

Edible cutlery: An emerging sustainable approach towards a healthy future

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Objectives: To evaluate a better and sustainable replacement for the plastic cutleries and to expand the field of study for edible cutlery.

Background: Plastics are artificial organic hydrocarbon polymers that have been altered for human needs and functionality. They contribute significantly to environmental pollution on a global scale and now pose a serious threat to the entire ecosystem. By generating pollution in the air, water, and soil, the regular use of plastic items puts both human life and marine life in danger. Due to its excellent durability and affordable price, plastic disposable cutlery is becoming more and more popular as the number of food outlets grows. Numerous chemicals, including BPA and PET, which either directly or indirectly harm a person's internal organs, are included in this plastic cutlery.

The literature of review search was conducted between the years of 2012 and 2023 using the key phrases "plastic waste," "edible cutlery," and "biodegradable cutlery" in the databases of Google Scholar, PubMed, and Research-Gate.

Based on plastic waste and edible cutlery, 24 studies in total were located. 80% of the papers included in this study provided information on the proper use of edible cutlery as a superior and sustainable alternative to plastic disposables. 20% of the research' databases on edible cutlery contained ambiguous information. The review show that edible cutlery is still a relatively new idea, thus attention needs to be paid to how to improve its water absorption qualities, cost, microbiological deterioration, shelf-life, packaging, and marketing.

Conclusion: The edible cutlery has both eco-friendly as well as biodegradable characteristics with another advantage being nutritious and healthy with no health-risks. In order to reduce the negative impacts of plastic pollution on the environment, the public at large are being educated and safety precautions are being put in place. Numerous efforts are done worldwide to provide the best substitute for plastic disposals with comparable features, making it the most preferred to lessen the invasion of plastic garbage globally.

Key Words: *Plastic waste; Edible-cutlery; Waste-management; Bio-degradable; Eco-friendly*

INTRODUCTION

Globally, the two main objectives have been modernization and economic growth. With the newest and quickest technology which have enormously increased the economic levels around the world, it has made our life simpler and easier but have begun to the degrade our environment [1]. Plastic being one of the biggest innovations have occupied a major segment our life in the form of plastic containers, bottles, packaging materials, cutleries, clothing, telecommunication, and footwear. What made plastic to be a bigger part of our lives? The affordable, lighter weight and powerful durable characteristics made it a part of our life. Nowadays plastic has turned into a central issue everywhere. All throughout the world, efforts are being made to eradicate plastic. It was estimated that 280 million tonnes of plastic were manufactured worldwide in the year 2012. Few of the researchers indicated that by the year 2050 the percentage of plastics weight would be higher than the fishes in the rivers, oceans and seas [2]. Why there is a need of plastic elimination in every part of the world? Polymers of plastic include potential life-threatening components that is inorganic fillings which includes silica and carbon and other components in the form of additives in order to enhance the production quality of the products manufactured from the plastics. Few life-threatening additives include Bisphenol A (BPA), Polyvinyl Chloride (PVC), phthalates and are found mostly in food packaging, toys, cosmetics, medical tools etc. [3,4]. These chemical components can cause deadly health conditions not only to humans but also to the marine lives as well. Therefore, there is a strong need to reduce the usage of plastic and finally eradicate from our lives entirely. To solve this ever-growing problem, researchers from all over the world have created an alternative solution known as edible cutlery. Out of concern for environmental pollution and the harm that people's intake of plastic does to their health, many start-ups have developed cutting-edge cutlery that is edible and biodegradable. Sorghum, the main component of edible cutlery, gives the item features like

being quite durable and easily decomposable during 5 to 6 days, as well as the ability to tolerate anything from hot soups to frozen desserts for roughly 15-20 minutes without disintegrating [5]. Plastics are amorphous by nature and lack a specific melting temperature, which can cause food contamination. Therefore, the use of edible cutlery is essential in the transition away from plastic cutlery [6]

Edible-cutlery is an impending range of eco-friendly, plant-based consumable utensils that are completely safe to use. These are regarded as being "ready to eat" because it requires no additional preparation. The use of edible cutlery allows for the serving of solid or semi-solid foods without the risk of their becoming soggy quickly [7]. The cutleries are often recognized as eco-friendly, biodegradable, and organic [6]. Even if there are biodegradable cutlery options in the market today, edible cutlery is preferable since it can be eaten right away. In addition to being edible, it also has qualities that make it nutritional and acceptable for consumption. To design eatable cutlery, a variety of raw materials can be used, but only a few specific flours provide the desired characteristics. These flours, such as rice flour, rice grain flour, soy flour, and sorghum flour, all have their own nutritional benefits and can enhance the physio-chemical properties of other raw materials [6,8]. Because grains are necessary components in the production of cutlery, they improve health by lowering the risk of serious illnesses like obesity, constipation, coronary heart disease, and others [9]. Protein, carbohydrate, iron, calcium, riboflavin, thiamine, folic acid, and niacin are among the nutrients found in these cutleries [10]. To create biodegradable edible cutlery, alternative materials including plant waste by-products are being utilized. Numerous distinctive characteristics of cutlery derived from plant proteins and fibers include affordability, lightness, availability, and biodegradability [11]. Countries like India, Myanmar, Indonesia, Nepal, Pakistan, and Sri Lanka employ banana and almond leaves to make bowls and plates. These are believed to improve heart and digestive health as well as weight loss, among other favorable

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health impacts [12]. Plastic cutlery is at a higher demand currently due to the increasing food outlets, banquets, and other party outlets. Being one of the most practical additions into the food and packaging industry, due to its inorganic nature, recycling and decomposition of plastic waste becomes a challenging issue [13]. The manufacturing of plastic cutlery which accounts a bigger percentage of plastic application in day-to-day life must be taken into consideration in the initiative of plastic eradication. Edible cutlery could be a good solution and aid to curb off the waste generated through the plastic cutlery waste.

LITERATURE REVIEW

History of cutlery

The use of natural materials like stone, wood, and shells by early humans as means of distributing food marks the beginning of the history of cutlery. Metal cutlery became the norm among the wealthy as the "Industrial Age" started in the 18th century. Silver was the preferred metal because it did not react with most foods. When stainless steel was introduced, which was more durable, affordable, and easy to work with, it made metal cutlery more widely available to the general public. Plastic dinnerware and cooking equipment first appeared after World War II, when metal was hard to get by. Companies began producing plastic cutlery in the 1960s as a less expensive substitute for traditional tableware. Plastic utensils were created to be used once, then discarded. As a result, less cleaning and upkeep was required, conserving valuable resources like water and electricity. Disposable plastic cutlery's low-cost increased demand in fast food restaurants and other ancillary enterprises. Fast food restaurants and convenience food became the preferred dinner choice for the hamster cage inhabitants with the arrival of the new century. This in turn led to an outflow of plastic cutlery and silverware being made and then discarded into the environment, polluting the ecosystem [8].

Edible cutlery: The origin and the future

The idea of edible cutlery was first put forth in India in 2011 by Narayana Peesapati, a former scientist at the International Crops Research Institute for the Semi-Arid Tropics in Hyderabad. On a flight from Ahmedabad to Hyderabad, the incident took place. He saw a passenger scooping out shrikhand, a delectable Gujarati delicacy, with a khakra. It was a thought to contemplate for this post-graduate man in forestry management who had previously avoided using plastic utensils. What Mr. Narayana encountered on a train station a few years ago did not sit well with him. In a modest restaurant, he had ordered Idli-Sambhar, which the steward delivered with plastic spoons. He observed that the spoon was oily and had not even been thoroughly cleaned. After that encounter, he was even more inspired to offer a better and healthy option. Narayana illustrates the increased danger that plastic, a petroleum by-product, poses to people's health. The likelihood of chemicals entering the human system is increased by the presence of many poisons in plastic. Plastic cutlery poses risks to the environment as well as to human health. By sandwiching chapati dough between two spoons, he attempted to create a three-dimensional spoon. But it quickly became wet, especially after he submerged it in water, said Narayana. He started experimenting with different flour blends and eventually created one that would hold its shape even in boiling liquid for more than 20 minutes [14].

Many of people are aware of the impacts of plastic and the harm it does to the environment, but they need a change. Since soups and other liquids may

be absorbed by cutlery, research should be done to determine the materials with the lowest ability for absorption. The shelf life of the cutlery is another issue that needs to be considered. Even though edible cutlery is thought to be scarce, demand for it has been rising. Ice cream, hot drinks, salads, and sweets like gulabjamun and rasmalai may all utilize it. Additionally, since the dinnerware is edible, it might act as food for insects and soil-dwelling bacteria. It is critical to conduct study on the safety of consuming such living creatures in such circumstances [6].

Types of edible cutlery

Around the world, different raw materials are utilized to manufacture edible cutlery, such as forks, spoons, bowls, plates, and straws. A study created edible cutlery from natural ingredients including whole wheat flour, banana blossom, and sorghum. Jaggery was utilized in the product as a sweetener and binding agent. According to their findings, edible cutlery degraded in sterile soil after 4-5 days. Increasing the amount of wheat-flour increases the dough's cohesiveness and adhesiveness. The addition of gluten-free millet helps in providing a good flavor to the product [15]. Another study developed edible spoon using soy protein isolate, morning glory stem fiber and glycerine as a plasticizer [6]. Similarly, Boapana et.al experimented on material selection for preparing edible plates. Cotton seed cake, groundnut oil cake, ragi flour, Cattle feed pellets, maize leaves, sago, waste flour procured from flour mill and jaggery. Two types of sample edible plates were developed: Type 1 (groundnut oil cake/cotton seed cake/cattle feed pellets) and Type 2 (waste flour procured from flour mill). As per their findings, number of materials used in Type 1 is more than Type 2. The cost of Type 1 (Rs.10.3/plate) is higher than Type 2 (3.28/plate). Type 1 is consumable only by the cattle's whereas Type 2 can be consumed by both. Rigidity of Type 2 is higher than Type 1 edible plates. Nutritional content of Type 1 edible plate is higher than Type 2. The study concluded that as per the endurance and durability. Also, as edible cutlery is new to the market, people do not use them regularly. The endurance of the product is doubtful as it might fade over time. Due to the inexpensive and readily available nature of plastic, it is a more popular choice [16]. A study was conducted to analyze the textural properties of edible spoons. Different types of flours such as refined wheat flour, hard wheat flour, soy flour and finger millet were used for development of different flour based edible spoons. The study revealed that edible spoon made of 100% refined flour gave the best textural properties as compared to the other flours. Whole wheat flour, finger millet also gave a good textural property but the firmness was quite higher in the edible spoon made from refined wheat flour. Soy flour gave a higher range of brittleness. Therefore, edible spoon made in combination of flours may give good textural characteristics [7]. One study developed edible cutlery using fruit wastes. Pineapple, pomegranate, and orange peel were used along with jackfruit powder and flax seed flour which performed as binding agents. Thus, according to their findings, pineapple gave the best appeal and minimal moisture than other two variations of orange and pomegranate. The study concluded that fruit waste may be combined with low-cost binders such as jackfruit seed flour and flax seed powder to generate edible cutlery [17]. A study used sorghum, spinach extract, and rice flour for the development of edible plates. Sorbic acid was used as an anti-fungal agent [18]. As per their investigation, sorghum is incredibly absorbent, making the use of edible cutlery quite adaptable. Rice flour, wheat flour and sorghum were used as the main components for the development of edible spoons (Tables 1 and 2).

TABLE 1
Types and composition of edible cutlery

Type of cutlery	Composition	Processing	Reference
Edible plate	Spinach concentrate Rice flour Sorghum flour Sorbito	Blending, Kneading, Sheeting, Moulding, Baking, Cooling and Packing	Sood and Deepshikha [18]
Edible spoon	Whole wheat flour Sorghum flour Rice flour	Mixing, Kneading, Moulding Baking, Cooling and Packing.	Rashid [19]
Edible bowl	Wheat bran Wheat flour Canola seed Oil salt rooibos tea	Preheating, Mixing, Sheeting Cutting, Moulding, Baking Cooling and Packing.	Poonia and Yadav [20]

Edible Spoon	Soy protein isolate Morning glory stem Glycerine	Washing, Cutting, Drying, Grinding, Mixing, Kneading, Sheeting, Moulding, Baking.	Wissuta Choeybundit [11]
Edible Bowl and Spoon	Whole wheat flour Banana blossom Sorghum Jaggery	~lq	Bishal Thagunna
Edible Bowl	Pineapple peel Pomegranate peel Orange peel Jackfruit seed flour Flax seed powder	Washing, Cutting, Drying, Grinding, Mixing, Kneading, Sheeting, Moulding, Baking	P Vyshali [17]

TABLE 2
Comparisons for different biodegradable cutlery

Biodegradable cutlery	Husk	Plastic	Bagasse	Bamboo	Edible	Starch	Leaf's
Cost	Rs.500/plate	Rs.0.3/plate	Rs.15/plate	Rs.15/Plate	Rs.3/plate	Rs.3/Bag	Rs.15/plate
Convenience	High	High	High	High	High	Moderate	High
Disposal	Easy disposal and reusability	Simple but destructive	Easy	Easy disposal and reusability	Easy disposal and Edible	Easy	Easy
Decomposition	4-8 weeks	Up to 500 years	<90 days	90-180 days	Up to 30 days	<24 hours	30-60 days
Availability	Online primarily	Retail and Online	Retail and Online	Retail and online	Retail and online	Online primarily	Online primarily
Environmental effects	produces fertilisers when it decays		produces fertilisers when it decays	Transforms into manure	produces fertilisers when it decays.	produces fertilisers when it decays	produces fertilisers when it decays

Advantages and disadvantages of edible cutlery

Advantages: Environment friendly edible cutlery can be easily discarded and consumed by animals, making them a sustainable option [7]. During times of war or in disaster-prone areas where there may be limited resources and food scarcity, providing edible cutlery can serve as an alternative food source that can be consumed when necessary [18]. Edible cutlery offers several therapeutic advantages, including anti-cancer, anti-obesity, anti-diabetic, and cardiovascular benefits [19-21]. Edible cutlery has the potential to decrease the reliance on plastic products, leading to fewer chemically harmful pollutants being released into the environment during the process of plastic degradation [15]. Edible cutlery has the added benefit of serving as both a tasty option and as a nutritional supplement to assist in improving our overall health and well-being [8]. Proper air-tight packaging can significantly extend the lifespan of cutlery, which can vary from several months to years. An excellent example of this is the edible spoon, which can remain usable for up to two years and holds up well in hot soups, salads, ice creams, and other food items. Most edible cutlery products are typically free from preservatives, as per the sources available [13].

Disadvantages: Compared to other types of cutleries, the price of edible cutlery is relatively high. Consumers' concerns about the durability of edible cutlery and its limited availability are significant factors that restrain them from frequently purchasing such products [22]. The shelf-life of edible cutlery is lesser than the other types due to the edible raw-materials used for its production [13].

DISCUSSION

Size of the edible cutlery market

Due to the rise in consumers choosing vegan products, the edible cutlery market has experienced substantial development in both developed and developing nations. In addition, the market has been boosted by the growing health consciousness and higher disposable income of consumers. However, the instability in the prices of raw materials and the expensive nature of natural and organic flours pose significant challenges for the edible cutlery market. Conversely, the increased demand for edible cutlery by the vegan community and the advent of diverse flavors and varieties of flavored flours present attractive prospects for the edible cutlery market [23]. In contemporary times, ensuring customer satisfaction holds a pivotal position across every industry, food manufacturing, B2B, or B2C business [19]. According to research, the market had a value of 2.62 billion dollars

in 2017 and is expected to exceed 3 billion dollars by 2025. Also, a study by National Geographic in 2018 revealed that Asia is responsible for half of the world's plastic production, with China accounting for 29% of the total manufacturing quantity [24]. A study estimates that the worldwide edible cutlery market will grow at a CAGR of 11.1 percent from 2019 to 2026, from a value of \$24,860.0 million in 2018 to \$56,970.4 million in 2026. In 2018, North America dominated the market for edible cutlery, accounting for 41.8% of all sales [12]. Growth in the market is anticipated to be fueled by the rising use of this product in the aviation sector, where steel products are anticipated to be an unprofitable alternative [6].

CONCLUSION

Plastic is the greatest menace to humanity and the environment, causing cancer, toxicity in the ocean, land erosion and air pollution. A demand exists plastic replacements or better solutions. Edible cutlery can be a good replacement of plastic utensils which exhibits harmful chemical substances. It has numerous advantage such as its biodegradable nature, edibility, nutritious alternative etc., yet there is a huge gap to be fulfil to eliminate plastic completely like the rate of fluid absorption is higher which makes them soggy; the cost is higher than other cutleries due to the higher rate of raw materials and processing; Chances of microbial spoilage is higher due to its edible nature; packaging of the cutlery is another problem; shelf-life is relatively low than the plastic cutleries; moisture can get easily into the product if kept in an open air; development of mould for different edible cutlery is also a difficult task. Due to all these reasons, the market of edible cutlery is still on the lower side making the plastic ones much more popular. From future perspectives, work can be carried on these gaps to achieve a good market value of edible cutlery and hence to attain sustainability.

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