Incorporation Of Herbs in Edible Cutlery

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Abstract—

*Cutlery manufactured from edible plant materials that are frequently infused with herbs is referred to as herbal edible cutlery. The purpose of these utensils is to provide a sustainable substitute for conventional single-use plastic and even hardwood cutlery. The concept is to produce edible and biodegradable cutlery to cut down on waste and encourage sustainability. Our Edible Cutlery is composed of wheat flour, rice flour and sorghum flour, and herbs are added for flavor and potential health advantages. The addition of these powders not only improves the nutritional profile but also adds unique flavors. The final product was made with ratio of 70:4:16 of wheat flour, rice flour and sorghum flour. Chemical parameters viz. water absorption, microbial count, protein and total fat content are estimated at 37%, 3*10^1 CFU/gm, 8.7gm and 0.5gm respectively. The product was also evaluated for nutritional composition analysis, antioxidant capacity and Phyto-chemical analysis. The energy content in the edible cutlery is calculated and found to be 377 Kcals.*

Keywords*— edible cutlery, herbs, starch, sustainable development, waste management, dietary supplement.*

1. INTRODUCTION

The over use of plastic is a catastrophe for the environment because only 9% of it is recycled. The existence of plastic polymers in the environment leads to defragmentation since many of the plastics that are currently in use do not disintegrate into smaller pieces and particles Numerous alternatives have entered our lives as a result of the growing knowledge of the negative impacts of single-use plastics and their increasing use. Therefore, there is an urgent need for creative inventions that can solve this environmental catastrophe, and our study on edible cutlery focuses in part on that. In addition to being tasty and wholesome, edible cutlery is the solution to the environmental problem in the plastic world, where the market is growing at a rate of thirty percent and filling landfills with non-recyclable waste.

Edible cutlery is a revolutionary concept which allows food to be consumed along with the cutlery. Therefore, when made from the ideal ratio of food groups, a creation like

edible cutlery functions as an additional type of nutrition that enhances both its functionality and palatability. It acts as a functional food by using readily available local ingredients, such as whole wheat flour, salt, water, natural preservatives, binding agents, and herbs like Moringa leaves powder, Tulasi powder, and Bermuda grass powder, which are used in this study. In addition, the inclusion of all the aforementioned components in this study helps to prevent malnutrition and helps in achieving the daily recommended nutritional requirements in a cost-effective way. Edible cutleries are going to be an environmentally friendly alternative to the present single-use plastic cutleries. It is going to be made from edible ingredients such as rice, wheat and sorghum (millet or jowar), which serves as the core elements. Sorghum takes 60 times less water to cultivate sorghum compared to rice. The crop has the ability to grow in 95 percent of the world's arable land. Sorghum has a super absorbent ability which makes the usage of edible cutleries extremely versatile, that is, it will not only be suitable with rice or wheat-based cuisines. It might however, compliment well with ice cream, yogurt, and variety of soups, as it does not degrade within hot or cold liquids. After moulding Drying process takes place. The heating process evaporates all the moisture from the dough, resulting in the final product being a hard cookie-like spoon [27].

New factors that should be considered while creating edible cutlery include functionality, palatability, nutritional profile, cost-effectiveness and nutraceutical profile, that may be of concern when making edible cutlery. Therefore, the current study aims to lessen the gap between malnutrition and recommended dietary intake by the concept of edible cutlery. To minimize plastic waste generated from disposable cutlery and to enrich the nutritional content, Edible cutleries are created.

2. REVIEW OF LITERATURE

A. Wheat Flour

Locally available wheat flour is purchased from the market. Wheat flour, especially whole wheat flour, is a good source of essential nutrients. Along with fiber, which supports a healthy digestive system, it also contains iron and B vitamins, among other vitamins and minerals. Whole wheat flour has the potential to improve heart health and control blood sugar levels. When making edible cutlery, wheat flour is the main component. In addition to giving the dough structure and texture, it may be moulded into a variety of shapes when combined with water and other ingredients. The dough can be baked or dried to produce strong, edible utensils that provide a sustainable substitute for conventional plastic silverware. The inclusion of external grain and germ components has a negative impact on the dough qualities of whole grain-based bread items, even though they have health benefits. [16].

B. Rice Flour

An alternative to gluten-containing flour that may be healthier is rice flour. It is a simple food to digest, a healthy energy source, and ideal for people who are intolerant to gluten. In addition, brown rice flour has more nutrients such as fiber, vitamins, and minerals than white rice flour. Since rice flour affects the final product's texture and structure, it is essential for the production of edible cutlery. It is also a source of starch. Rice flour creates a dough that can be formed into edible utensils when combined with water and other substances. It acts as an alternative for making environmentally friendly and sustainable silverware. When preparing a diet that is both appropriate and preferred by the elderly, rice and rice flour would be good choices [18]. In order to achieve smooth and soft textures in food preparation, flour needs to have a high water-absorbing capacity. The ability of food to absorb oil is correlated with rancidity, which is a key indicator of shelf life [19]. Instead of the more widely used milk and soy proteins, rice proteins are utilized as value-added ingredients in nutritional goods, such as sport nutrition supplements and baby formulae [20].

C. Sorghum Flour

Sorghum flour offers several health benefits. Sorghum is the fifth most important traditional crop and main basic food crops, in many developing countries [23]. It's a good source of dietary fiber, which helps regulate weight and supports digestive health. Furthermore, sorghum flour has a high antioxidant content, which may offer protection against a number of chronic illnesses. It is appropriate for people with celiac disease or gluten sensitivity because it is gluten-free. Additionally, sorghum flour contributes to general nutritional well-being by containing important elements including iron, magnesium, and B vitamins. Because of its high starch concentration, it can aid in the dough's binding and structure, which keeps the edible cutlery together. Sorghum flour gives the cutlery a distinctive flavor profile and is gluten-free, making it acceptable for anyone with dietary sensitivity. Sorghum is also a drought-resistant grain, which makes it a sustainable option for producing environmentally acceptable substitutes for conventional plastic utensils. Sorghum has been gaining popularity because it is devoid of gluten and novel hybrids that are suitable for human eating have been developed. Sorghum is becoming more and more popular as a wheat allergy sufferer's attractive substitute in snack meals and baked goods [24].

D. Moringa Leaf Powder

Moringa leaves have numerous health advantages and acts as a nutritional powerhouse. Along with minerals like calcium and potassium, they are full of vitamins, including vitamins A, C, and E. Rich in antioxidants, moringa can help to shield cells from the harm that free radicals do. The leaves may help decrease cholesterol and blood sugar levels and also contain anti-inflammatory chemicals. Moringa leaves can be a beneficial addition to your diet to enhance general health. Because they contribute nutritional value and possible health advantages, moringa leaves can be used in edible herbal cutlery. The combination used to make edible cutlery can have its nutritional value increased by adding moringa leaf powder. Malnutrition has been treated with moringa tree leaves, especially in small children and nursing moms. A single rounded tablespoon (8 g) of leaf powder provides nearly all of the vitamins, 40% of the calcium, 23% of the iron, and 14% of the protein that the body needs [5]. Moringa's antioxidant and anti-inflammatory characteristics may provide extra health benefits, making the cutlery both environmentally friendly and nutritious.

E. Tulasi Leaf Powder

Tulsi, or holy basil, is associated with various health benefits. Its leaves contain essential oils and phytochemicals with antimicrobial and anti-inflammatory properties. The adaptogenic qualities of Tulasi are well known for assisting the body in adjusting to stress. It might strengthen the immune system, promote respiratory health, and facilitate digestion. Incorporating Tulsi leaves into your diet or as herbal infusions can be a way to harness its potential health benefits. The inclusion of Tulasi (holy basil) leaves in edible herbal cutlery can add both flavor and potential health benefits. Tulasi leaves, known for their antimicrobial and anti-inflammatory properties, could enhance the overall profile of the cutlery. Additionally, they might impart a unique herbal essence to the cutlery, making it a more sensory and potentially therapeutic experience when used for eating. Several bioactive secondary metabolites found in Tulasi work alone or in concert to block inflammatory pathways. Additionally, there is data that suggests Tulsi may help treat metabolic problems in addition to pharmacotherapy and diet, which could lessen the need for high dosages of potentially harmful medications. [8].

F. Bermuda Grass Powder

Cynodon dactylon, popularly known as Bermuda grass, is a traditional herbal medicine with possible health benefits. It contains essential micronutrients such as calcium and iron and minerals such vitamins A and C. Bermuda grass has antioxidant and anti-inflammatory qualities and is utilized in certain cultures to treat digestive and respiratory

disorders. Using Bermuda grass powder in herbal cutlery can increase nutritional value and offer potential health advantages. Bermuda grass is high in vitamins and minerals, which can improve the nutrient profile of flatware. Its antioxidant and anti-inflammatory characteristics may provide further health benefits. For centuries, Indian herbalists have been using C. dactylon (Bermuda grass) as an oral supplementation for many ailments like mucus, fevers, diarrhea, diabetes, bleeding, cardiac arrhythmia and ulcer [26].

3. MATERIALS AND METHODS

A. Flowchart

Cleaning and grading of raw material
↓
Adding of binding agents and herbs
↓
Pulverize it into flour
↓
Weighing of composite flour
↓
Made into dough
↓
Rolling into sheets
↓
Shaping by using mould
↓
Drying (in hot air oven for 17 mins at 180 degrees Celsius)
↓
Edible cutlery

B. Material Selection

The selected ingredients used in the preparation of the edible cutlery are whole wheat flour, moringa leaf powder, Tulasi leaf powder, Bermuda grass powder, sorghum flour, rice flour was selectively procured from the local markets.

C. Sample Preparation

Flour such as sorghum flour, whole wheat flour and rice flour and herbs such as Moringa leaves, Tulasi leaves and Bermuda grass are purchased from the market, and checked for its quality. Thereafter, it is sun-dried for a day within a mesh fabric cover. They are ground into a fine powder. Next, specific amounts of whole wheat flour were weighed out for every variant**.**

Figure 1. Sample preparation

D. Preparation Of Moringa Leaves Powder

Usually, drying and crushing moringa leaves into a fine powder is how moringa leaf powder is manufactured. Selecting healthy moringa leaves from mature trees is the first step in making moringa leaf powder. Thoroughly wash the leaves to get rid of any pollutants or debris. Let them air-dry in a shady spot to avoid losing any nutrients. Before proceeding to the following stage, make sure the leaves are totally dry. Since the stems of the dried leaves can be rough and may not grind smoothly, remove them. To make a fine powder out of the leaves, use a food processor or a clean, dry grinder. For improved usability, a smooth consistency must be achieved. To preserve the nutritious value of the moringa powder, keep it sealed and out of direct sunlight and moisture. The nutritious value of the leaves is preserved during this method. Rich in vitamins, minerals, and antioxidants, it may help with better energy, immune system performance, and general well-being, among other health benefits. Moisture is quickly absorbed by moringa leaf powder, and the product may reabsorb it during or after grinding. For this reason, in order to lower the moisture content, moringa leaf powder should be dried for 30 minutes at 50 degrees Celsius. Powder that has been stored will deteriorate and lose some of its nutrients if it is exposed to heat or light. Under the following circumstances, moringa leaf powder can be kept for up to six months: Pure, dehydrated powder kept below 24°C (75.2 °F) in airtight receptacles shielded from light and moisture [5].

E. Preparation Of Tulasi Leaves Powder

To make Tulsi (Holy Basil) leaf powder firstly select fresh and healthy Tulsi leaves from the plant. Wash the leaves thoroughly to remove any impurities. Air-dry the leaves in hot air oven at low temperatures around 40ºC so that it does not lead to the loss of essential oils. This helps preserve their nutritional content. Remove the stems from the dried leaves. Use a clean and dry grinder to finely grind the Tulsi leaves into a powder. Store the Tulsi leaf powder in an airtight container, away from sunlight and moisture. Health benefits of Tulsi leaf powder include its potential as an adaptive, helping the body cope with stress. It also has antimicrobial properties, supports respiratory health, and may have anti-inflammatory effects.

F. Preparation Of Bermuda Grass Powder

Bermuda grass, also known as Cynodon dactylon or Durva grass, is used in traditional medicine for its potential health benefits. Processing Bermuda grass into powder involves several steps: Choose fresh and healthy Bermuda grass, ensuring it's free from contaminants. Wash the grass thoroughly to remove any impurities. Air-dry the grass in hot air oven at 38ºC until it is completely dry. This can be done by spreading the grass in a thin layer. Use a clean, dry grinder or mortar and pestle to grind the dried Bermuda grass into a fine powder. Ensure a consistent and smooth texture. Store the Bermuda grass powder in an airtight container, away from sunlight and moisture, to preserve its quality. Bermuda grass have antioxidant, anti-inflammatory and diuretic effects.

G. Dough Making

The ingredients are ready to be combined and worked into a dough once they have all been processed. The ratio required determines which percentage of substances to use. After the materials were ground into a fine powder and sieved to create a homogenous powder, wet ingredients like oil and water were added. The dough was then well kneaded after adding water, one teaspoon at a time. Once the water was incorporated, the dough with added value was prepared**.**

Figure 2. Dough making

Figure 3. Edible cutlery making spoon and plate

H. Edible Cutlery Making

Using a rolling pin, each was separately rolled out into a 2 mm sheet. The cutlery moulding machine is then used to form the edible cutlery. To maximize its functionality, a drop of vegetable oil (rice bran oil) is applied on the dough cutlery after it has been formed. To guarantee adequate sturdiness and overall cooking, tiny holes are pierced into them. An experimental temperature of 150°C was used to preheat the oven for about Ten minutes. To guarantee correct heating and browning, the moulded cutlery is then placed inside the preheated oven and baked for 17 minutes at 180°C. After baking, they are allowed to come down to room temperature before being kept. They are then transferred into airtight container and kept in a cold, dark place until they are evaluated.

Figure 4. Edible Herbal cutlery making

4. RESULT AND DISCUSSION

Through various trials and errors and by combining ingredients at different composition the edible herbal cutlery was prepared. The various compositions done at different trials is mentioned below. Trial 6 was standardized by considering various factors like chemical composition, energy and starch contents, water absorption capacity, moisture content ,nutritional and Phyto-chemical analysis. Consumers' acceptability was analysed .

Table 1.Composition of trials

RAW MATERIALS	TRIAL 1 (100 gm)	TRIAL 2 (50 gm)	TRIAL 3 (50gm)	TRIAL 4 (50 gm)	TRIAL 5 (2 kg)	TRIAL 6 (2 kg)
WHEAT FLOUR(gm)	60	14	27	30	1400	1400
RICE FLOUR(gm)	20	10	5	5	75	75
SORGHUM FLOUR(gm)	10	20	15	12	350	500
BERMUDA GRASS POWDER(gm)	3	1	1	1	5	8
TULASI POWDER(gm)	3	1	1	1	5	8
MORINGA POWDER(gm	4	1	1	1	5	8

Nutritional analysis, Antioxidant, Phytochemical analysis, Chemical analysis and drying characteristics were determined and Shelf life study were carried out for edible cutlery.

Physical attributes, the physical characteristics of food ingredients are crucial for creating new products. The right design of food processing, handling, and storage systems depends on the physical characteristics of the food, such as its water activity, dielectric, mechanical, rheological, and thermal qualities. Functional qualities such as emulsification, gelation, thickening, foaming, and the ability to bind fat and flavor, proteins are frequently utilized as components in food products.

Carbohydrates, using a pipette, a transparent aqueous solution of carbohydrates was put into a tiny tube. Additionally, a blank of water was ready. After adding a phenol aqueous solution, the mixture was stirred. To ensure optimal mixing, concentrated sulfuric acid was introduced to the tube at a quick pace. The one exception is starch, which may be precisely quantified by releasing glucose after it has been digested to glucose using certain enzymes (amylases). Non-starch polysaccharides make up the majority of the components of total dietary fiber, soluble dietary fiber, and insoluble dietary fiber. The methods used to determine the amount of total dietary fiber and its constituent parts involve the use of amylases to remove the digestible starch and proteases to remove the digestible protein, leaving behind an indigestible residue.

Along with carbs and fats, proteins are the nutrients in the diet that provide energy and play a significant part in the growth and maintenance of the human body. The body uses proteins for a vast array of additional purposes, including enzymatic activity and the passage of nutrients and other biochemical substances across cellular membranes. The body needs high-quality proteins from the food we eat in order to maintain these vital activities. Reduced growth and loss of muscle mass are the outcomes of higher turnover of muscle proteins caused by an inadequate intake of dietary proteins containing necessary amino acids. There may then be a decrease in hormone and enzyme activity, as well as compromised immunity.

1.Nutritional Analysis

For Nutritional composition analysis, quantity of 100 gram of the sample was tested. Nutritional information such as Calories, Total fat, Carbohydrates, Protein, Dietary Fibre, Sodium, Calcium, Vitamins and Antioxidants are tested. The following table summarizes the values of the above mentioned nutrients.

Table 2. Nutritional Analysis

S.NO	NAME OF THE NUTRIENT	VALUES
1.	Calories	377Kcal
2.	Total Fat	0.5gm
3.	Carbohydrates	84.5gm
4.	Protein	8.7gm
5.	Dietary fibre	6.2gm
6.	Sodium	540mg
7.	Calcium	68.3mg
8.	Vitamin A	5.7mcg
9.	Vitamin B6	1.2mg
10.	Vitamin C	3.8mg
11.	Vitamin D	0.6mcg
12.	Vitamin E	1.4mg
13.	Vitamin K	0.3mcg
14.	Potassium	493mg
15.	Iron	6.1mg
16.	Zinc	3.3mg

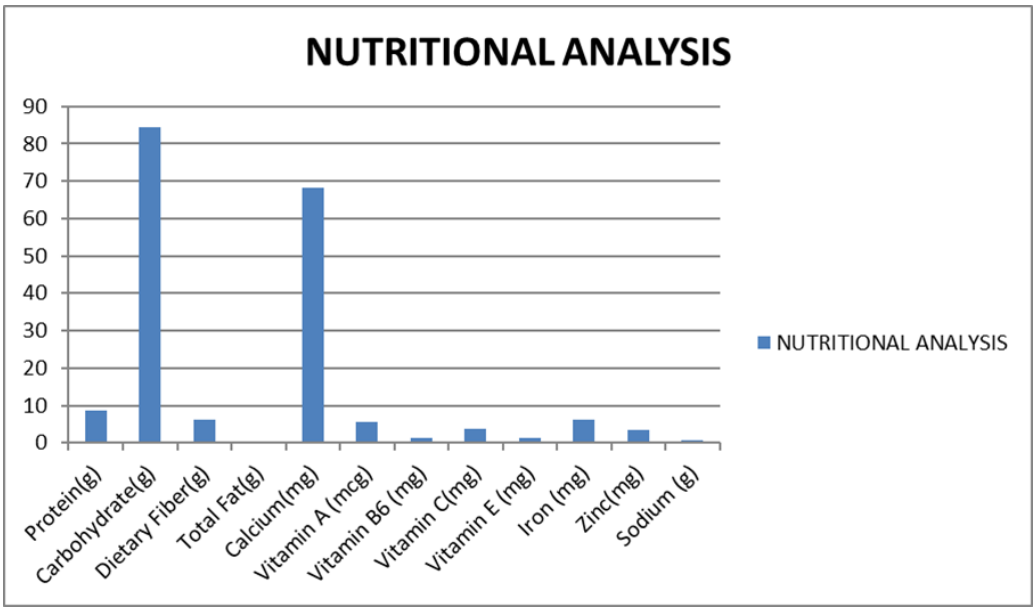

Figure 5. Nutritional analysis graph

2.Antioxidant

The total antioxidant capacity of the extract of the sample was evaluated by the phosphomolybdenum method.

Table 3. Antioxidant

S.no	NAME OF THE TEST	VALUE
1.	Total Antioxidant Capacity	102µg of AAE per gm

3.Phytochemical analysis

Phytochemicals such as flavonoids and tannins are rich in Tulasi, Bermuda and Moringa leaves powder are tested using UV-VIS Spectrophotometer test method.

Table 4. Phytochemical Analysis

S.no	NAME OF THE TEST	VALUE
1.	Tannin	1.5mg
2.	Flavonoids	2.6mg

4.Chemical Analysis

Water absorption capacity [WAC] of the herbal edible cutlery was determined using Gravimetric method.

Table 5. Chemical Analysis

S.no	NAME OF THE TEST	VALUE
1.	Water absorption	37% @ 30min

5.Shelflife Study

The Standard operating procedure specifies a horizontal method for the enumeration of Microorganisms by counting the colonies growing in a solid medium after aerobic incubation at 35ºC using IS 5402 test method.

Table 6. Shelf life

S.no	NAME OF THE TEST	VALUE
1.	Total Microbial Count	$3*10^1$ CFU/gm

5. CONCLUSION

The creation of edible herbal cutlery from a composite collection of components resulted in a creative solution to the dietary and environmental challenges that modern society faces. Its equimolar proportion of whole wheat flour and herbs, when combined with the other ingredients, demonstrated the highest degree of structural, sensory, and functional stability, making it the optimal option. It is therefore advised that this edible cutlery be successfully promoted, commercialized, and advertised in order to raise their level of public acceptance. Its impact on our environment, health, and nutritional status should be made more widely known. It is observed that incorporation of edible starch with Moringa leave powder, Tulasi leaf powder, Bermuda grass powder and Wheat flour in the production of edible Cutlery is been nutritionally and sensorily superior in most quality attributes.

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