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Review on edible cutleries with added nutraceuticals

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Abstract
Edible cutlery has emerged as an innovative solution to address the environmental issues associated with disposable plastic cutlery. This review paper aims to explore the production and properties of edible cutleries made using pearl millet, wheat, and rice flour. Pearl millet, a major cereal in dry and semi-dry regions of Africa and Asia, offers high nutritional value in terms of energy, dietary fiber, protein, vitamins, minerals, and antioxidants. Similarly, wheat and rice flour contribute to the cohesive strength of the edible cutleries, with rice flour's hygroscopic nature aiding in better bonding between particles. Finely powdered rice flour enhances cohesive strength, and its thickening properties contribute to the preparation process. Additionally, powdered kiwi fruit peels can be added to enrich the nutritional profile of the edible cutleries due to their antioxidant and antimicrobial properties. The review emphasizes the need for further research to evaluate the functional and physio-chemical properties of these edible cutleries. By utilizing alternative and sustainable ingredients, such as pearl millet, wheat, and rice flour, edible cutleries can contribute to reducing plastic waste and promoting environmentally friendly practices in the food industry.

Keywords: Edible cutlery, biodegradable, sustainable materials, environmental impact, functional properties, physio-chemical properties

Introduction
When it comes to the food industry cutleries have a very important role be it for preparation, serving or eating. Spoons might be one of the oldest equipment that humans have been using to deal with food items. The spoons in the olden days were made using natural elements like shells, wood, and animal bones. The oldest documented evidence of spoons being used is in England in the year 1259. By the 18th century, the use of forks and knives was introduced for the consumption of food. At this time silver was the material used to make them as it was non-reactive to most of the food items. Later it was replaced with stainless steel (Patil & Sinhal, 2018) [9]. Later with the introduction of plastic in the food industry, plastic cutleries became the cheap, lightweight easy to dispose alternative to metal cutleries. Today plastic cutleries are mostly used for the consumption of foods especially in restaurants, fast food joints and street foods as it is cheap and requires bare minimum maintenance. But as their usage and manufacture are continuously rising and collecting up in the environment and they last for hundreds of years, they become toxic to the environment and to us human beings. Plastic items degrade into microplastics when exposed to external factors, and these microplastics end up in the water, endangering aquatic species (Dordevic *et al*., 2021) [1]. Disposable plastic cutleries are the main reason for this. Therefore, the production and usage of environment-friendly, biodegradable cutleries are a way to reduce this toxic wastage produced from this one time use plastic.
Edible cutlery seems to be the solution for the development and protection of our environment. Edible cutlery or edible tableware and edible packaging are cutleries or packaging made of materials that are safe for human consumption. This leads to zero wastage because we are eating them after consumption. Although edible cutleries seem to be an innovation it has been in use since the 1400s. A bread bowl was first found in 1427 in Britain. Since then, many kinds of edible cutleries have been on the market, but they started to gain popularity just recently. Most of these cutleries claim to hold liquid products for up to 15-20 mints after which they get soggy. Therefore research needs to be carried out to find out the material with less absorption capacity (Natarajan *et al*., 2019) [8].
The aim of this study is the production of biodegradable edible cutlery and evaluation of its functional and physio-chemical properties. In previous studies, researchers have prepared sorghum flour for the preparation of edible cutleries.

When compared to rice, for development of sorghum only 60 times less water is required. Due to the super absorbent nature of sorghum it makes it flexible and hence can be used for consumption of a wide variety of food products ranging from frozen desserts to hot soups (Kabir & Hamidon, 2021) [7]. Here pearl millet is going to be use for the preparation of the cutlery since pearl millet have properties similar to that of sorghum. Pearl millet is one of the major cereals found in dry and semi-dry regions of Africa and Asia. It has high nutritive values in terms of energy, dietary fibre, protein, vitamins, minerals and antioxidants (Jukanti *et al*., 2016) [6]. Along with finger millet other edible ingredients to be used are wheat and rice flour. Since rice flour is hygroscopic in nature, it helps in better cohesive strength due to the formation of strong bond between adjacent particles. The cohesive strength of rice flour increases with decrease in particulate size of the flour (Jan *et al*., 2015) [3]. So, it will be better to use finely powdered rice flour. Thickening property of rice flour also help for the preparation of the cutlery. To make the product nutritionally rich, powdered peels of kiwi fruit will be added to the product. Peels of kiwi fruit have a good anti-oxidant and anti-microbial property (Salama *et al*., 2018) [11].

Edible cutlery

Plastic cutlery may be a practical option, it is hazardous to the environment and one's health. The existence of toxins and carcinogens that can be easily absorbed into the body is a petroleum by-product. Plastic cutlery processing has become harmful to the environment since chemicals and carcinogens can leach into food through the natural ecosystem, and plastics take up a lot of space and clog landfills every year. Biodegradable cutlery has sparked attention because of the recent prohibition on plastics, as well as environmental concerns. The purpose of this research is to raise awareness about the negative impacts of using plastic cutlery on the environment. As a result, the investigator tries an edible cutlery made from a mixture of sorghum flour, wheat flour, and rice. It is completely biodegradable because it is produced from natural materials. Moulding equipment is used to produce edible cutlery on the same scale. In this study, the researcher employed a manual method to make edible cutleries by laying the dough on a steel spoon and baking it at temperatures ranging from 300 to 360 degrees Celsius (Kabir & Hamidon, 2021) [7]. For this study pearl millet flour, wheat flour and rice flour are used for the preparation of edible cutlery.

Rice flour

Qualities of rice flour, the effects of two varieties, local (Abakalike) and foreign (Mama Gold), as well as two processing methods, semi-dry and wet grinding procedures, were explored in the study. Rice flour dispersibility ranged from 58.00 percent to 67.50 percent. The attribute of dispersibility affects how easily flour separates from water molecules and displays its hydrophobic properties. The semi-dry grinding method has a higher dispersibility than the wet grinding method. The bulk density varied between 1.34 and 1.53 grammes per millilitre. The particle size of the samples determines bulk density, which is a measure of the heaviness of a flour sample. Solubility levels ranged from 5.60 to 10.08 percent. The hydrogen bonds that hold the granules together would be weakened by shortening the chain length of the starch molecules, enhancing solubility. The swelling power ranged between 7.36 and 7.75 percent. The swelling power of the starch granules refers to the force within the granules, as well as the water absorption index of starch-based flour during heating. Water absorption capacity ranged from 1.64 ml/g to 2.14 ml/g. The results show that the flour has a high ability to bind water. The amount of amylopectin in the samples ranged from 19.76 percent to 23.76 percent. According to the findings of the current study, amylopectin is a function of flour starch and amylose concentration, meaning that one is a function of the other and that both traits are important in food preparation and development. Amylopectin is responsible for starch's high viscosity and waxiness (Joy, 2016) [5].

Pearl millet

Pearl millet (*Cenchrus americanus*) is an underutilized cereal grain constituting up to 70% starch in it. When compared to other cereals used in the production of functional foods, pearl millets can be used as a less expensive source of starch. This paper mainly focuses on techno-functional characters of pearl millet like solubility, gelatinization, swelling power, pasting property and digestibility. In comparison to commonly used starches, pearl millet starch has superior qualities, according to this study. The activities of native starches are limited, and their stability varies greatly depending on pH and temperature. Physical alterations have grown in favour in recent years because of their safe and environmentally friendly character. For extending the functions of pearl millet starch, novel physical modification methods such as ultrasonication, pulse electric field, irradiation, and cold plasma treatment may be used. As a fat replacer, food thickener, colloidal stabiliser, gelling agent, and bulking agent, pearl millet starch has the potential to be used in edible coatings and films, composite films, nanoparticle development, pharmaceutical and medical applications, -amylase production, and as a fat replacer, food thickener, colloidal stabiliser, gelling agent, and bulking agent. As a result, pearl millet starch appears to be a potential starch for competing in industrial applications with other commercially important starches (Punia *et al*., 2021) [10].

Utilization of grains for the preparation of edible cutleries

Natural components such as rice, wheat, and millets were used to create edible cutlery in this study. Dough will be made with a mixture of rice flour, pearl millet flour, and wheat flour with different compositions. The lukewarm purified water was then used to modify the mixture of three different samples and knead into dough. The dough was pre-sheeted by hand before being sheeted using a dough sheeter. The dough sheets were then cut in to required size. The dough was shaped into spoons, forks, and bowls, and then cooked for 40-60 minutes in an aluminium tray at 180 °C. The sedimentation experiments were used to determine the type of flour that is best for the preparation of appetising cutlery. Rice amylose and amylopectin, as well as gluten from wheat flour, have the potential to form a starch-water connection and hold a large quantity of moisture. Because the ratios of three flours used in blends are evenly connected to each other, the findings for SRC of different solvents revealed minute variance, which could be attributed to the composition of blends. The glutenin, gliadin, and pentosan properties of the flour, as well as the quantity of starch harm in the flour, are the main functions of SRC. The proximate analytical values obtained are within

permissible ranges, indicating that the newly created edible cutlery is safe to use (Iqbal *et al*., 2022) [2].

Addition of bioactive compounds in film/edible cutlery

Bioactive compounds are a valuable source of molecules for nutraceuticals, functional foods, and food additives since they contain a wide range of structures and activities. The most common approach is traditional liquid–liquid or solid–liquid extraction, although more advanced methods include pressured liquid extraction, subcritical and supercritical extractions, and microwave- and ultrasound-assisted extractions. Nutraceuticals are dietary supplements that contain a concentrated form of bioactive molecules from food in a non-food matrix and are used to promote health at higher doses than those found in regular diets. Traditional medications are thought to be safer and have fewer and milder side effects than nutraceuticals, which are routinely utilised to treat specific illnesses. Because they are high in multiple NBCs, whole foods like fruits and vegetables are the most basic form of functional foods. Fruits high in NBCs, including as polyphenols and carotenoids, have been shown to have antioxidant properties and lower the risk of some cancers. Drinks, cereals, bakery products, spreads, meat products, and eggs are just a few examples of functional food products now on the market. Probiotic organisms are now mostly obtained from functional foods such as dairy products and milk, which are regarded to be an excellent delivery mechanism for probiotic microorganisms. NBCs appear to be the way of the future in the field of functional foods and nutraceuticals. Functional foods are becoming more popular as people's eating habits change, and they become more concerned about their health. Nonetheless, some issues must be rectified before successful applications can be submitted (Joana Gil-Chávez *et al*., 2013) [4].

Kiwi fruit peel

The kiwi fruit have been getting a lot of attraction due to its health advantages. It can be consumed as it is or in the processed form. Due to the antibacterial, antifungal, and antioxidant properties of kiwi fruit it could be used as a medicinal fruit (Siddique *et al*., 2021) [12].

In this study bioactive and antioxidant potential of different parts of kiwi fruits were determined and compared. Fruit by products such as peels and seeds may constitute a higher nutritional value than the fruit's edible components. Furthermore, these residues may bioactive substances having a greater antioxidant capacity. Given the features of these materials, they have more activity than pulp. It was found that the phenolic component in the kiwi peel flours were higher than that in the fruit bagasse. The peel samples also had far more total flavonoids than the flesh and seed samples. The largest percentage scavenging of DPPH radicals by kiwi fruit powder extract antioxidants were identified in the peels, then flesh, and the lowest in the seeds. The highest amount of catechin was found in peel and lowest in the flesh. Amount of both quercetin and rutin were much greater in the peel samples when compared to the flesh, while quercetin was not found in the seed. Polyphenol levels were highest in the kiwi fruit peel, then in the meat, and the least in seeds. The powders made skin of kiwi fruit contained more bioactive components and antioxidant activity in the tested samples than the powders of kiwi fruit meat and seed. The usage of powder generated from kiwi fruit by-products can control the agro-industrial wastage, and these materials are interesting ingredients for product enhancement to boost dietary fibre and give bioactive compounds containing antioxidant activity (Wang *et al*., 2018) [13].

Conclusion and Future Prospective

In this review the significance of edible cutleries as a sustainable solution to the environmental challenges posed by traditional plastic utensils are discussed. The history of cutleries, from the use of natural elements to the advent of plastic, underscores the need for alternative materials that are biodegradable and safe for consumption. Edible cutleries have emerged as a promising innovation, with a long history dating back to the 1400s. These cutleries, made from edible materials, offer zero wastage as they can be consumed after use, reducing the accumulation of plastic waste.

The study discussed the production and evaluation of biodegradable edible cutleries, focusing on the use of sorghum flour and pearl millet as key ingredients. Sorghum and pearl millet possess desirable properties, such as flexibility and nutritional value, making them suitable for a wide range of food products. The inclusion of rice flour, with its hygroscopic and thickening properties, further enhances the cohesive strength of the cutleries. Additionally, the incorporation of powdered kiwi fruit peels adds nutritional value and beneficial properties, such as antioxidants and antimicrobial activity.

While edible cutleries have gained popularity, it is essential to address their limitations, such as their relatively short lifespan before becoming soggy. Future research should focus on identifying materials with reduced absorption capacity, enabling the development of longer-lasting edible utensils. Moreover, continued efforts in refining the production processes and optimizing the physicochemical properties of edible cutleries will contribute to their widespread adoption and commercial viability.

In conclusion, edible cutleries with added nutraceuticals hold great promise in mitigating the environmental impact of plastic waste while providing a safe and sustainable alternative for the food industry. Their development and utilization align with the global drive towards eco-friendly practices, paving the way for a greener future in the realm of food utensils and packaging.

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