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A Sustainable Living Approach: Biodegradable Flatware

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Abstract

Since a few years ago, our environment has been becoming more and more contaminated. In recent decades, there has been a notable quantity of pollution in the air, land, water, and noise. Depletion of the ozone layer has an impact on the environment and all living things. One of the main causes of soil pollution is plastic pollution, which reduces the nutritional efficiency of plants growing in that specific soil. The degradation of plastic takes anything from 20 to 500 years. Plastic cutlery, including straws, spoons, forks, cups, plates, and containers, takes a long time to break down and can cause harm to the environment, water, soil, and living things. Cutlery composed of metals such as steel, copper, and silver is available for usage. However, biodegradable cutlery is absolutely something we can utilize if we take into account our fast food eating habits, dining out in public or ordering junk food takeout, and anything that goes with our modern lifestyle. There are several of plant-based substitutes for conventional plastic cutlery. In the past, our fore fathers made plates out of Butea monosperma dried leaves. Today, many Indian regions and faiths emphasize consuming the leaves of Musa paradisiaca plants, particularly in the southern half of the country. This article provides a colourful discussion of plants and materials used to create plant-based cutlery. This worldwide issue has been the subject of much inquiry and scientific consideration; it is also mentioned in this paper.

Keywords: Pollution from plastic, plant-based cutlery, and the environment

Introduction

Due to growing ecological concerns about plastic pollution, there has been a surge in interest in ecologically friendly alternatives in a number of industrial areas in recent years. Food and beverage businesses have been given a lot of thought since single-use plastic cutlery, such as straws, spoons, plates, cups, bags, and so on, is a significant contributor to the world's plastic pollution issue. The creation and use of biodegradable cutlery has gained recognition as a viable substitute approach to tackle this environmental problem. A phrase like "biodegradable cutlery" describes silverware and cutlery composed of materials that decompose naturally and return to the environment unharmed. Because traditional plastic cutlery is persistent in the environment and negatively affects wildlife, ecosystems may be at risk. Most of it is composed of non-renewable resources, such as petroleum. Conversely, biodegradable products are designed to reduce the

environmental harm caused by single-use cutlery. This study looks at the many aspects of biodegradable cutlery, such as the material's composition, manufacturing processes, and its effects on society, the environment, and the environment. The purpose of the study is to educate the public on the potential benefits and drawbacks of employing disposable silverware in the foodservice sector. Plastic flatware pollution is a major sustainability concern due to the extensive usage of disposable plastic serving dishes and their detrimental impact on the environment.

Plastic pollution from single-use items: Many plastic cutlery items, such as straws, forks, knives, and spoons, are designed to be utilized just once before they are thrown away. A greater quantity of plastic debris clogs rivers, oceans, and various other ecosystems since these things have a greater probability to be carried by air or water due to their tiny size.

Plastic pollution from single-use products: Many plastic cutlery items, including straws, forks, knives, and spoons, are meant to be used once before they become waste. More plastics are littering rivers, oceans, and other ecosystems because these objects are more likely to be carried by wind or water because of their small size.

Littering and pollution: The environment will get contaminated if plastic cutlery waste is not disposed of properly and trash is not collected. Plastics can linger in the environment for hundreds of years before fully biodegrading.

Marine Pollution: Marine life is at risk when plastic cutlery finds its way into rivers and lakes. Marine life may utilize it because they mistake it for food, which might be dangerous. The damage to marine habitats would increase as the plastic cutlery gradually decomposes into microscopic plastic particles.

Issues in Landfills: A large portion of plastic cutlery ends up in landfills, which puts additional burden on them. Plastics have the potential to leak poisons and other harmful compounds into soil and groundwater when they decompose into tiny particles inside landfills.

Solutions and alternatives: One can use various sustainable materials such as corn starch to make the utensils that could be replaced with standard plastic cutlery. Such items include bamboo or other biodegradable materials. Encouragement of the use of reusable cutlery in place of single-use plastics is also another effective way to reduce waste. To create a more sustainable and environmentally aware way of using flatware, the reduction of plastic silverware pollution is being addressed through government regulation, corporate responsibility and openness, and human activity.

Many companies produce biodegradable cutlery, and the demand for such products has risen with the increasing environmental awareness of consumers. Some of the most popular companies that offer biodegradable dinnerware include Eco-Products, World Centric, Birch ware, Bambu, and Green Good. It's important to keep in mind that the cost of biodegradable cutlery may vary by location, and new businesses may ultimately join the market. In order to ensure that biodegradable cutlery composts properly, it is important to confirm which precise ingredients are utilized in its production and if they adhere to helpful composting recommendations.

FIG.1: WOODEN AND EDIBLE (BIODEGRADABLE) CUTLERY

FIG.2:

SOURCRS ARE USED IN BIODEGRADABLE CUTLERY

REVIEW OF LITERATURE

Because non-biodegradable materials carry a considerable danger, it is important to discover ecologically acceptable alternatives. Research has shown that adding grape flour to biodegradable spoons improves their nutritional profile. (Mousa *et al.,* 2022) observed that integrating 10% triethyl citrate into polybutylene adipate terephthalate had a greater influence on the elongation at break of composite material compared with PBAT alone.

Various compounds such as PLA, PBAT, PBS, PHBV, Bioplastic and Mater-Bi have been found as suitable substitutes for cotton swabs; nonetheless, it's crucial they are assessed for marine environment biodegradability according to (Jacquin *et al.,* 2021).

This review paper offers a summary examination of microorganism growth on each of the mentioned substrates and compares the biodegradation rates of these materials with those of cellulose or polypropylene products.

There are many noteworthy studies worth exploring including (Jandas *et al*., 2013), (Brownleeet *et al*., 2013), (Malafietal *et al.,* 1995), (Choeybundit *et al.,* 2021), (Choeybundit *et al.,* 2022) It was discovered that adding grape flour to the biodegradable spoons produced in the experiment improved their nutritional composition. It's inability to biodegrade poses significant environmental dangers, thus finding biodegradable alternatives is crucial. Triethyl citrate (TEC) added at a weight percentage of 10% to polybutylene adipate terephthalate (PBAT) increases the ideal composite's elongation at break from 2.10% to 4.20%, according to (Mousa *et al.,* 2022). This is a more substantial impact, Some materials that might be suitable substitutes for cotton swabs include polylactic acid (PLA), polybutylene adipate terephthalate (PBAT), poly (butylene succinate) (PBS), polyhydroxybutyrate-valerate (PHBV), Bioplastic, and Mater-Bi; nevertheless, it's crucial to test their biodegradability in marine environments.

In order to handle materials made of non-biodegradable polypropylene (PP) or alternatively biodegradable cellulose, (Jacquin *et al.,* 2021) assess these materials biodegradability in saltwater and give an outline of the microorganisms growing on these substances.

More interesting studies include (Jandas *et al*., 2013), (Brownlee *et al* 2013), (Malafi *et al.,* 1995), (Choeybundit *et al.,* 2021), (Choeybundit *et al.,* 2022), (Jain 2000) investigated the 1,16,000 tourists whose jobs take them to the Valley of Flowers in India every year for a total of four months. For the biodegradable wastes (BW) that are not used and may be biodegradable wastes (RBW) without issues, micro level bio composting is sufficient. In the contemporary state of affairs and wasted meals, non-biodegradable plastic utensils are a portion of the blended heterogeneous waste products created by fast food restaurants and dining areas that use disposable items like as silverware.

Bioplastics for sustainable development: General environment in India (Mishra *et al.,* 2012) covers a number of tree bone oilseeds in India. The use of microbes in plastic manufacture is a novel strategy, these biodegradable polymers find use in agriculture and medicine, and controlled pharmaceuticals are released into packaging and other sectors. The creation of biodegradable spoons and the assessment of their texture, activity as antioxidants, and overall polyphenol content were the objectives of (Dordevic *et al.,* 2021). It was found that the nutritional profile of the extensively manufactured biodegradable spoons increased when grape flour was added. One of the most significant scientific advancements brought about by the reduction of plastic packaging challenges is the development of biodegradable materials. (Gupta *et al.,* 2022) serves as the main catalyst for the production of biodegradable substances derived from food and plant waste in plastic bags.

A part from biodegradable polymers, poly (lactic acid) has been suggested as a potential superior substitute for conventional plastics. When combined, these studies might help assess the commercial potential of biodegradable polymers as substitute resources for commodity plastics (Haid *et al*., 2018). The use of biobased and biodegradable materials in place of plastic packaging has increased as a result of consumer awareness of the negative effects that plastic waste has on the environment and the need for rules and regulations pertaining to the bioeconomy and circular economy.

The focus of research has been on modifying biobased and biodegradable polymers to meet the requirements for cosmetic preservation while preserving sustainability and biodegradability. Cosmetic packaging has been searching for sustainable solutions in this competitive environment (Cinelli *et al.,* 2019). Food service containers, silverware, and one other single item in packaging frequently use biodegradable plastics.

(Masud *et al.,* 2021) examine a number of potential uses for them. The advantages of biodegradable plastics in conjunction with practical recycling techniques are delineated. (Flury *et al.,* 2021) explains that Biodegradable plastics should be used to address specific life circumstances and even if they are a crucial element of strategies to reduce the amount of plastic used in the environment. Plastic packaging plays a significant role in maintaining the health of food, but its non-biodegradable nature, recycling issues, and accidental leakage of hazardous substances into food and soil raise serious concerns for the environment and public health.
The primary goals of (Dordevic *et al*., 2021) were the development of biodegradable spoons, an analysis of their structure, and an antioxidant effect.

The last three years have seen significant technological and financial advancements that have opened up favourable markets for these products in the mass market and for ex, in the food storage sector, despite the fact that bioplastics based on plant-based materials and whether or not biodegradable and maintain a niche market demanding for serious investments in material and application development (Bastioli 2001) examines the most recent developments in the plastics sector related to bioplastics, taking into account their environmental effect, biodegradation activities, and user performance. The growing availability of more appealing alternatives has led to a renewed interest in biodegradable plant containers usefulness in the green sector and their market acceptance. By providing particular product features to

customers who value them most, producers and businesses are able to use their resources more efficiently. (Hall *et al.,*2010) worked to identify the characteristics of biodegradable pots that consumers identify as most distinctive. Businesses in the industry should use unique advertising strategies to market biodegradable containers to consumers in a targeted audience.

The capacity to pay for biodegradable plant containers was determined by (Yue *et al.,* 2010) The study's findings show that while participants were willing to pay more for biodegradable containers, the price varied depending on the type of container. The study examined synthetic polyether and lactic acid blends used as biodegradable bags for retail applications, additional research was conducted on control samples that contained polyethylene with pro-oxidant catalysts, commonly referred to as "biodegradable bags" in the marketplace (Araújo *et al.,* 2013). Following a period of time spent in simulated soil samples of these materials were examined using thermal analysis, which included a non-isothermal kinetic assessment.

Although many Brazilian city rules specify that market bags are made of biodegradable materials, their precise chemical composition is unclear due to a lack of specific surveillance policies. The composition of biodegradable cutlery and paper products was determined in a study conducted by (Finzi Quintão *et al.,* 2016). We looked at seven samples that were collected from Belo Horizonte's commercial market trading firm. (Gautam *et al.,* 2017) set out to investigate alternatives to plastic cutlery used in restaurant dining, particularly cutlery made from Areca palm and coconut tree materials.

A concise synopsis of a consumer survey, design, life cycle analysis, and an exhaustive manufacturing research will be provided. In a cradle-to-cradle fashion, methanotrophs might effectively take use of landfill CH_4 to produce biodegradable plastic. In their 2017 study, (Chidam *et al., 2022*). examine current problems, review methods for recycling plastic waste materials, and provide alternatives.

(Dordevic *et al.,* 2021) set out to create biodegradable flatware and demonstrate its consistency and antioxidant efficacy at a large polyphenol content. The research's findings suggest that the best alternative to plastic cutting board materials would be the spoon's back, which is made from a blend of all three flours plus xanthan. Traditional plastics are dangerous, non-biodegradable, and detrimental to the environment. Biodegradable polymers are being carefully researched in an attempt to replace them. According to (Mahajan *et al.,* 2023), polylactic acid (PLA) is the most dependable polymer for food packaging applications, other notable efforts are the core of transient electrically activated medical implants may consist of biodegradable and flexible electronics. Presently used electromagnetic power sources that are made entirely of edible materials and naturally existing precursors that are ingested in regular diets are compatible with non-invasive deployment techniques (Kim *et al.,* 2013).

Due to their lower environmental costs and the strong need for fresh, renewable natural polymers for recyclable and edible products. The use of hybrid carrageenan extracted from seaweeds like Mastocarpus stellatus in place of commercial kappa carrageenan in new products for film that is edible is investigated by (Larotonda *et al*., 2016). In order to create a novel biodegradable and flexible transparent electrode, (Miao *et al*., 2018) discussed the integration of three dimension (3D) interconnected conductive nanocomposite materials onto edible starch and chitosan-based substrates. With its exceptional properties, this biodegradable transparent electrode has great potential for use in edible and transient electronics as well as next-generation wearable green electronics. Because of its distinct qualities (easily accessible, nontoxic, tasty, biodegradable, environmentally friendly, and edible), starch may prove to be an appealing alternative to plastic.

This review article's main focus is on the effects of adding additives to starch-based biodegradable films. This includes their thickness, morphology, optical and water-based barrier, mechanical and oxygen-based barrier, antioxidant, and antimicrobial properties, as well as how these films meet the requirements for creating edible and biodegradable food-based films with practical performance (Singh *et al*., 2022).

According to a research by (Regubalan *et al.,* 2018), several types of potential bio-based materials have undergone significant development with the goal of producing edible films, foams, and hydrogels for use in food packaging applications.

(Rastogi 2019) talked about the technologies developed over the last three decades in the field of coconut research at CFTRI, including the technique for making dried coconut and the development of a technique for making spray-dried coconut milk powder, the water processing of coconuts, the production of vinegar from coconut water and virgin coconut oil, and beverages made with dried coconut and coconut powder, among many other things.

The largest contributor to the revenue of coconut processing sector is from copra coconut oil,
is brewer's yeast, powdered psyllium husks if needed raw egg yolks occasionally in between coconut oil and dried coconut. The development of bio-degradable composites is just the need.
increasing internationally in recent years to minimise environmental pollution caused by the
encompassing the nature of materials used in oil industry as structural elements.

The goal of (Matos *et al.,* 2019) was to assess the development of isolates from the edible fungus "Shitake" (Lentinula edodes) in a substrate based on coconut powder supplemented with wheat bran in order to establish a biodegradable composite.

They were motivated by understanding the effects of both how long Schizophyllum tuberclosumischinosporium was allowed to grow, as well as in different environmental conditions on these male reproductive cells. composite depending on the drying time of a colonized substrate.

At first a conventional compression moulding process was employed to produce an Cassava starch-coir composite foam and coconut husk-derived biochar. (CRF) (Nansu *et al.,* 2019). It means that this particular type of composite could potentially be fairly useful for Incrementally Building upon that fabric. shock proof, non-toxic and 100% biodegradable packaging. Researchers look for experimental conditions on the physical and microbial characteristics as well sensory profiling of coconut-based candies containing Lyophilized apple peel in vacuum fryer. (Karouw *et al.,* 2020) also used a biodegradable film with sago starch as the matrix. The coconut candy is then packed in finish biodegradable sago starch film, and preserved at room temperature for 40 days.

"Biodegradable foam" is a food industry product made of starch with the environmentally beneficial property of biodegradability. (Wahyuningsih *et al.,* 2021) investigated the use of bio silica and coconut oil to improve the qualities of starch-based bio foam products.

They contrasted commercial silica with bio silica, bio silica + coconut oil, and bio foam control (no filler). The use of coir fibre rein forced bio composites made from coconut husks is on the rise due to the growing need for sustainable, renewable, biodegradable, and recyclable materials.

Regarding their morphological, thermal, mechanical, and physical characteristics, as well as their useful production processes and surface treatments, (Hasan *et al.,* 2021) provided an overview of coir fibre and related composites. In addition, notable works include those by (Barlina *et al*., 2023) (Kalla *et al.,* 2021) (Rosa *et al.,* 2008).

The addition of VCO improved the starch-based films' mechanical, antibacterial, and water-barrier properties. Despite this and the growing importance of plastic items, they are used on a daily basis. For this reason, the goal is to find a material that can be used to create biodegradable items (such plates, glasses, cutlery, bags, and more) that decompose rapidly and offer a workable solution to this problem (Cubilla *et al.,* 2020).

The characteristics of planting banana peel and coconut fibre, as well as other components, have been examined in order to create a prototype of biodegradable materials for this project.
The main consumption locations where the disposal of grated coconut shells has been identified and combined with an analysis of the data's unpredictability and based on a structured face-to-face survey conducted within a representative sample of seven municipalities in the town of Bah's southern coastal region (Nunes *et al.,* 2020).

The area could produce 34 M (u = 47 k) of biodegradable tubing for seedling planting per calendar year, according to a gardening products-based assessment, leading to a gross annual revenue of RS 1,70,000 (u = 2350).

MATERIALS AND METHEDOLOGY

- **Materials**

Many plant-based materials are used in biodegradable clothing, including:

1. **PLA, or polylactic acid:** Made from natural resources like sugarcane or corn starch, PLA is a thermoplastic that breaks down and changes biologically. Disposable flatware is typically made using it.
2. **Starch-Based Bioplastics:** These can be made from potatoes, corn, or cassava combined with other starch sources. They may be made into cutlery and are compostable.
3. **Wood:** Wooden flatware, such as knives and forks made of sustainable materials such as bamboo or birch wood. Additionally, bamboo is considered a viable option due especially to its high growth and maturation rate.
4. **Bagasse:** Bagasse is a residue after sugarcane processing. It is used to manufacture biofuels, chemicals and objects. It makes bagasse items compostable and in texture it looks like the normal paper products just that these are made of sugarcane waste.
5. **Palm Leaf:** Using Palm leaf as a cutlery is very sustainable and feasible process. It is gathered from palm trees which can survive after the leaves are stripped off, making it environmentally friendly and in demand growing supply source.
6. **CPLA:** Cutlery manufactured from cornstarch is much like PLA and compostable; A creative alternative to conventional plastic plates in corn starch
7. **Sugarcane Fiber:** Another name for sugarcane fiber, which is a byproduct of processing sugarcane, is bagasse. It is used to make biodegradable dishes, bowls, and tableware. Bagasse is compostable and may be shaped into a wide variety of shapes.
8. **Wheat Straw:** After wheat grains are harvested, wheat straw is an unwanted agricultural byproduct. Because of its recyclable nature and ability to generate reusable cutlery, it has become more and more popular.

9. **Palm starch:** The starch of palm plants is used to make palm starch, which is used in the production of decomposable materials like tableware. When purchased responsibly, it is seen as a sustainable choice.
10. **Bioplastics made from hemp:** Hemp is a multipurpose plant that may be utilized to create bioplastics. Compostable, eco-friendly hemp bioplastics are used to make biodegradable tools.
11. **Coconut Husk:** The fibres found in coconut husks may be used to make biodegradable products like cereal. Coconut-based materials are often valued for their natural appearance and little environmental effect.
12. **Cassava:** A starchy root that naturally breaks down, cassava can be converted into polymers. Clearly, this compostable cassava-based cutlery is seen as an environmentally friendly alternative to plastic-tableware of the conventional kind.
13. **Algae-Based Bioplastics:** With algae as a feedstock, bioplastics can be produced algal-based bioplastic is being studied as a more sustainable alternative to a wide range of other products that are seldom used, including silverware.

Methodology

A specific procedure is adopted in the development and manufacturing of biodegradable materials with an objective of ensuring that the finished product surpasses performance and ecological standards. Below is an overview of techniques to create biodegradable crockery:

1. Selection of Raw Materials: Use recyclable and biodegradable materials, like PLA (polylactic acid) and bioplastics produced from starch and/or other materials derived from plant-based goods. This will help to minimize the environmental impact and ensure that everything you choose is sourced ethically.

2. Material Processing: Raw materials are processed into the most appropriate tableware shapes by applying techniques like extrusion, injection moulding, or thermoforming. Energy consumption and generated waste are reduced by applying sustainable recycling techniques.

3. Testing and Quality Control: To ensure the functionality and durability of the cutlery, establish strict processes for quality control. Test the product to ensure that its performance, heat resistance, and other features exceeded industry standards.

4. Biodegradability Certification: Ensure that the product is biodegradable and is able to achieve certifications through the relevant authority. Ensure conformance to International Biodegradation and Composability Standard, such as ASTM D6400 or EN 13432.

5. Design considerations: Consider measurements, weight, and shape in the production of the cutlery to ensure ergonomic comfort and use. Consider end-of-life options such as institutional composting or home preparation.

6. Packaging: Choose environmentally friendly packaging that meets the cutting-edge objectives for environmental sustainability. Ensure that the regulations regarding the biodegradability and disposal of packaging are well articulated.

7. Supply and Marketing: Creating a distribution plan that reduces the transportation industry's impact. Improve the biodegradability and reduce the environmental effect of usingit as a cutlery substitute.

8. Outreach Education: Teaching customers about the benefits of using biodegradable flatware and the proper disposal methods. provide detailed instructions on how to properly dispose of or let the cutlery disintegrate entirely.

9. Continuous Improvement: Continuously assess and improve the assembly process to improve productivity and reduce its negative impact on the environment. Stay informed of any new developments in compostable materials and technology and be ready for any upcoming change.

Manufacturers can utilize this kind of technology in designing biodegradable containers that aim to address the current global issues regarding common plastic containers while promoting sustainability initiatives.

RESULT & DISCUSSION

Different results and points of view will arise depending on the study on biodegradable flatware as there will be specific research with their own design, methods, and decisions. Let us just imagine what can be included in this conversation and take some ideas from here.

Biodegradability Performance: Study the material's universal biodegradability in various environments, such as composting, soil, water, etc. Discuss the rate of breakdown and compare it to standard plastic alternatives.

Environmental Impact: Assess how biodegradable cutlery might affect the environment by lowering the amount of plastic pollution. Compare and contrast the environmental impacts of conventional plastics with those of biodegradable cutlery production.

Material Composition: Talk about the sources of the materials that benefited from being biodegradable. Examine the sustainability of these materials and their potential effects on resource conservation.

Performance & Functionality: Examine the biodegradable materials' toughness, durability, and usefulness in comparison to more conventional solutions. Talk further about any disparities in findings or theories that could be confirmed.

Customer Acceptance and Perception: Investigate the manner in which users interact with biodegradable tools. Analyse their acceptance level and users' propensity to accept these nontoxic replacements.

Cost considerations: Explain about how much cheaper it is to manufacture and utilize biodegradable cutlery than ordinary plastics. Evaluate the economical possibility of broad implementation Cost considerations: Explain about how much cheaper it is to manufacture and utilize biodegradable cutlery than ordinary plastics. Evaluate the economical possibility of broad implementation.

Regulatory Compliance: Examine the requirements for biodegradable products in different jurisdictions. Discuss the potential benefits and issues that these regulations now provide.

Prospects and Suggestions for the Future: Provide suggestions for more research or advancements in the field of biodegradable textile technology. Talk about the potential integration of biodegradable kitchenware into more extensive green initiatives.

It's important to remember that specific findings and conclusions will depend on the specifics of the study, such as the type of organic substance used, the testing parameters, and the parameters for the assessment. Additionally, every step of time and the topic of debate may be based on changes in regulations and technology. A good way to lessen the environmental effect is to use biodegradable cutlery. However, biodegradable clothing is made of materials that break down naturally over time and contributes to a lower amount of plastic waste that ends up in landfills and the ocean. Utilizing biodegradable materials can help you further assist the environment in a number of ways:

Appropriate Disposal: Make sure biodegradable clothing is disposed of appropriately in a suitable waste stream. Certain materials can be composted, while others may need to be transported to a company that engages

in industrial composting. Verify the product information or the packaging to see if there are any special disposal instructions.

Composting: Try to use biodegradable waste. Additionally, composting and creating nutrient-rich soil reduce the need for landfill space. Determine if the tools may be disposed of at home or sent to a nearby commercial composting site.

Promote Sustainable Obsessed Goods: Select goods with little packaging to promote environmentally friendly purchases. Consider every aspect of your environmental impact while deciding what you should buy.

When you are able, reuse: Certain biodegradable cleaning materials could be able to be used repeatedly simply once. To make them even more durable, make plans to clean and reuse them as necessary.

Participate in Cleanup Activities: Participate in local cleanup initiatives that assist in clearing the environment of waste and recyclables. Engaging in such activities can raise awareness and help create a cleaner environment.

Encourage Policy Changes: Develop or support policies that specifically encourage the use of biodegradable and compostable materials. This may need the implementation of environmentally friendly corporate incentives or local laws restricting the use of single-use plastics.

Fig 3-Sugarcane bagasse meal trays decompose in 90 days, while this disposable serving platter made of bamboo and sugarcane breaks down after 60 days.

CONCLUSION

An overview of the key findings and discoveries from the research is usually included in a study on biodegradable cutlery. Below is an example of a conclusion section template:

A review of the results Provide a brief synopsis of the study's conclusions and observations, emphasizing user acceptance, environmental impact, and significant performance metrics.

The biodegradable materials' performance in terms of their ability to decompose in different environments is examined. Make note of any noticeable differences in the rates of degradation as compared to standard plastic replacements. The primary goal of the study is to provide a general overview of the detrimental effects of biodegradable clothing, with a

focus on the potential benefits for ecosystems and reducing the effects of plastic pollution. The material's composition examines the effects on the environment of the various components used in the production of biodegradable clothing. Discuss the potential consequences of these materials' renewable nature and resource conservation.

Discuss its practicality and benefits in relation to safer methods. Acceptance by members creates an overview of user opinions and recommendations about the use of biodegradable cutlery. Discuss any aspects that are altering users' acceptance or resistance to use. Take into account the desired outcome and balance the long-term financial benefits and manufacturing expenses of biodegradable clothing. Make a note of any compromise issues or difficulties with cost effectiveness. Discuss the potential positive or negative effects of legislation on the widespread use of biodegradable clothing.

Future prospects examine the potential contribution of biodegradable materials to environmental problem solutions. Making suggestions for further research and development that will enhance the technology to overcome identified issues. Give an overview of the biodegradable fabric's unique acceptance as an environmentally friendly alternative while taking into account all parameters that were examined.

Numerous microorganisms, including bacteria and fungus, contribute to the environmental degradation of biodegradable materials. The breakdown of organic matter, which involves polymers that break down over time, is frequently aided by the microbe Bacillus. It is widely acknowledged that Bacillus species are capable of synthesizing enzymes that break down complex chemical molecules. In addition, recent studies reveal that most bacteria, such as Actinobacteria, and Pseudomonas, are involved in the deterioration of biodegradable materials.

These microbes produce two types of enzymes called lipases and proteases, which may break down the molecules in plastics and convert them into less complex molecules. It's important to realize that the specific types of bacteria responsible for the decomposition process may differ depending on the environmental circumstances and the chemical makeup of the biodegradable material.

In addition, the term "biodegradable" can be very broad and many different kinds of microbes might be able to digest different types of biodegradable plastic or cutlery.

Also, the use of biodegradable flatware instead of traditional cutlery made of plastics that is bad for the environment and all living things. The article goes into detail regarding how polyester is poisonous and bad for everyone and its alternatives that are friendly to the environment and convenient to use each day.

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CONFLICT OF INTEREST

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

Reference

1. Kalla; H. Manjunatha; R. Devaraju; "Coconut Shell Powder Reinforced Epoxy Composites : A Review", AGRICULTURAL REVIEWS, 2021.
2. Aditi Mahajan; Inderdeep Singh; Navneet Arora; "An Integrated Multi-criteria Decision-making Framework for The Selection of Sustainable Biodegradable Polymer for Food Packaging Applications", ENVIRONMENT, DEVELOPMENT AND SUSTAINABILITY, 2023.
3. Alyssa Brownlee; Chris Li; Maria Lo; "Life Cycle Assessment: Aspenware Biodegradable Cutlery", 2013.
4. Anirudh Muralidharan Gautam; Nídia S. Caetano; Nídia S. Caetano; "Study, Design and Analysis of Sustainable Alternatives to Plastic Takeaway Cutlery and Crockery", ENERGY PROCEDIA, 2017. (IF: 3)

5. Ayamannil Sajeeb; Perikinalil Krishnan Rajendrakumar; "Comparative Evaluation of Lubricant Properties of Biodegradable Blend of Coconut and Mustard Oil", JOURNAL OF CLEANER PRODUCTION, 2019. (IF: 3)
6. B Akshai; R Visakh; Krishnanand J Kamath; Mohammed R Riyas; ML Joy; "A Novel Approach in Developing Environment-friendly Bio-lubricant from Coconut Oil, Mustard Oil and Its Methyl Esters", PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS, 2020.
7. B. Mishra; Rajat Kumar; "The Production Of Biodegradable Fuel From Nonedible Oilseed In India: A Review", IOSR JOURNAL OF APPLIED CHEMISTRY, 2012.
8. Mominul Sinan; "Bioplastics for Sustainable Development: General Scenario in India", CURRENT WORLD ENVIRONMENT, 2020.
9. Baburaj Regubalan; Pintu Pandit; Saptarshi Maiti; Gayatri T. Nadathur; Aranya Mallick; "Potential Bio-Based Edible Films, Foams, and Hydrogels for Food Packaging", 2018. (IF: 3)
10. Catia Bastioli; "Global Status of The Production of Biobased Packaging Materials", STARCH-STARKE, 2001.
11. Charles R. Hall; Benjamin L. Campbell; Bridget K. Behe; Chengyan Yue; Roberto G. Lopez; Jennifer H. Dennis; "The Appeal of Biodegradable Packaging to Floral Consumers", HORTSCIENCE, 2010. (IF: 3)
12. Chengyan Yue; Charles R. Hall; et al.; "Are Consumers Willing to Pay More for Biodegradable Containers Than for Plastic Ones? Evidence from Hypothetical Conjoint Analysis and Nonhypothetical Experimental Auctions", JOURNAL OF AGRICULTURAL AND APPLIED ECONOMICS, 2010. (IF: 3)
13. Cristiane M. Finzi-Quintão; K. Novack; A. Bernardes-Silva; "Identification of Biodegradable and Oxo Biodegradable Plastic Bags Samples Composition", MACROMOLECULAR SYMPOSIA, 2016. (IF: 3)
14. Dani Dordevic; Lucie Necasova; Bojan Antonic; Simona Jancikova; Bohuslava Tremlová; "Plastic Cutlery Alternative: Case Study with Biodegradable Spoons", FOODS (BASEL, SWITZERLAND), 2021. (IF: 3)
15. Emo Chiellini; Patrizia Cinelli; Salvatore D'Antone; V. I. Ilieva; "Environmentally Degradable Polymeric Materials (EDPM) in Agricultural Applications - An Overview", POLIMERY, 2002. (IF: 3)
16. Etienne Paul; Elisabeth Neuhauser; Yu Liu; "Biodegradable Bioplastics from Fermented Sludge, Wastes, and Effluents", 2012.
17. F. D. S. Larotonda; M. Torres; M. P. Gonçalves; A. Sereno; L. Hilliou; "Hybrid Carrageenan-based Formulations for Edible Film Preparation: Benchmarking with Kappa Carrageenan", JOURNAL OF APPLIED POLYMER SCIENCE, 2016. (IF: 3)
18. Francesco Razza; Maurizio Fieschi; Francesco Degli Innocenti; Catia Bastioli; "Compostable Cutlery and Waste Management: An LCA Approach", WASTE MANAGEMENT, 2009. (IF: 3)
19. Gurvendra Pal Singh; Sneh Punia Bangar; Tianxi Yang; Monica Trif; Vinod Kumar; Dinesh Kumar; "Effect on The Edible Starch-Based Review", POLYMERS, 2022. (IF: 3) Films By The Incorporation of Additives: A Review Polymer, 2022
20. Ibrahim Muhammad Shamsuddin; Sani N; Adamu M; Abubakar MK; "Biodegradable Polymers for Sustainable Environmental and Economic Development", MOJ BIOORGANIC & ORGANIC CHEMISTRY, 2018. (IF: 3)
21. Ioanna Kyrikou; Demetres Briassoulis; "Biodegradation of Agricultural Plastic Films: A Critical Review", JOURNAL OF POLYMERS AND THE ENVIRONMENT, 2007. (IF: 5)
22. J. de Araújo; Dulce Magalhães; N. A. de Oliveira; Hélio Wiebeck; Jivaldo do Rosário Matos; "Thermal Degradation and Kinetic Parameters of Polyester and Poly (Lactic Acid) Blends Used in Shopping Bags in Brazil", JOURNAL OF POLYMERS AND THE ENVIRONMENT, 2013.
23. Jagadeesh K. Mannekote; Satish V. Kailas; "Studies on Boundary Lubrication Properties of Oxidised Coconut and Soy Bean Oils", LUBRICATION SCIENCE, 2009. (IF: 3)

24. Jagdish C. Kuniyal and Arun P. Jain; "Tourists Involvement in Solid Waste Management in Himalayan Trails: A Case Study In and Around Valley of Flowers, India", JOURNAL OF ENVIRONMENTAL SYSTEMS, 2000. (IF: 3)
25. Jinlei Miao; Haihui Liu; et al. "Biodegradable Transparent Substrate Based On Edible Starch-Chitosan Embedded With Nature-Inspired Three-Dimensionally Interconnected Conductive Nanocomposites For Wearable Green Electronics", ACS APPLIED MATERIALS & INTERFACES, 2018. (IF: 3)
26. Justine Jacquin; Nolwenn Callac; et al. "Microbial Diversity and Activity During The Biodegradation in Seawater of Various Substitutes to Conventional Plastic Cotton Swab Sticks", FRONTIERS IN MICROBIOLOGY, 2021. (IF: 3)
27. Jyoteshna Kharb; Ritu Saharan; "Sustainable Biodegradable Plastics and Their Applications: A Mini Review", IOP CONFERENCE SERIES: MATERIALS SCIENCE AND ENGINEERING, 2022
28. K M Faridul Hasan; Péter György Horváth; Miklós Bak; Tibor Alpár; "A State-of-the-art Review on Coir Fiber reinforced Biocomposites", RSC ADVANCES, 2021. (IF: 3)
29. K Wahyuningsih; E S Iriani; B Amalia; "The Addition of Biosilica and Coconut Oil to Improve The Characteristic of Starch-based Biofoam Packaging", IOP CONFERENCE SERIES: EARTH AND ENVIRONMENTAL SCIENCE, 2021.
30. KAIRE TORN; GEORG MARTIN; GRETA REISALU; "DEGRADATION OF BIODEGRADABLE SINGLE USE PLATES AND WASTE BAGS IN TERRESTRIAL AND MARINE ENVIRONMENTS", 2022
31. Karthigeyan Chidambarampadmavathy; Obulisamy Parthiba Karthikeyan; Kirsten Heimann; "Sustainable Bio plastic Production Through Landfill Methane Recycling", RENEWABLE & SUSTAINABLE ENERGY REVIEWS, 2017. (IF: 3)
32. Katherine Cubilla; Yurisbeth González; Génesis Montezuma; María Samudio; Evidelia Gómez; "Fibra De Coco Y Cáscara De Plátano Como Alternativa Para La Elaboración De Material Biodegradable", 2020.
33. Layla Filiciotto; Gadi Rothenberg; "Biodegradable Impacts", CHEMSUSCHEM, 2020. (IF: 4)
34. Lovedeep Kaur; Jaspreet Singh; "Novel Applications of Potatoes", 2016.
35. Luane Alcântara Nunes; Maria L.S. Silva; Juliano Zaffalon Gerber; Ricardo de Araújo Kalid; "Waste Green Coconut Shells: Diagnosis of The Disposal and Applications for Use in Other Products", JOURNAL OF CLEANER PRODUCTION, 2020. (IF: 3)
36. Lyubov Dyshlyuk; Olga Babich; Daria Belova; Alexander Prosekov; "Comparative Analysis of Physical and Chemical Properties of Biodegradable Edible Films of Various Compositions", JOURNAL OF FOOD PROCESS ENGINEERING, 2017. (IF: 3)
37. M. H. Masud; A. A. Ananno; "Versatile Applications of Degradable Plastic", 2021. Markus Flury; Ramani Narayan; "Biodegradable Plastic As An Integral Part of The Solution to Plastic Waste Pollution of The Environment", GREEN AND SUSTAINABLE CHEMISTRY, 2021. (IF: 3)
38. Maja Rujnić-Sokele; Ana Pilipović; "Challenges And Opportunities Of Biodegradable Plastics: A Mini Review", WASTE MANAGEMENT & RESEARCH 2017. (IF: 5)
39. Manisha Deb Mandal; Shyamapada Mandal; "Coconut (Cocos Nucifera L.: Arecaceae): In Health Promotion and Disease Prevention", ASIAN PACIFIC JOURNAL OF TROPICAL MEDICINE, 2011. (IF: 6)
40. Maxwell Paca Matos; Juan Lopes Teixeira; Brenno Lima Nascimento; Sandro Griza; Francisco Sandro Rodrigues Holanda; Regina Helena Marino; "Production of Biocomposites from The Reuse of Coconut Powder Colonized By Shiitake Mushroom", CIÊNCIA E AGROTECNOLOGIA, 2019. (IF: 3)
41. Mirko Cucina; Gabriele Soggia; Patrizia De Nisi; Andrea Giordano; Fabrizio Adani; "Assessing The Anaerobic Degradability and The Potential Recovery of Biomethane from Different Biodegradable Bioplastics in A Full-scale Approach", BIORESOURCE TECHNOLOGY, 2022.

42. Mónica Duque-Acevedo; Luis J. Belmonte-Ureña; Fernando Toresano-Sánchez; Francisco Camacho Ferre; "Biodegradable Raffia As A Sustainable and Cost-Effective Alternative to Improve The Management of Agricultural Waste Biomass", AGRONOMY, 2020. (IF: 3)
43. Morsyleide de Freitas Rosa; Bor-Sen Chiou; Eliton S. Medeiros; Delilah F. Wood; Luiz H. C. Mattoso; William J. Orts; Syed H. Imam; "Biodegradable Composites Based on Starch/EVOH/glycerol Blends and Coconut Fibers", JOURNAL OF APPLIED POLYMER SCIENCE, 2008. (IF: 3)
44. N. Rastogi; "New Technologies for Value Added Products from Coconut Residue", BY-PRODUCTS OF PALM TREES AND THEIR APPLICATIONS, 2019.
45. Nathalie Gontard; Stéphane Guilbert; "Bio-packaging: Technology and Properties of Edible And/or Biodegradable Material of Agricultural Origin", 1992. (IF: 5)
46. Noran Mousa; Emmanuel Galiwango; Sabeera Haris; Ali H Al-Marzouqi; Basim Abu-Jdayil; Yousuf L Caires; "A New Green Composite Based on Plasticized Polylactic Acid Mixed with Date Palm Waste for Single-Use Plastics Applications", POLYMERS, 2022. (IF: 3)
47. P. J. Jandas; Smita Mohanty; S. K. Nayak; "Surface Treated Banana Fiber Reinforced Poly (lactic Acid) Nanocomposites for Disposable Applications", JOURNAL OF CLEANER PRODUCTION, 2013. (IF: 3)
48. Patrizia Cinelli; Maria-Beatrice Coltelli; Francesca Signori; P. Morganti; Andrea Lazzeri; "Cosmetic Packaging to Save The Environment: Future Perspectives", COSMETICS, 2019. (IF: 3)
49. Prashant Gupta; Bhagwan Toksha; Mostafizur Rahaman; "A Review on Biodegradable Packaging Films from Vegetative and Food Waste", CHEMICAL RECORD (NEW YORK, N.Y.), 2022. (IF: 3)
50. Rindengan Barlina; S. Liwu; J. Wungkana; J. Alouw; "Potency of Coconut Water As Raw Material for Biodegradable Plastics", IOP CONFERENCE SERIES: EARTH AND ENVIRONMENTAL SCIENCE, 2023.
51. S. K. Nath; Vipin K. Chawla; "Wood Substitution: Recent Developments in India", JOURNAL OF THE INDIAN ACADEMY OF WOOD SCIENCE, 2012.
52. Sara Guerrini; Giorgio Borreani; Henk Voojis; "Biodegradable Materials in Agriculture: Case Histories and Perspectives", 2017. (IF: 3)
53. Saurabh Sid; Rahul S. Mor; Anand Kishore; Vijay Singh Sharanagat; "Bio-sourced Polymers As Alternatives to Conventional Food Packaging Materials: A Review", TRENDS IN FOOD SCIENCE AND TECHNOLOGY, 2021. (IF: 4)
54. Seiichi Tokura; H. Nagahama; Hiroshi Tamura; "Preparation of Biodegradable Fibers from Food Wastes", 2007.
55. Steivie Karouw; Budi Santosa; Maria L Kapu'allo; "Pemanfaatan Biodegradable Film Pati Sagu Sebagai Bahan Pengemas Permen Kelapa (Utilization of Biodegradable Film from Sago Starch As Packaging for Coconut-Based Candy)", 2020.
56. Teresa N. Malafi; Marlene A. Devine; Larry L. Lesher; "A User Evaluation of Biodegradable Cutlery", JOURNAL OF ENVIRONMENTAL POLYMER DEGRADATION, 1994.
57. Teresa N. Malafi; Marlene A. Devine; Larry L. Lesher; "ATTITUDES OF U.S. NAVY PERSONNEL TOWARD THE USE OF BIODEGRADABLE PRODUCTS IN FOODSERVICE", FOODSERVICE RESEARCH INTERNATIONAL, 1995. http://vidyajournal.org
58. Tobias P Haider; Carolin Völker; Johanna Kramm; Katharina Landfester; Frederik R Wurm; "Plastics Of The Future? The Impact Of Biodegradable Polymers On The Environment And On Society", ANGEWANDTE CHEMIE (INTERNATIONAL ED. IN ENGLISH), 2018. (IF: 7)
59. Wenhao Zhang; "Analysis on The Development and Application of Biodegradable Polymers", IOP CONFERENCE SERIES: EARTH AND ENVIRONMENTAL SCIENCE, 2021. 59. Wissuta Choeybundit; K. A. Shiekh; P. Rachtanapun; W. Tongdeesoontorn; "Fabrication of Edible and Biodegradable Cutlery from Morning Glory (Ipomoea Aquatic) Stem Fiber-reinforced Onto Soy Protein Isolate", HELIYON, 2022.

60. Wissuta Choeybundit; Khursheed Ahmad Shiekh; Pornchai Rachtanapun; Wirongrong Tongdeesoontorn; "Fabrication of Edible and Biodegradable Cutlery from Morning Glory Stem Fiber-Reinforced Onto Soy Protein Isolate", BIOLOGY & SUSTAINABILITY EJOURNAL, 2021.
61. Worraphol Nansu; Sukunya Ross; Gareth M. Ross; Sararat Mahasaranon; "Effect of Crosslinking Agent on The Physical and Mechanical Properties of A Composite Foam Based on Cassava Starch and Coconut Residue Fiber", MATERIALS TODAY: PROCEEDINGS, 2019. (IF: 3)
62. Y. Zhang; J. H. Han; Z. Liu; "Starch-based Edible Films", 2008. (IF: 3) 63. Young Jo Kim; Sang-Eun Chun; Jay Whitacre; Christopher J Bettinger; "Self-deployable Current Sources Fabricated From Edible Materials", JOURNAL OF MATERIALS CHEMISTRY. B, 2013. (IF: 5)
63. Zhang Fangfang; Bai Xinpeng; G. Wei; Guoding Wang; Z. Shi; C. Jun; "Effects of Virgin Coconut Oil on The Physicochemical, Morphological and Antibacterial Properties of Potato Starch-based Biodegradable Films", INTERNATIONAL JOURNAL OF FOOD SCIENCE & TECHNOLOGY, 2019. (IF: 3)
64. Websites: 66. https://images.app.goo.gl/cypWo239rHXSSepq9
65. https://mscpi.com/about-us/
66. https://scitechdaily.com/this-disposable-tableware-made-from-sugarcane-and-bamboo-breaks-down-in-60-days/
67. https://www.bagasseproduct.com/product/Compartment-Sugarcane-Food-Tray.html
68. https://www.insinc.co.nz/blog/biodegradable-cutlery-NZ
69. https://www.researchgate.net/figure/The-production-process-for-bamboo products_fig1_340000697/downloadtp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6Il9kaXJlY3QiLCJwYWdlIjoiX2RpcmVjdCJ9fQ
70. https://www.sciencedirect.com/science/article/abs/pii/S0959652622002293
71. https://www.sciencedirect.com/science/article/abs/pii/S2213343723020493