.00^{d}	28.75 ±0.04^{e}	27.07 ±0.01^{c}	26.09 ±0.01^{d}
Crude fiber	1.29 ±0.01^{b}	1.45 ±0.02^{bd}	2.80 ±0.01^{ac}	1.28 ±0.01^{d}	1.49 ±0.01^{b}	2.89 ±0.04^{e}
Ash	1.02 ±0.02^{c}	1.61 ±0.03 ^{d}	1.30 ±0.01^{b}	0.97 ±0.02^{be}	1.23 ±0.04^{df}	1.21 ±0.01^{f}
Fat	0.49 ±0.03^{d}	0.70 ±0.01^{e}	0.77 ±0.02^{ab}	0.46 ±0.01^{d}	0.71 ±0.05^{c}	0.79 ±0.01^{a}
Protein	2.54 ±0.02^{e}	3.51 ±0.04^{a}	4.56 ±0.01^{b}	2.50 ±0.03^{c}	3.50 ±0.03^{a}	4.50 ±0.02 ^{ab}
Carbohydrate	74.43 ±0.03^{f}	69.94 ±0.05^{c}	71.8 ±0.03^{d}	72.76 ±0.01^{ef}	67.76 ±0.01^{a}	70.76 ±0.03^{a}
Energy (Kcal)	308.67 ±0.04^{c}	300.1 ±0.03^{b}	312.37 ±0.02^{a}	305.18 ±0.02^{d}	294.43 ±0.01^{a}	308.15 ±0.01^{b}

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

4.2 Vitamin & mineral content of fruits bar

There is significant changes in the value of vit-C ranged from **(** 2.58±0.01 to 4.59±0.01). But mineral content varied in different sample.

Table 4.3 Vitamin & mineral content of fruits bar

Sample	Vitamin-C	Calcium	Magnesium	Potassium	Iron
A	2.58 ± 0.04^{a}	1.5 ± 0.03^{c}	0.44 ± 0.04^{a}	1.71 ± 0.06^{b}	26.31 ± 0.06^{c}
B	3.521 ± 0.06^{a}	3.16 ± 0.01^{b}	0.386 ± 0.03^{a}	1.51 ± 0.05^{c}	16.31 ± 0.06^{a}
C	4.54 ± 0.03^{a}	1.64 ± 0.03^{b}	0.23 ± 0.04^{b}	2.27 ± 0.07^{a}	27.40 ± 0.45^{a}
D	3.18 ± 0.01^{a}	1.50 ± 0.05^{c}	0.20 ± 0.04^{b}	1.53 ± 0.05^{a}	26.81 ± 0.05^{a}
E	3.46 ± 0.01^{a}	3.20 ± 0.03^{a}	0.380 ± 0.04^{a}	1.50 ± 0.04^{a}	16.28 ± 0.03^{a}
F	4.59 ± 0.01^{a}	1.60 ± 0.01^{a}	0.22 ± 0.02^{a}	2.24 ± 0.01^{a}	26.40 ± 0.04^{a}

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

4.3 Antioxidant Capacity of fruit bar

From the table 4.7, that it was found that there was differences among all the samples in terms of antioxidant capacity .

Table 4.4 Antioxidant activity analysis of fruits bar

Sample	Antioxidant capacity (mg/100gm sample)TE
Sample A	1.30 ± 0.01^{a}
Sample B	3.56 ± 0.01^{b}
Sample C	2.56 ± 0.01^{d}
Sample D	1.21 ± 0.01^{e}
Sample E	3.46 ± 0.01^{c}
Sample F	2.50 ± 0.01^{d}

4.4 Microbial analysis

Total viable count and the fungal count were determined from 0 to 15 days after bar preparation, that according to table 4.5 . For the evaluation , specimens were stored at 40 for 15 days. Yeast and mold were not found when the products were produced and their presence was not found after 15 days.

Table 4.5 Microbial analysis of fruits bar

Sample formulation	TVC (ml CFU)	Yeast and mold
Sample A	5.7×10^2	No growth
Sample B	4.4×10^1	No growth
Sample C	4.7×10^2	No growth
Sample D	5.9×10^2	No growth
Sample E	4.3×10^1	No growth
Sample F	4.6×10^2	No growth

Legends : Mean values in a column that have various superscripts differ considerably ($p< 0.05$) , whereas those without superscripts do not.

4.5 Sensory evaluation

After doing the ANOVA test it was interpreted that, there were no significant differences between sample B and E in regard to appearance, color, sweetness, taste and texture. But sample C ranks highest in case of overall acceptance. In contrast to the other samples, sample A and D had the lowest levels of acceptance.

Table 4.6 Hedonic scale scoring test results

parameters	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F
Appearance	5.62 ± 0.01^a	5.62 ± 0.03^a	5.62 ± 0.05^a	5.62 ± 0.01^a	5.62 ± 0.01^c	5.62 ± 0.02^d
Color	6.40 ± 0.18^a	6.00 ± 0.01^b	5.94 ± 0.01^c	6.38 ± 0.03^b	6.10 ± 0.01^b	5.98 ± 0.01^a
Smell	5.09 ± 0.02^c	5.13 ± 0.02^a	5.17 ± 0.01^b	5.10 ± 0.01^a	5.14 ± 0.04^d	5.16 ± 0.01^c
Taste	5.45 ± 0.05^d	5.50 ± 0.02^d	5.75 ± 0.01^a	5.48 ± 0.01^e	5.52 ± 0.01^c	5.60 ± 0.15^e
Sweetness	5.00 ± 0.01^a	5.30 ± 0.01^a	5.40 ± 0.04^d	5.03 ± 0.02^b	5.28 ± 0.01^c	5.42 ± 0.01^f
Texture	5.12 ± 0.01^b	5.09 ± 0.04^c	5.15 ± 0.01^f	5.10 ± 0.01^c	5.06 ± 0.03^b	5.13 ± 0.04^a
Overall Acceptability	5.32 ± 0.01^f	5.47 ± 0.01^e	5.62 ± 0.13^d	5.30 ± 0.22^f	5.43 ± 0.01^a	5.58 ± 0.02^e

Legends: Values represent mean± SD and the presence of different superscript alonga column indicates a significant differences at $P < 0.05$.

4.6 Cost analysis

The quality measurement was given for sample C,the final accepted product from sensory characteristics.

Table 4.7 : **production cost analysis of wood-apple & muskmelon fruit bar**

Line Item	**Tk/Kg**	**Quantity Used (kg/ 1kg)**	**Total Tk for sample A**	**Total Tk for Sample B**	**Total Tk for sample C**	**Total Tk for sample D**	**Total Tk for sample E**	**Total Tk for sample F**
Woodapple	80	4	53.33	53.33	53.3	53.33	53.33	53.33
Muskmelon	100	1kg	16.67	16.67	16.67	16.67	16.67	16.67
Sugar	68		3.06			3.06		
Honey	1250	51gm	-	63.75			63.75	
Dates	380	72gm	-	-	27.36			27.36
Citric Acid	1200	6gm	7.5	7.5	7.5	7.5	7.5	7.5
Starch	1500	60gm	15	15	15	15	15	15
Subtotal			95.56	156.25	119.83	95.56	156.25	119.86
Processing cost @ 15% of raw material			109.89	179.68	137.80	109.89	179.68	137.83
Packaging cost	1.5 tk/piece	8 packet	12	12	12	12	12	12
Total production			121.894	191.68	149.8	121.89	191.68	149.8

By following this recipe, we can prepare seven packets of bars. So, the price of per packet bar is:

For sample A, per packet is = 121.89/8 tk

=15.23 tk

Sample B,E, per packet is 191.68/8 tk

=23.96tk

Sample C,F, per packet is = 149.8/8 tk

=18.72 tk

Here, market price for fruit bar is 15tk/10gm. In this study fruit bar with wood apple& Muskmelon using dates(sample C) costs slightly more than locally available fruit bar but provides more beneficial health effects considering nutritional value .

Chapter 5 : Discussions

5.1 Physical & chemical properties of fruits bar

The physical & chemical properties of Wood apple-Muskmelon fruit bar were shown in table 4.1. The moisture percentage of 6 fruit bar sample ranged from 20.75 to 28.75% , total soluble solids ranged from 78.60 °Brix to 78.89 °Brix ,acidity range (0.403-0.427) % respectively. The highest total soluble solids 78.89 °Brix was recorded in sample C and the lowest TSS 78.60 °Brix found in sample F. Sample C contain dates paste with blended wood apple and muskmelon. The conversion of insoluble to soluble fraction during storage may be the cause of the minimal increase in total soluble solids (Aradhitha et al., 1996). The researches on Fruits bar are corroborated by the rising trend of TSS content during storage. Acidity was higher in sample A (0.421 %) and lower in sample B (0.403 %). The acidity of food is influenced by acids found in natural food ingredients (Khoo, et al. 2017).

5.2 Nutritional composition of fruits bar

There was a wide range of variation in the moisture percentage of the bar samples, ranging from 20.76 to 28.75%. The results for wood-apple and muskmelon combined with dates were the greatest, while the values for wood-apple and muskmelon combined with sugar and honey were the lowest. As the sample D,E, F were dried under the sun somoisture could not remove properly .Moisture can be removed by the application of heat as in sun-drying or by mechanical drying. Sun drying is the most popular and oldestmethod of preservation (Imoudu and olufayo 2000). In these days, mechanical drying has replaced sun-drying. Sample A, B, C were dried in cabinet drier so controlled conditions of temperature, humidity and air flow was maintained. Highest moisture content was found in Sample D (28.75 ±0.01%) and lowest moisture content was found in sample C (20.70 ± 0.01%).The moisture content that was measured in this experimentwas quite low when compared to the results that Ali et al. (2021) achieved for peach that included wood-apple and muskmelon, which were 35%. The amount of moisture thatis contained in the food can, in many cases, be used as an indicator of how long it will

remain fresh (Fellows, 2000). Bar that contain a relatively modest amount of moisture can be stored for a considerable amount of time. There were statistically significant differences (P <0.05) in the moisture content of the bar samples.

For protein content, sample A (2.54 ± 0.01%) & D (2.50 ± 0.01%) had the lowest value while samples C (4.56± 0.01 %) and F (4.50± 0.01%) had the highest value (Table 4.2), which is comparable to the protein content of Wood –apple and papaya (0.42%). (Ali et al, 2021). According to the nutrition label, the most common components of bar are pulp, sugar, starch, and citric acid. This study reveals that the protein content of bar is low since none of the used components are a rich source of protein. There was a statistically significant difference (p<0.05) in the protein content of the bar samples.

The fat percentage varied between(0.46± 0.01%) and 0.79± 0.01)%. Sample F contained considerably (P<0.05) more fat than other bar samples. This study's fat content was lower than the 1.2% fat content documented by Kanojia (2018) for Aloe vera bar with apple.

Sample C contained the highest Percentage (2.802.80±0.01) of fiber and sample A contained the lowest % of fiber (1.29 ±0.01). As sample C made with dates which contain 8g / 100gm fiber naturally. On the other hand sample B and E made with honey as a sweetener which contain no fiber.

5.3 Vitamin & mineral content in fruits bar

Vitamins and trace elements are essential for maintaining the health and effective operation of the human body. Inadequate dietary intake of minerals and vitamins is frequently associated to an increased susceptibility to infectious diseases because of the compromised immune system. The quantities of vitamin C and trace components in each fruit on the bar varied significantly in this investigation. Sample C had a greater vitamin C content (4.54±0.01) mg/100g than the other samples. Because ascorbic acid oxidised into dehydro ascorbic acid during storage, the ascorbic acid quantity reduced. Similar result of decreased in ascorbic acid was also reported in papaya fruit bar during storage by (A.B, P.M and S.S 2018)in wood apple leather.

Table 4.3 showed the mineral contents of formulated fruits bar. According to Wood apple pulp fruit barwas found to contain calcium, magnesium, iron and zinc in high amounts followed by many other beneficial nutrients. Magnesium (3.20±0.03) was higher in sample E and Calcium were higher in sample B(0.386±0.03) .Iron

(27.40±0.45) and potassium (2.27±0.07) were higher in sample C. Iron was found almost similar in all the Sample. Calcium can play a crucial role in providing rigidity to the skeleton besides its involvement in the neuromuscular functions, blood clotting, and many other metabolic processes. It also contains iron which is used against anaemia, tuberculosis and disorders of growth (S Dr. Anthina, et al. 2022).

5.4 Antioxidants capacity of fruits bar

All of the samples in table 4.4 demonstrate a significant difference in antioxidant capacity. DPPH was a substrate that was utilized frequently for the purpose of determining whether or not a substance possessed antioxidant activity. This was especially true in the context of research involving the ability of biological and chemical substances to scavenge free radicals. According to the data, the antioxidant capacity of wood-apple & muskmelon fruit bar ranged from (1.21 ±0.002) mg TE/100g to (3.56± 0.002) mg TE/100g for a variety of various sweeteners. The antioxidant capacity of sample B was (3.56± 0.002), which is a considerably higher level than that of sample A (0.854). According to the findings of Rebeka et al., (2020), fruit bar made with honey received a higher mean score (22.04) than bar made with sugar .

5.5 Microbial analysis of fruits bar

The powdered mixed fruit drinks A, B, and C underwent microbiological testing as part of this investigation. At 7 and 14 days after the processing of mixed fruit drinks powder, the total viable count (TVC), isolation of bacterial count, yeast, and mould development were all analysed. The goods' maximum moisture level throughout storage for up to two weeks was 4.9%, which was not a good habitat for microbial growth. This prevented microbial analysis from being carried out. The overall counts of yeast, mould, and aerobic platelets were all within the permitted limits, according to Food Standards New Zealand and Australia (2001).

5.6 Sensory evaluation

Sensory evaluation of Wood-apple & muskmelon fruit bar was created in order to achieve the greatest organoleptic acceptance of all bar. Sample A (Fruit bar with sugar) received the highest mean score (6.40± 0.01) for color acceptance, suggesting that the panel deemed honey to be aesthetically pleasant. Sample C had the highest average score indicating that the panelists deemed this honey used as a sweetener to be the most aromatic. Fruit bar with sugar (sample A and D) and fruit bar with honey (sample B and E)

were given respective ratings of (5.32 ± 0.01 % and 5.30 ± 0.01%) and (5.47 ± 0.01% and5.43± 0.01%). The sensory properties of every fruit bar formulation revealed that sample C's overall appeal scored a moderate on the hedonic scale. The general acceptability of the sample B was modest, as evidenced by the sensory characteristics of every mixed fruit bar formulation. This study indicated that the developed fruits bar's sensory evaluations in terms of flavor , taste, colour , and general acceptance were very good.

5.7 Moisture on drying rate of fruits bar

Foods with a higher moisture content had a short life. The effect of hydrocolloids on the kinetics of dehydration, color and texture of muskmelon was evaluated by (baker and Reddy 2001) . The pulp was made from fresh muskmelon & wood apple and placed on aluminum trays before dried in a cabinet drier at 60°C and 15% relative humidity. The addition of hydrocolloids resulted in a decrease in the drying rate. It could be owing to the inclusion of gelling chemicals or gelatin during the manufacturing process. In woodapple-muskmelon fruit bar,the addition of starch decreased the drying rate compared to the traditional one.

Sample A,B,C were dried in Cabinet derier and sample D,E,F were dried under the sun .In sun drying there is no possibility of temperature & humidity control. Sun drying is not possible in cloudy weather or during rains. The colour is dehydrated or mechanically dried products remains uniform due to uniform drying temperature (Doymaz 2005).

Chapter 6: Conclusion

Fruits bar is a common food product in ready-to-eat foods. Fruits bar is high in fiber and low in calories, that's why it has a prominent place among healthy snacks. Natural fruit bars can have several health benefits, such as providing vitamins and minerals, containing fiber, being low in calories, containing antioxidants, and potentially reducing the risk of chronic diseases. The product, wood-apple and muskmelon fruit bar, could be successfully stored at an ambient temperature for 4 months without any deterioration. Wood-apple and Muskmelon fruit bars can be a good, convenient and natural alternative to junk foods or foods which are with high salt, sugar and fat. Fruit bars are concentrated form of food source with rich nutritional value as compared to fresh counterparts. So customers can be benefitted from this product because as it is inexpensive and highly nutritious. Sugar is an important ingredient in traditional fruit bar preparation. However, there is lot of scope to use of alternate sweeteners and other sugar substitutes for preparation of fruit bar to meet the increasing demands of low calorie snacks food. From this research, it could be concluded that sample C which was made Wood-apple and Muskmelon using dates was found to be best one, with the highest sensory score for organoleptic qualities and the highest nutritional value.

Chapter 7: Recommendations and Future Perspectives

The creation of wood apple-Muskmelon fruits bar has come to a successful completion. Additionally, it can reduce the wastage of highly produced muskmelon in our country due to its blend taste. The method can be applied medium to large scale food production in contemporary business. Based on current investigation, recommendations of this study are-

- The current study should be repeated to confirm the results of experiments.
- Moisture Content should be checked properly

Future Perspectives are

- Easy to prepare and can be store for a long time especially great for off season.
- Texture analysis should be done to different types of hydrocolloids
- Sugar can be replaced by other ingredients like protein fortifiers
- Similar research should be done on the other readily available fruits like guava, palm etc.
- Appropriate measures should be taken to enhance the nutritional value of commercially available fruit bar.
- In our country, very little study has been conducted on the processing of muskmelon and products made from muskmelon are hardly available in our marketplace. The creation of variety types of muskmelon fruits products may be well received in our local market and may be export in different country.

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Appendix

Questionnaire for Hedonic test

Name of the Taster: ……

Date: ……

Please taste these samples and check how much you like or dislike each one on seven sensory attributes such as color, taste, flavor, texture and overall acceptability. Use the appropriate scale to show your attitude by checking at the point that best describe your sense and feeling about the sample please give a reason for this attribute. Remember you are the only one who can tell what you like. An honest expression of your personal feeling will help us. For Taste/Flavor/Mouth feel/Appearance/Overall Acceptability.

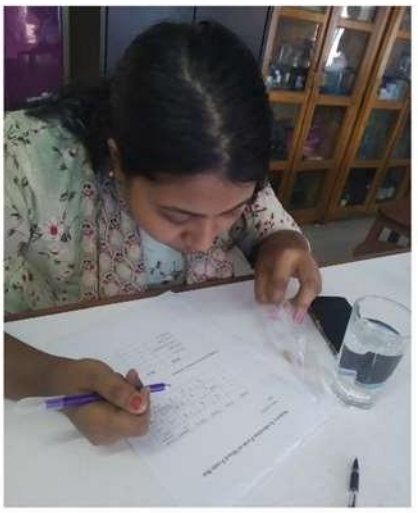
The scale is arranged such that; Like extremely =9, Like very much =8, Like moderately =7, Like slightly=6, Neither like nor dislike =5, Dislike slightly =4, Dislike moderately =3, Dislike very much =2, and Dislike extremely =1

Photo Galley

Final Product:

Analysis of Fruits Bar:

Sensory Evaluation:



Brief Biography

Sadia Islam passed the Secondary School Certificate Examination in 2012 from Adhunagar High School and then Higher Secondary Certificate Examination in 2014 from Kapasgola City Corporation Mohila College, Chattogram. She received her Bachelor of Science with Honor's in Food Science & Technology at Chattogram Veterinary and Animal Sciences University in Bangladesh. Now she's pursuing a Master of Science in Applied Human Nutrition & Dietetics at Chattogram Veterinary and Animal Sciences University's Department of Applied Food Science & Nutrition (CVASU). She has a strong desire to improve people's health through good guidance and recommendations, as well as to raise their understanding of food security and nutrition.