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# Process development and quality evaluation edible cutlery spoons supplemented with *Withania somnifera* root powder

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**Abstract**
The present study aims to prepare ecofriendly edible cutlery spoons by utilizing functional ingredients includes wheat flour, ragi flour, sorghum flour and Indian ginseng (*Ashwagandha*) roots powder. Indian ginseng root powder prepared by drying fresh roots in a tray dryer at controlled temperature. Edible cutlery spoons were produced using formulations containing wheat flour (60g) and sorghum flour (20g) was kept constant in all the samples. Ragi flour and ginseng powder level varied in different formulations of edible cutlery. Ginseng powder level varied from 0, 1, 2, 3, 4, 5 and 6% in sample S0, S1, S2, S3, S4, S5, and S6 respectively. Further, edible cutlery spoons were evaluated for sensory, physicochemical, textural and degradability test. Results for sensory evaluation indicated sample S3 and S4 received highest score and accepted by the panel. Proximate composition edible cutlery spoons showed increase in moisture, fat, crude fiber and ash content with increasing the level of ginseng powder in formulations. Degradability test revealed that complete decomposition occurred in 4-5 days in sterile soil. Texture profile results reported high values for fracturability and hardness for sample S0 (control) in contrast to S3 and S4. Radical scavenging activity possessed by sample and higher values reported with increased ginseng powder level. It could be concluded overall, a sustainable approach to prepare edible cutlery with potential nutritional and health benefits can be possible using ginseng powder, cereals and millets flour.

**Keywords:** Edible cutlery, Indian ginseng, finger millets, texture analysis, degradability

## 1. Introduction

Edible cutlery is an innovative invention made up from plant- derived product in which meals are served and can be consumed after completion of meal. It came into existence in India in 2010 by a firm name Bakeys as an alternative to single-use plastic cutlery (Poonia & Yadav, 2017) [18]. As single-use plastics is grave threat to entire ecological community, there is a substantial need to replace single use plastic cutlery with better alternatives like edible cutlery. Since edible cutlery is developed from mixture of flours it is also considered as EBO (ecofriendly, biodegradable and organic) (Das, 2016) [7]. Biodegradability and environmental friendliness are the two main benefits of using edible cutlery in lieu of plastic since plastic poses a grave threat to both mankind as well as ecosystem (Munir, 2017) [15]. Due to the fact that they do not really require any additional preparation, this edible cutlery is regarded as ready to eat product. Food that is solid or semi-solid can be served with edible cutlery without it quickly becoming mushy. But if they are not ingested, they can deteriorate in any environmental condition as they do not require any prerequisites for deterioration. These might be consumed without any accompanying food (Roy & Morya, 2022) [20].

Ashwagandha (*Withania somnifera*,) is also known as "Indian Ginseng" and "Indian Winter cherry ". The name ashwagandha is because of root smells like horse (“Ashwa”) urine and believe to provide power like horse when consumed (Mukherjee *et al*., 2021) [14]. It is a tiny, woody shrub of the *Solanaceae* family that grows to approximately two feet in height. It grows throughout Africa, the Mediterranean, and India. A 30-150 cm tall erect, evergreen, tomentose shrub found in waste lands and on bunds across India's drier regions. The roots are the principal parts of the plant that are utilized medically. Entire plant, roots, leaves, stem, green berries, fruits, seeds, and bark are all utilized (Gupta & Rana, 2007) [11]. Alkaloids, starch, reducing sugar, hentriacontane, glycosides, dulcital, witha niol acid, and a neutral molecule are all found in ashwagandha roots. The alkaloid concentration varies greatly (0.13-0.31%). Ashwagandha has pharmacological benefits in brain illnesses such as anxiety, Alzheimer's, dyslexia, depression, autism, addiction, amyotrophic, Parkinson's, Schizophrenia, Huntington's disease, lateral sclerosis, attention deficit hyperactivity disorder, and bipolar disorders

(Zahiruddin *et al*., 2020) [30]. Antiadaptogenic antialzheimer antiarthritic antidiabetic anticancer antihypoxic antiinflammatory, antischemic, antimicrobial, anti-stress, aphrodisiac, cardio-protective, antioxident properties and neuroprotective properties are some other health benefit present in Indian ginseng (Mandlik & Namdeo, 2020) [13].

Ragi or finger millet (*Eleusine coracana L.)* is one of the common millets in several regions of India and Africa (Shobana *et al*., 2013) [22, 23]. Although have been long since brought to India, it is originated from the highlands of Ethiopia. For the people of South India's rural areas, it is considered staple food. It is grown in many regions in India like Uttarakhand, Maharashtra, Andhra Pradesh, Orissa, Gujarat, West Bengal, and Bihar, Karnataka and Tamil Nadu are the main ragi-growing states (Bellundagi *et al*., 2016) [5]. Free sugars and non-starchy polysaccharides make finger millet, an abundant source of carbohydrates. Finger millet has a dietary fiber concentration that is significantly higher than that of brown rice, polished rice, and all other millet varieties, including foxtail, tiny, kodo, and barnyard millet (Sinha *et al*., 2022) [25]. Compared to milled rice, finger millet has greater concentrations of the sulfur-containing amino acids methionine and cystine. The protein digestibility of finger millet is affected by the tannin content of the grain (Gull *et al*., 2014) [10]. The lipid composition of finger millet is composed of 10-12% glycolipids, 5-6% phospholipids, and 70-72% neutral lipids, mostly triglycerides and traces of sterols. The percentages of oleic acid, linoleic acid, palmitic acid, and linolenic acid in lipids range from 46 to 62%, 8 to 27% and 20 to 35%, respectively (Devi *et al*., 2014) [8]. As compare to other millets and cereals, finger millet is exceptionally rich in potassium and calcium and contains phosphorus, iron, and many other trace elements and vitamins (Anitha *et al*., 2021) [3]. Finger also has several health benefits including antimicrobial properties, antioxidant properties, anti-diabetic properties (Devi *et al*., 2014) [8]. Finger millet change the physical, textural, and sensory features of edible cutlery (Krishnapriya & Jadeesh, 2021) [12].

Sorghum (Sorghum bicolor) is one of the most important cereal crops in India, behind rice and wheat. The crop is largely grown in Maharashtra and the southern states of Karnataka and Andhra Pradesh. 80% of total India's sorghum production is from these three states. Sorghum is also grown in Madhya Pradesh, Gujarat, and Rajasthan. India is the world's third largest producer of sorghum (Anitha *et al*., 2021) [3]. Most sorghum varieties contain high levels of phytochemicals, especially phenolic compounds, Sorghum has a high fiber content. It is mostly made up of insoluble (75%–90%) and soluble fibers (10%–25%). Prolamin (such as kafirins) and non-prolamin proteins (such as globulins, glutelins, and albumins) are two types of sorghum proteins (Ananda *et al*., 2020) [1]. Sorghum grains are rich in glutamic acid, proline and leucine but they are deficient in lysine, similar to other cereal grain. The lipids consist mainly of unsaturated fatty acids in sorghum grains, the most readily available being polyunsaturated fatty acids. Oleic, linoleic, palmitic, linolenic, and stearic acids are the principal fatty acids insorghum; the lipid profile of maize is similar but is more unsaturated.

Wheat is recognized as a great food for maintaining good health since it is an excellent source of dietary fiber, B-group vitamins, minerals, and protein. It has therefore become the primary grain and is used more frequently than any other cereal in the making of bread due to the quality and quantity of the peculiar protein it contains known as gluten (Choeybundit *et al*., 2022) [6]. In edible spoons, refined wheat flour supplies the structure. When water and refined wheat flour are combined, the white flour's proteins interact to generate gluten. During rising, the elastic gluten structure expands to hold the enlarging leavening gases (Krishnapriya & Jadeesh, 2021) [12].

## 2. Material and Methods

### 2.1 Raw materials

Ingredients required during this study includes Indian ginseng (*Withania somnifera)* roots, finger millet flour, sorghum flour, refined wheat flour was brought from nearby local market of Phagwara, Punjab

### 2.2 Location

The experiment of formulation and standardization of edible cutlery from Indian ginseng (*Withania somnifera)* and mixture of different flour includes ragi flour, sorghum flour, refined wheat flour was carried out in the research lab, Department of Food Technology & Nutrition, School of Agriculture, Lovely professional university, Phagwara, Punjab. (India).

### 2.3 Equipment, chemicals and glassware's

Chemicals of analytical grade, glassware's required and facility for equipment's such as weighing balance, hot air oven, muffle furnace, tray dryer, spectrophotometers was available in the Department of Food Technology & Nutrition, School of Agriculture, Lovely professional university, Phagwara, Punjab.

### 2.4 Methodology

The primary concern of this study is to replace single-use plastic cutlery with ecofriendly edible cutlery prepared by utilizing functional ingredients to promote additional health benefits. Formulations of functional edible cutlery made by using different proportion of ragi flour, sorghum flour, refined wheat flour, Indian ginseng powder and salt etc.

### 2.5 Preparation of Indian Ginseng root powder

Indian ginseng roots undergone through washing and slicing in thin 5cm strips. Roots pretreated with hot water at 100 °C for 2 min than place pretreated roots on tray evenly and dried using tray dryer for 12 hrs at 50 °C (Soni *et al*., 2018) till all the moisture removed. Dried roots was then grind into grinder in a fine powder which was further sued in formulation of edible cutlery.

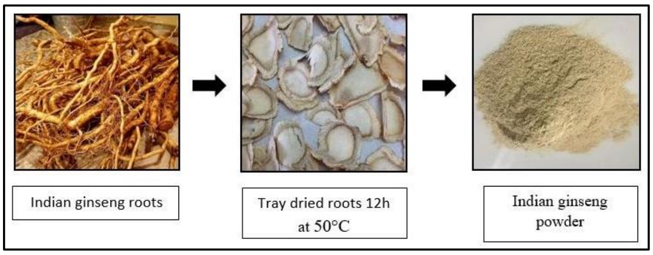



**Fig 1:** Preparation of fresh ginseng root powder

### 2.6 Preparation of Indian Ginseng (*Ashwagandha*) induced edible cutlery

This method was used with some minor modifications as given by Rajendran *et al*. (2020). Ragi flour, sorghum flour, refined wheat flour, salt and ginseng powder were combined into different proportions to make six different formulations *viz*., S1, S2, S3, S4, S5, S6 and S0 (control) were prepared. Table 1 represents the different formulation for preparation of ginseng incorporated edible cutlery. The formulations were carried out in triplicate. The ingredients were then precisely weighed according to formulations and the dough was prepared by combining all the ingredients and kneading them all together. It took around 10 - 15 minutes to prepare the dough. Prepared dough was then instantly sheeted with the help of dough roller. The sheeted plane dough was carved into a spoon using a specially designed spoon mould to shape the spoon. Spoons are pressed between the moulds. The spoon moulds along with the spoons were placed on the tray of aluminium and baked at 100-150 °C for 25 minutes, until the desired texture was obtained. The spoons are removed from the oven and kept for cooling at room temperature. Spoons are the packaged and stored at cool and dry place in closed container. Fig 2 and 3 depict the representation for development of ginseng induced edible cutlery.

**Table 1:** Formulation for development of edible cutlery

| Raw materials | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| | $S_0$ | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ |
| Refined Wheat Flour (g) | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| Ragi flour (g) | 19.5 | 18.5 | 17.5 | 16.5 | 15.5 | 14.5 | 13.5 |
| Sorghum flour (g) | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Indian Ginseng powder (g) | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Salt (g) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

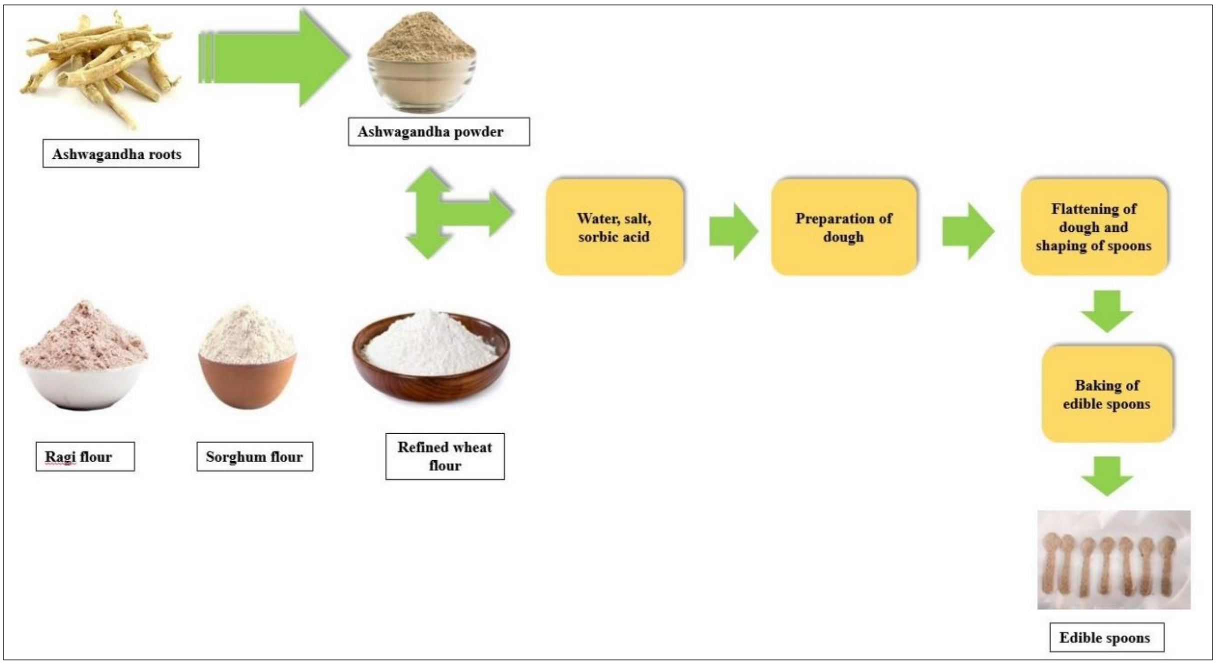



**Fig 2:** Systematic process for development edible cutlery spoons supplemented with Indian ginseng root powder

Finger millet flour, sorghum flour, white flour, Indian ginseng (Ashwagandha powdered form) (17:20:60:03)

↓

Add 25 ml water and other desired ingredient

↓

Mix all the ingredients and prepare a smooth dough by kneading

↓

Flattened and press the sough using dough roller

↓

Press the dough inside the steel mould (spoon moulds) and Baking at 100-150 °C for 20-25 min

↓

Cooling at room temperature and packed

↓

Store at cool and dry place

**Fig 3:** Flowsheet on unit operation carried out for development of edible cutler

## 3. Sensory evaluation

The sensory (organoleptic) evaluation of prepared edible cutlery was carried out using a standard nine-point hedonic rating scale. Edible cutlery sample were served to 10 qualified and semi-trained panelists to determine the organoleptic score for each sensory attribute *viz*., color and appearance, taste, texture, mouthfeel and overall acceptability (Sood & Deepshika 2018) [27]

## 4. Proximate analysis

Proximate composition of edible cutlery includes moisture, fat, protein, crude fiber and total carbohydrates were analyzed by standard methods of AOAC, (2005) [4] and Shabaana *et al*., (2021) [21].

### 4.1 Determination of Moisture content

Accurately weighed 2g of the sample in a dried and pre-weighed petri plate. The petri plate containing sample was then kept in hot air oven at 110 °C for 3-4 hour and cooled in a desiccator and weighed until the constant weight difference. Moisture percent by weight was then calculated using following formula (Vyshali *et al*., 2022) [29].

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

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

**4.2 Determination of Ash content**

Weigh 2-3 g of sample in dried, pre-weighed silica crucible. Burn the sample for charring on flame until smokeless point. Then the crucible with sample was placed in muffle furnace at 600 °C for 4-5 hour. It was then cooled in a desiccator and weighed take the readings until the weight is constant (Thagunna *et al*., 2023) [28]. Ash content was determined using the formula:

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

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

**4.3 Determination of Fat content**

The pre-weighed dried powdered sample is put in a filter paper thimble and kept in a glass cylinder of Soxhlet apparatus. Both an inlet tube and a siphon tube are included with this cylinder. The top of the cylinder is connected to a water condenser. The neck of a flask with a circular bottom that contains the solvent is fitted with the whole assembly. In a burner, the flask is heated. Through the inlet tube, the solvent vapours enter the cylinder and continue upward into the condenser. The crude organic material comes contact with the condensed solvent, which dissolves it. The moment the solution reaches the siphon tube top. The dissolved organic substance flows back into the flask in this manner, maintaining a constant flow of solvent vapours in the cylinder. The heating is then halted, and the liquid in the flask is then distilled to remove the solvent, leaving behind the organic product (Vyshali *et al*., 2022) [29].

$$\text{Crude fat (\%)} = \frac{(W2 - W1)}{S} \times 100$$

Where, W- Weight of empty flask (g), W2- Weight of flask and extracted fat (g), S- Weight of sample

**4.4 Determination of crude fibre Content**

Weigh 0.5 to 1.0 g of dried sample in a beaker, 5 ml of 1.26% dil. $H_2SO_4$ was added into sample and refluxed for 15 mins. The mixture was filtered and to the filtrate 5ml of 1.26% NaOH solution was added and refluxed further for 15mins. The mixture was filtered again and the filtrate washed with ethanol and refluxed for 15mins. It was filtered again and allowed to dry for 15mins. The residue obtained equivalent to fibre content was weighed (Thagunna *et al*., 2023) [28].

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

**4.5 Determination of Protein**

Digestion of organic matter with sulfuric acid in the presence of a catalyst, Rendering the reaction product alkaline then distillation and titration of the liberated ammonia, Calculation of the nitrogen content, Multiplication of the result by the conventional factor 6.25 to obtain the crude protein content (Thagunna *et al*., 2023) [28]

**5. Water absorption capacity (WAC)**

The edible cutlery spoons was submerged in water for a certain amount of time. The sample was taken out of the beaker and tissue paper was used to wipe away any surface water (Pastor-Cavada *et al.*, 2011) [17]. To calculate the percentage of water absorption, apply the formula below.

$$\text{WAC (\%)} = \frac{\text{weight of cutlery after water} - \text{weight of cutlery before water)}}{\text{weight of cutlery before water}} \times 100$$

**6. Biodegradability test (soil burial test)**

Using edible cutlery pieces, were buried in sterile soil for a specified period, and the gradual biodegradation of the samples was monitored daily (Dordevic *et al*., 2021) [9].

**7. Texture analysis**

The textural properties of edible cutlery spoons were sample were analyzed by the Texture Profile Analyser (FTC TMS-pro Texture Analyzer). Hardness, fracturability of the sample were determined using 75mm cylindrical probe was used to test the spoons (Krishnapriya & Jadeesh 2021) [12].

**8. Antioxidant activity**

DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging ability of the extracts was evaluated as described by AOAC method. A portion of the extract (1 mL) was mixed with 1 mL of the 0.4 mM ethanolic solution of DPPH radicals, incubated for 30 min, and the absorbance was measured at 517 nm (Najjar *et al*., 2022) [16]. Free radicals scavenging ability was expressed as percentage (%) inhibition.

$$\text{DPPH radical scavenging activity (\%)} = \left(1 - \frac{absorbance\ of\ sample}{absorbance\ of\ control}\right) \times 100$$

**9. Statistical Analysis**

Triplicate values were used to expressed as mean±standard deviation. Statistical analysis of the data was performed using the Statistical Package for the Social Sciences (SPSS) version 23.0. Tukey's test was used to compare the significant differences in the means at significance level of $p<0.05$.

**10. Result and Discussions**

**10.1 Proximate analysis of raw ingredients**

Data presented in table 2 shows the proximate analysis of raw materials used for development of edible cutlery was investigated. Results of moisture content of refined wheat flour showed higher value 11.32% as compare to ragi flour sorghum flour and Indian ginseng powder. Results obtained for crude fiber content of Indian ginseng powder was 32.3g which is higher compared to other ingredients. Crude fiber of ragi was found to be higher 9.49 as compare to the other flour. Refined flour had higher protein 10.34% and carbohydrate 74.29% content as compare to other ingredients. As ragi is richest source of fiber, protein and minerals (Shrestha & Srivastava, 2017) [24]. Table 3 contained the proximate composition of Indian ginseng induced edible cutlery of 3 different concentration S0 (control sample without ginseng powder), S3 and S4 (with ginseng) powder (Anderson *et al*., 2007) [2].

**Table 2:** Proximate composition analysis of raw materials

| Parameters | Ragi flour | Sorghum flour | Refined wheat flour | Indian ginseng powder |
|---|---|---|---|---|
| Moisture (%) | 10.77±0.01 | 09.07±0.001 | 11.32±0.005 | 7.43±0.002 |
| Ash (%) | 2.172±0.003 | 1.35±0.005 | 0.55±0.005 | 4.41±0.003 |
| Protein (%) | 07.15±0.005 | 09.98±0.003 | 10.34±0.004 | 3.95±0.002 |
| Fat (%) | 1.95±0.002 | 1.73±0.02 | 0.78±0.026 | 0.31±0.003 |
| Crude Fibre (%) | 9.48±0.005 | 8.59±0.002 | 2.15±0.005 | 32.3±0.05 |
| Energy (kcal) | 1345±0.57 | 1394±0.57 | 1475±0.57 | 236±1.0 |
| Total Carbohydrate (%) | 66.83±0.05 | 67.57±0.002 | 74.25±0.03 | 49.7±0.2 |

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

### 10.2 Sensory evaluation of edible cutlery spoons

Results of sensory evaluation of edible cutlery samples are represented in graph in fig. 4. Results found significant difference among the sensory properties (color, aroma, taste, texture, overall acceptability) different edible cutlery samples implying. Sensory panelists appreciated incorporation of Indian ginseng root powder in formulation of edible cutlery spoons same as pure biscuits (no ginseng). Results revealed that sample S5 and S6 received lowest sensory score and was least accepted by the panelist may be attributed due to high amount of ginseng which had bitter aftertaste. Moreover, sample S3 and S4 was received highest score and was highly accepted by the panel members. Hence, sample S3 and S4 were selected for further studies.

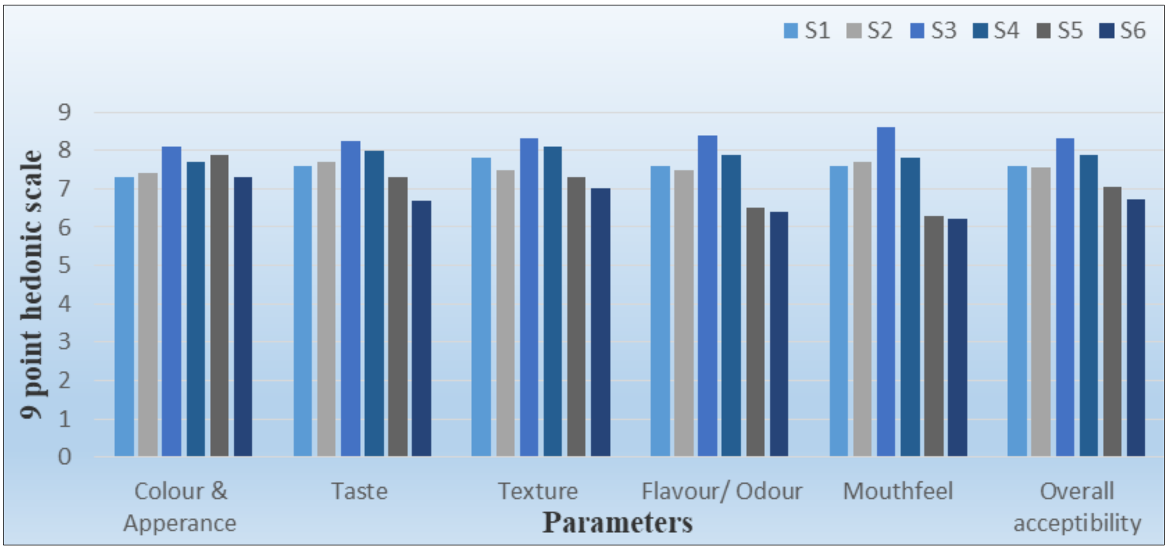



**Fig 4:** Sensory evaluation of Indian ginseng induced edible cutlery

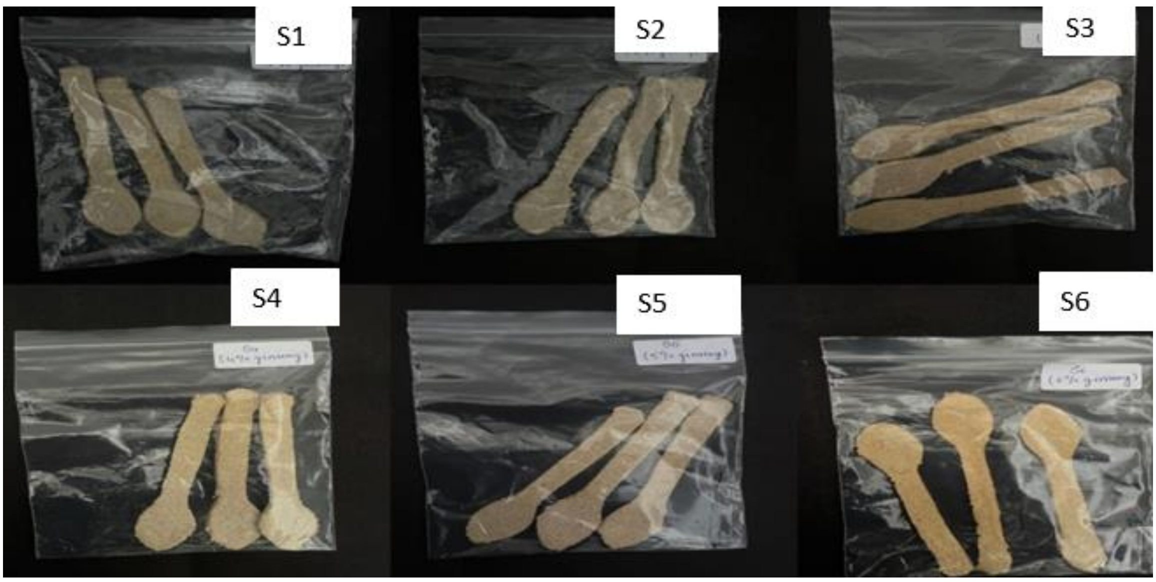



**Fig 5:** Different proportion of samples of edible cutlery

### 10.3 Proximate composition of ginseng induced edible cutlery

Date presented in table 3. shows proximate composition of Indian Ginseng induced edible cutlery of 3 different formulations *viz*., S0 (control), S3 and S4.

**Table 3:** Proximate analysis of ginseng induced edible cutlery

| Nutritional composition | S0 | S3 | S4 |
|---|---|---|---|
| Moisture (%) | 3.70±0.10$^{a}$ | 4.40±0.1$^{b}$ | 4.30±0.05$^{b}$ |
| Fat (%) | 1.96±0.02$^{a}$ | 2.46±0.026$^{b}$ | 2.53±0.025$^{c}$ |
| Ash (%) | 0.84±0.15$^{a}$ | 1.66±0.10$^{b}$ | 1.68±0.05$^{b}$ |
| Crude fibre (%) | 1.96±0.02$^{a}$ | 2.57±0.010$^{b}$ | 2.60±0.017$^{b}$ |
| Protein (%) | 5.96±0.025$^{a}$ | 5.89±0.010$^{ab}$ | 5.77±0.98$^{b}$ |
| Total carbohydrate (%) | 85.73±0.05$^{a}$ | 83.45±0.0$^{a}$ | 83.65±0.02$^{b}$ |

Values are means±Standard Deviations (SD) of three determinations
S0- control, S3- 3% ginseng powder, S4 - 4% ginseng powder
Result reported for moisture content of S4 sample was higher (4.3) compared to S3. The moisture content of S0 sample is associated with increase in Indian ginseng powder concentration as it has ideal water holding capacity and water absorption capacity. It was observed that ash (2.53%), fat (1.68%) and crude fiber (2.60%) content of S4 sample was more as compared to S0 and S3 samples. Results obtained for protein and carbohydrate content of S0 sample found 5.96% and 85.73% respectively which was higher than S0 and S4 due to increase in concentration of ragi flour which is rich source of protein and carbohydrate as well as absence Indian Ginseng powder which is also a poor source of protein (Shrestha and Srivastava, 2017) [24].

### 10.4 Water absorption capacity (WAC)

Water absorption capacity is ability of a product to absorb water within its structural boundaries. According to Shrestha & Srivastava, (2017) [24]. I was found that finger millet four have higher water absorption capacity. Data revealed from table 4. and fig. 6 showed a comparative study of three different edible spoon sample S0, S3, S4 at different time intervals 5min, 10min, 15min, 20min, 25min and 30min for water absorption capacity of spoons. Higher values for WAC was noted for sample S4 containing 4g of ginseng powder and 15.5g ragi flour. The properties of flours with increased fibre and protein is linked with high water absorption rate. Therefore, the presence of more protein and fibre in these ginseng powder and ragi flours could be the cause of more WAC. Water absorption capacity of S4 sample spoon was comparatively more than other two spoon samples S0 and S3. A similar study on water absorption capacity was conducted by Pastor-Cavada *et al*., (2011) [17].

**Table 4:** Water absorption capacity of Raw Materials

| Time (min) | WAC (%) | | |
|---|---|---|---|
| | $S_0$ | $S_3$ | $S_4$ |
| 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 | 29.50±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

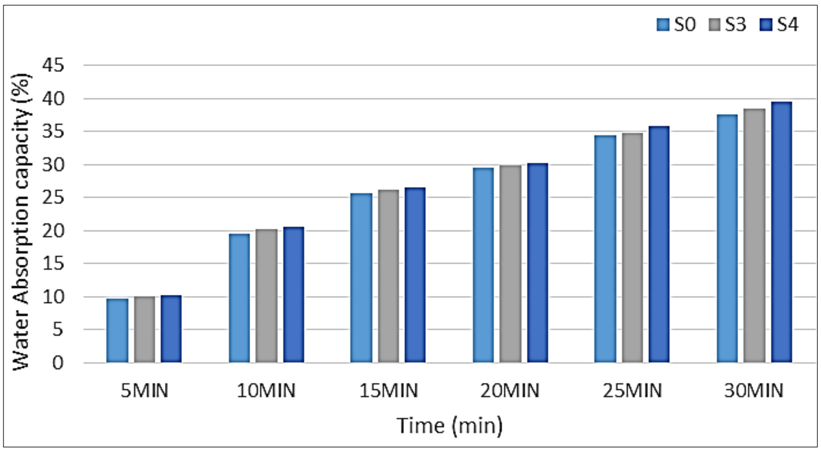



**Fig 6:** Water holding capacity of spoons

### 10.5 Biodegradability test (soil burial test)

Biodegradability test was performed to check the decomposition rate of the edible spoons. Edible cutlery was made from natural raw materials like sorghum flour, ragi flour, refined wheat flour, Indian ginseng powder without the use of any preservatives. As a consequence, mixing the edible cutlery with water is simpler, and the outcomes are as desired and satisfying. The edible cutlery completely decomposed in 4-5 days in sterile soil. Each sample began decomposing the following day and was entirely decomposed in 4-5 days as it was gradually broken down into tiny bits. The rate of biodegradability is significantly impacted by heavy rainfall. Both edible cutlery and the earth are capable of soaking rainwater. Moisture levels in the soil accelerate degradation. The next day, as seen in the image above, the sample had already begun to deteriorate due to insects. The deterioration of edible cutlery is also due to the presence of the microbial organism in soil. Fig.7 show day 1 of biodegradability test of all the three samples S0, S3, S4. It can be clearly observed on Day 2 of biodegradability the decomposition was observed and found to broken down into tiny bits. Day 3 of biodegradability test observed more breakdown of sample. Finally on Day 4 complete decomposition of the edible cutlery was observed. Degradation related study was also conducted by Dordevic *et al*., (2021) [9].

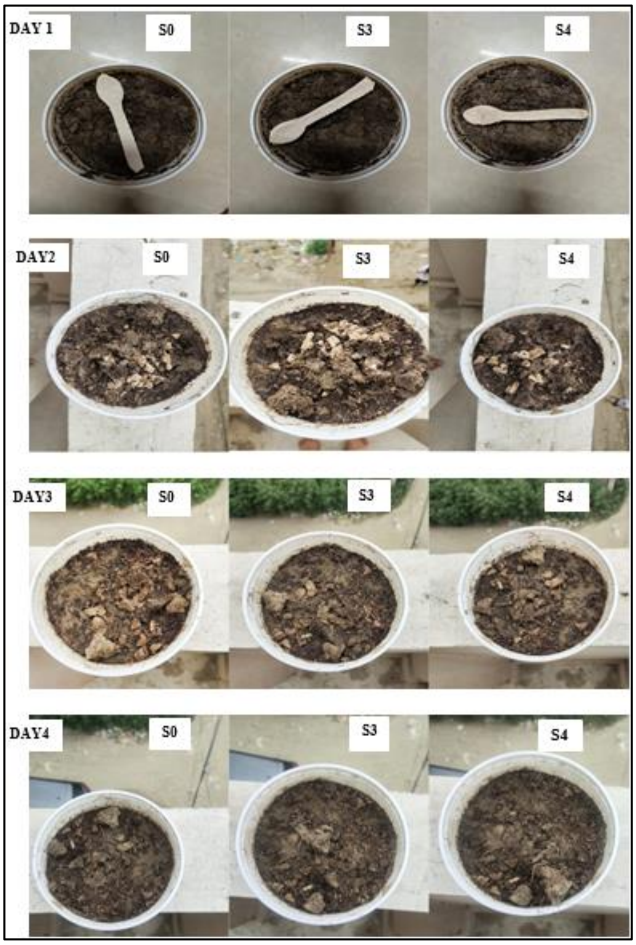



**Fig 7:** Biodegradability study of Indian ginseng induced edible cutlery spoon

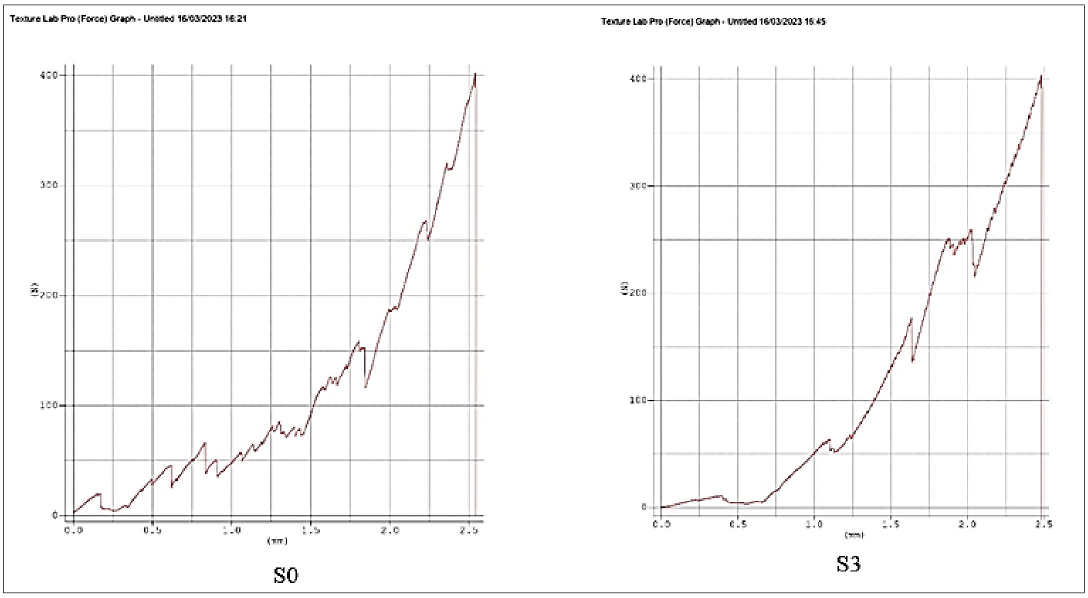
### 10.6 Texture analysis of edible cutlery spoons

Data pertaining to texture profile analysis of edible cutlery samples were studied for hardness and fracturability are given in table 5 and fig. 8. It can be observed from the data that higher values noted for fracturability (1.8mm) and hardness (410 N) in case of S0 sample. The greater fracturability and hardness may be attributed due to high amount of ragi flour in its composition. Moreover, sample S3 and S4 showed more or less similar results for both hardness and fracturability. A study on texture analysis of edible cutlery also conducted by Krishnapriya & Jadeesh, (2021) [12].

**Table 5:** Texture profile analysis of edible cutlery spoons

| Samples | Fractaurability (mm) | Hardness(N) |
|---|---|---|
| S0 | 1.8±0.02 | 410±0.81 |
| S3 | 1.65±0.01 | 405±0.54 |
| S4 | 1.61±0.02 | 401±0.76 |

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



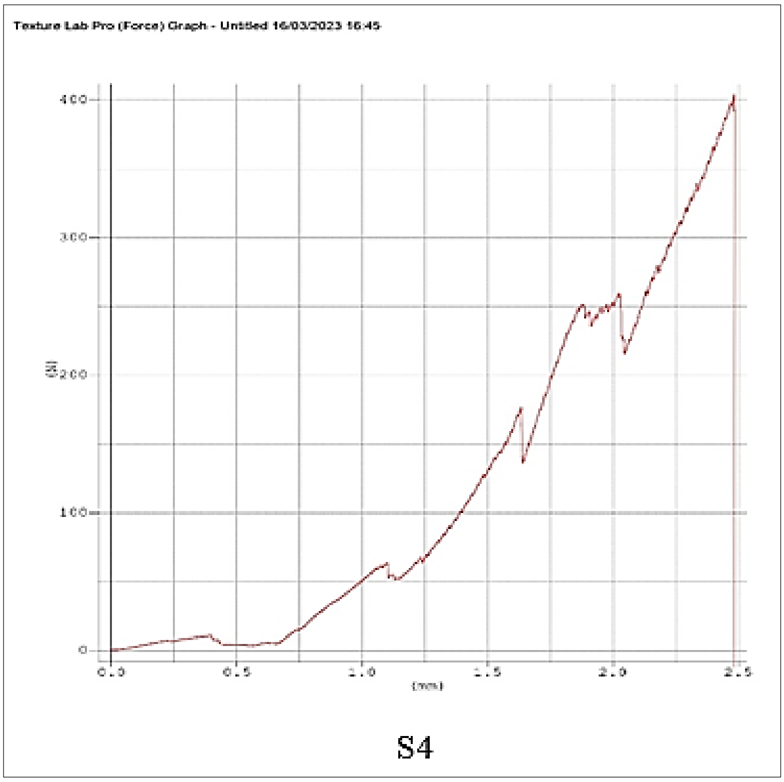



**Fig 8:** Texture profile analysis of edible cutlery spoons (S0, S3, S4)

### 10.7 Antioxidant Activity

Antioxidant activity of edible cutlery spoon supplemented with ginseng flour and ragi flour were studied and results given in table 6. It can be seen from results the antioxidant activity was increased with increased supplementation of ginseng powder and ragi flour in the formulations. Results showed higher antioxidant activity values for sample S4 (3.116%) compared to S3 (2.445%) and S0 (1.968%). The higher antioxidant activity values is directly linked with total phenolic content of Indian ginseng root powder.

**Table 6:** Antioxidant activity of samples

| Samples | Free Radical scavenging activity (%) |
|---|---|
| S0 | 1.968±0.12 |
| S3 | 2.445±0.14 |
| S4 | 3.116±0.14 |

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

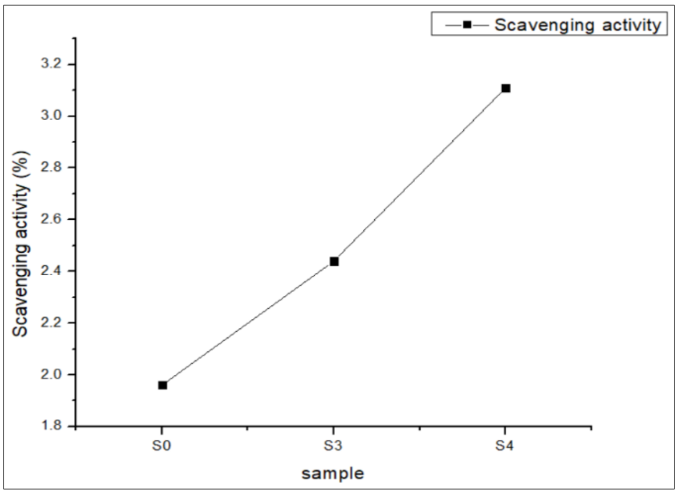



**Fig 9:** Graph of scavenging activity

### 11. Conclusion

A plastic cutlery generally composed of organic polymers which is considered as biggest threat to mankind and the nature which may leads to soil erosion, ocean toxicity and air pollution. Edible cutlery is a sustainable way for better alternative to one time use plastic cutlery. This research highlights the development of edible cutlery using Indian ginseng root powder as functional ingredients with addition to finger millet flour and sorghum flour for nutritional enrichment. Study suggests that a sustainable approach towards replacing plastic cutlery can be possible by using biodegradable ingredients with better nutritional value. The biodegradability of product has been studied and reported to be completely decomposed with enrichment of soil health without any negative impact on environment. Moreover, it can be more cost-effective technology due to its processing and availability of raw materials. Overall, the quality and advantages of the product can be enhanced with Indian ginseng, ragi, sorghum, refined wheat flour and other millets flour can be better utilized. This study also concludes that the prepared cutlery is tasty, healthy, and environmentally beneficial.

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