"Formulation and Quality Analysis of Multigrain Cookies"

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Abstract

The bakery industry is a traditional and growing food industry that is providing huge demand for convenient foods like biscuits, cookies, cakes, etc. Cookies are flat and crispy bread with meager moisture and are made of generally wheat or refined wheat flour along with various other ingredients. The demand for fibre and minerals-rich multigrain cookies is high and this demand inspired the preparation of Multigrain Cookies. The present investigation attempts to formulate higher nutritional value cookies with added health benefits by adding Ragi flour, brown rice flour and oats flour with whole wheat flour. In the present study samples, A, B, C and D were formulated in which multigrain cookies were prepared by using Whole Wheat Flour: Ragi flour: Oats Flour: Brown rice Flour (WF: RF: OF: BF) in the ratio of (75:50:25:10, 50:25:75:10, 25:75:50:10, 50:50:50:10) respectively. It was found that among all Samples sample B scored higher in flavor (6.8), color (7.45), appearance (7.6), and overall acceptability (7.6) and was considered the optimized product. The ash, titrable acidity, pH and moisture percent of Sample B were found to be 0.78%, 0.13%, 7.4, and 3.07% respectively. Later sample B is get treated with FTRI, SEM tests.
Keywords: Multigrain Cookies, wheat flour, Ragi flour, oats flour, Brown rice flour.

1. Introduction

The baking business is currently attempting to extend its product line while simultaneously establishing a means of maintaining and increasing people's health. In India, the bakery sector; considered as most important division among food handling industries. Due to an increase in demand for convenience foods, bakery items have become increasingly popular in India in recent years among various segments of the population. 80 percent of all bakery products made in the country are bread and cookies [1]. Wheat is commonly used as a key ingredient in bakery items. Baked goods are becoming more popular as a result of their accessibility, ready-to-eat convenience, and long shelf life. Nutrient availability, palatability, compactness, and convenience are all advantages of cookies [2]. Cookies are small, baked goods made with egg, flour, flavors, and butter or cooking oil. Substances such as dry fruits, or Choco chips may be included. Nowadays demand for multi-grain-based products, especially cookies is on the rise. Multigrain helps to increase the nutritional value of the processed product. This demand influences the production of multigrain cookies using Ragi flour, oats flour, wheat flour and Brown rice flour in different proportions. Cereals and legumes have a prominent place in international nutrition due to their widespread consumption. These cereals are high in fibre, nutritional proteins, lipids, vitamins, minerals, and phyto- promoting nutrient chemicals and high in carbohydrate and protein content. Some value additional dietary-rich cookies were also prepared by adding ripe banana peel powder and date powder [3]. A multigrain snack can help you get a lot of fibre and other health benefits [4]. Wheat is a primary food crop in India that ranks second world's secondly to rice. After China, the biggest wheat cultivation occurs in India. Punjab has most of India's total wheat production. Wheat is the world's number one cereal supply major portion of energy and protein in the Indian diets [17].

 It is the most widely consumed cereal in the world, and its popularity has grown in the present day due to numerous advantages in diets. Wheat contains tremendous energy in all its sections, including the bran, germ, and endosperm. Wheat is the most used cereal for creating bread, followed by rice and oats. Wheat contains mineral salts, calcium, potassium, Sulphur, magnesium chlorine, manganese, zinc, iodine, copper, and vitamins, among other things. Wheat is the primary source of protein in most people's diets [5]. India's traditional crop, finger millet (*Eleusine coracana*), is sometimes known as Ragi, nachni, or nageli. It has a high carbohydrate, fibre, calcium, and iron content. Finger millet is a popular millet that is brick red in colour and spherical in shape [6]. Carbohydrates, protein, crude fibre, and minerals are all found in finger millet [7].

The health benefits of finger millet are numerous. It aids in the reduction of body weight. Fiber-rich food aids in the reduction of cholesterol in the body. It is a pharmaceutical source that aids in the treatment of ailments such as anemia, diabetes, brittle bones, and osteoporosis [8].

The rich nutritional content in Oats (*Avena sativa L.*) gained a lot of admirers. Oats have a lot of merits to health, including hypocholesterolemia, and antidisease sufferers' diets. Oats, being the important ingredient in celiac-based food products such as baked products, healthy drinks, healthy breakfast and infant food, are receiving more demand as it is the house of nutrients. Research and development on oats and their products could aid in treating various ailments [9]. Oats have an excellently balanced nutritional content. It is rich in superior proteins and a balanced amino acid profile. Oats are abundant in lipids, particularly unsaturated fatty acids, minerals, vitamins, and phytochemicals [10].

The entire grain of brown rice is removed without the husk. The Flour of brown rice is used in baked goods because of its distinct textural and flavored characteristics. Brown rice is a house of manganese and a decent supplier of mineral compounds like selenium and magnesium, according to our food ranking methodology [46]. Brown rice has twice the protein amount of white rice. Brown rice has a high silica content (6 mg/g), owing to the presence of rice hull particles[47]. Seven formulations were developed by using refined-wheat flour, corn flour, kodo millet flour and butter, sugar, milk powder, and baking powder [11]. The current work was carried out to produce multigrain cookies using wheat, Ragi, oats and Brown rice flour. All four samples of cookies were made with four different proportions of multigrain flour. That is samples S1, S2, S3 and S4 were formulated using wheat flour: ragi flour: oats flour: brown rice flour (WF: RF: OF: BF) in the ratio of (75: 50: 25: 10, 50: 25: 75: 10, 25: 75: 50: 10 and 50: 50: 50: 10) respectively. Later sensory analysis was carried out on untrained and semi-trained persons to find out the best sample among the four samples. The best sample was further analyzed to determine quality parameters like ash content, Titrable acidity, moisture content and furthermore.

2. Material and Methods

This part provides the details of the ingredients and procedures that took place throughout the research thesis. All the work was carried out in the Food Technology department, School of Applied Life Science (SALS), Uttaranchal University, Dehradun, Uttarakhand (India). The purpose of this is to provide details about the selection and processing of raw materials as well as the selection of all process parameters and analytical procedures.

Experimental Materials

2.1 Selection of raw materials:

For the formulation of the multigrain cookies, the raw material (whole wheat flour, Ragi flour) was bought in bulk, to ensure uniform quality of product, from Prem Nagar local market, Uttarakhand along with ingredients like Butter and jaggery. The remaining raw materials (Oats flour and Brown Rice flour) were bought from an online shopping platform as they were unavailable locally.

2.2 Chemicals and equipment's

All analytical grade chemicals used for analysis were bought from certified suppliers. All materials like glassware were continuously cleaned, washed, sterilized and dried before use. A list of various equipment used during the experiments is given below.

Table 1: List of various equipment used during the experiments

Equipment	Purpose
Weighing balance	To weigh and measure ingredients and chemicals
Hot air oven	Drying the product and also for moisture content determination
Hot plate	To heat the crucible dish with the sample during the Ash content test
Baking Oven	To bake cookies at the appropriate temperature and time
Muffle furnace	To determine the Ash content in a sample
pH meter	To determine the pH of the sample

Preliminary trials to select process parameters for the final experiment

Preliminary trials were taking place in the Food Technology laboratory (SALS Uttaranchal University). The four samples of varying proportions i.e., Sample A, B, C and D are of whole wheat, ragi, oat and brown rice flours having different percentages were selected as mentioned in Table 2 for the development of multigrain cookies and out of which the best sample of cookies was determined by Hedonic scale evaluation.

Table 2. Composite flour formulation for the development of Multigrain Cookies from whole wheat, Ragi, Oats and Brown Rice flours respectively.

Sample code	Wheat	Ragi	Oats	Brown rice
Sample A	75	50	25	10
Sample B	50	25	75	10
Sample C	25	75	50	10
Sample D	50	50	50	10

2.3 Experimental Plan

The development of Multigrain Cookies was done as per the flow chart as shown in **Fig 3.1.** The process for making the raw material mixture starts with gathering the necessary ingredients: wheat, ragi, oats, and brown rice flour, along with jaggery, butter, water, and baking powder. These ingredients are then weighed out according to the required measurements. Once measured, the flour blend and baking powder are combined. Separately, the butter and jaggery are creamed together. After the butter and jaggery mixture is ready, it is then mixed with the flour blend. The resulting dough is then kneaded thoroughly before being sheeted and cut to the desired shape. The dough is then baked at 160°C for 18-20 minutes. After baking, the final product is left to cool before being packed. This is the complete process of making the raw material mixture used in the recipe.

2.4 Experimental Methodology

Four samples of the multigrain cookies were made as shown in table 3.1 using the composite flour in different ratios. To make a batch of cookies, 160 g of composite flour was measured into a mixing bowl. Separately, 60 g of jaggery and 60 g of butter were weighed. The butter and jaggery were then mixed together until they achieved a creamy texture. Next, 2.5 g of baking powder was measured and added to the flour blend. The butter-jaggery mixture and flour blend were mixed and kneaded well using enough water to form a well-developed dough ball. The dough was then left to rest for 10 minutes. Afterward, the dough was made into a round shape using a sheet and cut method, with the help of round-shaped molds. The shaped dough was then baked in a baking oven for about 20 minutes at a temperature of 160°C. Once the cookies were finished baking, they

were placed at room temperature to cool for about 10-15 minutes. After cooling, the cookies were packed into an airtight package to ensure their freshness.

2.5 Analytical Procedures

2.5.1 Detection of moisture

The amount of moisture in the cookie can be detected by heating a particular weight (5g) the of sample in an electronic hot air oven at 100-105 degrees Celsius for five hours. After three hours, it is taken out from the oven and weighed. Then again placed it back in the hot air oven for 2 more hours. Weighed the sample after each hour. Taken out the sample and cooled it down with help of a desiccator and weighed the dried sample to determine the moisture content as per the formula. The moisture content in cookies was determined by using the formula mentioned below

Moisture content (%) = $\frac{W1-W2}{W1-W} \times 100$

W → Petri plate weight alone in gm

W1 → weight of petri plate and sample before drying in oven in gm

W2→ weight of petri plate + dried sample in gm

2.5.2 Total Ash Content Determination

A crucible or silica plate was used to contain a 5 g sample of cookies. The crucible was then charred on a hotplate and after vapours from sample were completely heated out and a dark colour sample was obtained. The dish was then moved to a muffle furnace at a temperature of 550°C for 3 hours. After 3 hours the sample was taken out and kept in a desiccator for cooling. After cooling the weight of the dried sample was measured and compared to that of the wet sample.

The ash content is determined using the formula given below

Total Ash content (%) = $\frac{W2-W}{W1-W} \times 100$

W1→ Weight of the crucible and sample (g)

 W → Weight of crucible alone (g)

W2 → Weight of the crucible and dried sample (g)

2.5.3 Determination of pH using a pH meter

The pH value of food is one of the most essential characteristics. It provides producers with information about a product's shelf life, stability over time, and interactions with other items. A product's acidity/alkalinity is measured by its pH value. It is measured on a scale of 0 to 14. Acidic

values are those below 7. The pH of a sample below 7 shows the sample is acidic in nature and above 7 shows the sample is alkaline in nature.

Procedure

To measure the pH value of a sample of cookies, a sample solution was prepared using 5g of the cookie sample and distilled water. Prior to taking the measurement, the pH meter was calibrated to ensure accuracy. First, the pH meter was calibrated with pure water (pH 7), then with an acidic solution of pH 4.01, and finally with a basic solution of pH 9.21. This ensured that the pH meter was accurately calibrated and ready to use. Next, the electrodes of the pH meter were dipped into the sample solution, and the button to measure the pH of the sample was clicked. The pH value of the sample solution was then noted down for further analysis.

2.5.4 Determination of Titratable Acidity

The number of free protons and acids that are not associated in a solution are neutralized by reacting to a strong base is mentioned to as titrable acidity (TA). In the determination of the Titrable acidity of a sample, the sample solution is made and titrated with NaOH to obtain concordant value and further determine the percentage Titrable Acidity.

Procedure

To analyze the amount of acid present in a sample of cookies, a sample solution was prepared using 10g of the cookie sample dissolved in 100ml of distilled water. The next step was to prepare a standard solution of 0.1N NaOH in a burette. A conical flask was then filled with 10ml of the sample solution, and 2-3 drops of phenolphthalein were added to it. The solution in the conical flask was then titrated with the standard solution of NaOH until a pink color was obtained. The volume of NaOH required to reach the end point was noted down as the titre value. To ensure accuracy, this process was repeated three to four times to obtain concordant values. By averaging the concordant values, the amount of acid present in the sample of cookies could be accurately determined.

 Determine the titrable acidity of a sample using the formula given below

Titrable acidity (%) = [Volume of titrant × N× 90 ÷ V of sample × 1000] × 100

2.5.5 Scanning Electron Microscope (SEM)

SEM (Scanning Electron Microscopy) is the process in which a sample is treated with a beam of electrons and hence scans the sample and collects a magnified picture. SEM microscopy is another name for SEM Analyses. It is well known for microanalysis but at the same time, it shows failure

in inorganic solid material analysis. It is effective in recognizing outer chemical substances that are inorganic in origin, along with metal coatings for semi-quantitative results.

 SEM has a high-energy beam of electrons that are passed to the surface of the sample. These beams capture information and provide 2D images of various characteristics of the sample.

2.5.6 Infrared Spectroscopy with the Fourier Transform (FTIR)

The method of using infrared rays to scan the samples like powders, liquids, and films and thereby determine the chemical characteristics or to determine the contamination in a sample. It can be used for identifying organic or inorganic characters of a sample. The range of an infra-red ray used in FTIR is 1000-100 cm $^{-1}$

2.5.7 Sensory Evaluation

Sensory evaluation done by a 9-point Hedonic scale method was used to analyze the acceptability of the final goods against any recognized / acceptable food product with equivalent nutrient value. A panel of ten judges assessed the product on its taste, colour, texture, flavor, and overall acceptability. Judges provided extra comments in addition to the typical scoring range of 1-9. For the quality attributes, the mean score was calculated. The best product is categorized based on sensory evaluation since it provides consumers with sensory perceptions of the prepared product.

Panelist Name: **Date:**

Product Name: **Time:**

Score preference:	**Code**
Like extremely	9
Like very much	8
Like moderately.	7
Like slightly.	6
Neither like nor dislike.	5
Dislike slightly.	4
Dislike moderately.	3
Dislike very much.	2
Dislike extremely	1

Sample code	Flavour	Color	Texture	Appearance	Sweetness	Mouthfeel	Overall Acceptancy
A							
B							
C							
D							

3. Results and Discussion

The current examination has been done to analyse the effect of varying proportions of composite flour for the development of Multigrain Cookies. The current examination was done to find the top proportion of Multigrain Cookie with help of sensory analysis. whereas the Further quality analysis was based on the best sample obtained from sensory evaluation results.

3.1 Sensory characteristics of Multigrain cookies

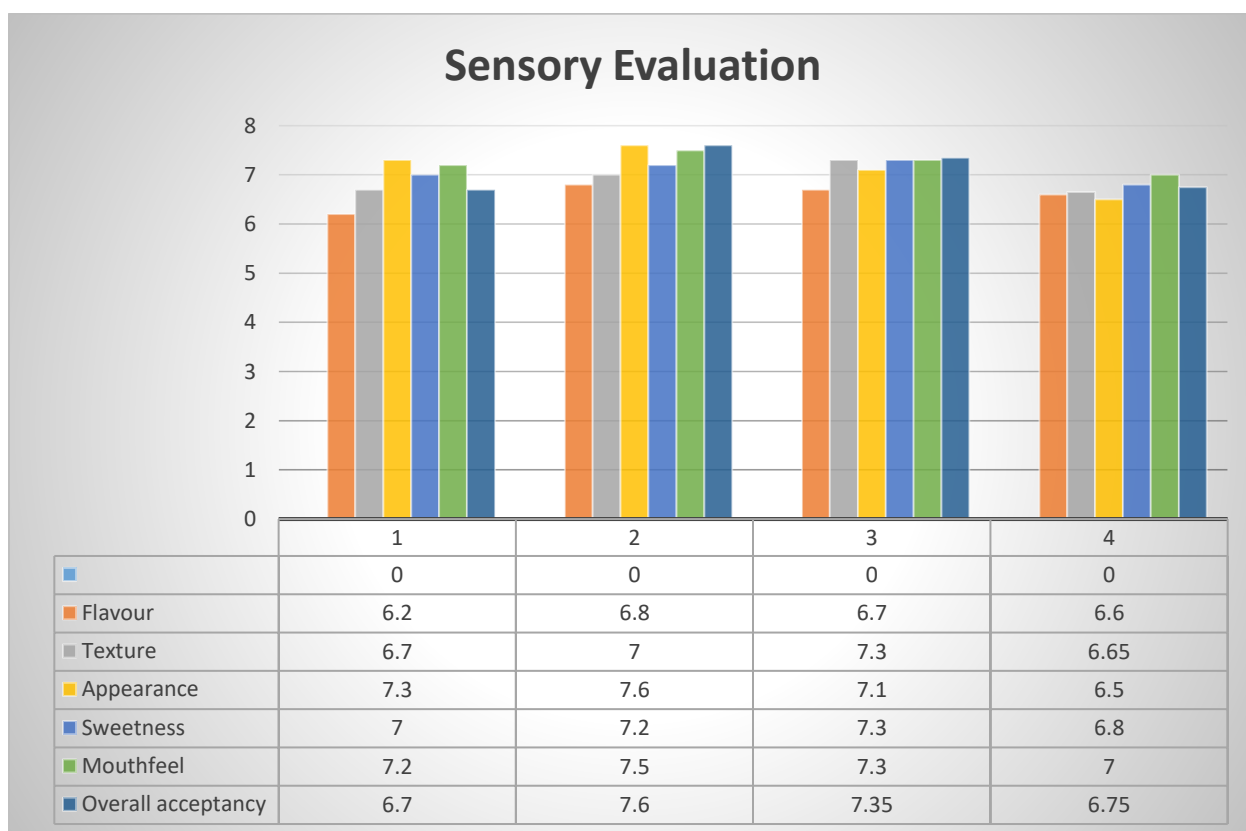**Fig 1: Sensory evaluation of multigrain cookies**

	1	2	3	4
■	0	0	0	0
■ Flavour	6.2	6.8	6.7	6.6
■ Texture	6.7	7	7.3	6.65
■ Appearance	7.3	7.6	7.1	6.5
■ Sweetness	7	7.2	7.3	6.8
■ Mouthfeel	7.2	7.5	7.3	7
■ Overall acceptancy	6.7	7.6	7.35	6.75

Table 3: Sensory Evaluation of cookies

Sample code	Flavour	Color	Texture	Appearance	Sweetness	Mouthfeel	Overall acceptancy
A	6.2	7.1	6.7	7.3	7	7.2	6.7
B	6.8	7.45	7	7.6	7.2	7.5	7.6
C	6.7	7.1	7.3	7.1	7.3	7.3	7.35
D	6.6	6.8	6.65	6.5	6.8	7	6.75

The samples with 75% of Oats flour (sample B) acquired the highest normal score for flavour whereas Sample A acquired the least normal score for flavour.

The same Sample B acquired the highest normal score for color, Appearance, and mouthfeel whereas Sample D acquired the least normal score for all the same.

Sample C acquired the highest normal score for sweetness whereas Sample D acquired the least normal score for sweetness.

In overall acceptancy Sample B obtained the highest score over all the other samples and Sample D acquired the least score for the same

Thus, Sample B with a 50:25:75:10 proportion of Wheat flour, Ragi flour, oats flour and Brown Rice flour respectively was selected as the best sample according to sensory evaluation.

Further quality analyses were done with the test samples of Sample B. There was an increase in taste and flavor scores of multigrain biscuits with the incorporation of composite flours. There was a decrease in organoleptic characteristics during storage [12].

3.2 Quality analysis of Multigrain Cookies

The nutritional parameters determined were moisture content, ash content, Titrable acidity and pH of Sample B.

Table 4: Different parameters of the cookies (sample B)

Parameters	Result value
Moisture content (%)	3.07
Ash content (%)	0.78
pH	7.4
Titrable acidity (%)	0.13

The different parameters of the cookies (sample B) analyzed are given in **Table 4.2**

3.2.1 Effect of moisture content

The moisture content of the sample is 3.07%. The moisture content of cookies is generally below 5% after baking, resulting in a crisp texture and good storage stability. The less amount of moisture guarantees that cookies generally have no microorganisms and a better shelf life. According to a previous study, it is evident that, the moisture content varied from 3.30 to 3.39% [13].

Table 5: Moisture content in different samples

Sample	Moisture Content
Current Sample	3.07%
Cookies (after baking)	Below 5%
Previous study [13]	3.30% to 3.39%

3.2.2 Effect of Ash content

The ash content of the sample was 0.78 %. The higher ash content in the cookies indicates that the mineral, germ, and bran content in cookies is high. 0.78% of Ash content is due to the different multigrain flours used for the preparation. According to a previous study, the treatment scored the lowest at 1.29%. All treatment combinations were having significant differences from each other [13].

3.2.3 Effect of pH

The pH of the sample was 7.4 Generally the pH of cookies will be between 7.2 to 8 and not more than 9. The pH of cookies is this much as baking powder or baking soda is added to it.
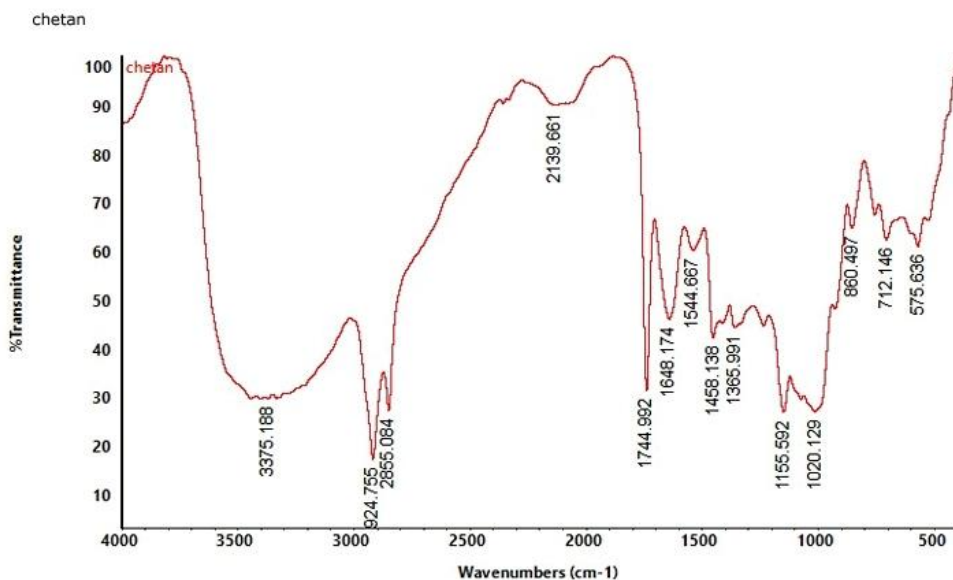
3.2.4 Effect of Titrable acidity

The titrable acidity of the sample was 0.13 %, the value is relatively lower than the optimum value. This may be due to loss of acidity during different preparation processes.

FTIR

Title: chetan
Number of sample scans: 16
Number of background scans: 16
Instrument Serial: BFJ2010008
Smart Accy: 40-5000950
Model: Nicolet Summit LITE
Source: IR
Detector: LiTaO3
Smart Accessory Title: iD1 Transmission
Smart Accessory ID: 40-5000950
Crystal type: : None
Beamsplitter: KBr
Sample spacing: 1.0
Digitizer bits: 24
Optical velocity: 0.4747
Aperture: 100.0
Sample gain: 1.0
High pass filter: 1.0
Low pass filter: 11000.0
Comments: None

Regions:

Region 1: 3987.24-399.19
Threshold: 99.080
Sensitivity: 50.000

Position	Intensity
575.636	60.968
712.146	62.291
860.497	64.607
1020.129	26.756
1155.592	26.767
1365.991	44.170
1458.138	42.009
1544.667	60.018
1648.174	45.930
1744.992	31.165
2139.661	90.072
2855.084	27.094
2924.755	17.129
3375.188	29.458

SEM
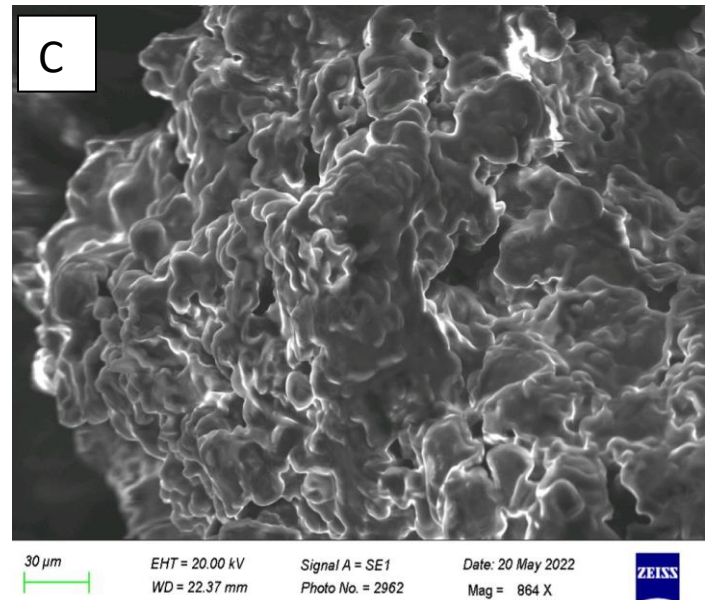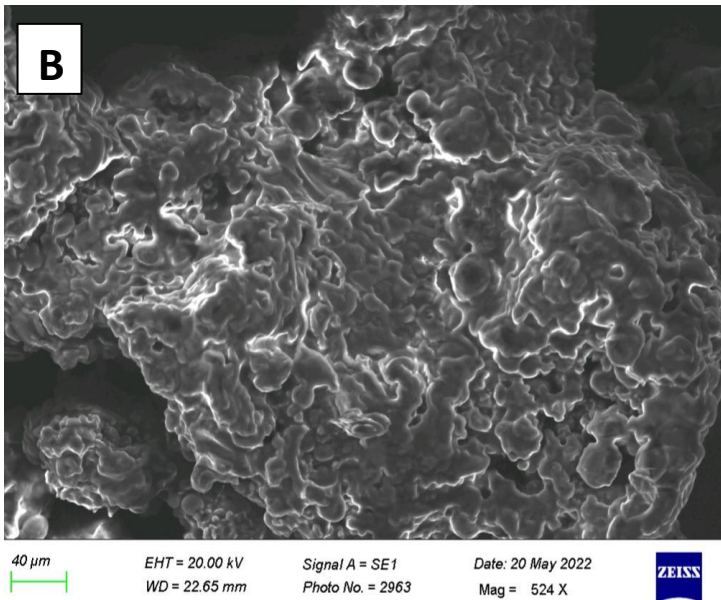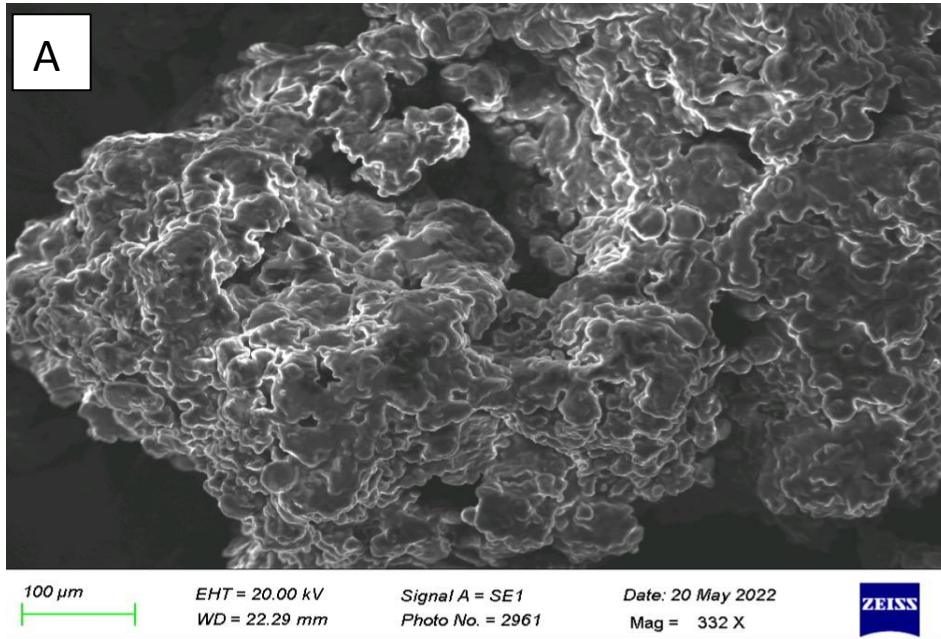
Conclusion

In the above experimental thesis, Multigrain Cookies were formulated from whole wheat flour, Ragi flour, Oats flour and Brown rice flour. Jaggery was used as a sweetener instead of refined white sugar. Jaggery consists of more nutritional value than white sugar. Butter was used as a fat source and baking powder was also added. Four proportions of flour blends were used to prepare four different samples, out of which one sample (sample B) was selected as the primary sample

through sensory evaluation. Sample B was then used for Quality Analysis to determine Moisture content, Ash content, pH, titrable acidity, SEM and FTIR.

The Multigrain Cookies with a high amount of Oats and Ragi were having good flavour, taste, color and appearance along with high nutritional value of minerals and fibres. These cookies can provide high nutrition and Eating quality for consumers with a pleasant mouthfeel.

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