Qualitative and Quantitative Evaluation of Soup prepared with Pomegranate (*Punica grantantum L.*) peel powder

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

Department of Applied Food Science and Nutrition

Faculty of Food Science and Technology

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Chattogram-4225, Bangladesh

November 2022

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

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DEDICATE TO MY BELOVED AND RESPECTED PARENTS AND TEACHERS

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Rifa Tasfia

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Abbreviation	
%	: Percentage
ANOVA	: Analysis of variance
AOAC	: Association of Official Analytical Chemists
°C	: Degree Celsius
DPPH	: 2,2-diphenyl-1-picrylhydrazyl
et al	: Et alii/ et aliae/ et alia
etc	: Et cetera
PPP	: Pomegranate Peel powder
PPS	: Pomegranate Peel Soup
g	: Gram
GAE	: Gallic acid equivalent
mg	: Milligram
ppm	: Parts per million
TFC	: Total Flavonoids content
TPC	: Total Polyphenol content
SD	: Standard deviation
TE	: Trolox equivalent

Abstract

The pomegranate fruit (*Punica granatum L.*) has been used for centuries in traditional medicine for its various health benefits. In recent years, research has focused on the health-promoting properties of the pomegranate peel, which is often discarded despite containing a significant amount of beneficial compounds. Pomegranate peel is a rich source of bioactive compounds such as phenolic acids, flavonoids, tannins, and alkaloids, which possess various pharmacological properties such as antioxidant, anti-inflammatory, anti-microbial, anti-cancer, and anti-diabetic effects. Additionally, they may also have beneficial effects on metabolic disorders such as diabetes and obesity, by improving insulin sensitivity and reducing fat accumulation. Furthermore, pomegranate peel extracts have been shown to possess anticancer properties, with a protective effect against cardiovascular diseases by reducing blood pressure, improving lipid profile, and preventing the formation of atherosclerotic plaques. Overall, the current evidence suggests that pomegranate peel extracts have promising health benefits and may be considered as a functional food ingredient or a natural supplement for the prevention and management of chronic diseases.Hence, attempts have been made in the current study to develop pomegranate peel based soup with 10%,20%,30% level of provision to ascertain the sensorial acceptability and subsequently to analyze the nutritional composition, bioactive compounds, antioxidant capacity profile. The ranges of protein, fat, crude fiber, ash and carbohydrate content were determined to be 4.78-5.25%, 9.79-9.89%, 4.37-4.41%, 5.98-6.41% and 64.37-64.94% respectively. Among the bioactive compounds, total flavonoid content and total phenolic content were significantly higher in the formulated soups, ranging from 215.34-343.84 mg QE/100g and 9.35-9.37 mg GAE/100 ml respectively, compared to the control (115.33 mg QE/100g and 3.22 mg GAE/100ml) with significant rise in antioxidant capacity ranging from 3.13-3.15 mg/100g. The quantity of TFC and TPC in the formulated soup with 20% pomegranate peel powder soup was 278.32 ± 0.640 mg QE/100g and 9.38± 0.0217 mg QE/100g respectively which depicts significant values with regard to other types. Soup with 20% supplementation had the highest acceptance rate in the sensory evaluation.

Keywords: Pomegranate, PPP (pomegranate peel powder), Pomegranate peel powder soup, proximate analysis, Bioactive compounds, Antioxidant capacity.

Chapter-1: Introduction

The pomegranate (*Punica granatum L.*) fruit has seen a surge in attention over the last ten years since it enables superior health advantages. In reality, growing trends in the consumption of superfruit, especially those with high polyphenol concentrations, are being driven by consumer knowledge of the advantages of natural goods for health and welfare. The biological activity and therapeutic benefits of the pomegranate's many components (arils, peels, leaves, and blossoms) and products (fresh and fermented juices, enhanced extracts, and seed oil) have been supported by several scientific research(Viuda-Martos et al., 2010) The pomegranate business shown amazing development and is presently the most promising among fruit industries, driven by consistently expanding consumer demand. The extracted pomegranate juice is typically concentrated to 65° Brix, requiring millions of tons of raw materials to generate one million tons of highly concentrated juice (K. R. Day, 2011). The pomegranate's skin and interior membranes make about 50% of its fresh weight on average. Because of this, waste effluents have increased in many nations where juice producing facilities have been erected (USA, Spain, Uzbekistan, Iran, India, and China). One of the most valuable by-products of the food business, this waste is made up of the pomegranate fruit's non-edible portions, namely the rind and interior membranes.

The non-edible components of pomegranates have received some attention in recent years, with the majority of these studies concentrating only on the phenolic compounds (extraction, measurement, and antioxidant activity) (Khan et al., 2019). Additionally, the usage of pomegranate peel in the food business was only mentioned in a small number of research. Dietary fiber (DF) is now regarded as a nutrient. It is advantageous from a physiological standpoint and plays a significant role in the digestive process because of its functional qualities, particularly the ability to store water. DF lessens the likelihood of colon cancer and promotes nutrition circulation in the bowel (Gullon et al., 2015).There is an increasing need to find alternative sources of fiber for dietary supplements in the context of health promotion and extending life expectancy. The by-products of various fruits and vegetables, including pea, apple, sugar beet, soy, and citrus, are a source of fiber used in food production. Pomegranate bagasse powder shown interesting technical and functional features opening up new possibilities for evaluating this by-product(Viuda-Martos et al., 2012).

Pomegranate peel is a substantial source of vital bio components, and many of them may be converted into valorized products, according to recent experimental findings. Its function as a carbon substrate for the production of bioactive substances like phenolics and flavonoids as well as its role in the biosynthesis of enzymes are also covered in the review. The creation of an integrated biorefinery concept to employ pomegranate peel will help in successfully using its major benefits since it is clear from recorded experimental findings that the fruit's peel has a wide range of uses (Arun et al., 2022). Just one-fourth of the food produced for human consumption is used to its full potential; the remainder is destroyed all over the globe. According to statistics, 400 billion dollars' worth of food is wasted worldwide at a rate of around 14%. (FAO, 2019). Among these, the vegetable and fruit industries produce a significant amount of waste—roughly between 25 and 30 percent (Kumar et al., 2021).

In recent global food scenario, pomegranate peel powder has been added to food salads for preservation (Lacivita et al., 2021),or enhancing the functional quality of Chikki-an Indian food made with jaggery and nuts (Advisor, 2016).When pomegranate peel at 1% was used as an additive functional quality of fish and meat products increased 50% ,high antioxidant properties was found in cereal and nut products with the use of 7.5% of pomegranate peel powder (Kandylis and Kokkinomagoulos, 2019). To take benefit from the pomegranate peel's health benefits, we try to make soup using varied ratios of the powder, which has a lot of antioxidant and bioactive chemicals.

Objectives

1. Valorization of pomegranate peels by decreasing the waste load through proper application of it’s discarded constituents.
2. Determination the bioactive compounds, anti oxidant compounds of pomegranate peel.
3. Utilization of plant products as an alternative source of medicinal compounds.

Chapter-2: REVIEW OF THE LITERATURE

2.1 Overview of Pomegranate peel

A considerable number of studies have been conducted in recent years to examine the effects of pomegranate peel powder when added to the soup. This review will investigate both qualitative and quantitative data related to this topic, with a special emphasis on using pomegranate peel powder as an original additive.

To assess its qualitative and quantitative properties, the use of pomegranate peel powder in soups has been studied. Pomegranates (*Punica granatum L.)*, with their delectable flavor and excellent nutritional benefits, are highly desirable fruit. The peels of this fruit, which are often overlooked as an agricultural by-product, can be transformed into products that possess industrial value along with medical and dietary advantages - making them incredibly valuable additions to any meal.

Studies have found that Pomegranate peel powder has a high economic value due to its availability as a byproduct of pomegranate juice production comprising nearly 30–40% of fruit portion. The antioxidant activity of Pomegranate peel powder has also been studied extensively and it was found that the peel contains large amounts of polyphenols and flavonoids which are responsible for the observed antioxidant activity(Yu et al., 2022). Pomegranate peel powder also exhibits higher content of essential minerals such as calcium, magnesium, phosphorus, potassium, iron, and zinc compared to many other fruits (Omer et al., 2012).

Pomegranate peel's high quantity and diversity of phytochemicals have prompted extensive research over the past ten years. Due to their role in influencing the antioxidant capacity and radical scavenging activity response against a variety of illnesses and inflammation, phenolic acids and hydrolysable tannins like ellagic acid and punicalagin are notable as being among the most frequently cited categories. Individual sugars and organic acids are two additional less studied substances found in pomegranate peel. Regarding the fruit that can be eaten, organic acids help to boost the antioxidant activity of the peel (Tozzi et al., 2022).

Pomegranate fruits possess a remarkable potential to guard against multiple inflammatory and chronic illnesses(Valero-Mendoza et al., 2023). The main components of pomegranate by-products, when included in food products, can significantly boost their functionalities.

The application of Pomegranate peel powder in soup preparation has also been studied by researchers. Soups made from Pomegranate peel powder were found to have low energy density which can make them a healthier option when incorporated into our diet(Narasimha et al., 2015). Furthermore, Soups made from Pomegranate peel powder can be considered a functional food since their consumption results in improved health-related results as a result of the existence of numerous bioactive chemicals in pomegranates.(Cano-Lamadrid et al., 2022).

2.2 Types of bioactive compound found in pomegranate peel:

a) Flavonoids:

Polyphenol molecules with 15 carbon atoms are known as flavonoids. They consist mostly of flavonoids, flavanols, and flavanones. Flavonoids have several biological functions, including antioxidant, antibacterial, anticarcinogenic, and neuroprotective actions. Many phytochemicals, such as food supplements, neutraceuticals, oils, and colour pigments, have been produced from natural sources. An abundant class of phytochemicals with a benzo-pyrone nucleus is known as flavonoids(Patel et al., 2018). Quercetin, a flavonoid of the flavanol type found in garlic, tea, and apples, is ingested on an almost daily basis. It is estimated that between 0 and 30 mg of quercetin is consumed on a day to day basis in the archetype Western diet (D'Andrea, 2015). Citrus fruit flavanones like hesperidin have marginal bioaccumulation, poor water solubility, and a brief biological life. (Manach et al., 2003). Narigenin, a natural flavanone also found in citrus fruits like grapefruit and oranges, improves insulin signaling in the brain and memory(Ghofrani et al., 2015). Due to their antioxidant qualities and possible health benefits, phenolic compounds, which are present in almost all plants, are of great interest to humans and an important component of the human diet. From a basic phenolic molecule to intricate high-molecular-weight polymers, these chemicals are architecturally diverse. There is growing evidence that suggests eating

foods containing a variety of phenolic chemicals, which have antioxidant properties, may reduce the chance of developing certain diseases.(Shahidi and Ambigaipalan, 2015)

b) Polyphenols:

Secondary metabolites called polyphenols are found in plants and are typically used to protect them against infections or UV radiation. The putative anti-oxidant properties of dietary plant polyphenols have attracted a lot of attention in the last ten years. Long-term exposure of plant polyphenols appears to offer protection against the development of cancer, cardiovascular diseases, diabetes, osteoporosis, and neurological diseases, according to epidemiology studies and related meta-analyses. The biological effects of plant polyphenols are discussed in this article in relation to their importance to human health(Pandey and Rizvi, 2009).Many hydroxyl groups are linked to benzene rings in polyphenols. Phenolic chemicals have attracted interest because of their prevalence in food, antioxidant activity, and their function in protecting against numerous disorders related to oxidative stress. Fruits and drinks (fruit juice, tea, and coffee) are the main sources of phenols in the diet, with cereals, vegetables, and legumes providing smaller quantities. In comparison to the about 100 mg found in a cup of red wine, tea, or coffee, fruits including apples, grapes, pears, cherries, and other berries can contain up to 200-300 mg of phenolic compounds per 100 g of fresh weight. On average, humans ingest around 1 g of phenolics each day (Quideau et al., 2011).

2.2.1 Health benefits of Bioactive compounds:

The secondary metabolites of plants known as bioactive substances are those with desired impacts on human and animal health and wellbeing (Kaur and Das, 2011). Consistent evidence from epidemiological, in vitro, in vivo, and clinical investigations has shown that a diet high in plant foods can lower the risk of various degenerative diseases, such as diabetes, obesity, cardiovascular problems, and cancer. For instance, research has indicated that a plant-based diet can prevent 20–50% of all occurrences of cancer. As an example, research studies have shown that about 20–50 % of all cases of cancer can be prevented by the plant-based diets(Glade, 1999)

Because of the presence of functional groups in their structure, bioactive substances exhibit antioxidant, free radical scavenging, and chelating activities. They were also responsible for most of the beneficial effects of flavonoids on health. In addition to preventing mutations, flavonoids also fight tumors. Flavonoids are known to block a wide variety of enzymes, including oxygenises (prostaglandin synthase), that play a pivotal role in the production of eicosanoids. As a result, flavonoids can reduce hyaluronidase activity and promote the health of proteoglycans found in connective tissue. The treatment described here would prevent germs from spreading or cancer from metastasizing(Batra and Sharma, 2013).

2.3 Antioxidants:

When present in low concentrations compared to those of an oxidizable substrate, an antioxidant significantly slows down or stops the oxidation of that substrate. Few compounds have been proven to act as antioxidants in vivo, despite the fact that several have been hypothesised to do so(Halliwell, 1990). Particularly in wealthy nations, preventative medicine has made significant strides in the last ten years. Given that the majority of chronic diseases are dietary-related, research has shown that nutrition is essential for their prevention. The idea of functional food expands on the idea that food is not only essential for survival but also a source of mental and physical health, assisting in the prevention and reduction of risk factors for various diseases or increasing particular physiological processes(Rosa et al., 2023).Natural substances known as antioxidants prevent damage from oxidation despite their relatively modest concentration compared to the dominant oxidizable substrate(Baek et al., 2012). More than 170 antioxidants have been described in recent research(Zhao et al., 2012). According to research, reactive oxygen species (ROS) have a positive effect on the immune system and can work as agents with anticancer, immunity-boosting, antibacterial, antimicrobial, antifungal, cholesterol-lowering, antiparasitic, and anti- 9 inflammatory effects(Bub et al., 2003). Fiber, polyphones, conjugated dimers of linolenic acid, limonene, epigallocatechin, soy protein, isoflavones, and vitamins A, B, C, and E are all antioxidants found in fruits and vegetables. Calcium, chlorophyllin, alipharin, sulfur compounds, tetrahydro curcumin, glutathione,

lipoic acid, indoles, thiocyanates, protease inhibitors, and marine aminols are only some of the ingredients(Karakaya et al., 2001).

2.3.1 Source of antioxidants:

Antioxidants are found primarily in vitamins C and E as well as in polyphone, lycopene, copper, a-carotene, cysteine, and sialic acid. Juices, beverages, and even heated liquids can contain high levels of antioxidants such as polyphenols, vitaminC, vitamin E, carotene, and lycopene(Ramadan-Hassanien, 2008). Fruits are utilised in the food business as a raw material in the production of fruit juices, concentrates, preserves, and dried fruits. The peel and seed of the fruit are the main production byproducts. Many are now interested in researching the antioxidant levels in fruit waste. All types of fruits are thought to contain a significant amount of naturally occurring antioxidants, including vitamins, phenol, flavonoids, and carotenoids. Consequently, the research on antioxidant activity in fruit peels, particularly that of local fruits like mango peel, watermelon rind, banana peel, and mangosteen pericarp, was given in this publication. According to the review, fruit peels are a good source of antioxidants and other bioactive substances that are beneficial to human health in particular(Greensill et al., 2009). Spices and herbs have excellent antioxidant activity, which makes their antioxidants quite potent. The whole or ground spices and herbs, extracts, capsules, or emulsions of the spices and herbs have been utilised as antioxidants(Embuscado, 2015). Anything that fights oxidation is an antioxidant. Any agent that significantly slows down or prevents the oxidation of a substrate when present in modest concentrations compared to that substrate is referred to as an antioxidant. Antioxidants are necessary to maintain human health and food quality. (Sehwag, 2014).

2.3.2 Functions of antioxidants:

Antioxidants have a crucial role in the protective benefits of plant-based diets. Consistent consumption of fruits and vegetables lowers the risk of developing chronic diseases. Phytochemicals, particularly polyphenols, found in fruits, vegetables, berries, beverages, and herbal medicines may be able to alter the imbalanced lipid and glucose homeostasis, lowering the risk of the metabolic syndrome and complications from type 2 diabetes. (Dembinska-Kiec et al., 2008) There are long-term advantages to eating foods high in antioxidants(Srivastava, 2016). Antioxidants have recently been linked to free radicals,

which are thought to be responsible for cell damage, cancer prevention, and increased longevity(Hu et al., 2020). All antioxidants function through the antioxidant system, which is responsible for protecting the body against free radicals and the hazardous by-products of their metabolism. Antioxidants go through a series of modifications, the last of which is the creation of a complex with lipids. Photo chemicals, compounds found in plants with persistent antioxidant activity, are receiving a lot of attention as dietary components that fight chronic illnesses(Somogyi et al., 2007).

2.3.3 Mechanism of antioxidant activity in the human body:

Reactive oxygen species (ROS) concentrations rise as a result of oxidative stress, which in turn affects cellular function when ROS generation and detoxification are in equilibrium. Damage from reactive oxygen species (ROS) may be seen in a variety of biological macromolecules, such as lipid peroxidation acid and protein(Pizzino et al., 2017). However, as ROS levels are beyond this threshold, ROS production increases. This might lead to an overload of impulses being transmitted to the cell, potentially compromising key components of the cell's signaling pathways. ROS causes irreversible damage to vital macromolecules. The principal cytosolic low molecular weight sulfhydryl compounds that serve as cellular reductants are protein-bound thiol and non-protein thiol. This has led to thiol being utilized extensively as an initial line of defense against oxidative damage. Long-term damage to cellular macromolecules caused by oxidative stress has been demonstrated to have a role in the onset of illnesses such as atherosclerosis, coronary heart disease, liver cancer, diabetes, and carcinogenesis(Adwas et al., 2019).Antioxidants can inhibit the formation of free radicals and reactive oxygen species(Ambigaipalan et al., 2015). Greater resistance to oxidative stress and the diseases it might cause can be attained by eating a diet high in organic foods rich in antioxidants(Elsayed and Azab, 2019). In essence, redox processes serve as the basis for the antioxidants' activity. We see redox reactions frequently in daily life. Free radicals are created as unavoidable byproducts of many physiological activities that take place in our body and have the potential to harm our cells. By being stymied by antioxidants, free radicals are propagated through a variety of mechanisms from chain initiation to chain termination(Jomova et al., 2013).

Chapter-3: Materials and methods

3.1. Experiment area

The experiment was administered in the lab of the Department of Applied Food Science and Nutrition, at the Chattogram Veterinary and Animal Sciences University (CVASU).

3.2. Experiment Duration

The six-month experiment began in June and ran throughout that time.

3.3 Experimental Design

Initially, a zone where pomegranates will be plucked was selected. After selecting samples, it was used to turn in and out of pomegranate peel powder. After then, soups were made using this powder. After processing the nutritional content, antioxidant capacity,and consumer acceptance tests of each product category were analyzed, the proximate composition of pomegranate peel soup mix (moisture, ash, crude fat, protein, crude fiber, and carbohydrate) was established.

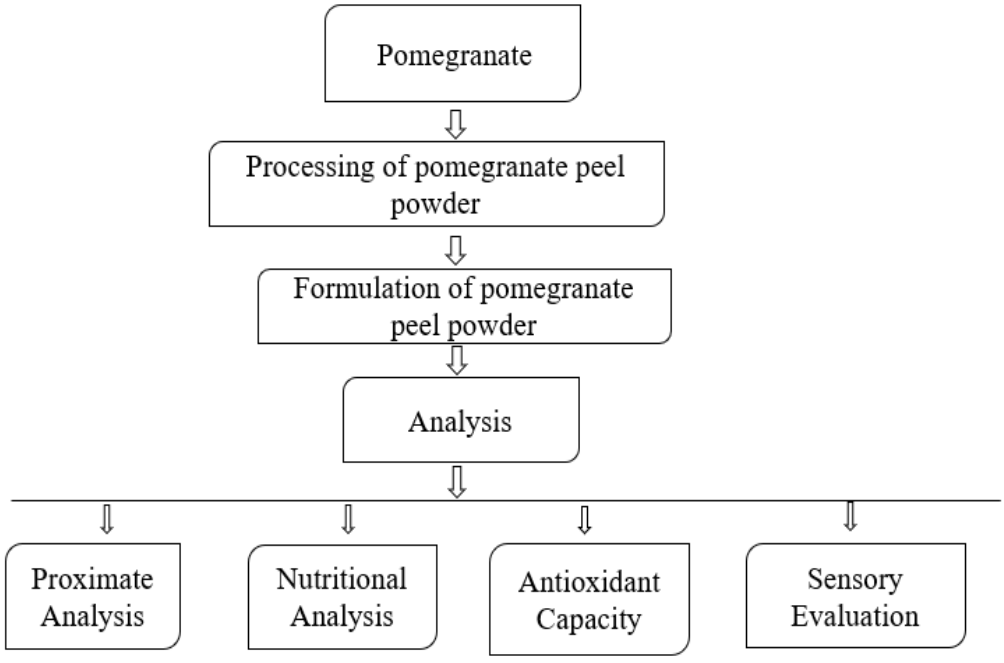

Figure 3.1: Study design

3.3.1 Sample Collection

Pomegranate was collected from local food stalls of Jhautala Bazar Wareless and other spices were purchased from modern trade and local market. Fresh fruits were carefully selected in order to maintain their quality. Butter, sugar, baking powder, baking soda, and wheat flour were some of the other essential items purchased at the local market. From the laboratory stock, additional incidental items needed for the experiment were obtained.

3.4 Peel powder preparation

Fresh peels were properly cleansed with water to get rid of any dust and dirt after being received. The peel was then divided into little pieces. After that, it was blanched for five minutes and then submerged in cold water. The collected peel was spread out on trays and dried for 12 hours at 60 degrees Celsius in a cabinet dryer. Using a grinder to smooth up the dried peel and a sieve to filter out the larger pieces. The peel powder was then sealed in a zipper bag and kept in an airtight container until it was needed.

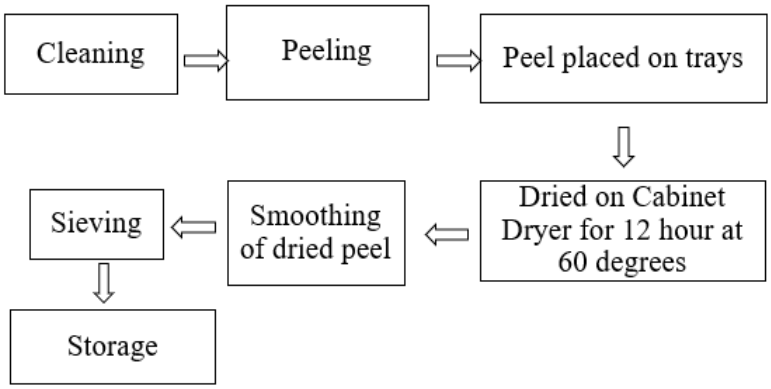

Fig 3.2: Peel Powder Preparation

3.4.1 Formulations for soup mix powder

According to the prescribed percentages for each component, all the elements were blended in three distinct formulations to generate a soup mix (Table 3.1). This situation raised questions about how to determine the product's retention ability of water in respect to percentage as well as water activity (aw). Sensory evaluations were conducted using the quantitative description method (QDA).

The percentage daily value (percent DV) was developed in order to determine the total amount of energy (kcal) and the percentage of energy given by the chosen mixing formula.

Methods for preparing soup powders: 300 mL of water and 20 g of mixed soup were combined, cooked for 15–20 minutes, and then prepared for one serving.

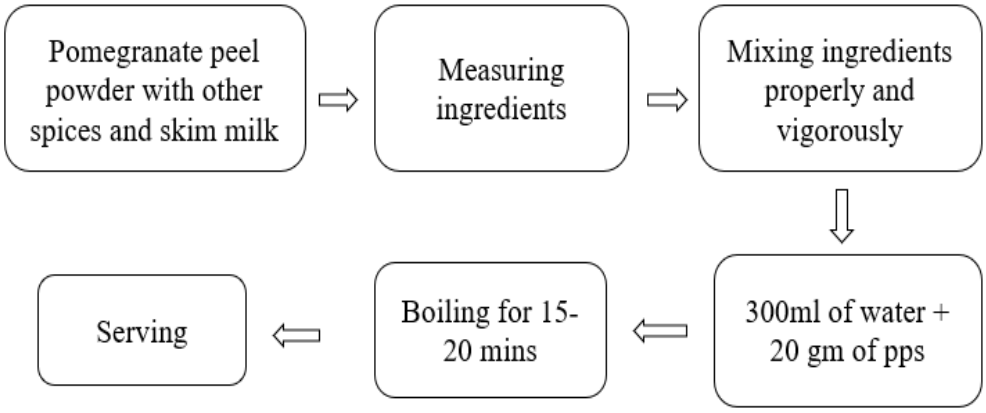

Fig 3.3: Processing steps of formulation for soup mix powder

Table 3.1: Formulations of pomegranate peel instant dried soup

Ingredients	Formulations (weight in gm)			
	Control	Type A	Type B	Type C
Pomegranate peel Powder	-	16.95	15.49	17.50
Broth Powder	20.72	3.77	5.23	3.22
Ginger powder	2.42	2.42	2.42	2.42
Mixed herb	5.48	5.48	5.48	5.48
Basil	2.39	2.39	2.39	2.39
Cardamom	2.06	2.06	2.06	2.06
Chicken Seasoning	6.49	6.49	6.49	6.49
Chili flex	2.42	2.42	2.42	2.42
Corn flour	46.36	46.36	46.36	46.36
Skim milk	7.54	7.54	7.54	7.54
Salt	2.06	2.06	2.06	2.06
Garlic powder	2.06	2.06	2.06	2.06
Total	100	100	100	100

3.5 Physicochemical Analysis

According to the AOAC 2016 procedures, soup mix samples containing pomegranate peel powder were examined for moisture, protein, fat, fiber, and ash. Antioxidant analysis was also performed on these samples.

3.5.1 Moisture content Principle:

The most considerable and commonly utilised criterion is moisture determination. in the preparation and testing of food products. Moisture content is explicitly interconnected economically for both the manufacturer and the consumer since the proportion of dry matter in a serving of food is adversely associated with the amount of moisture it contains.

Hence, moisture has a core impact on the consistency and structure of food.

Procedure

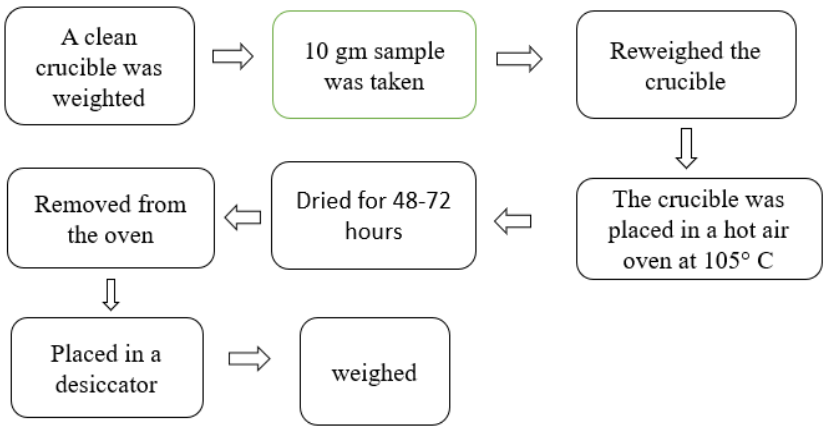

Fig 3.4: Process for Moisture Content Estimation

3.5.2 Assessment of Crude Fat Principle:

By soaking food samples in organic solvents like methanol or chloroform and separating the filtrate by filtration, the amount of fat in the samples can be calculated. The filtrate is divided into numerous funnels, the mixture is dried, and the estimated fat % is then calculated in order to determine the extract's quantity. The crude fat content of the samples was assessed using a soxhlet device in accordance with AOAC (2016) recommendations.

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

3.5.3 Crude Protein Assessment

Concentrated H_2SO_4, Digestion Mixture (Boric Acid Solution, Alkali Solution, Mixed Indicator Solution, Standard HCl), Potassium Sulfate Solution, Copper Sulfate Solution, Selenium Dioxide Solution, and Boric Acid Solution are among the reagents used for the assessment (0.1N). The nitrogen content of materials, both organic and inorganic, can be found out using the Kjeldahl method. The protein content of foods and beverages, meat, feeds, cereals, and forages is assessed using the Kjeldahl nitrogen method. Another use of the Kjeldahl method is to determine the nitrogen content of soil, wastewater, and other materials. It is an accepted technique that is described in several normative texts, including (AOAC, 2016).

Procedure

The proposition behind this method is to disintegrate the substance comprising powerful sulfuric acid and a digesting combination (H_2SO_4). Protein is oxidised and destroyed as a result, and organic nitrogen is converted into ammonia, which then persists as ammonium bisulphate in the acid mixture. The amount is then determined by titration by measuring the digest's alkaline pH and distilling the ammonia released into a reference acid solution.

0.5g of the sample was added to 100 ml Kjeldahl flasks that had been cleaned and dried, together with a piece of filter paper free of ash. To immaculate the comtents, digestion chamber had undergone heating for six hours after 10 ml of concentrated H2SO4 and a 1:1 gm digestion combination (sodium sulphate and mercuric oxide) were incorporated. The digested liquid was transferred to a 100 ml volumetric flask and diluted with distilled water

until the desired consistency was reached after the digestion process was finished and the beaker had had time to cool.

The solution was infused with 5 ml of 50% NaOH and 2.5 ml of 15% Na2S2O3 before being put into a micro kjeldahl distillation unit in a quantity of 10(10 ml). For five minutes, the solution underwent steam distillation. The distillate was placed in 2% boric acid solutions with an indicator to help with collection, and it was titrated with 0.02N HCl after that. Without using any medications, the same blank digestion was carried out concurrently.

3.5.4 Estimation of Crude Fiber

Principle:

Cellulose, hemicellulose, and lignin takes up the considerable portion of "crude fibre," the portion of carbohydrates that is water-insoluble. It can be calculated through digestion by boiling a specific quantity of fat-free food in a weak acid solution (1.25% H2SO4) for 30 minutes, then in a weak alkali solution (1.25% NaOH) for 30 minutes at constant volume. Thereafter, the remaining residue is subtracted from the ash. Using the AOAC method, the crude fibre was identified (2016). The residual material was then burnt in a muffle boiler to 550–600°C (white ash, 4-6 hours).

Procedure:

A glass rod was instilled into the beaker to aid in trouble-free boiling. After filtering the mixture through a shirting cloth, the leftover material was purified in hot water aiming to wipe out any acid that could have remained. Then, 200 ml of boiling 0.313 N (1.25 percent) NaOH was added to the beaker containing the material. In order to preserve the same volume, the mixture was boiled for 30 minutes before being filtered through a shirting cloth. The residue was dried after being cleaned until it was free of alkali using the same ratio of ether and alcohol. When heated for the following day at 80 to 100 degrees, it was then transferred to a crucible.

3.5.5 Ash Content

Utilizing AOAC (2016) procedures, ash content was calculated. The inorganic byproduct that remains after organic matter is destroyed is called ash content. The PPS mix was placed in a pre-weighed dry crucible of 10 gram. It was then burnt over a charcoal fire. In order to completely burn off the charcoal, the charcoal was then put in a muffle boiler and heated there for four hours at a temperature of about 600 °C. The crucible was taken out of the boiler when that occurred. Temperature was brought down in a desiccator if needed before weighing it.

Procedure:

The empty crucible was removed, placed in a desiccator for an hour, dried at 105 degrees Celsius, and then weighed to a constant weight. A sample of around 1 gm was taken and placed in the weighted empty crucible. After adding 1 drop of nitric acid, the crucible was put into a muffle boiler and the temperature was raised to 650°, where it was kept for three hours. Following that, a low flame was used to burn the specimen inside the crucible.

Following that, it was taken out, cooled, and kept in a desiccator. The weight of the crucible with the ash was then calculated.

3.5.6 Calculating the amount of total carbs

It was computed by calculating the difference between the Nitrogen Free Extractive and the carbohydrate content (NFE), and it was reported as the variation from 100 from the sum of the other proximate components.

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

3.6 Determination of Antioxidant capacity by DPPH scavenging method

The Making of an Extract:

One gram (1g) sample and put it in a Felcon tube. After waiting 72 hours, 10 ml of 100% methanol was added to the mixture. Continuous straining was done every 4 hours. It was filtrate after 72 hours and found methanoic extract.

Procedure:

Extract antioxidant activity was evaluated using a modified version of the DPPH assay(Almey et al., 2010). Methanoic DPPH solution was made by dissolving 6 mg of DPPH into 100 mL of 100% methanol. The methanoic extract was then diluted with 2 mL of DPPH solution. The ingredients were combined, shaken gently, and then let to rest for 30 minutes at room temperature in complete darkness. The absorbance was determined using a UV-VIS spectrophotometer with a 517 nm setting (UV-2600, Shimadzu Corporation, USA). The control was made by adding two milliliters of DPPH solution to one milliliter of methanol, which served as the blank. Scavenging activity was calculated by comparing absorbance readings of test samples with DPPH standard solution. The ability of an extract to scavenge DPPH free radicals is calculated using the following equation:

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

As the standard, Trolox was used, and the validation standard curve was TEAC composite (Trolox equivalent antioxidant mobility). The results were given as milligrams (mg) per 100 grammes of powder on a dry weight (DW) basis.

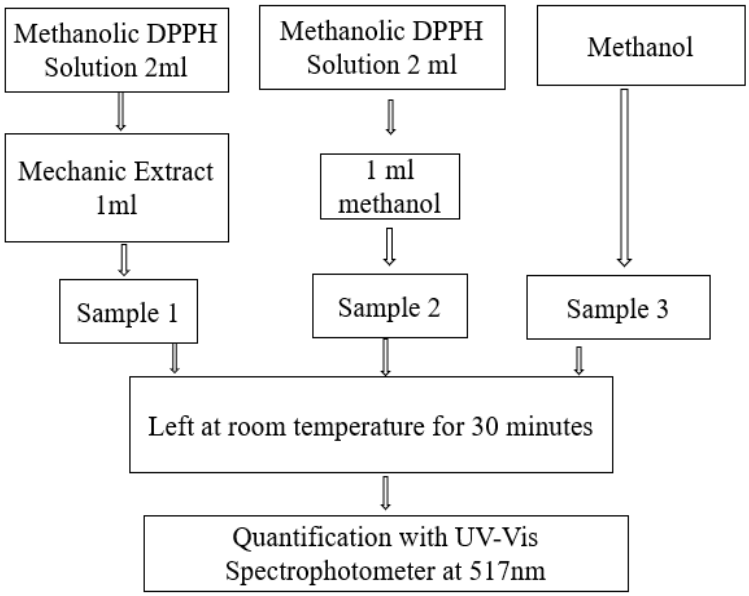

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Fig 3.5: Determination of Antioxidant capacity by DPPH scavenging

3.7 Determination of bioactive compounds

5 gm of TAC sample and an extra 1 gm each of TPC and TFC sample were put into Felcon tubes. 10 mL of 100% ethanol was then added, and the mixture was then left alone for 72 hours. Every four hours, there was continuous straining. An ethanoic extract was found in the filtrate after it had been collected and left for 72 hours.

3.7.1 Total phenolic content (TPC):

The Folin-Ciocalteu reagent method was used to quantify the TPC of the extracts with a few minor changes (Blainski et al., 1980).The Folin-Ciocalteu method was used to determine the sample's total polyphenol content (TPC) (Lamuela-Raventós, 2017).A falconer tube containing 1 ml of ethanoic extract and 1.5 ml of FC reagent was combined, and the mixture was left at room temperature for 3 minutes. After that, the combination spent 60 minutes being exposed to 1.5 cc of 7.5% Na2CO3. With C2H5OH as the blank, the absorbance at 765 nm was measured using a UV-VIS Spectrophotometer (UV2600, Shimadzu Company, USA). TPC was found to be mg GAE/g of extract in units of gallic acid equivalents (GAE).

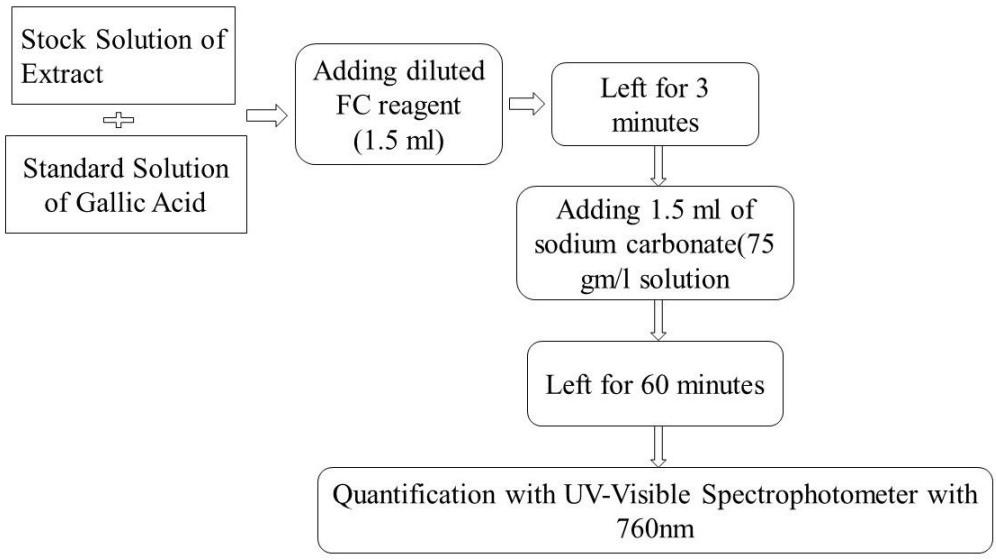


Figure 3.6: Determination of Total phenolic content (TPC)

3.7.2 Total flavonoid content (TFC)

A modified version of the aluminium chloride colorimetric method was used to quantify the total flavonoid content (TFC) in the fruit samples (Chang and Yang, 2002). Five millilitres of diluted extract and one and a half millilitres of 95% ethanol were added to a cuvette along with extract stock solutions (1 mg/mL). The cuvette was then filled with 2.8 mL of distilled water, 0.1 mL of 1 mol/L potassium acetate, and 0.1 mL of 10% AlCl3. It took 30 minutes for the mixture to reach room temperature. In order to quantify absorbance at 415 nm, a UV-visible spectrophotometer was used; the blank was 10% aluminium chloride replaced with nearly the same amount of pure water (UV-2600, Shimadzu Corporation, USA). The amount of flavonoids was determined by dividing the absorbance of the sample extract by the value from a quercetin standard curve. The effectiveness of TFC is measured in terms of quercetin equivalents per 100 grams of extract (mg QE/100g).

Procedure:

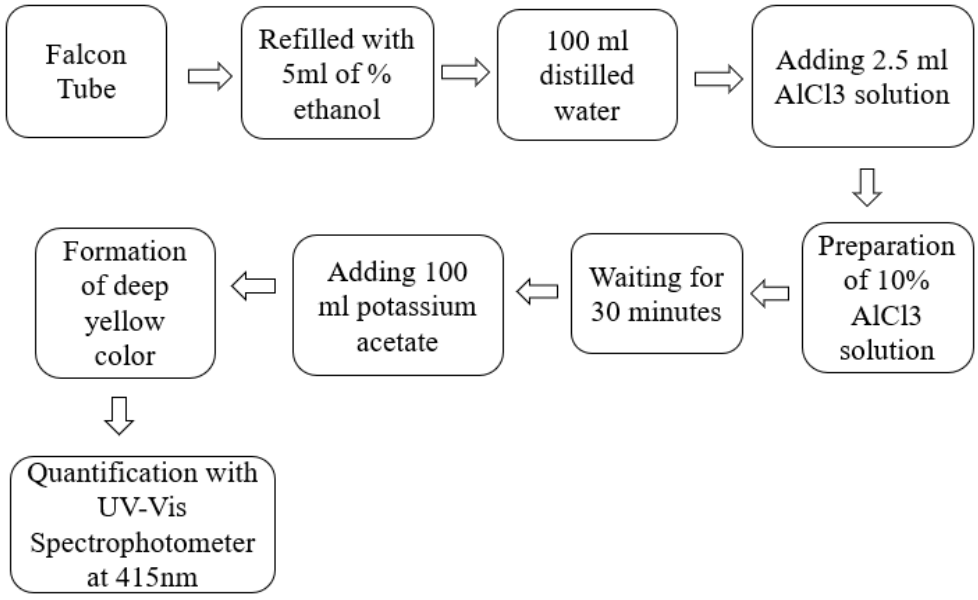


Fig 3.7: Determination of Flavnoid Content

3.8 Estimated energy

The quantity of protein, fat, and carbohydrate in each type of meal was estimated together with its energy content using the equation below. (Baer et al.,1997)

Energy is calculated as follows:

Energy (kcal) = (Protein × 4.1) + (Fat × 9.2) + (Carbohydrate × 4.1)

3.9 A study of the costs

The price of the instant PP soup mix powder was determined by adding together the costs of all the items used to manufacture the pomegranate peel instant soup mix powder, including the pomegranate. The taka value indicated in Table 4.3 was used to compute the cost per 40gm of instant soup mix powder.

3.10 Sensory analysis

3.10.1 Affective test

A "pomegranate peel soup mix" will pass or fail this test based on its level of acceptance. Ten panelists, equally split between men and women, conducted it within CVASU. Untrained panelists administered the test. The panelists were asked to select the best formulation out of three options based on how acceptable they thought it was.

To evaluate the characteristics of the sample, 5 points of deterioration were employed, with scores ranging from -1 (severe dislike) to -9. (like extremely). Color, smell, texture, taste, and general acceptability are among the sensory attributes that panels have assessed.

Table 3.2: Grading system for sensory assessment

Attributes	Score
Like Extremely	9
Like Very Much	8
Like	7
Like Slightly	6
Neither Like nor Dislike	5
Dislike Slightly	4
Dislike Moderately	3
Dislike	2
Dislike Extremely	1

3.11 Statistical Analysis

Statistical analyses were carried out utilising the Minitab 14.0 application. A one-way analysis of variance was performed on the data collected (ANOVA). Fisher's LSD test, with a level of significance of 0.05, was carried out using statistical software to see if there were any statistically significant differences between them ($p > 0.05$). The experiment, which involved ten panellists, produced the results listed below.

Chapter- 4: Results

4.1 Nutritional attributes

The moisture, protein, fat, crude fibre, ash, and carbohydrate content of pomegranate seed powder were evaluated in order to determine its nutritional qualities.

4.2 Nutritional Properties of pomegranate peel soup mix

The nutritional value of soup is shown in Table 4.1. All samples showed large variations. Type B significantly the higher concentrations of crude protein (23.54%), crude fat (5.68%), and crude fiber (14.06%) compared to Type A and Type C. Type B had the lowest crude fiber content (4.29%) and Type A has lowest fat content (9.79%) and the crude protein content (4.78%).

Table 4.1 Nutritional Properties of Pomegranate peel soup mix

Parameter in % value	Control	A	B	C	1-P value
Carbohydrate	27.65 ±0.02^{b}	64.63 ±0.032^{a}	64.37±0.03^{a}	64.94±0.19^{a}	0.001
Moisture	4.87 ± 0.03^{b}	9.91 ± 0.02^{a}	8.87 ± 0.06^{a}	9.62±0.07^{a}	0.001
Crude fibre	1.43 ± 0.01^{b}	4.39 ± 0.01^{a}	4.41± 0.01^{a}	4.37±0.07^{a}	0.001
Fat	2.39 ± 0.02^{b}	9.79 ± 0.01^{a}	9.89± 0.01^{a}	9.84±0.01^{a}	0.001
Ash	1.46 ± 0.03^{b}	6.38 ± 0.05^{a}	6.41 ± 0.01^{a}	5.98±0.01^{a}	0.001
Crude protein	2.38 ± 0.01^{b}	4.78 ± 0.01^{a}	5.30 ± 0.05^{a}	5.25±0.01^{a}	0.001

Legends: Values in the same row with the same superscripts but different Means ± SD are not statistically significant ($P<0.05$).

Type A – 10 % pomegranate peel soup mix

Type B – 20 % pomegranate peel soup mix

Type C – 30 % pomegranate peel soup mix

4.3 chemical makeup of corn flour and that of other spices

Corn flour includes ash (1.85%), calorific value (442.99 Kcal/100 g), crude fat (5.73%), protein (19.66%), carbohydrate (62.31%), fiber (3.67%), and protein (19.66%). Less than 0.5% fat and 36% calories are in skim milk. Ginger powder includes 5.02 to 5.82 percent of protein, 4.97 to 5.61 percent is crude fiber, 0.76 to 0.90 percent is fat, and 3.38 to 3.66 percent is ash. Ginger powder had 3.83 mg/100 g of ascorbic acid and 0.81 mg/100 g of beta-carotene.

4.4 Bioactive Components of formulations

The DPPH assay was used to calculate the total antioxidant capacity of soup. Table 4.2 displays the antioxidant concentration of the samples. 4.2.2 Total flavonoid concentration (TFC) of soup:

Using a modified aluminum chloride colorimetric method, we determined the total flavonoid content (TFC) of the fruit extract. The whole flavonoid count is shown in Table 4.2. This particular result was expressed as mg QE/100g extract.

Table 4.2 Bioactive Components of formulations

Type	**Total phenolic content (mg GAE/100g)**	**Total flavonoid content (mg QE/100g)**
Control	3.22 ± 0.02^{c}	115.33 ± 0.11^{c}
A	9.37 ± 0.06^{c}	215.34 ± 1.25^{b}
B	9.38 ± 0.02^{b}	278.32 ± 0.64^{a}
C	9.35 ± 0.01^{a}	343.84 ± 1.11^{c}
1-P value	0.001	0.001

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

4.5 Antioxidant content

Table 4.3 reveals that sample B had the significantly highest antioxidant capacity (3.13.02 mg/100g) while the control soup had the significantly lowest antioxidant capacity (1.15.03 mg/100g).

Table 4.3 Total antioxidant capacity

Type	Total antioxidant capacity (mg/100g)
Control	1.15 ± 0.03^{b}
A	3.13 ± 0.02^{a}
B	3.15 ± 0.01^{a}
C	3.14 ± 0.01^{a}
1-P value	0.001

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

4.5 Energy content

The evaluation imparts Type B to be of higher energy value following Type A and Type B respectively. The evaluation imparts Type B to be of higher energy value following Type A and Type B respectively. Preferred formulation Type B of Pomegranate peel instant soup mix powder has a 380.32 total energy content per 100 g, following by the Type C with 378.307 kcal. Type A has the lowest energy of the three types with 373.42 Kcal.

4.6 The standardization of soup mix

The ingredients for soup in Table 4.3 are abundant in nutrients that give energy. Energy levels increased as fat and carbohydrate content in the formula increased. Total energy provided by carbohydrate, protein and fat in formulas of mixed pomegranate peel powder (PPP)instant dried soup (in 100 g). For a number of reasons, soup mix needs to be standardized. The selection of top-notch ingredients is the first step in the standardization procedure. To ensure that each component satisfies the manufacturer's requirements for flavour, freshness, and purity, it must first be carefully selected and evaluated. The ingredients are then combined and measured in accordance with a particular formula that has been created and examined to ensure consistent outcomes. First off, it makes sure that every batch of soup mix is uniform in terms of flavor, texture, and nutritional content, which encourages repeat business and trust from customers. Second, by lowering the need for rework or product recalls, it contributes to waste reduction and increased efficiency. Last but not least, it assists in ensuring that the soup mix complies with legal standards and is suitable for ingestion. In essence, standardizing soup mixes is an essential step in ensuring the uniformity and quality of the finished products. It entails thoughtful recipe development, testing, ingredient choice, packaging, and labelling. The greatest standards of quality, safety, and nutritional value can be met by soup mix producers by adhering to a standardized method. The soup mix is tested after it has been assembled to make sure it satisfies the manufacturer's requirements for flavour, texture, and nutritional content. Trained taste testers evaluate the soup mix's appearance, aroma, flavour, and texture as part of this sensory testing process. To make sure that the soup mix satisfies the necessary nutritional standards, nutritional testing is also done.

4.7 Formulated best one

The proximate composition, sensory rating test and bioactive content of three types soup product (A, B, C) have been laid out in the aforementioned table (4.1- 4.5). In case of proximate composition, among these three formulations and control, sample B was higher in protein, fiber, fat, ash as well as energy content.

As overall energy content of B was higher than the other two samples, these made it the best one.

Among all the three formulated products, the overall acceptance of B had the highest score which was 8.60±0.51 on a hedonic scale of 9 points. The other two samples' total acceptance was lower than C. Therefore, Sample B was chosen as the top sample due to its superiority.

4.8 Sensory Evaluation

Together with nutritional value, organoleptic value is an important factor that influences the products that people choose. Finding the ideal ingredient proportion is essential when creating a mixed soup because it not only promotes a balanced diet but also enhances the flavour. The sensory qualities of the instant soup were assessed using the quantitative descriptive analysis method.

Statistics showed that there was no statistical difference between any of the sensory measures ($p>0.05$) (table 3). The acceptance rate of Type B for Sample 2 was the highest overall. The least quantity of positive comments, however, were given to sample. (Type A).

Table 4.4: Hedonic rating test for sensory evaluation of pomegranate peel soup

Formulation	Control	Sample 1	Sample 2	Sample 3	1-P value
Taste	7.88 ± 0.42^{b}	6.87 ± 0.46^{a}	7.33 ± 0.70^{a}	5.73 ± 0.46^{b}	0.001
Spiciness	7.26 ± 0.53^{b}	8.33 ± 0.49^{a}	8.60 ± 0.51^{a}	8.20 ± 0.56^{a}	0.001
viscosity	6.23 ± 0.48^{b}	8.00 ± 0.48^{a}	8.60 ± 0.51^{a}	7.87 ± 0.52^{ab}	0.001
Flavor	7.66 ± 0.62^{a}	6.87 ± 0.64^{b}	6.20 ± 0.68^{b}	6.93 ± 0.59^{b}	0.001
Appearance	6.94 ± 0.62^{a}	7.40 ± 0.51^{a}	7.37 ± 0.52^{a}	5.22 ± 0.70^{b}	0.001
Overall Acceptability	7.80 ± 0.55^{a}	8.00 ± 0.53^{a}	8.60 ± 0.51^{a}	5.93 ± 0.60^{b}	0.001

Legends: Values in the same row with the same superscripts but different Means ± SD are not statistically significant ($P<0.05$).

4.9 Cost Analysis

The total manufacturing costs for sample B, which received the highest sensory assessment score, and the control soup with a 20% pps mix are shown in Table 4.5. The weight was 48.5 gm following packaging.

Table 4.5: Production Cost analysis of Pomegranate Peel Soup

Ingredients	Weight in gm	Tk per kg	Total Tk per 70.5gm	Total Tk (for control)
Pomegranate Peel Powder	15	450	6.75	-
Broth Powder	15	350	5.25	5.25
Ginger powder	1	2500	2.5	2.5
Mixed herb	2	1700	3.4	3.4
Basil	0.50	6000	3	3
Cardamom	1	6000	6	6
Chicken Seasoning	8	2000	16	16
Chili flakes	1	1000	1	1
Corn flour	22	300	6.6	6.6
Skim milk	3	900	2.70	2.70
Salt	1	40	0.04	0.04
Garlic powder	1	550	0.55	0.55
Total	70.5	321,490	53.79	47.04
2.**Processing cost 15% of raw material**		3790	8.07	7.06
3.**Packing cost**		5tk per piece		
Total production cost			66.86	59.10

Per pack soup mix contain around 70.5 gm powder, which price will be 66-70tk.

Chapter -5: Discussions

5.1 Nutritional Analysis

When compared to other similar category (Wheat based Soup), which had much smaller magnitudes of fat ,crude fiber, and ash (that is 1.25%, 0.67%, and 4.82%, respectively) (Rokhsana et al., 2008), it was found that Pomegranate peel soup had a significantly greater amount of fat(9.89%), crude fiber (4.41%), and ash (6.41%) than wheat based soup (Table 4.1).Though formulated soup showed lower amount of protein (5.30 %),it is ,however, due to the constituents of pomegranate peel having reduced protein physiologically.

Pomegranate peel soups chemical composition is listed in Table 4.1. Samples A, B, and C were found to have drastically significant varying amounts of moisture, total carbohydrate, crude fiber, ash, fat, and crude protein. Increasing the proportion of peel powder caused the soups moisture content to significantly rise ranging from 4.87% to 9.91% in sample C, with sample B having 8.87% moisture content getting accepted in sensory analysis. Based on the comparison, we may conclude that adding peel powder to soup marginally modifies its hydration levels when compared to wheat based soup. Moisture content goes up a little from 6.99 found in wheat based soup to 8.87 in type B. The body's rate of food absorption and assimilation is directly related to the amount of moisture present in the diet. It's also a factor in how well food will keep.

The value of peel powder addition significantly raised the crude fiber levels of soups.Type B with 20% formula had increased level of crude fiber with 4.41 if compared with wheat based soup having a meagre 0.67% crude fiber.(Rokhsana et al., 2008).Type A had a carbohydrate content of 64.33%, type B was 64.37%, and type C was 66.04%. As anticipated, the incorporation of pomegranate peel powder into types A and B decreased the concentration of carbohydrates but increased in Type C. Carbohydrate content of pomegranate peel soup (64.63%) was observed somewhat smaller, when compared with wheat based soup(66.87%). Wheat's high carbohydrate content may be the cause.

It is well articulated that pomegranate peel powder insertion provided enhanced impact on the nutritional profile of formulated soup with significant values. Type B has the greatest

percentage compared to type A and C (Table 4.1). Type B had the highest ash concentration (6.41 %) out of the three types. Type a has 6.33%, whereas type C has 5.98 % ash. Ash content in food is mostly predicted by the amount of ash present.

In term of fat, Type C has the highest content of fat with 9.89% and Type A and B having 9.79% and 9.84 % correspondingly. Hence it is obtained that fat percentage is increasing with increasing peel powder concentration. It has improved value in terms of fat when equating with wheat based soup as the wheat based soup contains an insignificant amount of fat with only 1.25%. The calories is obtained from food are directly proportional to the quantity of fat it contains. The American Heart Association recommends that adults consume no more than 2% of their daily calories from fat to reduce their risk of developing cardiovascular disease, cancer, and senescence.

Regarding crude fiber, the amount enriched in pomegranate peel soup having 4.41% in average, while the wheat based soup had a modest amount of only 0.67 %. Hence the peel soup demonstrates significant health benefits. When comparing types, A, B, and C, Table 4.1 reveals that type B had a greater fiber content with a fiber percentage of 4.37%. Incorporating fiber into one's diet has been shown to reduce the body's absorption of cholesterol by cleaning out the digestive system of harmful toxins that might cause cancer. Protecting against metabolic diseases like hypertension and diabetes mellitus, fiber also provides weight to meals and lowers the consumption of excess starchy food, which is typical of the diet of the indigenes in this region (Sodamade et al., 2013). This suggests that Sample B is preferable to Samples A and C.

Table 4.1 reveals that the protein content of types A and B is 4.78% and 5.25%, respectively. The protein content of type C is lower, at 5.30%.

5.2 Antioxidant capacity:

Cells and tissues can be harmed by free radicals, and over time, this harmed tissue can help to produce chronic illnesses including cancer, heart disease, and Alzheimer's disease.

The primary plant chemicals that may reduce oxidative damage to tissues are those found naturally in plants and include antioxidants. Table 4.3 displays the results of the DPPH test on the antioxidant capacity of pomegranate peel soup where Type B dominating with

significantly highest amount of 3.15 % than the other two variants making it more preferable health wise. While comparing with available soups it is seen that these contains a moderate amount of 1.56 % anti-oxidant amount, much lower than the formulated peel soup(Rokhsana et al., 2008).Because of this, antioxidant capability is seen as advantageous for general health.

In the presence of antioxidants, a diamagnetic compound was discovered, as reported by Singh et al (2015). The DPPH activity levels in samples A is 3.13 mg/100 g and B has 3.15mg/100 g while C having 3.14 mg/100 g were different. Owing to high levels of phenolic acids, flavonoids and other polyphenolic compounds, pomegranate could be used as an effective scavenger of several reactive oxygen species(Derakhshan et al., 2018)By scavenging free radicals and lessening their negative effects, antioxidants can help stop or delay this damage.

5.3 Bioactive Component

Pomegranate has been propagated as a polyphenol-rich food with health beneficial effects due to its high antioxidative capacity, thus is being commonly referred as superfruit (Tehranifar et al., 2010).In this study, the TPC value of Type B (9.38±0.01 mg GAE/100g) was more than that of type A (9.37 mg GAE/100g) and C(9.35 mg GAE/100g) which is laid out in Table 4.3.Comparing with the Cream Soup with gingseng powder, which has average 0.53 mg GAE/100g TPC (Kwon et al., 2022) ,the pomegranate peel powder soup contains significant amount of TPC with 9.38 mg GAE/100g.Presence of enriched amount of polyphenols in Pomegranate peel leaded to this significant result.

Flavonoids, which are bioactive natural chemicals, may be found in almost every plant species. Catechins, flavonoids, flavones, and quercetin were the most common members of this family (Gadkari and Balaraman, 2015). Flavonoids are recognized for their strong antioxidant and anti-inflammatory, anti-cancer characteristics capabilities. The TFC content of types A and B is 215.34±1.248 mg QE/100g ,278.32±0.640 mg QE\100 g and C's is 343.84.±1.108 mg QE/100g, respectively, shown in table 4.2.It reveals during comparison that, peel powder soup contains markedly higher amount of TFC with a significant range of 215.34 mg QE/100g to 343.84 mg QE/100g than Cream soup with gingsen having 0.011 mg QE/100 g.

5.4 Hydrologic properties such as relative humidity and specific activity of water

The goods produced utilizing various formulations did not substantially vary in terms of moisture content (ranging from 7.0360.456 to 7.5060.569%) or water activity (aw), with values ranging from 0.2080.009 to 0.2100.012 percent, respectively. Microorganisms may develop down to an aw of 0.60. Halophilic bacteria, on the other hand, may flourish at aw values as low as 0.75, which is much lower than the typical aw of 0.87. (Beuchat et al., 2013). According to the International Council on Microbiological Standards for Foods, S. aureus may thrive at an aw as low as 0.83 under optimum circumstances (1996). As the Soup powder falls under this range it is recommended to best use within one month of packaging though this area is needed to be further assessed.

5.5 Soup's post-refrigeration quality

Depending on how and how long soup is stored under refrigerated, the quality of the soup may be impacted. Before refrigerating, let the soup cool. The refrigerator's temperature may rise due to hot soup, spoiling other food inside. Prior to putting the soup in the fridge, allow it to cool to room temperature. Items must be kept in a secure setting. The packaging for the commodities under examination was decided upon as double-sided aluminum bags with zipper closures. The moisture content and water activity of the product did not change after two weeks of storage. It has also been shown that the product has a high organoleptic value. Correctly reheating the soup makes sure the soup achieves an internal temperature of 165°F (74°C). The soup shouldn't be left out at room temperature for longer than two hours. It's crucial to immediately put soup in the refrigerator once it has been served since bacteria can multiply quickly in warm environments.

Chapter-6: Conclusion

The manufactured pomegranate poedered peel product is a suitable option for customers with a range of health concerns because its Nutrition Facts label is based on computer-generated data. According to its physicochemical and microbiological characteristics, this soup powder can be kept in a safe environment for up to five months. Since soup powder combines all the nutrients from different sources and has a balanced amount of energy, it is being developed as a suitable choice for addressing nutritional needs, particularly in the prevention of IBS and malnutrition in our nation.

Contrarily, a number of clinical investigations have demonstrated a number of health advantages of the pomegranate peel. As more people learn about numerous health benefits, its popularity is predicted to increase. In our investigation, it was shown that the soup made from pomegranate peel included higher levels of antioxidants, bioactive substances, crude ash, and fiber than regular one. The soup containing 20% peel powder (Type B) scored higher on a sensory assessment test across all quality areas than the other soups. Soup's nutritional value and health advantages will greatly improve as a consequence. It was determined that the nutritional results were satisfactory, which is excellent news for the general public's health. Vitamins and minerals are abundant in type B soup, which contains 20% pomegranate peel and may help prevent illnesses like these.

Chapter-7: Recommendations and Future perspectives

Today, more than 50% of Bangladesh's population has IBS; in these circumstances, soup might be an excellent supply of nutrients and energy. Pomegranates provide health benefits because they contain flavonoids and anthocyanins, which are preventive against a wide range of ailments, including inflammatory disorders. Modern food industry can use the process from medium and large-scale manufacturing. The authors provide the following recommendations and opportunities for more study in light of the current findings.

• The current study might be replicated to confirm the outcomes of the trial.

• The recipe may be adjusted further, and you can experiment with making mixed peel soups using other recipes and varied fruit ratios.

• It is advised throughout the entire season since it is easy to prepare, can be kept for a long time, and can be consumed quickly.

• For those who are economically underprivileged, it will be advantageous.

• Similar research should be done on other marketable fruits, such as apple, mango, and others.

• Modern packaging and storage solutions will be developed to improve PPP soup.

• Aromatic taste can be added to increase value.

• Because the findings are significant from a medical viewpoint, they will be helpful therapeutically.

• Despite having enough data in the sample to permit statistical comparisons between the analytical results. Due to the small number of samples investigated and the requirement that conclusions be supported by a larger inquiry, our findings should be interpreted with caution.

• Enough measures should be implemented to enhance the nutritional value of commercial soup.

Further research is needed to determine the optimal dose, safety, and efficacy of pomegranate peel extracts in humans.

Limitations of the Current Research:

1. Due to a lack of resources and time, it was very exacting to finish the research.

2. Of the several bioactive substances present, we only found TPC, TFC, and TAC.

3. Time restrictions prevent us from determining the types of flavonoids and catechin concentration in the goods.

4. In spite of the fact that GC-MS would produce more precise data, we used UV visible to examine the materials.

5. Examine the concentrations of bioactive compounds.

6. Shelf-life supervision needs further attention for research.

Reference

Advisor P. P. 2016. Scope of Functional Food-Chikki Prepared By Adding Pomegranate Peel. In Bull. Env. Pharmacol. Life Sci (Vol. 5).

Adwas A. A., Sedik Ibrahim Elsayed A., Elsayed Azab, A., and Amhimmid Quwaydir, F. 2019. Oxidative stress and antioxidant mechanisms in human body.

Almey, A., Khan A. J., Zahir S., Suleiman M., Aisyah , and Rahim K. 2010. Total phenolic content and primary antioxidant activity of methanolic and ethanolic extracts of aromatic plants' leaves. In International Food Research Journal (Vol. 17).

Ambigaipalan P., Al-Khalifa A. S., and Shahidi F. 2015. Antioxidant and angiotensin I converting enzyme (ACE) inhibitory activities of date seed protein hydrolysates prepared using Alcalase, Flavourzyme and Thermolysin. Journal of Functional Foods, 18, 1125–1137.

Arun K. B., Madhavan, A., Anoopkumar A. N., Surendhar A., Liz Kuriakose L., Tiwari, A., Sirohi, R., Kuddus, M., Rebello, S., Kumar Awasthi, M., Varjani, S., Reshmy, R., Mathachan Aneesh, E., Binod, P., and Sindhu, R. 2022. Integrated biorefinery development for pomegranate peel: Prospects for the production of fuel, chemicals and bioactive molecules. Bioresource Technology, 362.

Baek K.-H., Skinner, D. Z., Baek K.-H., and Skinner D. Z. 2012. Production of reactive oxygen species by freezing stress and the protective roles of antioxidant enzymes in plants. Journal of Agricultural Chemistry and Environment, 1(1), 34–40.

Batra P., and Sharma A. K. 2013. Anti-cancer potential of flavonoids: recent trends and future perspectives. *3* Biotech, 3(6), 439.

Blainski A., Lopes, G. C., Carlos J., and De Mello P. 1980. molecules Application and Analysis of the Folin Ciocalteu Method for the Determination of the Total Phenolic Content from Limonium Brasiliense L. Molecules, 18, 6852–6865.

Bub A., Watzl B., Blockhaus M., Briviba K., Liegibel U., Müller H., Pool-Zobel, B. L., and Rechkemmer, G. 2003. Fruit juice consumption modulates antioxidative status,

immune status and DNA damage. The Journal of Nutritional Biochemistry, 14(2), 90–98.

Cano-Lamadrid M., Martínez-Zamora L., Castillejo N., and Artés-Hernández F. 2022. From Pomegranate Byproducts Waste to Worth: A Review of Extraction Techniques and Potential Applications for Their Revalorization. Foods 2022, Vol. 11, Page 2596, 11(17), 2596.

Chang C.-C., and Yang H.-M. W.-H. 2002. Estimation of Total Flavnoid Content in Propils by Two Complementary Colorimetric Method.

D'Andrea G. 2015. Quercetin: A flavonol with multifaceted therapeutic applications Fitoterapia, 106, 256–271.

Dembinska-Kiec A., Mykkänen O., Kiec-Wilk B., and Mykkänen H. 2008. Antioxidant phytochemicals against type 2 diabetes. *British Journal of Nutrition*, *99*(E-SUPPL. 1).

Derakhshan Z., Ferrante M., Tadi M., Ansari, F., Heydari A., Hosseini M. S., Conti G. O., and Sadrabad E. K. 2018. Antioxidant activity and total phenolic content of ethanolic extract of pomegranate peels, juice and seeds. Food and Chemical Toxicology, 114, 108–111.

Elsayed A., and Azab A. E. 2019. Oxidative stress and antioxidant mechanisms in human body Schistosomiasis View project Natural products View project. Article in Journal of Biotechnology.

Embuscado M. E. 2015. Spices and herbs: Natural sources of antioxidants - A mini review. Journal of Functional Foods, 18, 811–819.

Ghofrani S., Joghataei M.-T., Mohseni S., Baluchnejadmojarad T., Bagheri M., Khamse S., and Roghani, M. 2015. Naringenin improves learning and memory in an Alzheimer's disease rat model: Insights into the underlying mechanisms. European Journal of Pharmacology, 764, 195–201.

Glade M. J. 1999. Food, nutrition, and the prevention of cancer: A global perspective. Nutrition, 15(6), 523–526.

Greensill C. V, Walsh - K. B., Valentino F., Wawan Cenggoro T., Pardamean B., Ibrahim U. K., Kamarrudin N., H Suzihaque M. U., Abd Hashib S., and Alam S. 2016. Local Fruit Wastes as a Potential Source of Natural Antioxidant: An Overview A Design of Deep Learning Experimentation for Fruit Freshness Detection Local Fruit Wastes as a Potential Source of Natural Antioxidant: An Overview.

Gullon B., Pintado, M. E., Fernández-López J., Pérez-Álvarez J. A., and Viuda-Martos M. 2015. In vitro gastrointestinal digestion of pomegranate peel (*Punica granatum*) flour obtained from co-products: Changes in the antioxidant potential and bioactive compounds stability. *Journal of Functional Foods*, *19*, 617–628.

Halliwell B. (1990). How to characterize a biological antioxidant. Free Radical Research Communications, *9*(1), 1–32.

Hu K., Martorell mmartorell M., Daniela Calina udeccl, Cho W. C., Sharifi-Rad J., Kumar A. N., Fokou T. P., Mishra P. A., Rayess E. Y., Sharifi-Rad M., Anil Kumar N. V., Zucca P., Maria Varoni E., Dini L., Panzarini E., Rajkovic J., Valere Tsouh Fokou P., Azzini E., Peluso I.,Calina D. 2020. Lifestyle, Oxidative Stress, and Antioxidants: Back and Forth in the Pathophysiology of Chronic Diseases. *Front. Physiol*, *11*, 694.

Jomova K., Lawson M., and Valko M. 2013. Mechanisms of antioxidant activity. Food Oxidants and Antioxidants: Chemical, Biological, and Functional Properties, 325–342.

K. R. Day, E. D. W. 2011. Commercial pomegranate (*Punica granatum* L.) Production in california. Acta Horticulturae, (890), 275–285 | 10.17660/actahortic.2011.890.39.

Kandylis P., and Kokkinomagoulos E. 2020. Food Applications and Potential Health Benefits of Pomegranate and its Derivatives.

Karakaya S., El S. N., and Taç A. A. 2001. Antioxidant activity of some foods containing phenolic compounds.

Kaur S., and Das M. 2011. Functional foods: An overview. Food Science and Biotechnology, 20(4), 861–875.

Khan M. K., Paniwnyk L., and Hassan S. 2019. Polyphenols as Natural Antioxidants: Sources, Extraction and Applications in Food, Cosmetics and Drugs. 197–235.

Kumar K., Srivastav S., and Sharanagat V. S. 2021. Ultrasound assisted extraction (UAE) of bioactive compounds from fruit and vegetable processing by-products: A review. Ultrasonics Sonochemistry, 70.

Lacivita V., Incoronato A. L., Conte A., Alessandro M., Nobile, D., Rizzo V., and Giuseppe M. 2021. Pomegranate Peel Powder as a Food Preservative in Fruit Salad: A Sustainable Approach.

Lamuela-Raventós R. M. 2017. Folin–Ciocalteu method for the measurement of total phenolic content and antioxidant capacity. Measurement of Antioxidant Activity and Capacity: Recent Trends and Applications, 107–115.

Manach C., Morand C., Gil-Izquierdo A., Bouteloup-Demange C., and Rémésy C. (2003). Bioavailability in humans of the flavanones hesperidin and narirutin after the ingestion of two doses of orange juice. European Journal of Clinical Nutrition, *57*(2), 235–242.

Narasimha M. K., Uzma F., Soumya K., and Srinivas C. 2015. Antibacterial activity and phytochemical screening of aqueous and methanolic extracts of pomegranate (*Punica granatum*) peel against bacterial wilt of tomato. International Journal of Agriculture Innovations and Research, 3(6), 1786–1792.

Omer H. A. A., Abdel-Magid S. S., and Awadalla I. M. 2019. Nutritional and chemical evaluation of dried pomegranate (*Punica granatum L.)* peels and studying the impact of level of inclusion in ration formulation on productive performance of growing Ossimi lambs.

Pandey K. B., and Rizvi S. I. 2009. Plant polyphenols as dietary antioxidants in human health and disease. Oxidative Medicine and Cellular Longevity, 2(5), 270.

Patel K., Kumar, V., Rahman M., Verma, A., and Patel D. K. 2018. New insights into the medicinal importance, physiological functions and bioanalytical aspects of an important bioactive compound of foods ‘Hyperin’: Health benefits of the past, the

present, the future. Beni-Suef University Journal of Basic and Applied Sciences, *7*(1), 31–42.

Pizzino G., Irrera, N., Cucinotta M., Pallio G., Mannino F., Arcoraci V., Squadrito F., Altavilla D., and Bitto A. 2017. Oxidative stress: harms and benefits for human health. Oxidative Medicine and Cellular Longevity, 2017.

Quideau S., Deffieux D., Douat-Casassus C., and Pouységu L. 2011. Plant polyphenols: Chemical properties, biological activities, and synthesis. Angewandte Chemie - International Edition, *50*(3), 586–621.

Ramadan-Hassanien M. F. 2008. Total antioxidant potential of juices, beverages and hot drinks consumed in Egypt screened by DPPH in vitro assay. Grasas y Aceites, 59(3), 254–259.

Rosa I. S., Pires L. O., and Ishida J. K. 2023. Nutraceuticals Productions from Plants. Plants as Bioreactors for Industrial Molecules, 367–391.

Sehwag S. 2014. Antioxidant Activity: An Overview Antioxidant potential of oleoresins from rosemary and sage and use as bio-preservative in sunflower oil View project Development of functional confection from syzygium cuminii View project.

Shahidi F., and Ambigaipalan P. 2015. Phenolics and polyphenolics in foods, beverages and spices: Antioxidant activity and health effects - A review. Journal of Functional Foods, 18, 820–897.

Somogyi A., Rosta K., Pusztai P., Tulassay Z., and Nagy G. 2007. Antioxidant measurements. Physiological Measurement, 28(4), R41.

Srivastava S. 2016. Antioxidants and its functions in human body-A Review.

Tehranifar A., Zarei M., Nemati, Z., Esfandiyari B., and Vazifeshenas M. R. 2010. Investigation of physico-chemical properties and antioxidant activity of twenty Iranian pomegranate (*Punica granatum L.)* cultivars. Scientia Horticulturae, 126(2), 180–185.

Tozzi F., Núñez-Gómez D., Legua P., Del Bubba M., Giordani E., and Melgarejo, P. 2022. Qualitative and varietal characterization of pomegranate peel: High-value co-product or waste of production Scientia Horticulturae, 291, 110601.

Valero-Mendoza A. G., Meléndez-Rentería N. P., Chávez-González M. L., Flores-Gallegos A. C., Wong-Paz J. E., Govea-Salas M., Zugasti-Cruz A., and Ascacio-Valdés J. A. 2023. The whole pomegranate (*Punica granatum. L*), biological properties and important findings: A review. Food Chemistry Advances, 2, 100153.

Viuda-Martos M., Fernández-Lóaez J., and Pérez-álvarez J. A. 2010. Pomegranate and its many functional components as related to human health: a review. Comprehensive Reviews in Food Science and Food Safety, 9(6), 635–654.

Viuda-Martos M., Ruiz-Navajas Y., Martin-Sánchez A., Sánchez-Zapata E., Fernández-López J., Sendra E., Sayas-Barberá E., Navarro C., and Pérez-Álvarez J. A. 2012. Chemical, physico-chemical and functional properties of pomegranate (*Punica granatum L*.) bagasses powder co-product. Journal of Food Engineering, 110(2), 220–224.

Yu D., Li, J., Zang J., Mo, Y., Ma, J., Gao W., Zhang L., and Li J. 2022. Pomegranate peel as a source of bioactive compounds: a mini review on their physiological functions. Front. Nutr, 9, 887113.

Zhao Q., Xiong H., Selomulya C., Chen X. D., Zhong H., Wang S., Sun W., and Zhou Q. 2012. Enzymatic hydrolysis of rice dreg protein: Effects of enzyme type on the functional properties and antioxidant activities of recovered proteins. Food Chemistry, 134(3), 1360–1367.

Appendices

Appendix A: Questionnaire for hedonic test of Pomegranate peel powder

Education level:

(a) Bachelor's degree (b) Master's degree

(c) other specify…….....

Date:

Sample code:

Instruction: You are given four samples. Please start your evaluation from left to right. Evaluate each attribute by circling the appropriate scale which indicates your degree of liking. Rinse your mouth with plain water before testing each sample.

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

Attributes	9 Like Extremely	8 Like very much	7 Like	6 Like slightly	5 Neither like nor dislike	4 Dislike slightly	3 Dislike moderately	2 Dislike	1 Dislike extremely
Appearance									
Texture									
Smell									
Taste									
Overall acceptability									

Comment: (if)

Appendix B: Photo Gallery (Procedure of making Pomegranate Peel Soup)

Peeling

Pomegranate Peel Drying

Grinded and Sieved

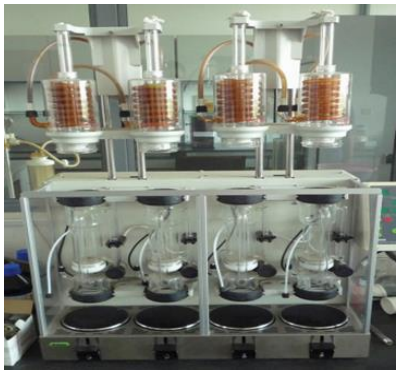
Mixing other ingredients

Preparing soup

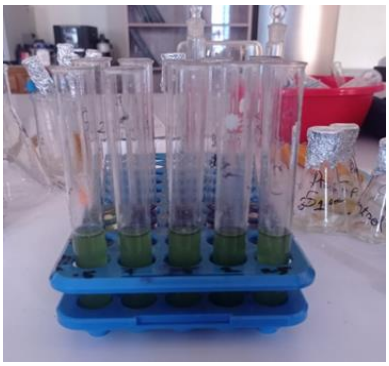
Appendix C: Pictures of analysis

Crude Fiber Determination

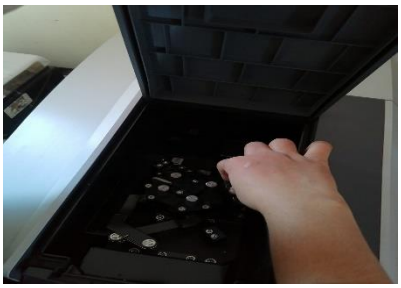
Crude Protein Determination



Fat Determination



Analysis of Bioactive Compound



UV-Vis Spectrophotometer

Sensory Evaluation

Brief Biography

Rifa Tasfia passed the Secondary School Certificate Examination in 2012 from Bangladesh Mahila Samity Girls' High School, and then Higher Secondary Certificate Examination in 2014 from Chattogram Cantonment Public School and College. She received her B.Sc. (Honors) in Food Science and Technology from the Chattogram Veterinary and Animal Sciences University's College of Food Science and Technology in Chattogram, Bangladesh. She is currently a pursuing for the Master of Science in Applied Human Nutrition and Dietetics at Chattogram Veterinary and Animal Sciences University's Department of Applied Food Science and Nutrition. She is very inquisitive about working to improve people's health condition by providing appropriate advice and suggestions and raising knowledge of nutrition and food safety among the public.