EXPLORING THE POTENTIAL OF WATERMELON RIND: PHYSICOCHEMICAL AND SENSORY EVALUATION OF WATERMELON RIND BISCUITS

A PROJECT REPORT
BY

SHRABONI SAHA
ID: 191-34-158

Submitted to the Department Nutrition and Food Engineering in the partial fulfilment of B.Sc. in Nutrition and Food Engineering

Supervised By

Dr. Nizam Uddin
Associate Professor & Head
Department of Nutrition and Food Engineering

FACULTY OF HEALTH AND LIFE SCIENCES (FHLS)
DAFFODIL INTERNATIONAL UNIVERSITY
JUNE 2024

APPROVAL

This Project titled "**Exploring the Potential of Watermelon Rind: Physicochemical and Sensory Analysis of Watermelon Rind Biscuits**", submitted by **Shraboni Saha** to the Department of Nutrition and Food Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Nutrition and Food Engineering and approved as to its style and contents.

EXAMINING COMMITTEE

Chairman ____________________________ ____________

External ____________________________ ____________

Member-1 ____________________________ ____________

Member-2 ____________________________ ____________

……………………..

Dr. Nizam Uddin
Associate Professor & Head
Department of Nutrition and Food Engineering
Faculty of Health and Life Science
Daffodil International University

DECLARATION

I hereby declare that this project has been done by me under the supervision of **Dr. Nizam Uddin, Associate Professor & Head,** Department of Nutrition and Food Engineering, Daffodil International University. I also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

Supervised by

Nizam

…………………..

Dr. Nizam Uddin
Associate Professor & Head
Department of Nutrition and Food Engineering
Daffodil International University

Submitted by

Shraboni Saha

……………………

Shraboni Saha
ID:191-34-158
Department of Nutrition and Food Engineering
Daffodil International University

ACKNOWLEDGEMENT

First, I express my heartiest thanks and gratefulness to almighty for His divine blessing makes it possible to complete the final year project successfully.

I am really grateful and wish my profound indebtedness **Dr. Nizam Uddin, Associate Professor & Head,** Department of Nutrition and Food Engineering, Daffodil International University. Deep Knowledge & keen interest of our supervisor in the field of “Food Development” to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts and correcting them at all stages have made it possible to complete this project.

I would like to express my heartiest gratitude to Dr. Nizam Uddin, Associate professor and Head**,** Department of Nutrition and Food Engineering, for his kind help to finish our project and also to other faculty members and the staffs of the Department.

I would like to thank my entire course mate in Daffodil International University, who took part in this discussion while completing the course work.

Finally, I must acknowledge with due respect the constant support and patients of my parents.

ABSTRACT

Watermelon rind is rich in nutrients and low in calories but most people throw it without thinking about the usage of it. The main objectives of this study is to reduce the wastage of nutritious watermelon rind and developed biscuits from the grinded watermelon rind which has been done by drying the rind, also to find out the nutritional value of developed biscuits and the sensory quality of it. Firstly watermelon rind flour has been produced. For this watermelon rinds are cut into 2-3 cm pieces and washed into citric acid solution and then placed into 60 degree Celsius for 48-56 hours. After the preparation of watermelon rind flour biscuits have been made. After preparing the biscuits some tests have been done to find out its nutritional value. Sensory test has also been done. Result shows that 3 gm of watermelon rind flour biscuit contain 5.83% (sample 1), 4.34% (sample 2), 4.66% (sample 3) of moisture; 0.99%(sample 1), 1.08% (sample 2), 3,385 (sample 3) of ash; 22.89% (sample 1), 23.06% (sample 2), 25.18% (sample 3)of fat; 3.17% (sample 1), 4.07% (sample 2), 4.39% (sample 3) of crude fiber; 4.97% (sample 1), 5.34% (sample 2), 6.59% (sample 3) of protein and 62.18% (sample 1), 62.11% (sample 2), 55.80% (sample 3) of carbohydrate. A sensory test has also been done called hedonic test. There were 30 participants for this test. Different coded sample were given to the participants and asked them to rate it from scale 1 to 9 which is basically dislike extremely to like extremely. After this test result shows that all participants preferred 7% watermelon rind biscuit.

TABLE OF CONTENT

LIST OF FIGURE

LIST OF TABLE

CHAPTER 1

INTRODUCTION

1.1 Introduction

The tough outer skin of a watermelon is called the rind, and it is usually green on the outside before the fruit's pink and red flesh turns pale white inside. In contrast to the fruit it guards, the skin is noticeably harder and less luscious, yet to popular belief, it is absolutely edible. But eating the watermelon's rind by itself might not be the best or most practical method to consume this portion of the fruit.

Not many people realize that the peel of this fruit has a lot of nutrients in it, but most just toss the peels in the trash. The rinds of watermelon contain all the nutrients present in the luscious fruit as well as extra concentrations of particular minerals, vitamins, antioxidants, and active substances.

Although this peel is hard, it is low in calories and high in potassium, zinc, vitamin C, and vitamin A. Chlorophyll, citrulline, lycopene, amino acids, flavonoids, and phenolic compounds are among the many nutrients found in watermelon rinds. (2022)

A popular fruit in the tropics and subtropics, watermelon is widely available. One of the most significant vegetable crops, it has large, round, oval, or oblong fruits with smooth skin, dark green rinds, or occasionally pale green stripes that turn yellowish green when ripe. It is also a good source of phytochemicals and is highly vitamin-rich (Vitamin A 590 IU, Niacin 0.2 mg/100 g, and Vitamin C 0.7-7.0 mg/100 g). It can be served as a snack or appetizer for breakfast.

Possesses lycopene, which has been found to be protective against an increasing number of cancers, and is a popular source of carotenoid that quenches thirst during the hot summer months. It is also a delicious thirst-quencher that helps quench the inflammatory agents that cause conditions like diabetes, atherosclerosis, arthritis, asthma, and colon cancer. Cucurbit seeds are a good source of fat and protein in particular. The body uses citrulline, which is present in watermelon, to produce arginine, another amino acid. The fruit also has a high lipid content and many smooth, compressed seeds with a thickening border that are either black or yellow-white in color.

Antioxidant molecules have been linked to the observed therapeutic effects of watermelon.

Studies on watermelon fruits have focused on their antioxidant, phytochemical, and anti-nutritional properties as well as their ability to keep for longer periods of time. Furthermore, it has been discovered that the fruit juice possesses high-quality (proximate) rind (peels) and nutritious components that may encourage ingestion or other uses. In order to possibly utilize the peel (rind) dried powder extract in food and manufacturing processes, this study aims to determine some of its functional properties. (Egbuonu, 2015)

1.2 Nutrition of watermelon rind

While the spectrophotometric methods reported by Onwuka were used to determine vitamin A, B1 (thiamine), B2, B3 (niacin), and B6, the method provided by Okwu and Josiah was used to determine vitamin C (ascorbic acid). The spectrophotometric approach described by James was used to determine the mineral content, namely the phosphorous, iron, zinc, manganese, copper, potassium, sodium, calcium, and magnesium. The Jenway Digital Spectrophotometer, Model 6320D, produced by Jenway Equipment Company, France, was used for this purpose. Using a Jaway Digital Flame Photometer, the flame photometric method was used to determine the amounts of potassium and sodium. (Egbuonu, 2015)

1.3 Health benefit of watermelon rind

The rind of watermelon is rich in potassium, magnesium, vitamin C, and vitamin A. They also include a lot of fiber, which promotes healthy digestion and, as a result, lowers cholesterol and blood sugar. Because watermelon rinds contain a lot of citrulline, eating them has also been demonstrated to reduce blood pressure. Supplementing with citrulline has been associated with heart health and better blood circulation in general. (2022)

There are many health benefits of the watermelon rind. Some benefits are given below:

- Good source of fiber
- Helps to control blood pressure
- Contains amino acid (which is good for health)
- Aids in digestion
- Low cholesterol levels
- Aid skin health
- Improve immune system

1.4 Objective of the study

1. To develop biscuits from watermelon rind by drying the rind
2. To observe newly developed biscuits shelf life which is 90 days
3. To observe proximate composition of the biscuits
4. To observe sensory quality of newly developed biscuits.
5. To reduce wastage

CHAPTER 2

LITERATURE REVIEW

2.1 Literature review

Food waste has been a major source of worry in recent years. "Food (including inedible parts) lost from the food supply chain, not including food diverted to material uses such as bio-based products, animal feed, or sent for redistribution," is how the European Union defines food waste. FAO (2016) estimated that over 1.6 billion tonnes of food are wasted annually worldwide, with fruits having one of the highest rates of food waste.
Seed is primarily made up of oligomeric catechins (2.5 mg/g of seeds) and flavonol derivatives (3.4 mg/g of seeds). Pods and seeds are rich in phenolic compounds with key biological qualities like quartering derivatives, catechin oligomers and hydroxycinnamic. The greatest fruit crop in the world, watermelon (Citrullus lanatus), produced about 109 million tonnes worldwide in 2013. This is known to be a good source of phenolic compounds, carotenoids (primarily lycopene), free amino acids (arginine and citrulline), mineral salts (K, Mg, Ca, and Fe), and vitamins A, B, C, and E.

Despite being edible, the watermelon rind makes up around 1/3 of the entire fruit mass and is typically thrown away. Taking watermelon output into account, almost 36 million tonnes of watermelon rind were produced in 2013. Even if some research has indicated that watermelon rind can be utilized as an adsorbent to remove heavy metals from aqueous solutions (Petkowicz et al., 2017)

Because watermelon rind powder (WRP) is a receptive source of bioactive chemicals and dietary fiber, it may find application in the production of functional foods like cookies. The effects of varying the replacement percentages of wheat flour with either WRP or hi-maize starch (HMS) (10–30%) on the baked goods' quality were investigated. With the addition of increasing amounts of WRP or HMS, the cookies' nutritional fiber content rose. The total phenolic content, 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity, and ferric reducing antioxidant power increased when the amount of WRP added to the cookie dough increased. When preparing cookies, using up to 20% WRP and 30% HMS encourages: improved antioxidant activity, a rise in dietary fiber, and a drop in anticipated glycemic index to medium (for WRP) and low (for HMS) values. Despite these modifications, the cookie still tastes good. (Rimando & Perkins-Veazie, 2005)

Industrial processing produces large volumes of trash from fruits and vegetables as well as their byproducts. Thus, they must be controlled or ready for use. The current study's goal is to determine whether white watermelon rind powder (WMRP) may be used to partially substitute wheat flour at various percentages (10, 20, 30, and 40%) while making cakes.

Investigations were conducted into the impact of substituting white watermelon rind powder on the cakes' physicochemical, sensory, and shelf life characteristics. The resulting cakes' higher fiber content was a direct result of raising the WMRP substitution levels, according to the results. The WMRP cake samples had higher mineral contents, especially in Ca, K, and Mg. Significantly increasing the cake volume was substitution with WMRP. The textural analysis's findings indicated that powdered watermelon rind reduced every textural metric. The more substitution there was, the darker the color tone of the cakes. Cakes made with WMRP obtained high mean scores for general acceptability, according to the results of the sensory evaluation, with the exception of the 40% substitution level. At zero time and during storage, the microbial counts of all WMRP cake samples were lower than those of the control. According to a microbiological analysis, the addition of WMRP during cake manufacturing resulted in an extension of the cake's shelf life when compared to the control sample. (HASSAN et al., 2017)

In order to determine the proper amount of watermelon rinds to utilize in four different bakery products—cookie bars, fruit cake, vanilla cream Eclairs, and coconut tartes—this study examines the use of watermelon rinds. Using "Randomized Complete Block Design, RCBD," the research was organized. There was a taste test using the Nine-Point Hedonic Scale to determine preferences, a quality test to assess the items' chemical and physical makeup, and an acceptance test to gauge the opinions of one hundred participants. It was discovered that the individuals who conducted the testing preferred the application of watermelon rinds in syrup at 15% of the total weight of components in the cookie bar, as opposed to 10%, 15%, and 20% of the total weight of the ingredients. Favorite scores are 7.70, 7.90, 7.85, 7.90, 7.80, and 7.80 for overall appearance, color, smell, taste, and food texture, respectively. The average of preferred scorn was compared using One-way ANOVA, and it was discovered that the differences in color, taste, texture, and overall aroma and taste were statistically significant at ($p < 0.05$). At 100 grams, the approximate chemical composition of cookie bar adding watermelon rinds in syrup was 436 kcal, 57.10 g of carbohydrates, 6.10 g of protein, 20.40 g of fat, 15.20 g of moisture, and 1.24 g of ash. The physical quality of the water was 0.80. When watermelon rinds were substituted for cherries in fruit cake at 50%, 75%, and 100%, the test subjects preferred using the watermelon rinds at 100%. Favorite scores are 7.40, 7.90, 7.95, 8.00, 7.90, and 7.75 for overall appearance, color, fragrance, taste, and food texture, respectively. The average of preferred scorn was compared using One-way ANOVA, and it was discovered that the differences in color, taste, texture, and overall aroma and flavor were statistically significant at ($p < 0.05$). Watermelon rinds in syrup substitute cherry fruit cake had an approximate chemical composition of 330 Kcal, 63g of carbohydrates, 6.08g of protein, 5.93g of fat, 23.70g of moisture, 1.31g of ash, and 0.78 physical quality of water activity (AW). It was discovered that the individuals who conducted the study preferred the Eclair with vanilla cream that had watermelon rinds added at 20%, 40%, and 60% of the weight of the vanilla cream. Favorite scores are 8.50, 8.40, 8.40, 8.00, and 8.10 for overall, color, smell, taste, and food texture, respectively. One-way

ANOVA was used to compare the average of favorite scorn, and the results showed that the differences in food texture, color, flavor, and overall. The Eclair watermelon rinds with vanilla cream added had the following approximate chemical compositions at 100g: calories 190 Kcal, carbohydrate 28.80g, protein 4.24g, fat 6.40g, moisture 59.70g, ash 0.82g, and physical quality of water activity (AW) of 0.97. The testing participants preferred the watermelon rinds replacement of coconut in coconut tarte at 75%. Watermelon rinds can be used in place of coconut at 50%, 75%, and 100%. Favorite scores are 8.05, 7.85, 7.70, 7.65, 7.70, and 7.60 for overall appearance, color, smell, taste, and food texture, respectively. One-way ANOVA analysis of the average preferred scorn revealed that the differences in appearance, color, taste, texture, and overall quality were statistically significant at ($p < 0.05$). When watermelon rinds were substituted for coconut in a 100g batch of coconut tarte, the approximate chemical compositions were: calories 167 Kcal, carbohydrate 27.80g, protein 1.78g, fat 5.38g, moisture 64.30g, ash 0.69g, and physical quality of water activity (AW) of 0.78. This study discovered that the four bakery goods that the consumers were impacted by had added value and used local ingredients derived from the nation's agriculture. The majority of participants were female and ranged in age from 21 to 30 on average, according to the results of the technology transfer of baked items from watermelon rinds to the community. There was a high degree of overall project satisfaction, and respondents had positive things to say about the trainers. (Keeariyo et al.,2016)

As nutritionally and functionally useful flours of food industry by-products, melon peel flour (MPF) (0, 2.5, and 5%) and melon seed flour (MSF) (0, 1.25, and 2.5%) were substituted with wheat flour in cookie formulation for value-added goods in this study. A few of the cookie samples' chemical, physical, and sensory characteristics were looked into. The findings demonstrated that adding MPF may considerably reduce the cookie's lightness, redness, and yellowness while adding MSF improved the cookie's lightness. The diameter and thickness of the cookie samples increased with the addition of MSF and MPF, resulting in an increase in the spread rate values. The cookie samples' ash, protein, fat, energy total phenolic content, antioxidant activity, phytic acid, and minerals increased as the MSF level rose, however the hardness and carbohydrate readings indicated the opposite pattern. Additionally, cookies with MSF and MPF showed sensory qualities that were more appealing than those of control cookies. (ERTAŞ & ASLAN, 2020)

A non-essential amino acid called citrulline was first discovered in the juice of Citrullus vulgaris Schrad. Watermelons and subsequently extracted from casein using tryptic digestion. Other cucurbitaceous fruits, such as bitter melon, cucumber, muskmelon, pumpkin, bottle gourd, dishrag gourd, and wax gourd, have also been found to contain citrulline. Citrulline, a non-essential amino acid, is abundantly available in watermelon (Citrullus vulgaris Schrad.) as a natural source. Human nitric oxide system uses citrulline, which may have antioxidant and vasodilatation effects. Gas chromatography–mass spectrometry (GC–MS) was used to establish a method to separate glutamic acid and citrulline, which co-eluted in a high performance liquid chromatography analysis. Using GC-MS, the citrulline content of various types, varietals, flesh hues, and tissues in watermelons was determined. Seeded and seedless varieties have comparable levels of citrulline content, with a range of 3.9 to 28.5 mg/g dry weight. Compared to watermelons with yellow or orange flesh, those with red flesh showed slightly lower levels of citrulline (7.4, 28.5, and 14.2 mg/g dwt). On the basis of dry weight (24.7 and 16.7 mg/g dwt), the rinse had a slightly higher citrulline content than the meat (1.3 and 1.9 mg/g fwt, respectively). These findings suggest that the skin of watermelon, an underutilized agricultural waste, is a natural supply of citrulline. (Rimando & Perkins-Veazie, 2005)

A project had been done with watermelon rind. This study evaluated the physical and chemical characteristics of powdered watermelon rind and sharlyn melon peel, with the goal of using them to partially replace wheat flour at levels of 2.5%, 5.0%, and 7.5%, or fat at levels of 5.0%, 10%, and 15%, in cake recipes. Compared to sharlyn melon peels, watermelon rinds contained higher levels of moisture, ash, fat, protein, and carbs (10.61, 13.09%, 2.44%, 11.17%, and 56.00%, respectively). However, compared to watermelon rinds (17.28%), the level of crud fiber in sharlyn melon peels was higher (29.59%). Shallyn melon peels had greater oil and water absorption capacities (WAC and OAC, respectively) than watermelon rinds, measuring 2.24 and 1.65 g of oil per gram and 7.7 and 7.13 g of water per gram, respectively. When compared to sharlyn melon peels, watermelon rinds had considerably higher levels of β-carotene (96.44%) and free radical scavenging activity (39.7%). It included a variety of phenolic chemicals, with coumaric acid (8.8 μg/g dw) being the least common and 4-hydroxybenzoic acid (958.3 μg/g dw) and vanillin (851.8 μg/g dw) being the most frequent. Conversely, four phenolic compounds—vanillin, coumaric acid, 4-hydroxybenzoic acid, and chlorgenic acid—were found in the peels of Sharlyn melon. The volume and specific volume of the baked cakes were increased to surpass those of the control group by the addition of WMR and SMP powders to the batter at all investigated levels. Additionally, these substances limit the oxidation of lipids and the production of free fatty acids during cake staling stroge. It turns out that using watermelon rinds and sharlyn melon peels in place of 5% flour and 10% fat resulted in cakes that were edible and did not differ much from the control. (Romdhane et al., 2017)

The second-biggest fruit production in the world, watermelon has a lot of opportunity for rind waste to be valorized. The effectiveness of the process,esterification degree, monosaccharide composition, and molar mass of watermelon rind pectin were all modeled using an experimental design, along with the effects of temperature, pH, and time on changes in their structural properties (linearity, branching degree, and extraction severity). All of the answers' models were experimentally validated and well-fitted (R2 > 90%, lack of fit $p \geq 0.05$). While exhibiting a higher branching degree with longer galactan side chains and a stronger protein interaction, the WRP yield (13.4%), purity (540 μg/g galacturonic acid), and molar mass (106.1 kDa) at optimal yield conditions were similar to those of conventional pectin sources. Milder extraction conditions ($pH \geq 2$) resulted in highly branching entangled pectin structures, whereas harsher conditions (pH 1) yielded purer homogalacturonan fractions with average molar weights (80 kDa) at the expense of yield. This study highlights novel compositional properties in WRP and suggests that, depending on the targeted structure, novel tailored pectin components could be produced with a wider potential application scope.

The structural features, functional attributes, and biological activities of polysaccharides isolated from watermelon rinds (WMRP) were examined in the current work, along with hot water extraction optimization efforts. The isolated polysaccharides' rough, multicavity surface was shown by SEM pictures. Galactose predominated among the extracted polysaccharides, according to GC-FID data, which also showed that arabinose, glucose, galacturonic acid, rhamnose, mannose, xylose, and traces of glucuronic acid were also present. According to the results, WMRP exhibited strong antioxidant and antihypertensive properties. These polysaccharides also provided defense against DNA damage caused by hydroxyl radicals. Additionally, the isolated polysaccharides' functional qualities were assessed. Good interfacial dose-dependent properties were demonstrated by WMRP. Overall, the findings indicated that WMRP offers a potential natural source of antihypertensive and antioxidant compounds.(Dhakal, D., & Pradhananga,M.L.(2017)

Mostly made up of carbs, fiber, and wax, the rind of a watermelon makes up 30% (w/w) of the total fruit mass. Because of its disagreeable flavor, the rind is frequently thrown away. Watermelon rind waste has been suggested for use as high-fiber flour, food ingredient, dietary supplement, and bio-sorbent material in a number of research. However, as they will dictate the quality of the extraction yield, appropriate preprocessing and extraction techniques must be taken into consideration prior to the development of the supplied product. Consequently, the goal of this review is to present a thorough summary of extraction and preprocessing methods. It is important to compare the various processes used in the preextraction and extraction of watermelon rind. Preprocessing factors such sample quality, drying conditions, and grading and grinding methods that impact extraction yields are covered. To determine which extraction methods are most effective at removing phytochemicals from watermelon rinds, a number of extraction procedures are correlated, including infusion, maceration, digestion, reflux, ultrasound-assisted extraction (UAE), and microwave-extraction(ME). (Ahamad et al., 2022)

In a batch system that was well-stirred, the biosorption of copper, zinc, and lead on the rind of watermelon was examined. pH had a notable impact on the biosorption process. It was discovered that the ideal pH values for Cu, Zn, and Pb biosorption were 5.0, 6.8, and 6.8, respectively. When Pb content is less than 100 mg/L, watermelon rind can remove up to 99% of the metal within pH ranges of 5 and 6.8. Watermelon had a biosorptive capacity of 6.281, 6.845, and 98.063 mg/g for Cu, Zn, and Pb, respectively. While the pseudo-second-order kinetic model showed more advantages for characterizing kinetic data than the pseudo-first-order kinetic model, the equilibrium data fit the Langmuir adsorption isotherm well. A suitable eluent was discovered to be NaOH. In a single-component or multi-component system, the resorption efficiency of these three metals after desorption in NaOH solution was as high as 99%. Based on the characterization investigation, the primary mechanisms were determined to be ion exchange and micro-precipitation. Watermelon rind has a high metal absorption capacity, is reusable, and can be used as a low-cost, environmentally beneficial bio sorbent to remove lead from water and waste water. (Liu et al., 2012)

CHAPTER 3

MATERIALS AND METHODS

3.1 Materials

3.1.1 Used materials

1. Watermelon (Ripe)
2. Wheat Flour
3. Corn Flour
4. Butter
5. Sugar
6. Milk Powder
7. Salt
8. Baking Powder
9. Egg
10. Nigella Sativa

3.1.2 Location

1. Buy raw okra from various fruit shops in Uttara and Comilla Crockeries super shop in DNCC Market
2. Food Analytical Laboratory
3. Food Processing Laboratory
4. Food Microbiology Laboratory

3.1.3 Preparation of Watermelon rind flour (WRF)

The watermelon is first carefully cleaned by dipping it in fresh water in order to remove the dirt. After that, the watermelon is divided into many pieces using a knife. The watermelon's rind, or white portion, is removed from its green skin by slicing it into pieces with a chipping machine and then washing it in a solution of citric acid. After chopping the rinds (white sections) into 2-3 cm pieces, they are carefully cleaned in a solution of citric acid for a minute. After that, the watermelon rind was dried for 48 to 56 hours at 60°C in an oven. I used a blender or grinder to ground the powder into flour when it had cooled down enough to pass through a sieve. WRF cookies were kept in airtight glass jars at 4°C until production.

Figure-1: Processing of Watermelon rind flour

3.1.4 Preparation of Watermelon rind powder biscuit

● The recipe's directions were followed while weighing the raw ingredients needed to produce the biscuits.
● The first step was to beat the butter and sugar well to form a creamy texture. So I beat 55 grams of butter and 45 grams of sugar in a beater bowl for about 12 to 15 minutes to form a well handled creamy texture.
●Then I beat the egg and milk powder mixture until it got a creamy and fluffy texture.
●At that point I sifted all the dry ingredients through a sieve and poured them into the beater bowl one by one. The mixture is then gently kneaded into dough.
●I poured the dough on a wooden chopping board and kneaded it well so that the dough is soft and perfect for making biscuits.
●Then I put baking paper gently on the dough and made the dough a little thick with a balloon. Then I cut each biscuit (round shape) into 1cm thickness using a cookie cutter.
●Then the biscuits cut by cookie cutters were placed on a baking plate (mold) lined with baking paper, one by one, and baked at 160 degrees Celsius for 25 to 30 minutes.
●After baking, after the biscuits came to normal temperature for a while, I kept them in a zipper bag and stored them.

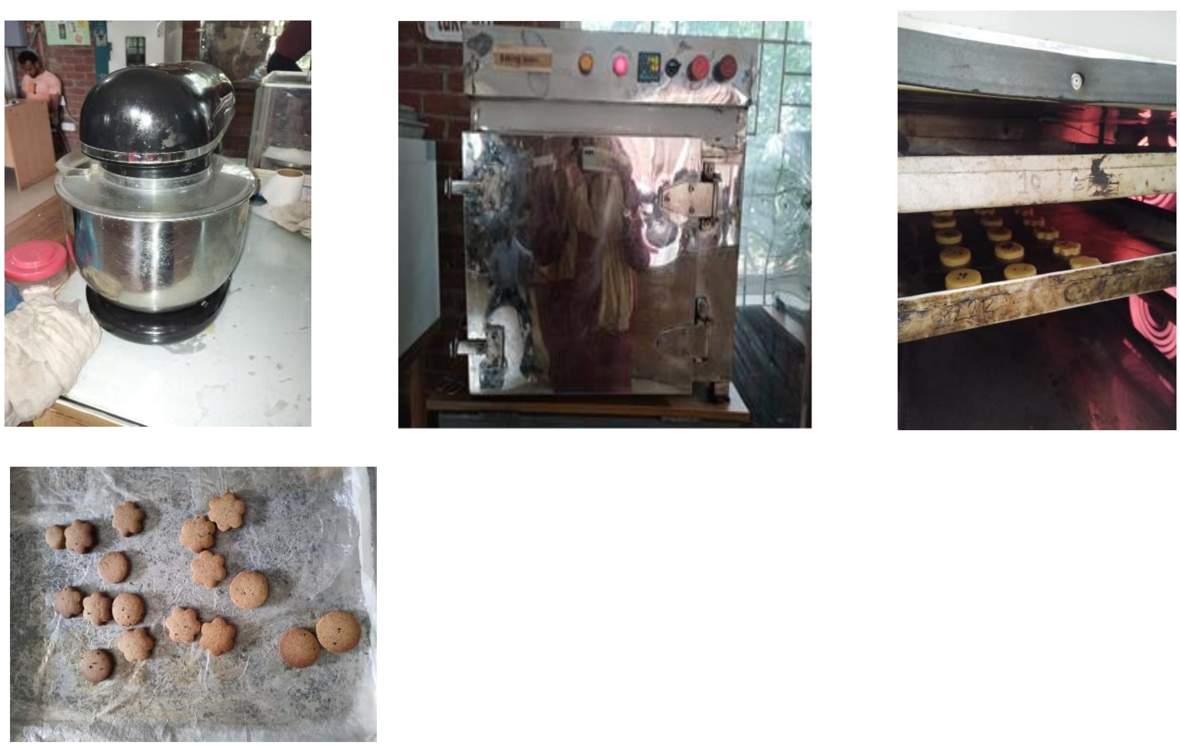

Figure 2: Watermelon Rind flour Biscuit

3.1.5 Formulation of different biscuit production

Table 1: Different biscuit production

Ingredients (gm)	**Control Biscuit**	**WRF (3%) Sample -1**	**WRF (5%) Sample -2**	**WRF (7%) Sample -3**
Wheat Flour	100	97	95	93
Watermelon rind flour	0	3	5	7
Butter	55	55	55	55
Sugar	45	45	45	45
Corn Flour	8	8	8	8
Milk Powder	10	10	10	10
Salt	2	2	2	2
Baking Powder	2	2	2	2
Egg	55	55	55	55
Nigella Sativa	5	5	5	5

The watermelon rind flour biscuit was developed through a process of trial and error, with three different recipes examined in an effort to determine the optimal biscuit development. Iterative process analysis yielded the optimal formula for obtaining the desired characteristics. After undergoing these steps, sample 3 had the appropriate amount of rind flour—7%. Subsequent analysis was performed on the biscuit containing 7% rind flour and compared to the control sample.

3.2 Method

3.2.1 Proximate analysis of Watermelon rind powder biscuit

3.2.2 Determination of Ash

The inorganic residue that remains in a food sample after the organic content has ignited is referred to as ash. The AOAC method was used to measure ash.

Apparatus

1. Crucible lid
2. Balance meter
3. Spatula
4. Electric muffle furnace
5. Desiccator
6. Hand gloves.

Procedure

1. Take weight of the empty crucible with the help of lid by measuring balance.
2. Place 3-gram examines into the crucible and close by lid.
3. Place that crucible into the electric muffle furnace at 600°C for six hours.
4. After six hours of ignition the crucible has taken out and cooled into desiccator.
5. The weight of the crucible was measured again after cooling.

Figure-3: Electric Muffle Furnace

Calculation

Ash%=Mass of Ash ÷Mass of sample ×100

3.2.3 Determination of Moisture

In commercial food manufacturing, moisture content is a standard criteria**.**

Apparatus

Moisture analyzer

Reagent

No reagent

Procedure

Figure 4: Digital Moisture Analyzer Machine

1. Find out the initial weight of the sample with the help of weighing the sample before drying.
2. Set needed parameters (temperature, time) and dry the sample.
3. Take weight of the sample after drying and compare it with the initial weight to calculate the loss on Drying.

3.2.4 Determination of Fiber

Apparatus

1. Balance machine
2. Muffle furnace
3. Hot plate
4. Hot air oven
5. Measuring cylinder
6. Conical flask
7. Beaker
8. Funnel
9. Cotton cloth
10. Crucible

Figure-5: Oven

Reagent

1. 0.0128 m Sulfuric acid: Dilute 3.49 ml H2SO4(9%) in 500 ml of distilled water
2. 0.313 m Sodium Hydroxide: Dissolve 6.25 NaOH in 500 ml distilled water

Procedure

1. Take measure 200 ml of 0.128m Sulfuric acid and pour it into a 500 ml of conical flask
2. Measure approximate 3g of sample
3. Transfer the examine into the conical flask to mix up with acid solution
4. Place the flask into a hot plate and boil the sample for thirty minutes
5. After 30 min boiling, Take a discard conical flask of 1000ml and filter the boiling sample using a cotton cloth
6. Clean the filtrate with hot water so that the acid reside remove completely

7. Measure 200 ml of 0.313 m NaOH solution
8. Pour the NaOH solution into the conical flask washing the filtrate
9. Rotate the flask to mix and place on hot plate
10. Boil the sample like previous
11. After 30 min boiling, filter the examine to separate NaOH solution and the clean with hot water
12. Collect the filtrate in a clean and dried crucible till no filtrate is left
13. Place the crucible on hot plate to remove the excess water.
14. Set the temperature at 230 degree.
15. Take out the crucible from the oven and dry for 2 hours after drying.
16. 20 minutes later, take the weight of crucible with fiber.
17. Keep the crucible inside the muffled furnace, burn the fiber at 500 degree temperature for two hours.
18. After burning take the crucible out from the furnace and cool it in the desiccator.
19. After twenty minutes take the weight of the crucible containing ash.
20. Keep the weight noted.
21. Calculation the amount of fiber.

Calculation

Fiber%= W1-W2/Ws× 100 (W1=Weight of Empty Crucible,W2=Weight of Sample with Crucible,Ws=Weight of Sample)

3.2.5 Determination of Fat

Apparatus:

1. Crucible lid
2. Weight balance
3. Soxhlet Apparatus

Chemical: Petroleum Ether or N-Hexane

Procedure:

1. Weigh a thimble and a bottle of boiling water.
2. Place the sample in the thimble.
3. Weigh the thimble using the sample.

Figure-6: Soxhlet Apparatus

4. Finally, insert the thimble into the Soxhlet gadget.
5. Then put it in a cooking flask. 6. Add n-hexane to the flask.
7. Then set the thermostat heater to the proper setting.
8. The heat vaporized the n-hexane and rose to the top of the device. After the water has cooled to
its vaporization point, it is retained within the sleeve. N-Hexane added to the boiling flask helped
release the sample fat. It takes 6-8 hours to complete this process.
9. After 6-8 hours, remove the flask containing the fat.
10. Keep the flask on the warm plate and wait for the n-hexane to evaporate.
11. Then, to remove the remaining n-hexane, put the flask in an electric oven.

12. Weigh after cooling in a desiccator.

Calculation

Fat%= [{(w2-w1)/ws}*100] ws=weight of sample,w1=weight of flask,w2=weight of flask with fat

3.2.6 Determination of protein

Apparatus

1. Sulphuric acid/H2SO4
2. Digestion mixture (2g CuSO4+ 98g K2SO4)
3. 40% NaOH
4. 0.1 N HCL
5. Methyl red indicator
6. 0.1 N NaOH
7. Distilled water

Plane of action

Dissolution:

1. Select a sample. Digestion mixture (2 gm), H2SO4 (10 ml), and 4 gram
2. Place the flask of digestion on it.
3. To obtain an average value, use two digestion flasks for this process.
4. Heat for 3 to 4 hours at first.
5. There will not be any H2SO4 whitish smoke at the end, and the solution will be perfectly transparent.
6. Let it cool for a while.

Distillation:

1. Transfer the mixture into a conical flask, filling it to the 100 ml mark with distilled water.
2. Transfer 10 milliliters to the distillation flask from conical flask.
3. Add 10 milliliters of 40% NaOH and 150 milliliters of distilled water to the distillation flask.
4. In the trapping conical flask, add two drops of methyl red (1%) and fifty milliliters distilled water and ten milliliters 0.1N HCl.
5. Use three distillation flasks for this process, with a blank in one of them.
6. Utilize three conical flasks with three different trapping solutions while keeping everything the similar.
7. Position and turn on the condenser.
8. Turn on the distillation machine and let it run for half an hour.

Titration:

1. Start by adding 0.1N NaOH to the burette.
2. Use three different trapping solutions for the titration.
3. A shift in color from pink to pale yellow will mark the conclusion.

Calculation

$(B-S)\times 1.4\times 10\times 5.95\times 0.1/$ Weight of sample

3.2.7 Determination of Carbohydrate

The carbohydrate content was calculated by difference utilizing formula:

%Carbohydrate = 100 – (Moisture + Ash + Fat + Protein + Crude Fiber)

Moisture	Ash	Fat	Protein	Crude Fiber	100-all
5.47	1.30	22.14	4.78	2.29	(100-35.98)

3.3 Sensory analysis

In a hedonic test, each panelist typically receives representations of more than one samples. They assess every sample according to a given criterion using a set of standards. These selected terms were used during a mock evaluation, with corresponding descriptive terms ranging from 9 " Like extremely" to 1 "Dislike extremely" according to a nine-point hedonic scale. Biscuit samples were coded A (1), B (2), C (3) and D (4) was coded because the panel members could not understand the amount of watermelon rind

For watermelon rind biscuits Hedonic test, 30 panelists participated. Biscuits were given to them and asked them to rate them orderly extremely dislike to extremely like in term of appearance, taste, flavor, texture. They gave their opinion as their taste buds.

3.4 Shelf life of watermelon rind biscuit

An experiment has been done with the newly developed biscuits. They were kept in zipper bag and it has been found that the shelf life of the biscuit is 90 days.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Results and Discussion

4.1.1 Proximate composition

Table 2: Proximate conformation of watermelon rind biscuit

Parameters	Examine 1	Examine 2	Examine 3	control
Moisture%	5.83	4.34	4.66	5.47
Fat %	22.89	23.06	25.18	22.14
Ash %	0.99	1.08	3.38	1.30
Fiber %	3.14	4.07	4.39	2.29
Protein %	4.97	5.34	6.59	4.78
Carbohydrate %	62.18	62.11	55.80	64.02

The proximate composition of three types of watermelon rind biscuit snacks of different percentage rind flour was analyzed. The composition parameters evaluated were Moisture %, Fat%, Ash%, protein%, carbohydrate% and Fiber%. Moisture percentage of the prepared WRF biscuit samples were precipitation to be 5.83% for sample 1**,** 4.34% for sample 2 and 4.66% for sample 3. The moisture content of each sample ranged from 4.34 to 5.83%.Then the fat percentage of the prepared watermelon rind flour biscuit samples were precipitation as 22.89% for sample 1**,** 23.06% for sample 2 and 25.18% for sample 3. Fat content of samples 3 WRF biscuit was observed as more than that of the other samples. Then the ash percentage of the prepared watermelon rind flour biscuit samples were precipitation as 0.99% for sample 1, 1.08% for sample 2 and 3.38% for sample 3. Sample 3 WRF biscuit was found to have more ash than the other samples. Then the fiber percentage of the prepared watermelon rind flour biscuit samples were precipitation as 3.14% for sample 1, 4.07% for sample 2 and 4.39% for sample 3. Fiber content of sample 3 WRF biscuit was observed as more than that of the other samples. Then the protein percentage of the prepared watermelon rind flour biscuit samples were precipitation as 4.97% for sample 1, 5.34% for sample 2 and 6.59% for sample 3. Protein content of sample 3 WRF biscuit was observed as more than that of the other samples. The Carbohydrate percentage of the prepared watermelon rind flour biscuit samples were precipitation as 62.18% for sample 1, 62.11% for sample 2 and 55.80% for sample 3. The best-accepted WRF cookies' approximate composition is as follows: for every 100g of cookies, there are 12.18% moisture, 4.68% protein, 30.04g fat, 1.77g ash, 3.25g crude fiber, and 45.69g carbohydrates. (S et al., 2021)

4.2 Sensory quality of watermelon rind biscuit

4.2.1 Appearance of watermelon rind biscuit

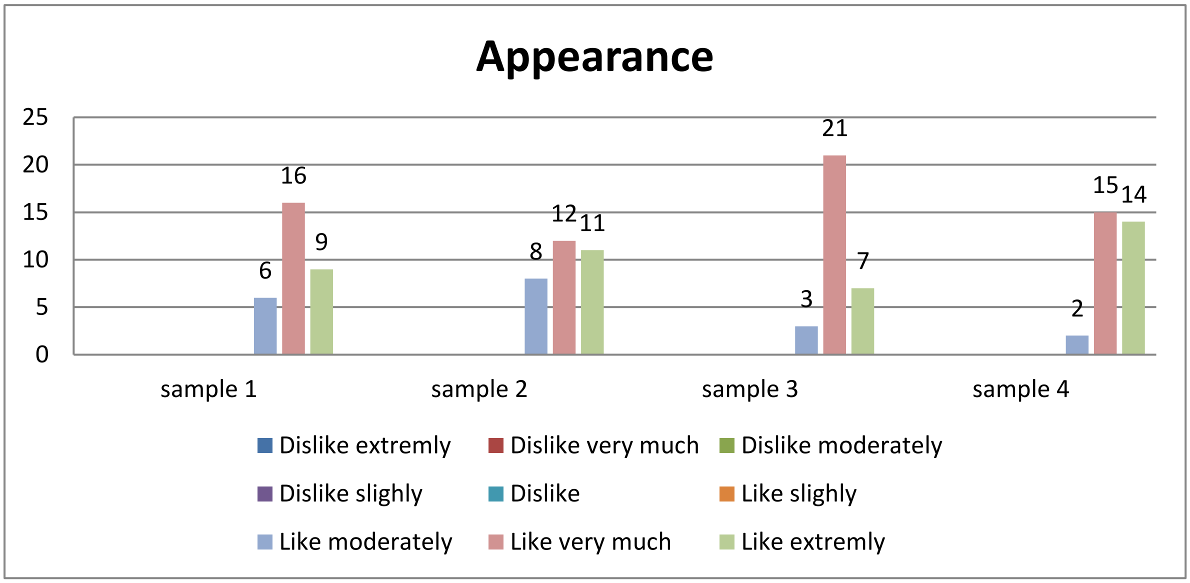

Fig 7: Appearance of watermelon rind biscuit

According to panelist opinion, result shows that maximum panelist like very much the biscuit with 5% rind flour in case of appearance.

4.2.2 Taste of watermelon rind biscuit

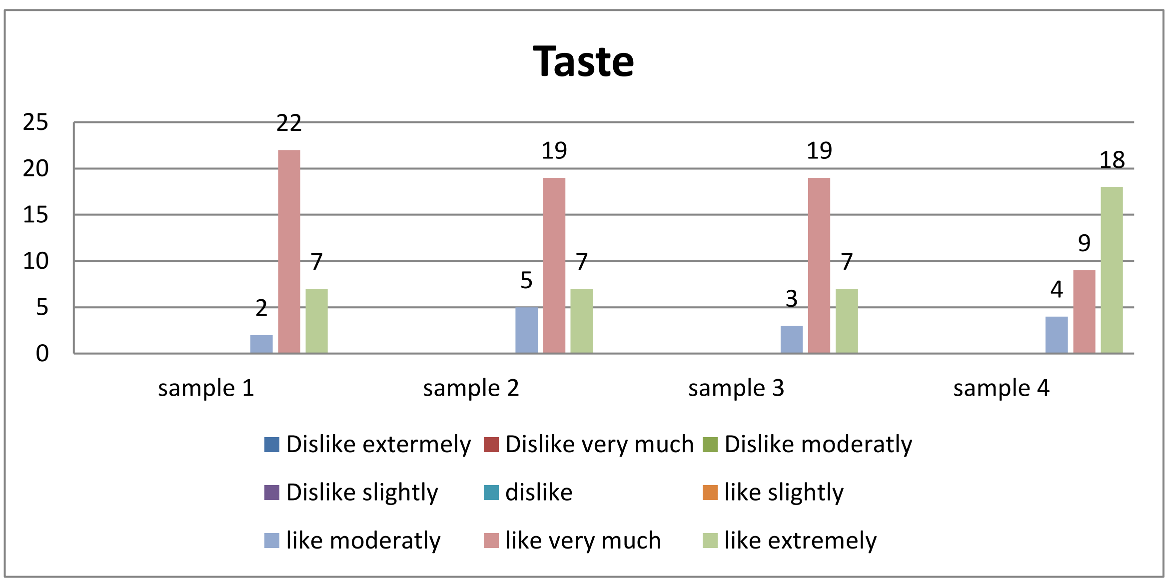

Fig 8: Taste of watermelon rind biscuit

This chart shows that, maximum panelist like very much the control sample and then they like extremely as their second choice which is 7% rind flour biscuit in term taste

4.2.3 Flavor of watermelon rind biscuit

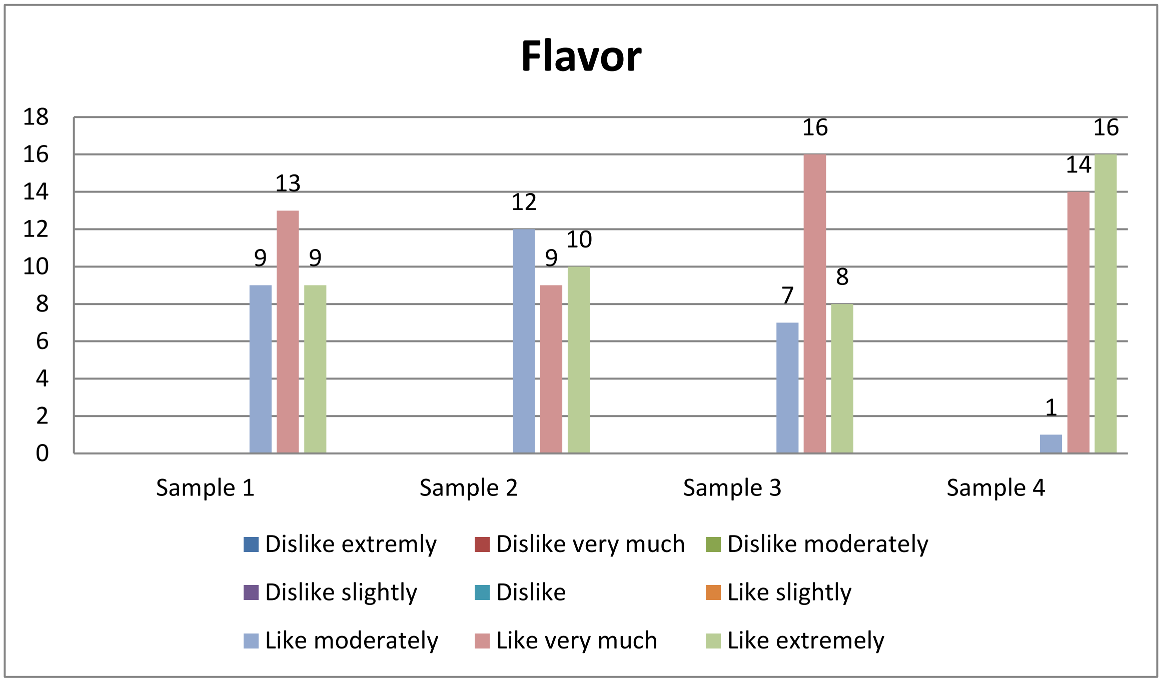

Fig 9: flavor of watermelon rind biscuit

After receiving opinion from panelist, result shows that maximum panelist like extremely the biscuit with 7% rind flour in case of flavor.

4.2.4 Texture of watermelon rind biscuit

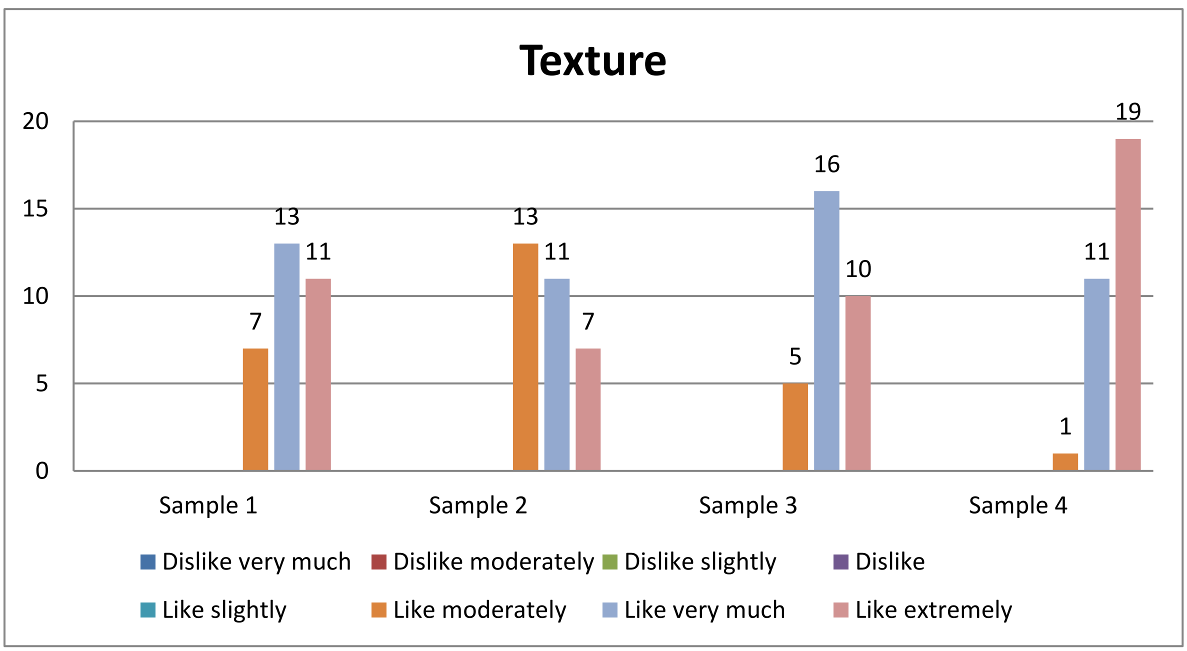

Fig 10: Texture of watermelon rind biscuit

After receiving opinion from panelist, result shows that maximum panelist like extremely the biscuit with 7% rind flour in case of texture.

4.2.5 Texture of watermelon rind biscuit

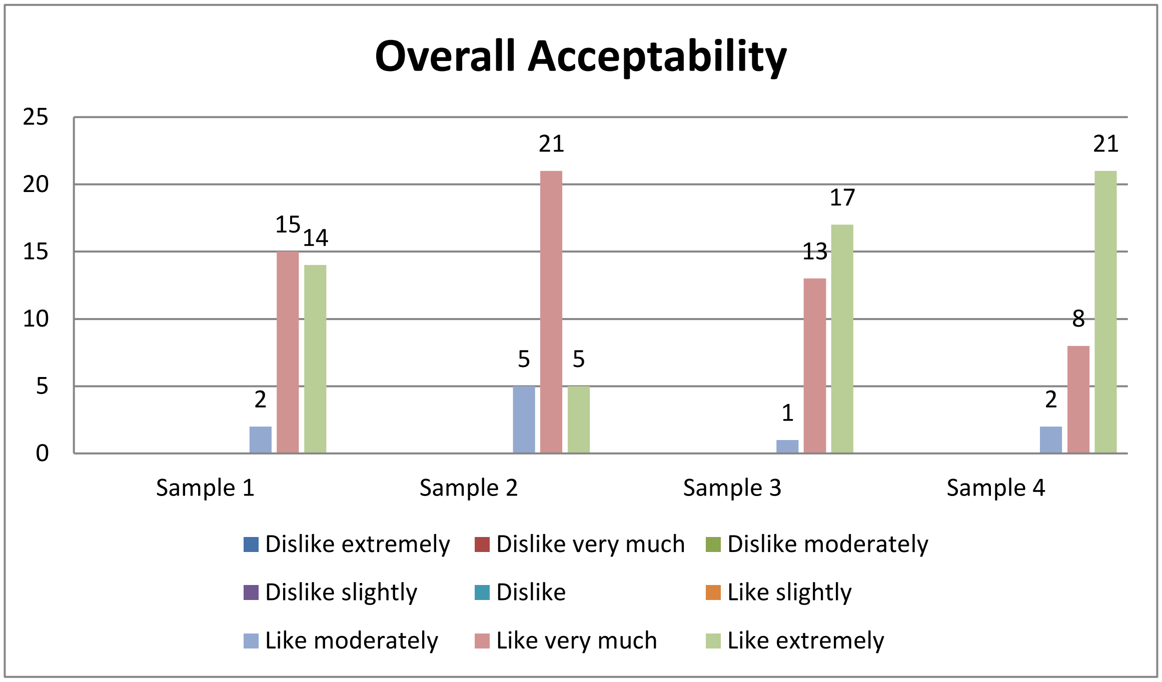

Fig 11: Texture of watermelon rind biscuit

Finally this chart represents that the overall acceptability among the sample, sample 4 is liked extremely which is made with 7% rind flour.

4.2 Shelf life of Watermelon rind biscuits

Biscuits that have been stored in zipper bag was safe and perfect for consumption after three months.

CHAPTER 5

CONCLUSION

Watermelon rind flour has very intriguing nutritional formations. Evaluations of quality and variety of watermelon rind flour biscuits is an encouraging initiative with several benefits for environment and health. Using watermelon rind, this innovative method not only helps reduce food waste but also improves the nutritional content of the biscuits. The watermelon rind flour biscuit, which contains 7% watermelon rind flour, appears to have a well-balanced nutritional profile. Its fat content is moderate (25.18), its protein content is relatively high (6.59), its ash content is normal (3.38) and its dietary fiber content is moderate (4.39). These biscuits are healthier than regular biscuits as they are high in protein and fiber due to the use of watermelon rind flour.

However, when evaluating the quality of biscuits, it is crucial to consider other factors including taste, texture and flavor and overall acceptability. Samples containing it significantly improved the sensory properties of control samples and achieved higher ratings in the process.

Consequently, the use of watermelon rind flour in biscuit fortification is a technique with considerable potential, which may develop new opportunities for the fortification of bakery products. Because these watermelon rind flour biscuits can be really liked by individuals of all ages. And this biscuit is very nutritious for diabetics as it has less sugar than other biscuits. Since the biscuits are made with watermelon rind flour, patients can easily get fiber and protein from the biscuits. Because watermelon rind is an excellent source of protein and high in dietary fiber. The development of two formulations, rich in dietary fiber and rich in protein, was made

REFERENCES

‘Pasta making from wheat semolina and watermelon rind: Effects of ratios of watermelon rind flour on the product quality’ (2022) *Science & Technology Development Journal - Engineering and Technology* [Preprint]. doi:10.32508/stdjet.v5i4.1032.

Egbuonu, A.C. (2015) ‘Comparative assessment of some mineral, amino acid and vitamin compositions of watermelon (Citrullus Lanatus) rind and seed’, *Asian Journal of Biochemistry*, 10(5), pp. 230–236. doi:10.3923/ajb.2015.230.236.

Rimando, A.M. and Perkins-Veazie, P.M. (2005) ‘Determination of citrulline in Watermelon Rind’, *Journal of Chromatography A*, 1078(1–2), pp. 196–200. doi:10.1016/j.chroma.2005.05.009.

Petkowicz, C.L.O., Vriesmann, L.C. and Williams, P.A. (2017) ‘Pectins from food waste: Extraction, characterization and properties of Watermelon Rind pectin’, *Food Hydrocolloids*, 65, pp. 57–67. doi:10.1016/j.foodhyd.2016.10.040.

Rimando, A. M., & Perkins-Veazie, P. M. (2005). Determination of citrulline in watermelon rind. *Journal of Chromatography A*, *1078*(1-2), 196-200.

HASSAN, N.S., MAHMOUD, A.H. and EL-KHOLAN, E.A. (2017) ‘Quality enhancing of cake using white watermelon rinds’, *Egyptian Journal of Agricultural Research*, 95(4), pp. 1653–1667. doi:10.21608/ejar.2017.151563.

Keeariyo, C., Chomchom, N., & Thedkwanchai, S. (2016). Application of Watermelon Rinds for Bakery Products.

ERTAŞ, N. and ASLAN, M. (2020) ‘Kavun Atıklarının Bisküvi üretiminde Kullanım Potansiyeli üzerine Bir Araştırma’, *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi*, 23(5), pp. 1216–1224. doi:10.18016/ksutarimdoga.vi.681812.

Romdhane, M.B. *et al.* (2017) ‘Optimization of Polysaccharides extraction from Watermelon Rinds: Structure, functional and biological activities’, *Food Chemistry*, 216, pp. 355–364. doi:10.1016/j.foodchem.2016.08.056.

Dhakal, D., & Pradhananga, M. L. (2017). Utilization of watermelon rind (byproduct) in preparation of candy and its quality evaluation. *International Journal of Multidisciplinary papers*, *2*(1), 1-6.

Ahamad, S. *et al.* (2022) 'Recent trends in preprocessing and extraction of Watermelon Rind Extract: A comprehensive review', *Journal of Food Processing and Preservation*, 46(7). doi:10.1111/jfpp.16711.

Liu, C., Ngo, H.H. and Guo, W. (2012) 'Watermelon rind: Agro-waste or superior Biosorbent?', *Applied Biochemistry and Biotechnology*, 167(6), pp. 1699–1715. doi:10.1007/s12010-011-9521-7.

S, A., S, S.B. and KG, V. (2021) 'Byproduct utilization of watermelon to develop watermelon rind flour based cookies', *The Pharma Innovation*, 10(2), pp. 196–199. doi:10.22271/tpi.2021.v10.i2c.5658.

APPENDICES

Appendix 1: proximate composition

Sample	Parameters	Result
Watermelon Rind Flour	Ash Content (%)	1.30
	Protein Content (%)	4.78
	Fat Content (%)	22.14
	Fiber Content (%)	2.29
	Moisture Content (%)	5.47
	Carbohydrate Content (%)	64.02

Appendix 2: Sensory evaluation

Hedonic Rating Test

Assessor's Name: ………………. Date: ………………..

Product: watermelon rind biscuit

Please test the sample and give numerical score ranging from 1 to 9 in the appropriate space.

Parameters	watermelon rind biscuit
Appearance	
Taste	
Texture	
Flavor	
Overall acceptance	

Appendix 3: Synopsis

Department Nutrition and Food Engineering (NFE)
Faculty of Health and Life Sciences (FHLS)
Daffoldil International University
Daffodil Smart City,Birulia,Savar,Dhaka-1216,Baangladesh

Synopsis of the thesis

1.Name: Shraboni Saha

2.ID: 191-34-158

3.Project title: Exploring the potential of watermelon rind:physicochmical and sensory evaluation of watermelon rind biscuits.

Introduction

The tough outer skin of a watermelon is called the rind, and it is usually green on the outside before the fruit's pink and red flesh turns pale white inside. In contrast to the fruit it guards, the skin is noticeably harder and less luscious, yet to popular belief, it is absolutely edible. But eating the watermelon's rind by itself might not be the best or most practical method to consume this portion of the fruit.

Not many people realize that the peel of this fruit has a lot of nutrients in it, but most just toss the peels in the trash. The rinds of watermelon contain all the nutrients present in the luscious fruit as well as extra concentrations of particular minerals, vitamins, antioxidants, and active substances.

Although this peel is hard, it is low in calories and high in potassium, zinc, vitamin C, and vitamin A. Chlorophyll, citrulline, lycopene, amino acids, flavonoids, and phenolic compounds are among the many nutrients found in watermelon rinds. (2022)

A popular fruit in the tropics and subtropics, watermelon is widely available. One of the most significant vegetable crops, it has large, round, oval, or oblong fruits with smooth skin, dark green rinds, or occasionally pale green stripes that turn yellowish green when ripe. It is also a good source of phytochemicals and is highly vitamin-rich (Vitamin A 590 IU, Niacin 0.2 mg/100 g, and Vitamin C 0.7-7.0 mg/100 g). It can be served as a snack or appetizer for breakfast.

Possesses lycopene, which has been found to be protective against an increasing number of cancers, and is a popular source of carotenoid that quenches thirst during the hot summer months.

It is also a delicious thirst-quencher that helps quench the inflammatory agents that cause conditions like diabetes, atherosclerosis, arthritis, asthma, and colon cancer. Cucurbit seeds are a good source of fat and protein in particular. The body uses citrulline, which is present in watermelon, to produce arginine, another amino acid. The fruit also has a high lipid content and many smooth, compressed seeds with a thickening border that are either black or yellow-white in color.

Antioxidant molecules have been linked to the observed therapeutic effects of watermelon. Studies on watermelon fruits have focused on their antioxidant, phytochemical, and anti-nutritional properties as well as their ability to keep for longer periods of time. Furthermore, it has been discovered that the fruit juice possesses high-quality (proximate) rind (peels) and nutritious components that may encourage ingestion or other uses. In order to possibly utilize the peel (rind) dried powder extract in food and manufacturing processes, this study aims to determine some of its functional properties. (Egbuonu, 2015)

Objectives

1. To develop biscuits from watermelon rind by drying the rind
2. To observe newly developed biscuits shelf life which is 90 days
3. To observe proximate composition of the biscuits
4. To observe sensory quality of newly developed biscuits.
5. To reduce wastage

Materials

Ingredients:

1. Watermelon (Ripe)
2. Wheat Flour
3. Corn Flour
4. Butter
5. Sugar
6. Milk Powder
7. Salt
8. Baking Powder
9. Egg
10. Nigella Sativa

Instrument:

1.Saucepan
2.knife
3.Oven
4.Blender

Methods:

Start ➲ Cut the watermelon rind ➲ Dry in oven ➲ Blend watermelon rind

⬇

Pour the dough in board with biscuit shape ⬅ Beat the mix all the ingredients

⬇

Bake ➲ Keep and store

Place of study:

1. Buy raw okra from various fruit shops in Uttara and Comilla Crockeries super shop in DNCC Market
2. Food Analytical Laboratory
3. Food Processing Laboratory
4. Food Microbiology Laboratory

Period of study:

I Started my project work on 23 May,2023.

Supervisions:

Supervisor: Dr. Nizam Uddin, Associate Professor and Head, Department of Nutrition and Food Engineering,Daffodil International University

Co-Supervisor: Mr. Abu Saeid, Lecturer (Senior Scale), , Department of Nutrition and Food Engineering,Daffodil International University

Expected Outcome:

To reduce wastage.To Satisfy Customers & remain competitive in the market,the food industry must prioritize quality,shelf-life & affordability

CONCLUSION:

Watermelon rind flour has very intriguing nutritional formations. Evaluations of quality and variety of watermelon rind flour biscuits is an encouraging initiative with several benefits for environment and health. Using watermelon rind, this innovative method not only helps reduce food waste but also improves the nutritional content of the biscuits. The watermelon rind flour biscuit, which contains 7% watermelon rind flour, appears to have a well-balanced nutritional profile. Its fat content is moderate (25.18), its protein content is relatively high (6.59), its ash content is normal (3.38) and its dietary fiber content is moderate (4.39). These biscuits are healthier than regular biscuits as they are high in protein and fiber due to the use of watermelon rind flour.

However, when evaluating the quality of biscuits, it is crucial to consider other factors including taste, texture and flavor and overall acceptability. Samples containing it significantly improved the sensory properties of control samples and achieved higher ratings in the process. Consequently, the use of watermelon rind flour in biscuit fortification is a technique with considerable potential, which may develop new opportunities for the fortification of bakery products. Because these watermelon rind flour biscuits can be really liked by individuals of all ages. And this biscuit is very nutritious for diabetics as it has less sugar than other biscuits. Since the biscuits are made with watermelon rind flour, patients can easily get fiber and protein from the biscuits. Because watermelon rind is an excellent source of protein and high in dietary fiber. The development of two formulations, rich in dietary fiber and rich in protein.

Reference:

‘Pasta making from wheat semolina and watermelon rind: Effects of ratios of watermelon rind flour on the product quality’ (2022) Science & Technology Development Journal - Engineering and Technology [Preprint]. doi:10.32508/stdjet.v5i4.1032.

S, A., S, S.B. and KG, V. (2021) ‘Byproduct utilization of watermelon to develop watermelon rind flour based cookies’, The Pharma Innovation, 10(2), pp. 196–199. doi:10.22271/tpi.2021.v10.i2c.5658.

Signature of the Supervisor

Supervisor:

Dr. Nizam Uddin

Associate Professor & Head

Department of Nutrition and Food Engineering

Daffodil International University

Applicant

Shraboni Saha

ID: 191-34-158

Department of Nutrition and Food Engineering

Daffodil International University

Appendix 4: Plagiarism Report

Drying of watermelon rind & development of biscuits from Rind

ORIGINALITY REPORT

23%	21%	13%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	dspace.daffodilvarsity.edu.bd:8080 Internet Source	3%
2	www.researchgate.net Internet Source	2%
3	repository.rmutp.ac.th Internet Source	2%
4	s3.amazonaws.com Internet Source	2%
5	www.mdpi.com Internet Source	1%
6	pdfs.semanticscholar.org Internet Source	1%
7	123dok.com Internet Source	1%