Nanotechnology Perceptions
ISSN 1660-6795
www.nano-ntp.com

Edible Cutleries: A Sustainable Solution for Disposable Plastics

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Plastic has emerged as a serious danger to the environment as a whole, and daily use of plastic items has various negative effects. Beyond-description losses include the air pollution brought on by burning plastic, the marine ecosystem being contaminated, animals' internal organs being damaged by microplastics, and people being indirectly harmed by eating meat, seafood, and other goods which abundant in microplastics. To assess the usage of plastic plus its replacement using a better choice, this study reviewed studies on various types of cutlery, ways to produce edible cutlery, its medicinal characteristics, and the food cutlery industry. Since they occur on a regular basis, they degrade the quality of life. It is not possible to totally eliminate plastic because it is continually utilized and necessary; nevertheless, plastic usage may be decreased by utilizing better alternatives. Therefore, cutlery composed of plant- based ingredients such rice, sorghum, flour, soy, and wheat bran flour is a superior option. Edible cutlery is the best option for replacing plastic cutlery since it is environmentally friendly and biodegradable. This cutlery can contribute to the transformation of an unhealthy lifestyle into a healthier one by reducing the risks of cancer, endocrine disruption, and weakened immunity caused by exposure to food-storing plastic packaging that leaches. The ultimate goal of the study was to decrease the usage of plastic and products made of plastic. It can help to achieve the sustainable development goals (SDG) of the United Nations Organization, which include ensuring healthy lives and promoting well-being to everyone at all ages (SDG-3) and taking urgent action to combat the effects of climate change and its impacts (SDG-13).

Keyword: Climate action, carcinogenic, biodegradable, healthy, well-being, toxicity

1. Introduction

Plant-based edible cutlery allows food to be presented or consumed like a meal. The product is commonly known as EBO (eco-friendly, biodegradable, and organic) due to its blend of

flours. Bakey's, an Indian company, has been selling edible cutlery is a commercial item since 2010. (Reddy, 2016). Scientist Narayana Peesapaty of Hyderabad, India, noticed people using khakras instead of plastic spoons to scoop rice during a dinner on an aircraft. It gave him the idea to construct a flour spoon. (Das, 2016). Biodegradability and eco- friendliness are the two main arguments in Favor of edible cutlery over plastic cutlery, as plastic poses a serious risk to both the environment and human health. Edible cutlery may be made using a variety of components, but some types of flour provide the right qualities for the finished result. Additional components such as rice flour, the bran of rice flour, soy flour, sorghum flour, and so on. possess inherent nutritional advantages and, when combined with other items, can improve the physico-chemical characteristics of the mixture. Better options, including edible cutlery, must be used in Favor of plastic cutlery since plastic poses a serious danger to the environment as a whole. The use of plastics and the difficulty in getting rid of them is a big problem in today's culture. (Patil and Sinhal, 2018). Consequently, plastics ultimately enter our bodies in microplastics. Certain research claim that plastics contain the dangerous chemical bisphenol A (BPA). BPA is a chemical that mimics hormones and has been related to a number of detrimental effects on children's health. This includes altered behaviour, obesity, abnormalities in reproduction, changes to the cardiovascular system, and cancer. (Schugand Birnbaum, 2014). Rich fibre, calcium, potassium, vitamins B and A, and other nutrients are included in the edible cutlery. (Munir, 2017). Since whole grains are the main ingredient, they improve health by averting conditions like constipation, obesity, coronary heart disease (CHD), and other serious illnesses. (Hollænder et al., 2015).

Replacement of plastic cutters is necessary.

Only 25% of the 15 Mt of plastic garbage produced annually in India gets recycled (United Nations Development Programme, 2018). Around the world, 350 million tons of plastic are produced annually. In 2017, plastic ranked as the third most common material manufactured by humans, after steel and concrete. By 2050, over 12,000 Mt of plastic garbage will either wind up in the environment or landfills if current production and waste management patterns continue. (Geyer et al., 2017). It is critical to acknowledge that microplastics can have detrimental effects on human health, ecosystems, and biota when they enter the body through the skin, food, or inhalation. Numerous animal species, including tiny zooplankton, enormous animals, birds, and fish, confuse plastic for food and perish consequently (De Sá et al., 2018). Merely 9% of the total plastic produced in history been repurposed, whilst 6.3 billion tons of waste were disposed of in landfills by the ocean instead of reaching a recycling facility. The primary ingredient in edible cutlery, sorghum, provides the cutlery properties similar to having the ability to endure anything from steaming soups to ice cream over fifteen to twenty minutes without disintegrating as well as being extremely durable and readily broken down for five to six days. This helps edible cutlery replace plastic cutlery. (Natarajan et al., 2019). Plastics have no specific melting point due to their amorphous structure, which might contaminate food. Therefore, a crucial role for edible cutlery is to replace plastic silverware.

Plastic's harm to the environment

The term "plastic" comes from "plastikos," a Greek word that meaning "with mold through various shapes." Roughly 4% of the globe's crude oil and gas are used as a source of feed for plastics, and an additional 3-4% are needed to power their production. They are becoming

more and more well-liked due to their special qualities, which include light weight, affordability, robustness, strength, corrosion resistance, thermal as well as electrical insulation, versatile fabrication and layout capabilities, and the ease with which they can be molded into a range of products (Hopewell et al., 2009) and they are useful for a variety of purposes (Thompson et al., 2009). Although plastics have greatly benefited human civilization, the ingredients used to make them possess a variety of drawbacks. (Mwanza and Mbohwa, 2017). Poly-halogenated compounds, heavy metals, bisphenol A (BPA), di-(2- ethylhexyl) phthalate (DEHP), and BPA are among the toxic substances included in plastics. They are all detrimental to the well-being of humans (Halden, 2010). Most Among these substances been shown to exist readily immobilized within the surroundings, which can have adverse effects on health including hormone system system disruption. (North and Halden, 2013). Materials that are solid or semi-solid and variable degrees of power, versatility, and, harnesses, and other properties are commonly referred as plastic. To enhance the plastic's unique qualities, strength, and durability, a variety of additives are utilized, including plasticizers, carbon, and silica. Food can get contaminated by plastic, coatings, paper, paper board, and various additional polymers employed on production equipment instead packaging (Trasande et al., 2018). Dioxins and other persistent organic contaminants are released into the environment together with polyaromatic hydrocarbons and Co2, a greenhouse gas, when waste plastic is burned and converted pyrolytically (North and Halden, 2013). Linking the kinds and concentrations of additives present in plastics to biological organisms' absorption and accumulation is the primary issue at hand. (Andrady and Neal 2009). Material made of plastic is a serious environmental issue as a result of their accumulation and resistance to disintegration (Webb et al., 2012). When it comes to managing garbage, they have several drawbacks despite their many advantages (North and Hal den, 2013). Although the plastics industry is essential to foreign exchange gains, there is a serious issue with the company's wastewater effluents. Such wastewater effluents pollute the land, produce disagreeable Odors, and harm the quality of surface and groundwater, all of which have an influence on the well-being of the local population and aquatic life (Ilyas et al., 2018). There are several methods for getting rid of plastic garbage, such as burning, recycling, as well as disposal (Webb et al., 2012). That's exacerbated via the reality that most plastics decompose slowly, rendering contaminated soil unusable for extended periods of time. It appears that plastic waste components have been a common sight in landfills for over 20 years. (Tansel and Yildiz, 2011). This is because landfills have a limited supply of oxygen, making the surrounding air almost anaerobic. (Tollner et al., 2011), and anaerobic environments further lower the rates of landfill deterioration. The decomposition of plastic releases methane (Royer et al., 2018). Hazardous substances that cause pollution and global warming include polyaromatic hydrocarbons, which Greenhouse gases like CO2 and organic contaminants that persist like similar to dioxins when recyclable plastic is ignited or pyrolytically converted. (Mwanza and Mbohwa, 2017). The materials that are most frequently seen in the water are plastics, and plastic particles include significant concentrations of organic pollutants. Among the dangerous materials discovered in marine plastic wastes are Poly chlorinated biphenyls (PCBs), the nonylphenol (NP), and natural pesticides including bisphenol A (BPA), aromatic hydrocarbons that are polycyclic (PAHs), dichloro-diphenyl-trichloroethane (DDT), as well as polybrominated diphenyl ethers (PBDEs) (PBDEs) (Ilyas et al., 2018). Possible side effects include breast cancer, hormonal imbalance, and behavioural alterations, develop mental detriment (hormones disparities, abnormal

growth, and neurological impairment), arthritic conditions cancer, diabetes, and DNA hypomethylation. (Zhou et al., 2011).

Toxicity

Products like food containers, drink bottles, and receipts are made of plastic. The majority of everyday plastic is made of the dangerous toxin BPA (Adilene). Our digestive system and regular hormonal activity are disturbed by BPA. Numerous research have confirmed that BPA is an endocrine disruptor that has negative impacts on health. (Gore et al., 2014). The Canadian government has likewise classified BPA as a "chemical of concern," which has led to steps being taken to reduce BPA exposure in the most vulnerable populations. The most typical polyester plastics used currently is PET (Polyethylene Terephthalate), which has a five-decade lifetime. (Pirillo et al., 2021). Phthalates are abundant and widely distributed in the global environmental conditions following its discharge from the manufacture, use, and disposal of PVC products. Numerous research have been conducted on the subjects of obesity, heart disease, reproductive problems, as well as breast cancer. (Cariati et al., 2019). Polymers are hazardous and non-biodegradable, which contributes significantly to climate change.

Production of Edible Cutlery

Table 1 lists the creation of the the creation of required to make edible cutlery. The principal ingredients are sorghum and paddy. Benefits of sorghum include the fact that it requires 60 times fewer liters of water to grow than rice (Rashid, 2019). Nearly all of the arable area on Earth is suitable for the crop's cultivation (Munir, 2017). Sorghum/Jowar yields 1051 kilos per hectare, or 4.38 million tons, annually (Tonapi, 2020) and rice, or paddy, yields 2578 kg/ha of land and generates around 112.91 million tons (Skand et al., 2020).

Varieties of Cutlery

There is a vast array of cutlery available, with different food manufacturing sectors producing spoons, forks, plates, and bowls among other sorts etc The following is how cutlery is made in different parts of the world (Natarajan et al., 2019). Peesapathy founded as this business both in India and and it operates globally, producing edible tableware (forks, spoons, and even chopsticks) from rice, wheat, and desiccated millets (the sorghum or jowar). The Taiwan-based Sugu Company claims to possess created the "globe's initial kind of edible dinnerware" in 1986 is a way to reduce the amount of wasted dinnerware. The company manufactures edible plates along with other tableware. Nobuhiko Arikawa, a Japanese designer from the Rice Design business, created edible tableware for the Orto Café in Japan. Furthermore, a couple of designers from Belgium possess developed a fresh range of aesthetically pleasing and environmentally responsible edible food containers. Two young entrepreneurs named Helene Hoyois or Thibaut Gilquin create containers using potato starch, fluid, and oil. The co-founders of the American company Loliware stated that they were concerned about the environment and that they intended to develop a novel kind of ecologically friendly cup. Table-1 classifies the kind of edible cutlery. The bowls, spoons, and plates are meant to take the role of throwaway plastic dinnerware.

Table 1. The kinds and content of edible cutlery

Name of cutlery	Unprocessed Materials	Nutrients	Methods/Procedu res	References
silverwere Plate Biodegardble	Rice Flour, Sorghum Flour, Spinach Extract, Sobitol	moisture. 2.57% Ash:1.60 Fat crude: 1.72% Protein crude: 4.81% crude fibre 0.6% Neutral detergent fiber content-3.40% detergent fiber 1.64%. Starch- 4.5 % Flavonoids- 2.72 Phytochemicals-0.64 mg Proteins-1.06g Fat-(0.12) Mineral: 0.13 grams	combining, Kneading, Roofing, Forming, Baking, Cooling Packing.	Sood and Deep shikha, 2018
silverwere Spoon Biodegradable	Flour wheat Flour Sorghum Flour Rice Flour	cellulose – 0.19g Zinc– 0.56mg Calcium – 2.43mg Beta-carotene-3.97mg Thiamine – 0.03mg Riboflavin – 0.01mg B vitamins-0.28mg Folic acid – 1.33mg	Blending Mixing Forming Baking Cooling Packing	Rashid, 2019
Bowls Munch Biodegradable	Bran of Wheat Flour wheat Seed Canola Oil Salt Tea Rooibos	Vitality- 380Kcal Complete Protein – 3.5g Gluocse – 15.6g Whole Sugar – 0.7g Fat Saturated – 0.1 Food Fibre – 4.5g Whole Sodium – 71.1g	Preheating Blending Sheeting Chopping Molding Baking Cooling Packing	Poonia and Yadav, 2017

Table-2 Table Comparing cutlery that is edible and that isn't

Edible	Non-edible	References
Edibility: In addition to being used for meals, cutlery may also be consumed by itself.	Edibility: Not a single piece of cutlery is edible.	Poonia and Yadav, 2017
Biodegradable: As the substance has a natural half- life of five to six days.	None	Natarajan et al., 2019
Sturdy: If as the cutlery is properly packaged in an airtight manner, it can survive for months or even years. For instance, the spoon is edible and may be used in hot salads, soups, ice cream, and other dishes for up to two years.	It may continue for a number of years.	Patil and Sinhal, 2018 Natarajan et al., 2019
Nutritious: Due to their high dietary fiber and energy content, they able to considered wholesome and meet the physical daily add on needs.	None	Sood and Deepshikha, 2018
Cost: Compared to metal cutlery, the item is less expensive.	None	Poonia and Yadav, 2017

Eco-friendly: A product with a low environmental impact. Given that the product has no effect on any environmental ecological parameters.	None	Natarajan et al., 2019
Minimization that of waste: It is able to aid in reducing the amount of plastic silverware that is wasted worldwide.	None	Natarajan et al., 2019
Organic: Its organic aspect comes from the fact that it is composed of natural raw nilcomponents.	None	Rashid, 2019
Preservatives: These majority of edible cutlery goods don't include preservatives, depending on the supplier.	None	Natarajan et al., 2019
Option: It is able to take the place of the plastic silverwere.	None	Patil and Sinhal, 2018
Market Expansion: Numerous nations noticed this trend and are aware that it might lead to the emergence of manufacturing industries in the food processing sector in the next years. Global import and export patterns are also positive for the capital of these nations.	None	Rashid, 2019
Sustainable: This product's sustainability may help the economy and the environment alike.	None	Natarajan et al., 2019

Standard Procedure of Edible Cutlery

Edible cutlery may be made using a variety of ingredients, but two of the most popular fundamental materials are the flour from sorghum (sorghum bicolour) and rice flour (Oryza sativa). These ingredients assist to preserve the desired result and chemical characteristics as While sorghum grain has more pantothenic acid, nicotinic acid, or biotin than wheat grain, it has almost identical amounts of riboflavin and pyridoxine. (Morya et al., 2017) can improve the product's quality. Basic operations are included in the production process. Sorbic acid along with additional components are added after the two flours are initially combined with an additional of 10 milliliters of water. The finest antifungal agent is sorbic acid, which should be added in droplet quantities together with other ingredients and thoroughly kneaded to create a fine dough. Afterwards, the dough is laid out to create a fine sheet, and the moulding process is carried out using a pre-made mold. After that, the product is cut and baked for ten to fifteen minutes at 166 °C. It is then allowed to cool before being packed in an airtight container and kept in a cool, dry location. Figure 1 illustrates the methodical flow process of making edible silverware. This way, the dough will remain free of bacteria that cause spoiling and mold. (Sood and Deepshikha, 2018).

Preservative

Because it is a renewable chemical, sulfuric acid has become the most widely used food preservative worldwide, keeping the world's food system functional. It works wonders against yeasts, molds, and germs. This study examined the effects of the sorbates, a chemical preservative, on the fungus that causes bakery products to rot at various temperatures, pH

levels, and doses. (Kumar et al., 2015). Almost all cutlery recipes follow a similar process that changes according on the raw ingredients, time, temperature, and other factors.

Culinary Usages

Some find it best consumed raw, while others like to take it with hot liquids like soups, tea, and coffee. Children's school lunch baskets also include edible forks for eating. When soaked in liquids for an extended length of time, they might become mushy despite their inherent crispiness and crunch. Its shelf life, when kept in a dry, cold environment, is two years from the date of manufacture. (Natarajan et al., 2019).

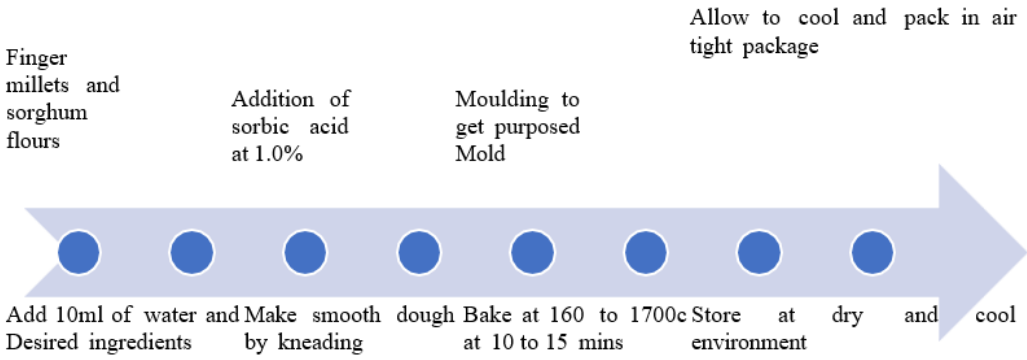


Fig 1. Diagrammatic representation of the edible cutlery unit in operation

Household

The residential application category is expected to increase at the fastest pace, 9.0%, between 2019 and 2025. Due to the growing usage of food-safe cutlery in professional settings, people have been urged to use it more regularly at home. (Kadam and Deshmukh, 2020). Since edible cutlery is constructed of wholesome grains that are beneficial to youngsters, parents of small children have embraced it as a better substitute for plastic spoons. This product will increase demand for culinary knives since it can be eaten like cookies and milk for a healthy breakfast.

Therapeutic Properties of Edible Cutlery

Minerals, vitamins, carbohydrates, protein, and fiber are abundant in the silverware. It tastes more like a simple biscuit and has a slight sweetness to it. Edible cutlery may be provided in times of war and disaster-prone areas when food is scarce due to a shortage of resources. (Sood and Deepshikha, 2018). It is low in fat, high in calories, and suitable for a diet. It contains a variety of nutrients, including minerals like calcium (Ca) and iron (Fe), as well as vitamins B1, B2, B3, B9, and E (Munir, 2017). In addition to being an excellent source of energy, they come with the nutritional supplement. It satisfies the sense of fullness in the stomach even after a little soup or hot beverage. The comparison of edible and non-edible (ordinary) silverware is displayed in Table 2. Eating with edible cutlery promotes wellbeing and excellent health. The edible cutlery is made of several raw materials, such as sorghum and paddy, and offers unique nutritional and medicinal qualities. Together, they demonstrate a number of health advantages, including protection against cardiovascular disease, diabetes, obesity, and cancer (Morya et al., 2022).

Diabetes type I

In the majority of countries, diabetes mellitus, sometimes referred to as diabetes, was the most prevalent health risk. Type 2 diabetes is increasing globally at a substantially concerning pace. Significantly, the prevalence has reached 14.3% in India, and major methods to the prevention of Type 2 diabetes are required. (Kumari and Morya, 2021). Increased whole grain consumption has been linked to a lower risk of chronic disease (1–12), and the difference seems to be significant. Reducing the risk of chronic diseases is essential since chronic illnesses including Type 2 diabetes (T2D), cardiovascular heart disease (CHD), and hypotension are all costly. Whole grain diets raise HDL (high-density lipoprotein) blood while lowering LDL (low-density lipoprotein) cholesterol, blood pressure, and triglycerides.

(Kumari and Morya, 2021; Hollænder et al., 2015). Due to its low glycemic index and high dietary fibre content, sorghum helps Indians with T2D management and prevention. Reduced intake of magnesium, dietary fibre overall, or both were linked to an increased risk of diabetes (Weng et al., 2012). In 2010, the Indian Institute of Millets Research (IIMR) in Hyderabad, in partnership with the National Institute of Nutrition (NIN) and the Indian Council of Medical Research (ICMR) undertook a study on sorghum-based meals under the National Agricultural Innovation Project (NAIP). The results of the experiment demonstrated that diets based on sorghum reduce levels of postprandial blood glucose, low glycaemic index, and glycosylated haemoglobin. (Prasad et al., 2015).

Anti-obesity

Practically every chronic ailment, including diabetes, dyslipidaemia, and mental illness, has been linked to an increased risk of obesity. It has a major effect on the risk of stroke, cardiovascular disease, several malignancies, and osteoarthritis. (Hruby and Hu, 2015). diets that include items that increase satiety For long-term weight maintenance and hunger control, appropriate ties may be beneficial. (Hetherington et al., 2013), as well as the avoidance of chronic disorders linked to fat.

Relieving Constipation

Dietary fiber is well recognized for preventing and treating constipation. A number of studies on the impact of dietary fiber derived from organic sources on bowel movements have been published, along with thorough analyses and meta-analyses. (Watanabe et al., 2018).

Anti-cancerous

Cancer is a horrible disease that affects people everywhere. Meals based on sorghum fulfil a beneficial function by providing sustained phenolics that may aid in the prevention of cancer. (Chen, 2017). Foods based on sorghum have a well-documented anti-carcinogenic potential, and several studies have shown that polyphenol-rich sorghum is effective in preventing cancer. (Khan et al., 2021; Lee et al., 2020).

Celiac Disease

A gluten-induced enteropathy of the small intestinal tract in genetically susceptible individuals is known as celiac disease (CD), an inflammatory condition. There are still many places where celiac disease goes undiagnosed, which can have major health consequences.

(Kumari and Morya, 2021). The sole treatment available about celiac disease at the moment calls for a lifelong gluten-free diet To be able to improve life quality, reduce prevent lymphoma, small intestinal adenocarcinoma, ulcerative jejunoileitis, and resistant celiac disease. (Caio et al., 2019). Foods based on sorghum are thought to be a nutritious diet for those with gluten intolerance since they don't include gluten . (Pontieri et al., 2013).

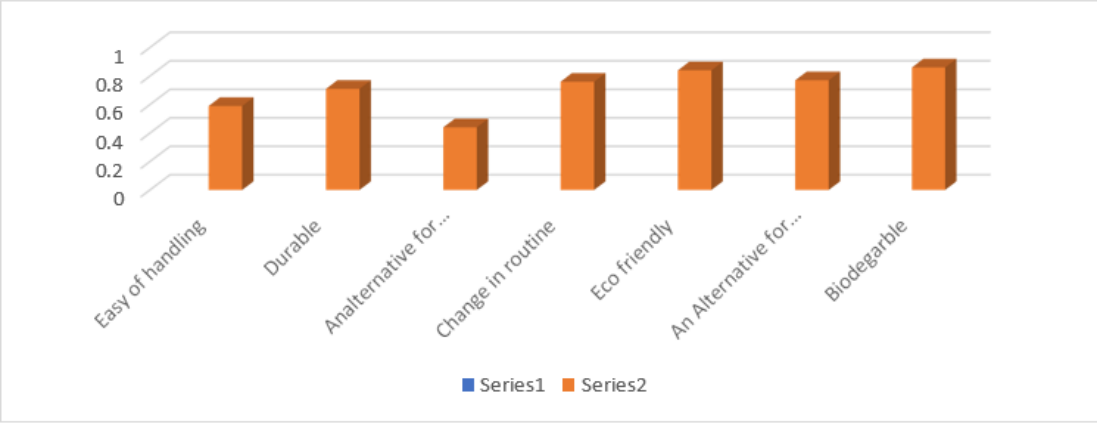
Coronary Heart Disease

Consuming entire grains been associated with a lower incidence of cardiac disease in the coronary heart. (Helnaes et al., 2016). Eating a well-rounded diet consisting of fish, poultry, vegetables, fruits, and grains that are whole lowers the possibility of having a stroke or heart attack, according to over time prospective studies. Consuming dietary fibre has been linked, in both men and women, to a decreased risk of cardiovascular disease (CVD) and coronary heart disease (CHD) (Threapleton et al., 2013).

Market of Edible Cutlery

Consumer preference for vegan food has caused a rise in the application of edible cutlery in developed and developing nations alike. Individuals are more inclined to use freshly created edible silverware instead of throwaway plastic flatware. (Patil and Sinhal, 2018). Customer satisfaction is the most important component for every industrialist, food manufacturer, B2B, or B2C firm in the present day. (Rashid, 2019). Sorghum-based edible silverware might be a practical replacement on the disposable plastic silverware which is destroying the planet. Within the US, there is a huge need for single-use cutlery. For instance, buys 40 billion plastic cutlery pieces a year (Munir, 2017). There is an annual demand of 640 billion dollars for plastic cutlery worldwide. The market was estimated to be worth 2.62 billion dollars in 2017; by 2025, it is expected to have grown to a value of over 3 billion dollars. According to another National Geographic study published in 2018, Asia produces half of all the world's plastics, with China contributing 29% of the manufacturing output (Parker, 2018). Single-use plastic spoons will gradually be phased out by the European Union by 2020 (Welle, 2018). Consequently, the silverware indicates a significant marketplace potential in light of food- safe silverware in several rich nations. Based on data, the The market for edible cutlery worldwide was projected to be worth $24,860.0 2018 saw thousands enter and is expected to grow at a rate of 11.1 percent compound annual growth (CAGR) to arrive at $56,970.4 thousand by 2026. With 41.8 percent of global sales in 2018, North America topped the edible cutlery market. (Dublin, 2020). The primary drivers driving the demand of edible cutlery are shown in Fig 2. In addition, the market for edible cutlery has expanded due to rising disposable income and health concern. Other factors supporting the market's growth include the introduction of novel, healthful spices and flours through different industry participants. (Kadam and Deshmukh, 2020). The increasing use of this item of this object inside the aviation industry, where the steel products are seen to be an unfeasible substitute, is anticipated to increase market growth over the forecast period. Given that the US business is a well recognized standard market across many countries, the following is chosen as an example for the culinary cutlery industry.

An illustration of the need for edible silverware (Patil and Sinhal, 2018)



2. Conclusion

Better solutions for humans or substitutes for plastic are required. As plastic poses the greatest threat to both humankind and the environment, it is responsible for air pollution, ocean toxicity, soil erosion, and cancer. Plastic cutlery should be replaced with edible alternatives. Additionally, it can be more affordable when raw material output rises, assisting in the final product's ability to fulfil the financial requirements of the client. The biodegradability, eco-friendliness, edibility, and many health benefits of edible cutlery help to address the issue at hand. Consequently, goals 3 and 13 of the sustainable development agenda are aided by edible cutlery. The product may be improved and manufactured with the help of the same will have the same benefits and traits.

Future Perspectives

The majority of people are aware of how plastic harms the environment, but something needs to change. As the silverware may absorb soups and liquids placed in it, research ought to be conducted as well to identify the materials with the lowest absorption ability. Furthermore, it is important to take these materials' shelf life into account. Despite the fact that edible cutlery is becoming more and more necessary, its availability is thought to be quite limited. It may be added to salads, hot drinks, ice cream, and desserts like rasmalai and gulab jamuna. Moreover, since the dinnerware is edible, insects and soil microbes may find sustenance in abandoned tableware. Under such circumstances, research on the safety of eating such live creatures is essential (Natarajan et al., 2019).

ACKNOWLEDGEMENTS

The authors acknowledge the scholars whose work has been referenced in this manuscript.

CONFLICT OF INTEREST

The authors state that they do not have any conflicts of interest.

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