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Edible Cutlery - A Revolutionary Contribution to The Society

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Abstract: Cutlery only includes utensils used to cut food like a knife, spoon, and fork. Early humans utilized Natural materials including stone, wood, shells, and animal and fish bones to contain and distribute food in them. Plastic tableware and kitchen utensils first appeared after World War II, when metal was hard to get by. Companies began producing plastic utensils in the 1960s as a less expensive substitute for traditional silverware. These single-use plastic utensils were created to be used once and then thrown away, eliminating the need to clean and maintain them and saving precious resources like water and power (Datta et al, 2021). With plastic cutlery solid waste production is increasing, mainly plastic garbage. Which are released into the environment and pollute the biosphere. Although an appealing choice, plastic cutlery is potentially harmful to the environment and human health. According to the Times of India, 22,000 tons of plastic waste is generated in India from plastic cutlery supplied with food through online food delivery systems. The recent prohibition on plastics and the environmental risk created the idea of biodegradable cutlery. "Biodegradable" refers to the ability of things to get disintegrated by the action of micro-organisms such as bacteria or fungi (with or without oxygen) while getting assimilated into the natural environment. Biodegradable cutlery can be edible or non-edible. According to (Patil & Sinhal, 2018) durability, ease of use, biodegradability, and the alternative of metal and plastic, being novel and unique necessitated the production of biodegradable cutlery. Cutlery that can be used in place of plastic cutlery and could be eaten is known as edible cutlery. On the basis of edibility, applicability, and raw material used in making, edible cutlery is classified into different types. The purpose of this review is to study the various ingredients used in making edible cutlery such as flour and vegetable wastes and the method of preparation.

Index Terms - Biodegradable, edible, cutlery, disposable, ecofriendly, pollution, solid waste, plastic, plastic waste management.

I. INTRODUCTION

The modernization of the society has added many new aspects to the lifestyle. For example, the invention of machines made for domestic work has increased the working capacity, efficiency and reduced the consumption of time and human energy. Similarly, plastic / disposable cutlery also brought a new revolution in industrialization along with reducing the consumption of time and human energy. According to the Oxford Dictionary cutleries are knives, forks, and spoons, used for eating and serving food. Both crockery and cutlery are tableware but there is a difference between the two. According to TradeIndia.com Cutlery only includes those utensils which are used to cut food like knife, spoon and fork. On the other hand, crockery refers to tableware or dinnerware which includes items like plates, bowls, saucers, cups etc. There are various types of cutleries available in the market. The classification depends on the raw material and the specific purpose of use. Based on raw material we can classify the cutlery into metallic, plastic, or ecofriendly cutlery while based on purpose of use it can be knife, fork or spoon.

The first recorded use of the word "cutlery" was in the 14th century, and by the 17th century, cutlery had become an essential part of the dining experience (Tomkin, 2023). History of cutlery dates back to the time of early humans. Early humans utilized Natural materials including stone, wood, shells, and animal and fish bones to contain and distribute food in them. Wooden spoons have been used in rituals since the early 1200s in England, where they were not only used to eat food but also to show wealth and status. When the 'Industrial Age' began in the 18th century, metal cutlery became the standard among the affluent. Silver was the preferred metal because it did not react with the majority of foods. Plastic tableware and kitchen utensils first appeared after World War II, when metal was hard to get by. Companies began producing plastic utensils in the 1960s as a less expensive substitute for traditional silverware. These single-use plastic utensils were created to be used once and then thrown away, eliminating the need to clean and maintain them and saving precious resources like water and power (Datta et al, 2021). Cutlery is available in various types, each designed for specific purposes. The most common types of cutleries include knives, forks, and spoons. Knives are used for cutting and slicing, while forks are used for spearing and holding food. Spoons are used for scooping and serving food.

Plastic cutlery is convenient to use, distribution and store, but effectively dispose of it is challenging. With the use of plastic cutlery solid waste production is increasing, particularly plastic garbage. Which are released into the environment and pollute the biosphere. Significant ecological consequences have resulted from disposing of solid waste in waterbodies, particularly when plastics are introduced into the food chain through bioaccumulation (Goutam Roy et al, 2021). Plastic products thrown into landfills turn into microplastics due to external factors. From landfills, they can pollute groundwater, or from precipitation, they can pollute other water bodies. Microplastics, or microscopic particles (5 mm in size), are now common in soil, air, rivers, lakes, and seas and are mostly produced through surface weathering breakdown of plastic trash. Additionally, man-made items including disposables, microbeads, and virgin pellets make their way into the water. The spectrum of animal species that can consume or otherwise interact with microplastics will increase as it decreases in size (Lebreton and Andrady, 2019). Although an appealing choice, plastic cutlery is potentially harmful to the environment and human health. Petroleum by-products often contain toxins and carcinogens that are easily consumed by humans and can cause cancer. Processing plastic cutlery has become bad for the environment as plastics take up a lot of space and fill landfills with plastic waste every year, which can leech chemicals and carcinogens into food through the natural ecosystem. (Kabir et al, 2021). According to the Times of India, 22,000 tonnes of plastic waste is generated in India from plastic cutlery supplied with food through online food delivery systems (Times of India). The recent prohibition on plastics and the environmental risk created the idea of biodegradable cutlery. “Biodegradable” refers to the ability of things to get disintegrated by the action of micro-organisms such as bacteria or fungi biological (with or without oxygen) while getting assimilated into the natural environment. Biodegradable cutlery can be edible or non-edible. Edible cutlery is cutlery which can be eaten and which also provides some amount of nutrients. Materials are disintegrated chemically during biodegradation by bacteria or other living factors. A substance can be digested by microbes and converted into organic molecules if it is biodegradable. It is a vital process in the disposal of waste and the environment. According to (Patil & Sinhal, 2018) durability, ease of use, biodegrability, alternative of metal and plastic, being novel and uniqueness necessitated the production of biodegradable cutlery. Cutlery that can be used in place of plastic cutlery and could be eaten is known as edible cutlery. These plant-based cutlery items are seen as a healthier alternative to those manufactured of plastic. Chopsticks, spoons, forks, knives, and sporks are some of the most frequently used edible cutlery items globally.

II. Types of Biodegradable Cutlery

According to (Allied Market Research, 2022) biodegradable cutlery can be classified as:

- **On the basis of edibility** biodegradable cutlery can be edible or non- edible.
- **On the basis of the applicability** cutlery is divided into spoon, fork, knife, spork, and chopstick.
- **On the basis of raw material** millet, corn, wheat, bran, rice bran etc.

III. Methods of Making Biodegradable Cutlery-

A developer requires base flour, starch, flavouring agents, preservative and equipment for moulding and cooking for the production of edible cutlery. Research work has been done on edible cutlery by many researchers. Some of which are as follows.

Table 1: Raw material and method of preparation used in the making of edible cutlery

Type Of Cutlery Made	Raw Material Used	Method and Result	Reference
Edible Cutleries	composite flour blends of whole wheat, foxtail millet, and roasted Bengal gram, skimmed milk powder, orange fruit powder, and beetroot extract	In order to assess its capacity to satisfy the recommended daily allowances, phytochemical profile, functionality, and economic viability, researchers have developed edible cutleries using composite flour blends of whole wheat, foxtail millet, and roasted Bengal gram, along with enrichment of skimmed milk powder, orange fruit powder, and beetroot extract in proportions as suggested in a balanced diet. Three different recipes were baked for 17 minutes at 180°C. The analysis showed that variant 2, which contained whole wheat flour and foxtail millet flour in an equimolar ratio together with other ingredients, was the most effective substitute for plastic cutlery.	Krishita Mukherjee, Arivuchudar Raju ,2023
Edible Spoons	spinach, beetroot, and jamun fruit extract with different proportions of sorghum, rice and wheat flour	They used spinach, beetroot, and jamun fruit extract with different proportions of sorghum, rice and wheat flour and standardized the proportion on the basis of texture and strength of the product. They used sorbic acid @1.0 % as anti-fungal agent to increase the product's shelf life. They added guar gum for binding and to get firmer, with good consistency and viscosity.	Sindhu et al 2023
Edible Spoons	wheat flour, ragi flour, sorghum flour, and powdered Indian ginseng (Ashwagandha)	In this study functional components such as wheat flour, ragi flour, sorghum flour, and powdered Indian ginseng (Ashwagandha) roots are used to create environmentally friendly edible cutlery spoons. Indian ginseng root powder is created by carefully controlling the temperature of drying fresh roots in a tray dryer. In order to create edible cutlery spoons, formulations containing wheat flour (60g) and sorghum flour (20g) were used in all experiments. The amounts of ginseng powder and ragi flour varied in several edible cutlery formulations. Additionally, the sensory, physicochemical, textural, and degradability of spoons used for eating were assessed. With more ginseng powder in the formulations, edible cutlery spoons' approximate composition exhibited an increase in moisture, fat, crude fibre, and ash content. According to a degradability test, full breakdown took place in sterile soil in 4-5 days. In contrast to samples the texture profile results for control sample revealed high values for fracturability and hardness. Extreme scavenging activity was present in the sample, and larger values were noted with more ginseng powder. Overall, it can be said that employing ginseng powder, cereals, and millets flour to make edible cutlery with	Hazra S and Sontakke M 2023

		potential nutritional and health benefits is achievable.	
Soy Protein Isolated (SPI) Cutlery	incorporated with 5–20% (w/ w) crude morning glory stem fibre (MGSF)	SPI cutlery samples without and with MGSF were subjected to hydraulic hot press moulding at 160 C for 5 min pressing time. SPI with 5% MGSF showed decreased lightness values compared to the control SPI (without MGSF). SPI with 5% MGSF showed decreases in impact strength and compression load compared to the control SPI. SPI with a 5% MGSF sample showed slightly lower water absorption followed by decreases in the degree of swelling and solubility. Micrographs revealed a 5% MGSF formed uniform matrix with SPI in comparison to the control. Additionally, stiffness decreased with the addition of 5% MGSF to SPI thereby increasing deflection in comparison to the control SPI and other treatments. Thus, SPI cutlery added with 5% MGSF potentially retained the physical and mechanical properties of edible and biodegradable cutlery for food applications. They have also suggested the number of cracks will increase with the increased fibre.	Choeybundit et al, 2022
Edible Cutlery	whole wheat, banana blossom, jaggery, and sorghum	For their study they used whole wheat, banana blossom, jaggery, and sorghum. They use kitchen bowls and steel spoons as moulds. The manual development of edible cutlery involves pouring flour onto steel spoons and cooking utensils, baking them at 180 °C for 40 minutes, and then testing them for proximate analysis, organoleptic properties, water absorption and biodegradability. The researchers did not use any kind of preservative. They found that the samples prepared for edible cutlery were spoiled in 4 to 5 days. Proximate analysis revealed that the cutlery containing banana blossom had the highest fibre content.	Bishal Thagunna et al 2022
Edible Cutlery	foxtail millet and pearl millet and cassava tuber along with wheat flour	Shabana M *et al* 2021 [20] have used foxtail millet and pearl millet and cassava tuber along with wheat flour to develop edible cutlery. Millet is rich in fibre and cassava is a good source of starch. Moringa leaf powder has been added to the dry ingredient powder to increase the amount of micro and macro nutrients. Egg, corn starch, gelatine and rice flour were used as binding agents. Proximate analysis of samples was done. Based on the results, researchers have established that edible cutlery is a viable alternative to plastic cutlery, which is also a source of nutrition.	Shabana M et al 2021

Edible Cutleries	mixture of sorghum flour, wheat flour, and rice	The three samples were prepared using steel cutlery. The samples are then tested for water absorption and soil burial examination. They suggest for commercialized purposes, to get the same shape, edible cutlery should be properly moulded and some flavour can be applied to it depending on customer demand.	Kabir *et al* 2021
Biodegradable Spoons	water, grape, proso millet, wheat, xanthan, and palm oil	The goals of the investigation were the development of biodegradable spoons and the examination of their texture, antioxidant capacities, and overall polyphenol content. The spoons were developed by mixing various concentrations of the following ingredients: water, grape, proso millet, wheat, xanthan, and palm oil. Some spoons are dried in a fruit dehydrator, and the samples are baked at 180 or 240 degrees Celsius. The analysis's findings indicate that a spoon made from a combination of all three flours plus xanthan is the most effective substitute for plastic cutlery. The great strength and antioxidant activity of this spoon was evident. It established that the nutritional profile of the experimentally developed biodegradable spoon improved by the use of grape flour.	Dordevic et al 2021
Edible Spoon	soya flour, finger millet flour, refined wheat flour & whole wheat flour.	A study to analyse the textural attributes of edible spoons made from soya flour, finger millet flour, refined wheat flour & whole wheat flour. A texture profile analyser is used to analyse textural attributes like hardness, springiness, cohesiveness, gumminess, chewiness, and resilience. Results of the textural analysis showed edible spoon made with refined wheat flour was better in the textural attributes.	Ms. Krishnapriya *et al* 2021
Nutrient-Rich Edible Cutlery	composite flour made of wheat flour, pearl millet, and barnyard millet	The goal of work was to create nutrient-rich edible cutlery using a composite flour made of wheat flour, pearl millet, and barnyard millet, and to use Box Behnken design and Response Surface Methodology (RSM) to optimise the composition based on water absorption characteristics at different temperatures, including room temperature (29°C), cold temperature (10°C), and hot temperature (50°C). Wheat flour, pearl millet, and barnyard millet flour levels were varied from 0 to 40%, 0 to 50%, and 0 to 50%, respectively. Pareto analysis of variance was used to analyse the data collected from the experimental investigation, and a second order polynomial equation was fitted to the data. The optimal composition was determined to be 50.12% wheat flour, 26.18% barnyard, and 0% pearl millet flour based on individual and combined responses using Derringer's desired function methodology. Under this composition, water absorption was 49.76%, 35.93%, and 41.09% for temperatures of 10 °C, 29 °C, and 50 °C, respectively. The	Rajendran et al 2020

		nutritional value of the optimised sample was 5.67 g/100g of protein, 2.36 g/100g of total fat, and 83.68 g/100g of carbohydrates. This type of product replaced plastic cutlery because it biodegraded in just five days.	
Biodegradable Cutlery	Pea Peels	For this study, they used pea peels to make a biodegradable film and estimated their proximate values, tensile strength, surface thickness, and water solubility. The results showed a high nutrient content of Crude Protein 19.79%), ash 7.7%, fat 2.27% and fibre 1.84%) in the waste peas. The biofilms developed in this study have a good tensile strength of 5,96 MPa, a thickness of 70 µm and a water solubility of 2,46%.	Upasana *et al* 2019
Bioplastics	Potato Peels in dough	They used potato peels for the production of bioplastics and water absorption capacity and biodegradability were analysed. They found that the produced potato peel bioplastic had a higher water absorption capacity than commercial bioplastic. Thus, PPB may not be used in the food service industry but can be used as packing material.	Bezirhan, Ezgi & Bilgen, H. Duygu. 2019
Edible Plate	rice flour and sorghum flour	In order to enhance the nutritional content of the dough as well as its appealing hue, spinach juice was used to make it instead of water. The final product was prepared using rice and sorghum flour in a 50:50 ratio. The projected values for the chemical parameters like moisture, ash, protein, and fat are 2.57, 1.60, 4.81, and 1.72 percent, respectively. The product underwent proximate, nutritional, and phytochemical evaluations. The edible plate's energy is estimated to be 343.4 Kcals.	Sood and Shikha, 2018

IV. Vegetable Wastes Used in Making of Edible Cutlery

According to Upasana et al 2019 in India alone more than 1 million tons of pea peels are generated annually. Cauliflower is a vegetable with the highest waste index, contributing to 45-60% of the total weight of the vegetable (El-Sayed, Sanaa et al 2018). Therefore, this review focuses only on their qualities so that their reuse can be increased.

According to Bondonno et al 2021, fruits and vegetables have a high ability to delay and frequently prevent the onset of chronic diseases, including cardiometabolic, neurological, and musculoskeletal problems, as well as several malignancies. They propose that glucosinolates (and isothiocyanates) exert their anti-inflammatory, antioxidant, and chemoprotective properties through a variety of pathways. Even though there is proof that eating a diet high in glucosinolates lowers the risk of developing chronic diseases, more extensive placebo-controlled human trials with standardized glucosinolate supplements are required in the future. All plants, including the most frequently consumed plants in the Brassicaceae, Capparaceae, and Caricaceae families, contain the secondary plant metabolites known as glucosinolates. These vegetables' bitter flavor and strong odor are brought on by glucosinolates. They have reviewed the effect of glucosinolate on cardiometabolic, neurological, and musculoskeletal disorders. Epidemiological studies have indicated a possible beneficial association between cruciferous vegetables and hyperglycemia and diabetes, hypertension, and dyslipidemia. In research on both animals and people, isothiocyanates such raphasatin and sulforaphane may prevent or lessen glycemic-related problems. In a study involving hyperglycemic mice administered with or without

sulforaphane (0.5 mg/kg daily for 5 days/week) for 3 months and with 3 months of additional observation, it was discovered that sulforaphane prevents diabetes-induced hypertension and heart dysfunction.

According to (Wani and Kaul, 2011) the dried cauliflower green leaves are very nutrient-dense and a good source of carotene (43.11 mg per 100g), iron (60.38 mg), copper (1.55 mg), manganese (5.86 mg), and zinc (5.10 mg). Dietary fibre, minerals, iron, and beta carotene are all present in good amounts in cauliflower leaves. One of the finest ways to preserve green leafy vegetables is by dehydration. Green leafy vegetables can be used to supplement nutritionally deficient products since they are abundant in vital micronutrients. To improve the quality of traditional products and prevent anemia diseases, powdered cauliflower leaves can be used to treat health issues (Pankar et al 2018).

According to Kumari, T et al 2022, the development of functional meals with potential health benefits could be greatly aided by the insoluble dietary fiber (IDF) found in pea peels. Utilization may help reduce food waste and disposal-related environmental impacts. Among the many commercial food companies, including those in the beverage, dairy, meat, and other health-promoting food sectors, the developed IDF from green pea peel (GPP) has significant economic viability. It has the potential to generate significant economic benefits each year and be a novel method of producing functional food components to extract IDF from GPP by-products that have previously been mostly discarded. Abd El-Galil et al 2021 studied the anticoagulation, fibrinolytic, antioxidant, antiproliferative and prebiotic activity of six aqueous extracts of *P*. sativum waste and their sulphated derivatives, with particular attention to the content of certain bioactive compounds. As an important source of bioactive chemicals, the peels of the plant are beneficial primarily as antioxidants and anticarcinogenic agents against prostate, colon and breast cancer. Thus, it could be reused for further medicinal applications.

Moussa, M.M. et al. 2021 investigated pea peels with high protein content (35%), in order to develop a new way to maximize the usage of protein content from pea husks and for its future application as a value-added food ingredient. Green curd made from pea peels and dehydrated. created and added to instant soup powders and snack crackers.

V. Conclusion- To conclude this review, I would say that biodegradable cutlery can prove to be a great option as a replacement for plastic cutlery. Biodegradable cutlery is a beneficial option not only for the environment but also for health in edible form. Through which nutritional requirements can also be met. Edible cutlery made from vegetable wastes can be a boon for the society. Because the reuse of vegetable waste can reduce the money and human labour involved in disposal management, at the same time, many benefits can be obtained from their nutritional properties. Commercially also edible cutlery made from vegetable waste can be a revolutionary invention for food processing industries, packaging industries which can provide benefits with very less investment.

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