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Research Article

DEVELOPMENT AND QUALITY EVALUATION OF BIODEGRADABLE EDIBLE CUTLERY: A REPLACEMENT FOR A CONVENTIONAL ONE

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ABSTRACT

Objectives: The objectives of this research were to develop a safe, sustainable alternative to plastic cutlery using water, wheat flour, finger millet, rice flour, water, jaggery, oil, and salt in varying amounts.

Methods: Edible cutlery was manufactured using a manual method by putting the dough on a steel spoon and cooking bowl and baking it at 180°C for 40 min and evaluating their proximate analysis, sensory attributes, water absorption capacity, and biodegradable test.

Results: Sample S3 was found to be best in terms of nutrition including moisture, protein, fiber, fat, and ash (4.8, 7.23, 2.3, 3.7, and 1.97%). Carbohydrate content was found higher in S1 compared to S2 and S3 which are 90.43%. Similarly, S1 had the highest overall sensory attributes including color, appearance, texture, flavor, odor, and overall acceptability (7.64, 7.82, 6.91, 7.0, 6.9, and 7.45%) and has a high amount of water absorption capacity (31.59%) compared to S2 and S3.

Conclusions: Biodegradable and edible cutlery would provide a completely new perspective and alternative to the fight against plastic pollution.

Keywords: Edible cutlery, Environment, Biodiversity, Hazard, Plastic product.

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INTRODUCTION

Plastic items have long been popular due to their convenience and economic efficiency, but it is a major issue, because they significantly increase the amount of non-biodegradable garbage [1]. Plastic is one of the most adaptable items on the market, and its incorporation into our daily life presents challenges. Plastics are simple to produce, inexpensive, and long-lasting, which is why plastic pollution is becoming a significant concern [2]. In today's scenario, the production and disposal of solid waste are particularly problematic. Plastic utensils are one example, disposed of in large numbers, and causing severe environmental pollution. Although some of the plastics strewn in open yards are being attempted to be recycled, some of them cannot [3]. The production of plastics worldwide from 1950 to 2018 is shown in Fig. 1.

METHODS

The key concern in this paper is to eliminate plastic cutlery by replacing it with edible cutlery that can be ingested after use and readily destroyed. The commodity is derived from natural ingredients, such as whole wheat, banana blossom, and sorghum, to manufacture edible cutlery. The raw materials, used in this study, were procured from the local market of Pokhara.

Formulation of edible cutlery's

This method was employed based on [5] and slightly modified. Three distinct compositions – Sample S1, S2, and S3-were created for the dough by combining rice flour, millet flour, wheat flour, and banana blossom paste. The Formulation of newly developed edible cutlery's composition representing in Table 1.

Wheat flour

Of all the cereals, wheat has unique proteins such as gliadin and glutenin that, when combined with water and mechanical kneading, create a gluten network that gives the grain its elastic toughness and helps it maintain its shape when baking [6].

Finger millet

As a member of the Poaceae family, finger millet is also called ragi or madua in India, rapoko in South Africa, or dagusa in Ethiopia [12-14]. It contains high levels of minerals, dietary fiber, protein, and starch patterns [15]. The processing of millet grains into foods with additional value has huge potential in underdeveloped countries, where millets are underutilized [16].

Banana blossom

Banana flower a by-product of waste is a good source of fiber and can be used to create food products that are high in fiber. Alkaloids, flavonoids, tannins, and phenolic compounds, which are known to have anti-cancer, anti-microbial, and antioxidant activities, are among the bioactive substances found in the flower [8].

Jaggery

Jaggery is a traditional non-divergent natural sweetener that is popular in Southeast Asia and the Indian Subcontinent. It acts as a glue material that helps in binding the product [17].

Proximate analysis

Proximate tests on the final product, such as moisture and ash, as well as chemical analyses of fat, protein, and fiber, were performed at AOAC [9] standards.

Water absorption percentage

An unknown weight cutlery sample was immersed in water for a specific period. After a certain time, the sample was removed from the beaker and the surface water was removed with tissue paper. The following formula is used to determine the percentage of water absorption [10].

$$Water\ Absorption(\%) = \frac{(Weight\ of\ cutlery\ after\ water - weight\ of\ cutlery\ before\ water)}{Weight\ of\ cutlery\ before\ the\ water} \times 100$$

Biodegradability test (soil burial test)
Using edible cutlery pieces, the sample sheets were buried in sterile soil for a specified period, and the gradual biodegradation of the samples was monitored daily [11].

Sensory evaluation
The sensory (organoleptic) evaluation was conducted using a standard nine-point hedonic scale approach. To determine the organoleptic score for each characteristic, 25 qualified and semi-trained panelists were served samples of cutlery. The Sensory graph of different samples Shown in Fig. 5.

Statistical analysis
The data reported were the average of triplicate observations. Data observed were analyzed by single factor analysis of variance.

RESULTS AND DISCUSSION

Proximate analysis
Table 2 represents the result of the proximate analysis of various samples. The moisture content of S3 was observed high as compared to S1 and S2. The Banana blossom powder has a high water holding capacity and this may be the reason for the high moisture content in S3. Ash content was estimated that S3 had the highest content of ash among other samples. The banana blossom and millet are good sources of fiber and ash. The protein content of samples was noticed in S3 due to millets, banana blossoms, and wheat flour. Fiber content was observed at 2.3% in S3, S2 was 1.62%, and S1 at 0.92%. The high amount of carbohydrates observed in the S1 sample is due to the high amount of rice and wheat present and is a good source of carbohydrates. Iqbal *et al*. [5] studied the proximate analysis of edible cutlery using sorghum, rice, and wheat flour has almost similar results but some changes due to the addition of millets and banana blossom.

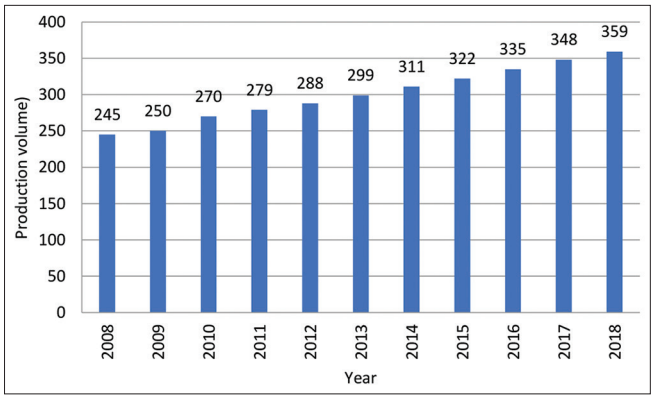

Fig. 1: Plastic production* value in million metric tons [4]

Water absorption capacity
For testing water absorption, three samples of edible cutlery were used. The three samples were manufactured from different ratios of rice flour, finger millet flour, and wheat flour. From the above graph, it can be analyzed that Sample S1 absorbed more water on average than Sample S2 and Sample S3. Sample S1 was made up of 40 g of rice flour and 60 g of wheat flour. Blend A contains a maximum amount of wheat flour and rice flour which are capable of forming gluten networks and building starch-water bonds that retain moisture well [5]. However, water absorption for Samples S2 and S3 has a lower absorption percentage as compared to Sample S1. The maximum water absorption for Sample S1 was found to be 31.59 % compared to Samples S2 and S3 28.42% and 27.11%, respectively. The water absorption capacity graph is representing in Fig. 3.

Biodegradability test (soil burial test)
Natural raw materials were used without the addition of any preservatives to create edible cutlery. As a result, combining the edible cutlery with water is easier, and the results are satisfactory, as intended. In sterile soil, the edible cutlery entirely decayed in 4–5 days. As each sample was gradually broken down into smaller pieces, it started decaying the next day and was completely decayed within 4–5 days. Heavy rains have a significant impact on the rate of biodegradability. Both the soil and edible cutlery are capable of absorbing rain water. The rate of deterioration increases with soil moisture. From the above picture in next day, the insects already started to degrade the sample. The degradation of edible

Table 1: Formulation of newly developed edible cutlery's composition

Raw material (gram)	S1	S2	S3
Rice	40	40	40
Millet	0	10	20
Wheat Flour	60	45	30
Banana Blossom dried powder	0	5	10
Jaggery	15	15	15
Oil	1.5	1.5	1.5
Salt	0.35	0.35	0.35

Table 2: Proximate analysis of different sample

Nutrition composition	S1	S2	S3
Moisture (%)	2.98	3.6	4.8
Fat (%)	1.94	3.2	3.7
Ash (%)	0.83	1.73	1.97
Fiber (%)	0.92	1.62	2.3
Protein (%)	2.9	6.4	7.23
Carbohydrate (%)	90.43	83.45	80

Fig 2: Newly developed edible cutlery with different formulation

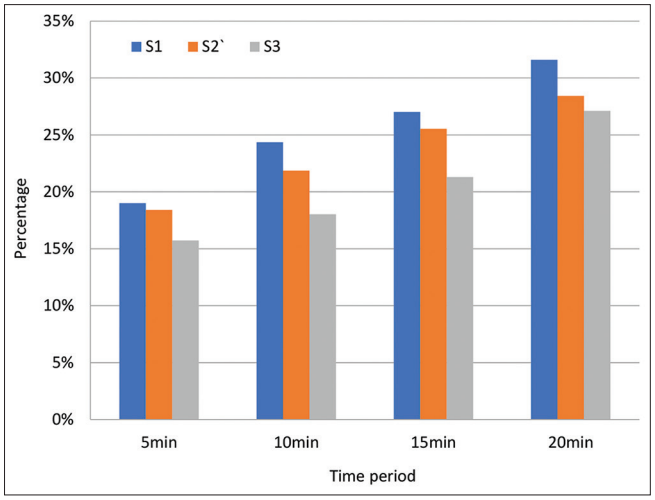

Fig. 3: Water absorption capacity

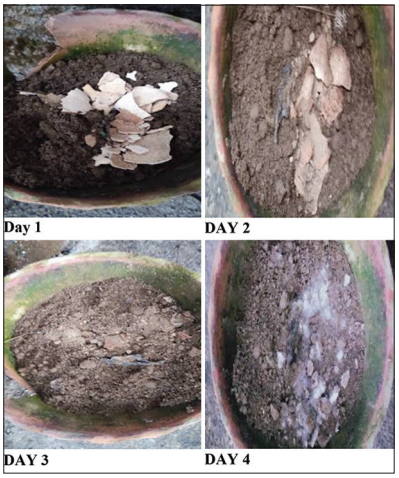

Fig. 4: Biodegradable results for 4 days

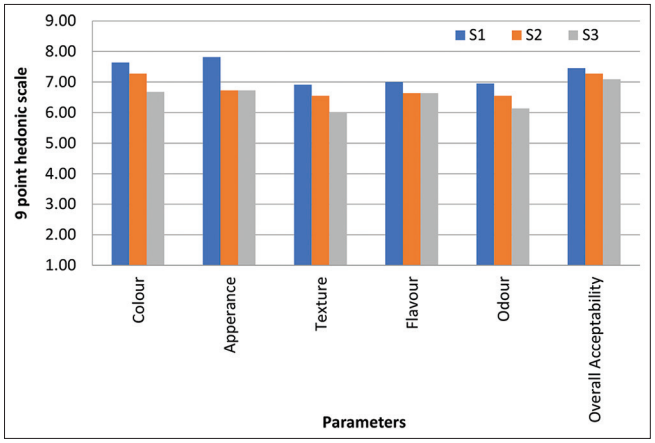

Fig. 5: Sensory graph of different samples

cutlery is also due to the presence of the microbial organism in soil [7]. The biodegradable 4 day result shown in Fig. 4.

Sensory evaluation

Sensory evaluation was done on all three edible cutlery samples (S1, S2, and S3) to assess several aspects such as color, appearance, texture, flavor, odor, and overall acceptability. A 25-member panel used a 9-point Hedonic scale to evaluate these qualities. According to the panelist feedback, Sample S1 was found more acceptable when compared to Samples S2 and S3. Among the samples, sample A contains the highest amount of wheat flour, 60%w/w. The color, appearance, texture, flavor, and odor for Sample S1 were found to be 7.64, 7.82, 6.91, 7.0, and 6.9. The overall acceptability of Sample S1 was found to be high at 7.45 as compared to other samples, that is, 7.27 and 7.09. For the appearance such as the shape, wheat provides the gluten network that helps in maintaining the structure of the product. According to the Shah *et al.* [18] study, increasing the amount of wheat flour increases the dough's cohesiveness and adhesiveness. The addition of gluten-free millet cereal helps in providing a great flavor to the product [5] The Newly developed edible cutlery with different formulation samples Shown in Fig. 2.

CONCLUSIONS

A plastic product is composed of organic polymers that contribute significantly to global environmental contamination. Producing ecofriendly silverware is one strategy to reduce the waste caused by the usage of plastics, especially disposable ones. This study also concludes that the prepared cutlery is tasty, healthy, and environmentally beneficial. It also reduces plastic usage, which lessens the amount of chemically hazardous substances released into the environment as plastic degrades.

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CONFLICTS OF INTEREST

The author does not have any conflicts of interest.

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