Original Research Article

NUTRITIONAL & ANTIMICROBIAL ANALYSIS OF DEVELOPED EDIBLE BASKET USING NORI SHEET

Abstract

Increasing the shelf life and material containment of food products is now a challenge for food packaging and preservation technologies. In recent years, there has been a notable surge in the applications of edible cones. Because it is environmentally friendly and biodegradable, the vegan basket is the best option as a paper cutlery substitute. In addition to being associated with higher diet quality, cereals are known to be more nutrient-dense foods that include protein, fat, and carbohydrates. Using energy-dispersive X-ray spectroscopy (EDS) and scanning electron microscopy (SEM) with Fourier transform infrared spectroscopy (FT-IR), water absorption capacity (WAC), fat, protein, fiber, carbs, and moisture content, the edible basket was nutritionally analyzed and characterized. An experiment was carried out to find out how well the edible cone absorbed water. Food poisoning or food spoilage can be caused by microbial infections, as is well known. In order to preserve quality and safety as well as to increase the shelf life of packaged food, its surrounds function as a microbial barrier. To make sure that the created product was free of microbial growth for this reason, the study included a disc diffusion method (antimicrobial testing). The result assured that the edible cone was safe and free of infection; a positive result was given after 48 hours.According to the results, a basket could be the best alternative to plastic cutlery.Edible baskets are basically good to the health of the body. It is because these offer iron, protein, fiber, and calcium. These could have a lifespan until 6 months. Once you're not done eating them and already reached their expiration date, then you can just pour some water on these utensils or let them decompose. These can be degraded with three days. Using edible basket is good for everyone and for the whole environment. Edible utensils help limit the use of plastics, resulting to the reduction of plastic wastes.

Key words-: Edible basket, Antimicrobial,~~Characterization, Nutritional analysis~~, Sushi Nori seaweed sheet

Comment [DMF1]: Keywords should not repeat the same words of the title, use "keywords" about the presented research that are useful for searching and indexing

1. INTRODUCTION

The creative innovation of edible cutlery, which is composed of plant-derived materials, allows meals to be presented and then devoured. It was created in India in 2010 by a company called Bakes as a substitute for single-use plastic cutlery (1).Single-use plastic cutlery is a major threat

to the entire ecological community-:hence it is imperative to replace it with better solutions, like edible cutlery. Edible cutlery, which is made from a combination of flours, is frequently called EBO (eco-friendly, biodegradable, and organic). [2] Biodegradability and environmental friendliness are the two key benefits of using edible cutlery instead of plastic, as plastic poses a significant risk to both people and the environment.[3]. Since it doesn't truly require any more preparation, this edible cutlery is regarded as ready to eat. In contrast, they can decay in any kind of environment if they are not consumed because they don't require any particular circumstances to do so. [4]. Ragi, also referred to as finger millet, is a commonly consumed millet in numerous regions of India and Africa.[5].Although it originated in the Ethiopian highlands, it was brought to India long ago. It is regarded as a staple dish among the rural residents of South India. In addition to Karnataka and Tamil Nadu, other Indian states that practice ragi farming include Uttarakhand, Maharashtra, Andhra Pradesh, Orissa, Gujarat, West Bengal, and Bihar.[6]. Because finger millet includes both free sugars and non-starchy polysaccharides, it's an excellent source of carbohydrates. Brown rice, polished rice, and all other millet varieties—including tiny, foxtail, kodo, and barnyard millet—have far less nutrient-dense fibre than finger millet. [7]. Finger millet has a higher concentration of the amino acids methionine and cystine—two of which include sulfur—than milled rice. The amount of tannin in the grain affects how well finger millet breaks down proteins. [8]. Finger millet contains a high percentage of triglycerides, small levels of sterols, 5-6% phospholipids, 10-12% glycolipids, and 70–72% neutral lipids. The percentages of oleic acid, linoleic acid, palmitic acid, and linolenic acid in oils and fats are 46–62%, 8–27%, and 20–35%, respectively. [9]. In addition to having phosphorus, iron, and numerous other trace minerals and vitamins, finger millet is remarkably high in potassium and calcium when compared to other millets and cereals[10]. The finger also has health-promoting properties that are antimicrobial, antioxidant, and anti-diabetic. [9]. Wheat is well known for being an excellent food for maintaining good health because of its high level of dietary fibre, B-group vitamins, minerals, and protein. Wheat has replaced all other grains as the primary grain and is used more frequently than any other cereal for making bread because it includes a special protein called gluten in both large and small amounts. [12]. The structure of edible spoons is derived from processed wheat flour. When the two ingredients are combined, the white flour's proteins react with the water to generate gluten. Throughout rising, the elastic gluten structure swells to make room for the increasing leavening gases. [11].This edible cutlery can be called "ready to eat" since it doesn't require any extra preparation. Edible cutlery can be used as utensils as well as for serving solid or semi-solid foods. It takes a bit for them to get moist. These are environmentally benign since they can be easily discarded and eaten by animals. They don't require any additions to be eaten. When food is scarce due to a lack of resources during a natural catastrophe or conflict, edible cutlery can be provided. (13). Cutlery and edible containers are linked to certain health benefits. The leaves that are used to build the containers often contain compounds like alkaloids and antioxidants that are beneficial to health. Food particles seep through leaves and end up in our food when they are placed there. These compounds may lower the chance of even the deadliest diseases, such as cancer and diabetes. (14). Furthermore, when it

comes to edible cutlery composed of flours, it is possible to select flours that are composed of healthful yet uncommonly ingested grains. (15).The science, art, and technology of enclosing or safeguarding goods for use, sale, distribution, and storage is known as packaging. The market offers a variety of packaging materials, including PET, paper, cardboard, and plastic, in addition to cutting-edge technologies like aseptic packaging, active vacuum, and intelligent vacuum. Among them is packaging that is edible. Food Production Daily reports that a novel form of environmentally friendly edible food packaging has been developed that allows food contained within to be consumed. David Edwards, a biomedical engineer and Harvard professor, created edible packaging, commonly known as the "future of food packaging," or Zoe [16]. With the increasing use of plastics, majorly the disposable ones and with growing consumer awareness of the negative impact of plastic on the environment various paper-based products have been produced (16). This study aims to develop a healthy, edible, and biodegradable alternative to plastic cutlery. A detailed analysis of the nutritional profile and antimicrobial test of the resulting vegan edible basket had conducted, which was never done before.Currently, edible packaging gives replacement to other packaging because it inhibits loss of gas, aroma and moisture of the packed food.(17)

2. MATERIAL & METHOD

2.1 Materials

The study was carried out at BabasahebBhimraoAmbedkar University's Food Science and Technology Laboratory (FSTL). The edible basketwas formed using Refined wheat flour, whole wheat flour, rice flour, bajra flour (pearl millet), corn starch purchased from Lulu Mall Lucknow&powdered sugar, and baking powderwere procured from the Local market of Lucknow.Nori sheet was purchasedfrom Nature’s Soul, New Delhi.

2.1.1Preparation of Edible Basket

This study focused on the preparation of a vegan edible basket by using multigrains, cereals and other ingredients. After various trials were conducted on each constituent’s development process and concentration, many formulations were conducted.

Table 1.Composition of the edible basket by using different flour (g/100g fresh weight?)

Ingredients	Bajra	Multigrains	Refined flour	Whole wheat flour

Flour	45.4g	55.6g	52.8g	48.9g
Powdered sugar	10.5g	11.6g	11.6g	10.9g
Salt	7.6g	6.5g	5.6g	6.7g
Corn starch	10.8g	7.5g	8.6g	8.9g
Melted butter	12.9g	8.9g	10.5g	12.8g
Baking powder	5.9g	5.9g	5.5g	5.9g
Spices	6.9g	4g	5.4g	5.9g

Comment [DMF2]: specify

2.1.1.1Development of Composite Flour

Composite flour for the development of edible basket contained a mixture of 30% refined flour, 20% multigrain, 5% bajra, 20% whole wheat, 20% rice flour and 20% corn starch. Table 2 lists the edible basket's ingredient concentration.

Table 2.Concentration of ingredients for composite flour edible basket

Ingredients for making composite flour	Concentration
Refined flour	**30%**
Multigrain	**20%**
Bajra	**5%**
Whole wheat flour	**20%**
Rice flour	**10%**
Corn starch	**15%**

Comment [DMF3]: g/100g instead of % (to use S.I.)

In the formulation of edible basket composite flour are used as the main ingredients in which Bajra, whole wheat flour, and refined wheat flour are used as the composite flour.

2.1.1.2 Development of different edible basket by using different flour

Three distinct varieties of edible baskets weredeveloped throughout the formulation process using various raw materials. Dough usingbajra flour and other unprocessed components was prepared for the first sample of edible basket. Dough using wheat flour and refined wheat flour along with additional raw ingredients was madefor the second sample of the edible basket. For the third sample, the dough was prepared usingmultigrain and additional raw components. The fourth sample was prepared using anori sheet, other cereals and multigrain.

The edible basket was categorized into three categories: cereal edible basket (type S0), multigrain edible basket (type S3), and nori sheet edible basket (type S4). 2.1.5 Development of edible basket by different materials.

Table 3.Preparation of edible basket by Cereals, multigrain, nori sheet

Samples	Raw materials amount								
	Refined flour	**Bajra flour**	**Nori sheet**	**Wheat flour**	**Multigrains**	**Corn flour**	**Baking powder**	**butter**	**Other ingredients**
S0	20g	10g	-	15g	-	10g	10g	20g	15g
S3	-	-	-	-	50g	10g	10g	15g	15g
S4	20g	-	15g	15g	5g	10g	10g	10g	15g

2.2. Nutritional analysis

2.2.1.Moisture ~~estimation~~

As per AOAC 2020, precisely weighed two gram~~me~~s of the material into a preweighed, dried petri dish. After the sample-containing petri plate was cooled in a desiccator for three to four hours at 110 °C, it was weighed until there was a consistent weight difference. The following formula was then used to determine the moisture percentage by weight.(23)

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

Where, W – weight of empty petri plate (g),

W1 - weight in grams of the dish with the sample before drying,

W2 - weight in grams of the dish with the sample after drying.

2.2.2Ash content

Ash estimation was done~~on the basis of~~based on AOAC 2020. In a dried, pre-weighed silica crucible, weigh two to three gram~~me~~s of the material. The sample was flame-burned until it was smokeless for charring. A muffle furnace was then used to hold the crucible containing the sample at 600 °C for four to five hours. When constat~~the~~ weight was ~~reached~~reached, ~~a consistent value,~~material was ~~it was~~ weighed once~~after being~~ cooled in a desiccator. (24)

Ash content was determined using the formula:

Ash (%) = $\frac{(W2-W3)}{(W2-W1} \times 100$

Where, W1 - weight in grams of the empty crucible,

W2 - weight in grams of the crucible and the sample

W3 - weight in grams of the crucible and ash

2.2.3Fat estimation Fat estimation

As per AOAC 2020, the product's fat content was determined using the Soxhlet technique. The dried powdered sample that has been preweighedis placed in a filter paper thimble and stored in a glass cylinder of the Soxhlet device. This cylinder comes with an intake tube as well as a syphon tube. A water condenser is attached to the top of the cylinder. The entire system is inserted into the neck of a flask with a circular bottom that holds the solvent. Heat is applied to the flask in a hob. The solvent vapor enters the cylinder through the inlet tube and ascend into the condenser. When the condensed solvent comes into touch with the crude organic substance, it dissolves. The instant the solution enters the top of the syphon tube. In this way, the dissolved organic material returns to the flask, ensuring that the solvent vapour in the cylinder is always flowing. After the heating stops, the solvent is distilled out of the liquid in the flask, leaving the organic product behind.(29)

Crude fat (%) = $(W2-W1)\ S \times 100$

Where, W- Weight of empty flask (g)

W2- Weight of flask and extracted fat (g)

S- Weight of sample

Crude fiber (%) = $\frac{(W2-W1)}{(W1)} \times 100$

2.2.4Protein Estimation

The Kjeldahl technique was used to estimate the protein content of the samples. Five grammes of the samples were put to the digestion flask, along with ten millilitres of concentrated H2SO4 and five grammes of the K2SO4:CuSO4:Na2SO4 digestion mixture (equal ratio). The flask was stirred to fully combine the ingredients before being placed on a heater to begin digestion until the mixture became transparent (blue- green in colour). The entire procedure took three hours to complete.

The resulting solution was brought to room temperature and put in a volumetric flask of100 ml.Distilled water was used to top up the volume.Thereafter, ten millilitres of digest were gently added to the distillation tube, along with 10 ml of 0.5 N NaOH.

Due to the presence of NH4OH, a yellowish tint emerged during distillation. The distillate was then titrated with a 0.25mol/L standard HCL solution until a pink colourwas obtained. In order to determine how much titrant was utilised, the initial and final readings were recorded at this phase and marked as Vs. The nitrogen content of acetanilide or tryptophan after the addition of 1 g

ofsaccharose was determined at the titration stage for the blank, and the volume of titrant utilisedwas indicated as Vb. The %N in samples was calculated via the given formula followed by the calculation of % P by multiplying the %N with the protein factor (PF) that is 6.38(28) Protein % = $Vs - Vb \times F \times C \times f \times (N)\, m \times 1000 \times 100$

Where,

Vs-the volume of titrate used for the sample

V_b–the volume of titrant used for blank

F- molar reaction factor of titrant (HCl-1 and H2SO4- 2)

C- concentration of titrant (mol/L) = 0.25mol/L

f- Factor of titrant = 1

M(N)- Molecular weight of Nitrogen = 14.007g/mol

m- sample weight

1000- conversion factor(ml into L)

%N- % weight of N

2.2.5 Water absorption capacity (WAC)

For a predefined amount of time, water was poured over the edible basket. Tissue paper was used to remove any remaining surface water after the sample was taken out of the beaker. To find the percentage of water absorption, use the following computation. (9)

WAC (%) = weight of cutlery after water− weight of cutlery before water)/ weight of cutlery before water × 100

2.2.6.1 TSS (Total Suspended Solid)

- The surface of the refractometer prism was cleaned and allowed to dry.
- Afterwards, a tiny quantity of sample was applied to the refractometer's prism.
- After looking through the eyepiece, point the prism away from the sun and towards a bright area of light.
- Stayed focused, taking a reading of the blue color's base on the scale. *H*
- After that, note the percentage Brix 20).

2.2.6.2 Total Soluble Solids (TSS)

Using 4.7 cm Whatman GF/C glass fibre filters to filter a known volume of material and drying it at 103–105 °C allowed for the estimation of TSS. The TSS was calculated using the difference in filter weight pre- and post-filtration. (20)

2.2.7SEM

The morphological surface characteristics of the samples were analyzed using a scanning electron microscope model (JSM 6490 LV, JEOL, Japan)2. Multiple magnifications were used to examine the sample, including ×800, ×2000, and ×5000Before scanning, a small layer of platinum was applied to the film samples to produce electricity. The working distance of 7.4 mm and the acceleration voltage of 15 kV were selected. The SEM apparatus was operated at a current of 58 µA [18]

2.2.7.1 EDS

Energy- dispersive X- ray spectroscopy (EDS) analysis displays the chemical characteristics of the developed edible basket as shown in 3.2.4.3

2.2.8FT- IR

Thermo Fisher Instruments, USA provided the Nicolet-6700 FTIR spectrometer, which was used to analyze edible cone powders in order to identify their functional group. The 400–4000 cm–1 wave number range was used to acquire the spectra, and Singh et al.'s analysis of the resulting spectra was performed. (17)

2.3Antioxidant ~~activity~~capacity

The AOAC method was used to assess the extracts' capacity to scavenge DPPH (2,2-diphenyl-1-picrylhydrazyl) radicals. After 30 minutes of incubation, 1 mL of the extract and 1 mL of the 0.4 mMethanolic solution of DPPH radicals were combined, and the absorbance at 517 nm was determined. The percentage (%) suppression of free radical scavenging was used to express the ability. (21)

DPPH radical scavenging activity (%) = $(1 - absorbanceofsample/\ absorbanceofcontrol) \times 100$

Comment [DMF4]: equivalents of the radical are needed for the units of activity, the % is not considering volume or extraction, is uncomplete

2.4Antimicrobial analysis

2.4.1 Agar diffusion method

Tests, long-term storage, enrichment, upkeep, and cultivation are just a few uses for these mediums. The formulation limits the amount of time that each functional classification can be stored. "Chemiochemical-physical characteristics of the medium which are retained" refers to the length of time certain cultural media have been kept on display. There is generally a short shelf life of 30 to 90 days for agar plates, which are Petri dishes that contain commercially available

solid growth material. Factors such as medium composition (ranging from general-purpose to specialized formulations), sterilization process, storage temperature, exposure to light, and packaging are significant determinants of overall shelf-life and microbiological growth efficiency. Several studies have found that the shelf life of packed agar plates used for drug sensitivity testing, isolation, enrichment, or selection varies. Microorganisms encompass various entities such as bacteria, fungus, and parasites. Ulysses et al., for example, examined twelve different media types of varying complexity that were wrapped in shrink-wrap film, stored at 5 °C, and coded for periods of three to thirty days. Shelf-lives ranging from 90 to 120 days can be awarded to the medium after tests for pH, sterility, weight loss (water loss), and the ability to maintain bacterial growth have been conducted. It is required to support the target microorganism's development and characterization. (20)

2.4.2Total Plate Count Microbial Shelf Life

- Dilute a sample up to a 10-4 series.
- Pipped out 100µl onto the centre of an agar plate surface from the relevant required dilution series.
- Lighted a lamp with the glass spreader.
- Using a sterile glass spreader, uniformly distribute the sample across the agar surface while carefully rotating the petri dish underneath.
- For a whole day, the plate was incubated at 371C.
- After the incubation period, take out all the petri plates that had anywhere from 30 to 300 colonies. Plates containing more than 300 colonies are deemed too numerous to count (TMTC) because they cannot be tallied.
- The dilution factor multiplied by the number of colonies multiplied by the quantity of specimen added to liquified agar yielded the number of bacteria (CFU) per millilitre or gramme of sample.
- This procedure was carried out on several days (days 1, 3, and 5) using the same sample.(20)

2.4.3Determination of Colony Forming Units

- The aseptic procedure was used to make the first dilution, which involved adding 1 millilitre of sample to 9 millilitres of sterile peptone water. It's a 1/10 dilution.
- Keeping the tube between the palms of both hands and quickly spinning it to create a vortex, the 10-1 dilution is then shaken to distribute the germs and break up any clumps.
- Following the 10-1's shaking, take off the cap and aseptically move 1 millilitre to a second 9 millilitre peptone water container.
- Since that this was a 10-1 dilution, the second blank displays a 10-2 dilution of the original sample. After that, a 10-4 dilution was achieved.
- Agar plates were center-mounted, and 100µl was pipetted out from the corresponding required dilution series.

- After adding the chilled medium to the plate, the agar-sample mixture was quickly and carefully mixed while the plate was placed on the LAF cabinet's platform or table top.
- When the agar had fully set, the pour plates were turned over and incubated for a full day at 37ı C.
- After the incubation period, choose every petri dish that has between 30 and 300 colonies. Plates with 300 colonies or more are too many to count (TMTC) and cannot be totaled.
- Too few to count (TFTC) refers to plates with fewer than 30 colonies. Each plate should have its colonies counted.
- By dividing the number of colonies by the dilution factor and multiplying the amount of specimen put to liquified agar, one can calculate the number of bacteria (CFU) per millilitre or gramme of sample.

Number of Bacteria/ml = Number of colonies observed/ amount plated on media*Dilution factor. (20)

2.5CFU

Represents the unit of measurement for live bacteria or fungus called colony forming units. With CFU, viable cells are estimated as opposed to a direct microscopic count, which counts all cells, alive or dead. It took incredible growth to produce a viable colony, and at the time of counting, it was difficult to determine if the colony originated from one or 1,000 cells. CFU/ml for liquids and CFU/g for solids are the stated findings, which take this uncertainty into account.20)

Statistical analysis??

Comment [DMF5]: missing

3 Result and Discussion

3.1Proximate analysis

Data presented that the proximate analysis of edible basket prepared by using cereals,multigrains andnorisheet. Results of moisture content of (nori sheet) S4 Nori sheet had higher protein 41.4% as compared to other ingredients. As nori sheet the is richest source of, protein,

Table 4.Proximate analysis of edible basket

Sample	Moisture %	Protein %	Ash %	Total Fat %
S0	13.7	11.6	1.22	5
S3	13.1	8.8	1.00	1.5
S4	13.19	41.4	2.00	0.95

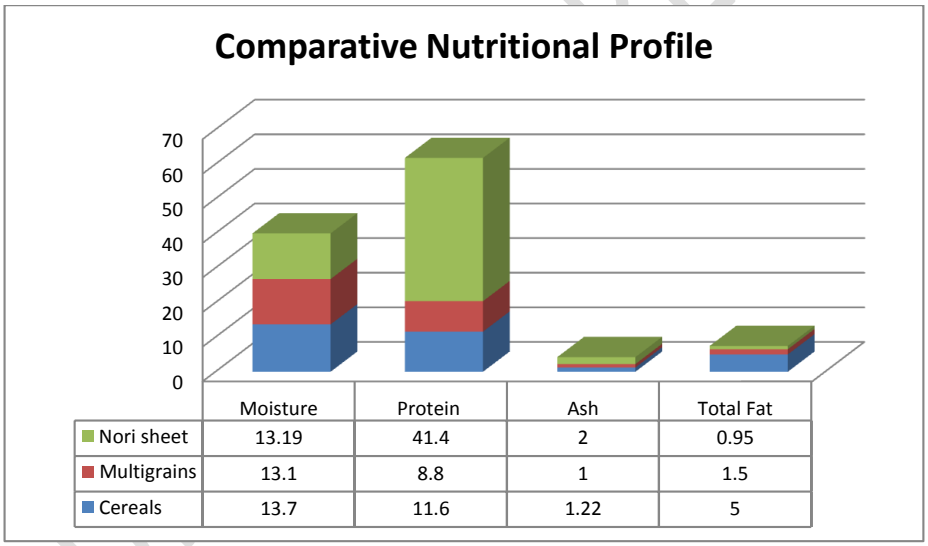

Figure1. Comparative nutritional profile of S0, S3, S4 (cereals, multigrains, nori sheet)

Comment [DMF6]: any statistical significance???

3.2.3 Water absorption capacity (WAC)

Within its structural limits, a product's ability to absorb water is known as its water absorption capacity. I discovered that the nori sheet has the greatest capacity to absorb water .In Table 5, the water absorption capacity of three distinct edible basket samples (S0, S3, S4) was compared at various time intervals (5, 10, 15, 20, 25, and 30 minutes). Sample S4, which contained 4g of

multigrain powder and 15.5g of rice flour, had higher WAC values than the other samples. The characteristics of flours with higher protein and fibre content are associated with a higher rate of water absorption. Thus, the higher protein and fibre content in these rice flours and multigrain powders may be the reason for increased WAC.The S4 sample spoon had a relatively higher water absorption capacity than the S0 and S3 basket samples. While the S0 basket is produced with cereals, the S3 and S4 baskets are prepared with multigrains and nori sheets, respectively.

Table5. Thewater absorption capacity of different basket

Time (min)	**WAC (%)**		
	S_0(cereal)	**S_3 (** multigrain)	**S_4(** nori sheet)
5 min	9.70±0.04	10.10±0.09	10.25±0.05
10 min	19.51±0.05	20.21±0.08	20.51±0.09
15 min	25.70±0.09	26.20±0.09	26.50±0.08
20 min	25.70±0.08	29.90±0.10	30.21±0.10
25 min	34.50±0.16	34.70±0.12	35.90±0.24
30 min	37.60±0.12	38.50±0.14	39.50±0.22

Values are means± Standard Deviations (SD) of three determinations (19)

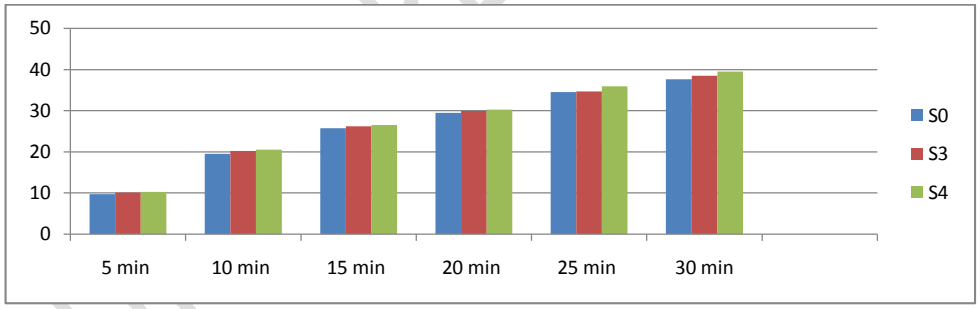

Fig2. Water holding capacity of edible basket

3.2.4 SEM

The edible basketwas analyzed and studied for its morphology:

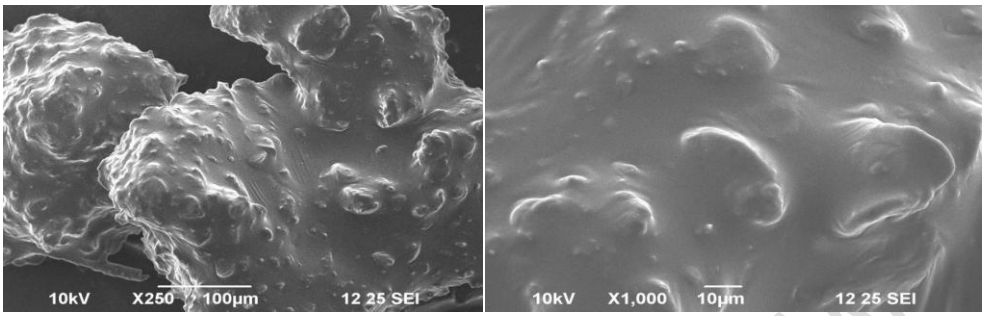

Figure 3. SEM images of Premix Powder at X250 & X1000 level magnification

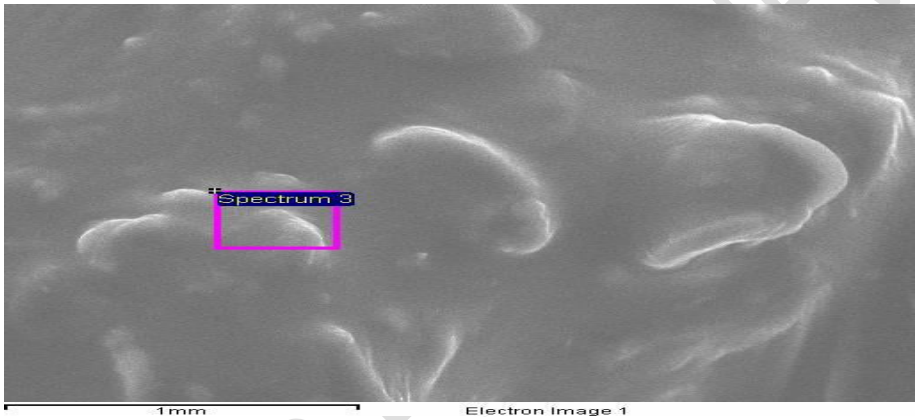

Fig 3a. Scanning electron microscope morphology of the edible basket powder surface

The scanning electron microscope morphology of the edible basket powder surface is shown in the above figure. The irregular and rough structure of the basket powder was caused by the combination of rice flour and nori sheet, with some nori sheet particles visible.

List 1.Structure of the basket powder

Element	**Weight%**	**Atomic%**
O K	78.09	91.93
Na K	4.44	3.64
Cl K	4.69	2.49
K K	1.85	0.89

Pt M	10.94	1.06
Totals	100.00	

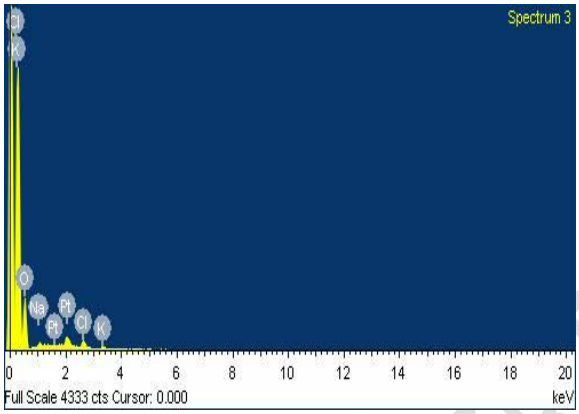

Figure 4. EDS Spectrum

The distribution of minerals in the edible basket sample was established using EDX and SEM. O, Na, Cl, K, M, and Pt were the elements found in the produced edible basket. In list no. 1, the percentage of these elements is provided. Based on Figure 4, it is evident that the element with the highest concentration is Oxygen (78.09%), while Potassium (1.85%) is the element with the lowest concentration.

3.2.5.1 FT-IR

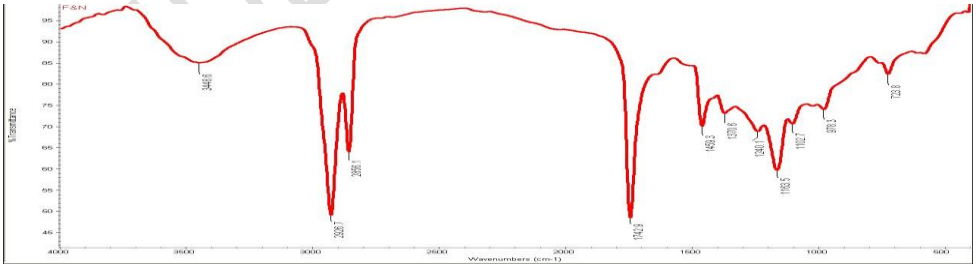

Fig 5.FT-IR analysis of edible basket on the basis of their morphology

The edible basket preparation entails physically combining the components because the FT-IR data for the consumable did not disclose any new peaks. The absorption band observed at 3000-

3500 cm-1 is indicative of the stretching vibration of the OH group in relation to the intra- and intermolecular interactions of the hydroxyl group present in the adjacent starch molecules. The creation of hydrogen bonds between the constituent materials in each film is revealed by (Guadarrama-Lenzama). As a result, hydrogen bonding may be crucial to the development of films and their unique qualities. The stretching vibrations of the glycerol's C-HH and C-H2 bonds correlate to 2856.1–2926.7 cm-1.

3.3Antioxidant activity

Edible cutlery spoons with added multigrain flour, grains, and nori sheets have antioxidant properties. Results indicate that increasing the amount of multigrain powder and cereals in the formulations enhanced their antioxidant activity. According to the results, sample S4 (3.116%) had greater antioxidant activity values than samples S3 (2.445%) and S0 (1.968%). There is a clear correlation between the total phenolic content of multigrain powder and the greater antioxidant activity values.(21)

Table 6. Antioxidant activity of samples

Sample	**Free Radical scavenging activity (%)**
S_0	1.968±0.12
S_3	2.445±0.14
S_4	3.116±0.14

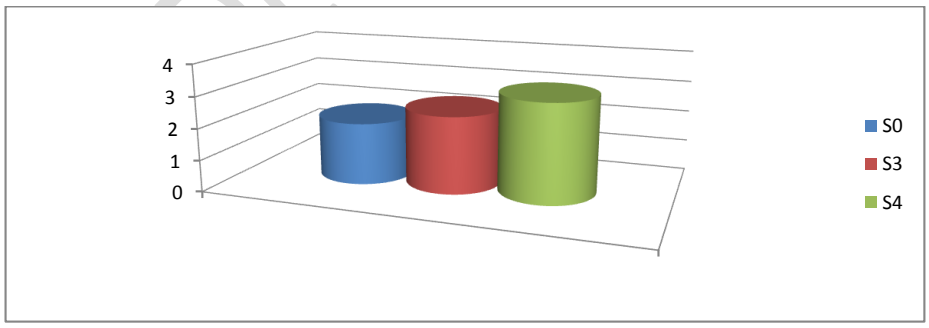

Fig 6. Graph of scavenging activity

The yield percentage of cereals, Multi grain, and Nori sheet was calculated through equation 1 and the yield % coming from the raw stage are shown in Table 7.Total Extracted Yield (%):

Table7. Tabular Representation of Total Extraction Yield

Selected Raw Sample	Initial Weight(Raw)	Final Weight (Dehydration)	Total Extracted Yield (%)
Cereals	500gm	300grm	30
Multi grains	500grm	250grm	25
Nori Sheet	300grm	200grm	20

During the processing of raw selected sample we observed that the highest yield percentage seen in the cereal sample and after that Multi grain and Nori sheet respectively show in 3.3.2

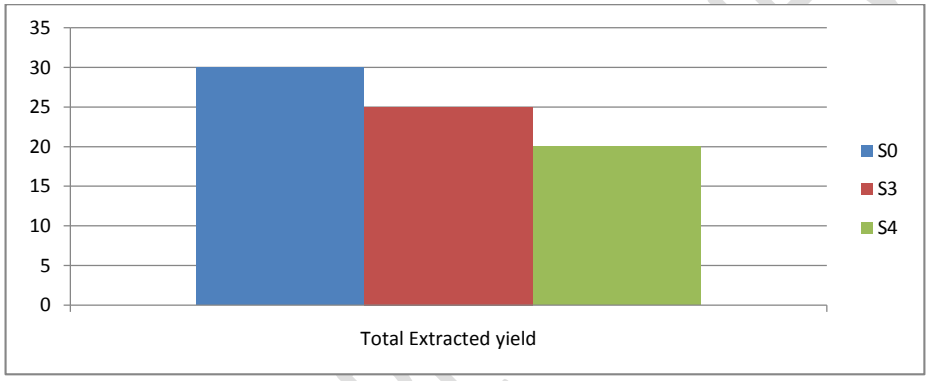

Fig7. Graphical Representation of Total Extraction Yield

3.4 Analysis of microbes

3.4.1 Report on the test

- Calculate the colony forming units (CFU/ml) using the test.
- Utilised method: Pour Plate Method for Total Plate Count.

3.4.2 Type of Media:

• Total number of plates: Agar media plate count s

Total suspended solid (TSS)

Test sample (T1)

3.4.3Observation and result:

Fig 8. Shelf- life on plate count media in different time period for sample T1

Table 8 Total % Brix (T1 sample)

S. No.	Sample code	% Brix x	Average TSS ± SD
1.	T1	2%	2.33 ± 0.471
2.	T2	2%	
3.	T3	3%	

Table 9. Total CFU count

S. No.	Sample code	PCA	
1.	T1	Count	CFU\ ml
		65	65×10^{-J}

Table 10.Shelf life in different time period (T1 sample)

S.No	Sample code	Day1		Day3		Day5	
1.	T1	Count	CFU\ml	Count	CFU\ml	Count	CFU\ml
		3	3×10^{-J}	6	6×10^{-J}	66	66×10^{-J}

*** PCA: SDA:** Sabouraud dextrose Agar (yeast and mould count); MAM: MacConkey Agar Media (total coliform count); Plate count Agar (total plate count); The dilution employed was 10-4, and the plated sample was 100 µl. Not relevant numerous to count, TMTC. (20)

4 Conclusion

The disposal of plastic trash is the main issue in solid waste management. The use of plastic cutlery and containers is growing daily, particularly as a result of the elevated trend of meal delivery apps. The purpose of this paper is to offer an alternative to plastic cones. A biodegradable and edible basket was created, and its proximal components were examined. The created baskets were discovered to have a high protein content of 69.63%.Under SEM inspection, the created basket's shape was found to be smooth. Aside from this, the sample's projected shelf life was one month because, after five days in an open setting, no microbiological growth was found in the sample. The same SEM study was performed for confirmation, and no microbial growth was found. EDS and SEM (scanning electron microscopy). Furthermore, an examination of the FT-IR spectra showed that the alkane group (CH) was located at 2939.52 cm-1 and the hydroxyl group (OH) was at 3402.43 cm-1Using FT-IR and SEM methods, a shelf-life analysis was also conducted. Images captured with a 20kV SEM of a material exposed to the elements for 30 days show no signs of microbial proliferation. In the FT-IR, an absorption band may be observed between 3000- 3500 cm1.An environmentally friendly method of using disposable cutlery is provided by the current study. Further research is needed to lower the cost of biodegradable cutlery so that it can rival plastic silverware in the market. The main goal of Edible Basket is to promote environmentally friendly lifestyles by eliminating plastic waste from

food consumption. Since they began making them, they have actually been able to replace the waste product, which was 1.2 million plastic utensils. This review concludes that because edible basket packaging and coating are edible and biodegradable, they can be used in the food industry and contribute to a decrease in industrial waste and environmental pollution. A key component of the sustainable packaging system is edible packaging. It helps lessen dependency on nonrenewable resources. The intrinsic qualities of the film-forming materials have a major role in the effectiveness and functional characteristics of edible packaging material.

References

1) Poonia A, Yadav P. Trends in edible cutlery and tableware. Beverage & Food World. 2017;44(10):36-38. https://www.researchgate.net/publication/337103303

2) Das S. How to save the planet, a spoon at a time, 2016. Retrieved from https://www.hindustantimes.com/morelifestyle/how-to-save-the-planet-a-spoon-at-a-time/storycK3yrQNSgkQh9dqucXatVK.html 8. Devi PB, Vijayabharathi R, Sathyab.

3) Munir S. Edible cutlery: The future of Eco Friendly Utensils, 2017. Retrieved from https://www.kickstarter.com/projects/1240116767/ediblecutlery-the-future-of-eco-friendlyutensils?_pxhc=1604109376360

4) Roy TR, Morya S. Edible cutlery: An eco-friendly replacement for plastic cutlery. Journal of Applied and Natural Science. 2022;14(3):835-843. https://doi.org/10.31018/jans.v14i3.3627.

5) Shobana S, Krishnaswamy K, Sudha V, Malleshi NG, Anjana RM, Palaniappan L, et al. Finger millet (ragi, Eleusinecoracana L.). Advances in Food and Nutrition Research, 2013, 1–39. https://doi.org/10.1016/b978-0-12- 410540-9.00001-6

6) Bellundagi V, Umesh KB, Ravi SC. Growth Dynamics and forecasting of finger millet (ragi) production in Karnataka. Economic Affairs. 2016;61(2):195. http://dx.doi.org/10.5958/0976-4666.2016.00027.9

7) Sinha NM, Kumari N, Dikshit N, Kant S. Ragi Traditional But Nutritional Especially in the Era of COVID-19. Indian Journal of Clinical Practice. 2022;32(10):20-25. https://ijcp.in/

8) . Gull A, Jan R, Nayik GA, Prasad K, Kumar P. Significance of finger millet in nutrition, health and value added products: a review. Magnesium (Mg). 2014;130(32):120. https://www.jecet.org/

9) Devi PB, Vijayabharathi R, Sathyabama S, Malleshi NG, Priyadarisini VB. Health benefits of finger millet (Eleusinecoracana L.) polyphenols and dietary fiber: a review. Journal of food science and technology. 2014;51(6):1021–1040. https://doi.org/10.1007/s13197- 011-0584-9

10) Anitha S, Givens D, Botha R, Kane-Potaka J, Sulaiman N, Tsusaka T, et al. Calcium from Finger Millet: A Systematic Review and Meta-Analysis on Calcium Retention, Bone Resorption, and In Vitro Bioavailability. Sustainability. 2021;13(16):8677. http://dx.doi.org/10.3390/su13168677

11) Krishnapriya M, Jadeesh S. Textural analysis of edible spoons. International Journal of Creative Research Thoughts (IJCRT). 2021;9(9):c610–c614. https://doi.org/10.6084/m9.doi.one.IJCRT2109284

12) Choeybundit W, Shiekh KA, Rachtanapun P, Tongdeesoontorn W. Fabrication of edible and biodegradable cutlery from morning glory (ipomoea aquatic) stem fiber-reinforced onto soy protein isolate. Heliyon. 2022;8(5):1-8. https://doi.org/10.1016/j.heliyon.2022.e09529

13) SangitaSood,Deepshikha, "Development and Quality Evaluation of Edible Plate" *ARC Journal of Nutrition and Growth* . 2018; 4(2) : 1-4.

14) Sherrif A. Not just Banana, eating on these native leaves can leave you nourished too! The Better India. Retrieved from https://www.thebetterindia.com/151444/bananaleaves-indian-food-tradition-science-news/ (2018, July 20). Accessed 2022, December 21.

15) Vasudeva S. All you can eat: Are edible spoons the future of cutlery? NDTV Food. Retrieved from https://food.ndtv.com/opinions/all-you-can-eat-areedible-spoons-the-future-of-cutlery-1208615 (2017, July 18). Accessed 2022, December 21.

16) Zoe Bain. Is Edible Packaging the Future of Packaged Foods?. 2022. Available from: https://www.delish.com/food/news/a38926/edible-food-packaging/

17) Krochta JM, De Mulder-Johnston C. Edible and biodegradable polymer films: Challenges and opportunities. Food Technology. 1997;51:61-73

17) Singh, S. J., &Chinnamuthu, P. (2021). Highly efficient natural-sunlight-driven photodegradation of organic dyes with combustion derived Ce-doped CuO nanoparticles. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, *625*, 126864.

18) Huang JY, Liao JS, Qi JR, Jiang WX, Yang XQ. Structural and physicochemical properties of pectin-rich dietary fiber prepared from citrus peel. Food Hydrocolloids. 2021 Jan1;110:106140

19) Pastor-Cavada E, Drago SR, González RJ, Juan R, Pastor JE, Alaiz M, et al. Effects of the addition of wild legumes (Lathyrusannuus and Lathyrusclymenum) on the physical and nutritional properties of extruded products based on whole corn and brown rice. Food Chemistry. 2011;128(4):961–967. https://doi.org/10.1016/j.foodchem.2011.03.126

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21) Najjar Z, Kizhakkayil J. Shakoor H, Platat C, Stathopoulos C, Ranasinghe M. Antioxidant potential of cookies formulated with date seed powder. Foods. 2022;11(3):448–452. https://doi.org/10.3390/foods11030448

22) Vyshali P, Serena S, Muthamma PB. Development of an Edible and Biodegradable Tableware Using Fruit Wastes - An Alternative to Plastic Tableware. International Journal of Food and Nutritional Sciences. 2022;11(4):85– 90. https://doi.org/ 10.4103/ijfans_114_22

23) Thagunna B, Shrestha G, Karki R, Barnal K. Development And Quality Evaluation Of Biodegradable Edible Cutlery: A Replacement For A Conventional One. Asian Journal Of Pharmaceutical And Clinical Research. 2023;16(2):49–52.