VEGAN FOOD PACKAGING BY USING ORANGE PEELS

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Abstract

The current research is an attempt to create biodegradable food containers using orange peels as an environmentally friendly alternative to traditional plastic-based packaging. Orange peels, a byproduct of the citrus industry, were processed to extract starch, pectin, and cellulose, which were mixed with natural plasticizers to make bioplastics. These materials were then molded into containers and assessed for thermal, mechanical, and antimicrobial properties. Orange peels contain natural compounds that have been known to improve food preservation by enhancing shelf life and preventing spoilage. The use of readily available agricultural waste like orange peels not only reduces the cost of production but also diminishes environmental pollution and gives value to sustainable packaging solutions.

1 Introduction

Plastics have greatly transformed modern society with the extensive use of plastics in day-to-day life. These are applied in various industries like healthcare, technology, and packaging due to their durability, flexibility, and affordability. However, the rapid rise in plastic

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consumption and related environmental challenges have raised severe concerns. The global annual production of plastics was forecasted to reach more than 500 million tons by 2020, coupled with its corresponding pollution and waste management problems.[1] Plastic wastes released into the environment have deposited poisonous chemicals, which have threatened human life and wildlife.[2] According to reports, about 5 trillion plastic particles are floating in the oceans between the Arctic and Antarctic regions and thereby causing a gigantic ecological imbalance. [3] Plastic products, especially single-use plastics, take hundreds of years to decompose and release microplastics during degradation. These microplastics not only pollute soil and water but also enter food chains, causing potential harm to human and animal health.[4] Such concerns necessitate immediate action to reduce the use of conventional plastics and develop eco-friendly alternatives. In response, governments worldwide, including the Government of India, have implemented strict measures to curb single-use plastics.[5] Conventional plastics are produced using chemicals including bisphenol A, phthalates, among others, which contribute majorly to environmental pollution as well as human health dangers. These chemicals release from the environment when plastics decay, posing a severe danger to ecosystems. BPA has been associated with endocrine disruption of both wildlife and humans. This will affect reproductive health and development. Similarly, plasticizers such as phthalates are proven to be contaminants of soil and water, causing damage to aquatic life and affecting the food chain. Besides that, conventional plastics have much reliance on fossil fuel to be produced, releasing various dangerous greenhouse gases into the environment, thereby contributing to climatic change. The toxic nature of these chemicals, along with the age taken by traditional plastics to decompose, being several hundred years, only magnifies environmental issues like plastics in oceans, rivers, and landfills. The shift to bioplastics, made from renewable sources and free from chemicals dangerous to human health, such as BPA and phthalates, offers a more sustainable alternative, helping reduce the overall negative environmental impact of plastic wastes. The peels are rich in starch, pectin, cellulose, and

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hemicelluloses. All these give the peels suitability as raw materials for the production of biodegradable plastics. [6]

Additionally, Food waste such as orange peels, shrimp shells, and coffee grounds have become one of the most promising resources for biodegradable alternatives to conventional plastics.[7]

Orange.peels are a readily available, underutilized food waste material with high potential for the orange peel bioplastics have exhibited great properties, like antimicrobial activity, which qualify them for medical applications and food packaging.[8] The other thing is that the bioplastics are biodegradable, and they carry less carbon footprint than any other conventional plastic, hence the most eco-friendly. Pectin and cellulose found in orange peels give the bioplastics durability and structural strength needed for most industrial applications.[6]

Production of bioplastics from orange peels also counters major environmental concerns. Since orange peels emit methane as they decompose, the gas is a potent greenhouse one that contributes approximately 20% to global methane emissions.[9] Orange peels being used as feedstock for bioplastics saves wastes and aids in reducing methane emissions as efforts are taken to counter global warming.[9] Moreover, using this agricultural waste reduces the reliance on fossil fuel-based raw materials; hence, it directly reduces the greenhouse gases generated in the traditional plastic production process. [5] Orange peels-based bioplastics may also decrease soil and water pollution brought about by regular plastics. The breakdown products of regular plastics called microplastics collect in soil and aquatic ecosystems, threatening biodiversity and adulterating food chains.[3] Biodegradable orange peel bioplastics therefore eradicate long-term ecological dangers.

Beyond the increased shelf life, it may also be instrumental in the retention of texture and moisture of packaged foods through controlled exchange of moisture by allowing breathable characteristics of bioplastics. Unlike traditional plastics that may trap moisture in packages and cause fresh produce to wilt or degrade, bioplastics from orange peels can allow the entry

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and exit of controlled amounts of moisture. This helps to keep the packed foods fresh and nutritious while being an environmentally friendly food preservation method, which is highly efficient. Incorporating orange peel bioplastics in food packaging resolves environmental concerns but also introduces a more natural and efficient food preservation method, creating benefits both for consumers and the food industry

In conclusion, using orange peels for food packaging can be a sustainable solution addressing waste management and environmental issues. This approach contributes to the circular economy, where resources are reused and recycled, by transforming food waste into valuable materials for packaging. As the research on orange peel-based bioplastics continues to advance, it has a potential to revolutionize the food packaging industry, thereby providing a safer and more sustainable alternative to harmful plastics.

2. Experimental Procedure

2.1 Materials

2.1.1 Reagents and Chemicals

Reagents and chemicals utilized for packaging orange peel-based veganfoods are orange peel powder or pectin (film base), glycerol or sorbitol (plasticizers), calcium chloride and citric acid (crosslinkers), distilled water and acetic acid (solvents/pH adjusters), ethanol (for extraction), and orange essential oil (for antimicrobial action).

1.1

1.1.1 Orange peel

The study makes use of orange peels as the prime raw material in the manufacture of bioplastics. This is because the peels are rich in cellulose, pectin, and hemicellulose, essential in the manufacture of degradable packaging materials. These will ensure that the bioplastics are stronger, flexible, and durable in use while still being nonhazardous to the environment. Besides, orange peels have natural antimicrobial compounds such as limonene and flavonoids that improve the food preservation properties of the packaging through the inhibition of

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microbial growth. Because they are waste material coming from juice and citrus processing industries, it is a cost-effective and sustainable resource for packaging solutions

1.1.2 Glycerol

Glycerol is added during the manufacture of bioplastics as a plasticizer in order to enhance the toughness, elasticity, and workability while reducing brittleness. Glycerol breaks the intermolecular bond within the polymer matrix, giving the bioplastic more deformability and flexibility for packaging material applications. Since glycerol is non-toxic, readily biodegradable, and easily available, it is a preferred additive for the development of ecological packaging materials. Its use complements the orange peel-derived bioplastics by enhancing their mechanical properties without compromising their environmental sustainability.

2 Methodology

2.1 Process of making food container

For the development of a biodegradable material for food packaging, 20 oranges were peeled, washed, and cut into small pieces. They were dried for one day to remove moisture and ground into a fine powder. A measured 15g of the orange peel powder was mixed with 5ml of glycerol, followed by the addition of 2-3ml of 0.1N hydrochloric acid add in mixture. The mixture was mixed well, and distilled water was added to make it into a paste-like consistency. The paste was spread evenly onto butter paper and kept at room temperature (about 45°C) for three days, which resulted in a natural material that could be used for food packaging applications.

2.2 Preparation of Orange Peel Powder

3.2.1 Peeling and Washing: Fresh oranges were carefully peeled to separate the outer layer (peels) from the fruit. The peels were then washed well under running water to remove

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any dirt and contaminants. Finally, the washed peels were put aside for drying preparation.

3.2.2 Cutting and Drying: The washed orange peels were cut into small, uniform pieces using a sharp knife. These pieces were then spread evenly on a clean surface to facilitate uniform drying. The drying process was carried out at room temperature for 24 hours in a well-ventilated area.

3.2.3 Grinding to Powder: After drying, the orange peel pieces were fed into a grinder, which broke them into a fine powder. The resulting powder was then carefully collected in an airtight container to prevent moisture contamination, where it was stored until further use.

2.3 Preparation of the Mixture

3.3.1 Measurement of Ingredients : Accurate measurements were taken using precise instruments. Specifically, 15g of prepared orange peel powder were weighed using a digital balance. Additionally, 7 milliliters of glycerol and 3 milliliters of 0.1N hydrochloric acid were measured separately using graduated cylinders.

3.3.2 Mixing Process: The orange peel powder was added to a clean mixing bowl. Glycerol was then slowly poured into the powder while stirring continuously to ensure an even mixture. Finally, hydrochloric acid was slowly added to the mixture, again with continuous stirring, to complete the preparation of the mixture.

3.3.3 Consistency Adjustment: Distilled water was added dropwise to the mixture, allowing for precise control over consistency. Continuous Stirring ensured that the mixture came together smoothly, ultimately achieving a uniform, paste-like consistency without forming any lumps.

3.4 **Drying the Mixture:** The paste was evenly spread onto butter paper using a spatula, ensuring a uniform layer thickness to facilitate even drying. The coated paper was then placed in a dry, well-ventilated area at room temperature, where it was allowed to dry completely. Once dry, the resulting material was carefully collected and preserved for further

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studies.

3.5 **Observations During Preparation:** The orange peel fragments dried naturally in the ambient air humidity and ventilation condition. To achieve the ideal paste consistency, distilled water was slowly added to the mixture. The final paste was then left to dry under environmental condition for 24-48 hours.

3 Results and Discussions

The prepared bioplastic from orange peels resulted in a thin, leather-like or board-like material .The following observations and analyses are noteworthy:

Figure 1:

1. Physical Characteristics: The final product exhibited a uniform structure, suggesting a successful blending of orange peel powder, glycerol, and hydrochloric acid.

The material was characterized by a smooth texture and rigidity, thus suitable for possible applications such as packaging or lightweight structural use. The thickness and flexibility were well-balanced, giving it a desirable strength-to-weight ratio

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Figure 2:

2. Weight-Bearing Capacity: The bioplastic showed that it can withstand 20 grams of weight without deformation. This suggests its strength and is ideal for light-weight packaging.

3. Water Resistance: Immersing the material in water for 24 hours softened it due to moisture absorption. Although this limits the water resistance, it reflects the biodegradable nature of the bioplastic. Some surface treatments or additional additives might improve the resistance to water.

4. Heat Resistance: The bioplastic was exposed to a hot air oven, and it experienced minor weight reduction probably due to the loss of moisture. However, it retained its structural integrity, which is good resistance to moderate heat exposure. This makes it suitable for applications involving warm food items.

5. Cold Resistance: When placed in a refrigerator for 24 hours, the bioplastic showed no significant changes in shape or texture. This demonstrates its suitability for cold storage applications, such as packaging fresh or frozen food.

6. Soil Biodegradability: Preliminary soil tests indicate that the bioplastic is

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Figure 3:

Figure 4:

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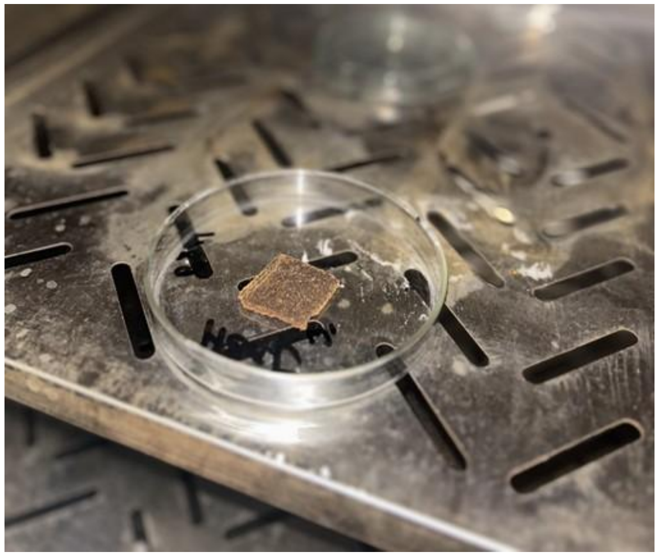

Figure 5:

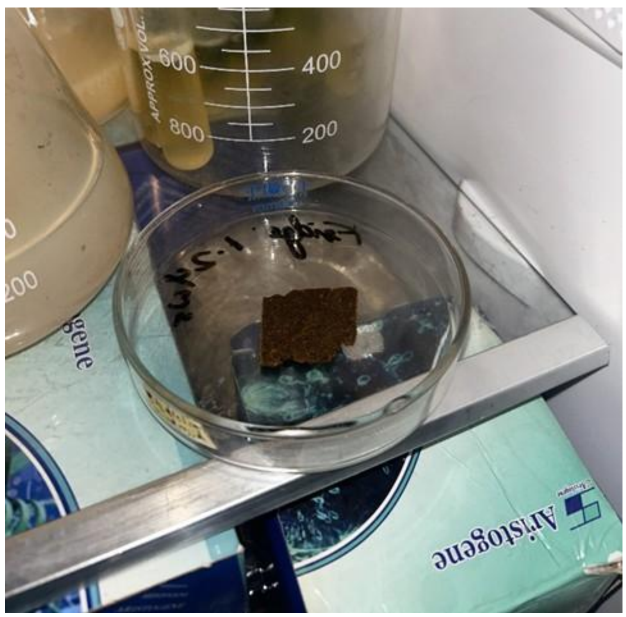

Figure 6:

biodegradable, degrading naturally in the environment over time without harming it. This property aligns well with the goals of reducing plastic pollution and supporting sustainable practices.

7. Overall Performance: The bioplastic derived from orange peels possessed good performance through various tests; weight-bearing performance, hot storages, cold storages are some examples among them. This bioplastic, however requires improvement on the

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Figure 7:

water resistance characteristic for it to be of benefit in all usages. Generally, it should be used mainly because it was lightweight, thus biodegradable, with fair environmental stress endurances. Orange peel bioplastics find much potential applications in food packaging; however, water resistance along with mechanical property need further optimisations to fully employ these kinds of bioplastic in future applicationsThis section highlights the main findings from the survey conducted on menstrual health and hygiene awareness among individuals aged 16 to 21 years. The results are organized into several key themes, such as awareness, menstrual hygiene practices, and access to menstrual products, to offer a thorough understanding of the topic. The discussion also places these findings in a broader context, comparing them with existing research and pointing out areas that need improvement.

Weight analysis of orange peel bioplastic under different environmental condition

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Table 1:

	Inserted weight	Day-1	Day-2	Day-3
Refrigerator	1.2	1.09	0.9	0.9
Drying	1.8	1.3	1.3	1.3
Degradation	1.1	0	0	0
Water	1.9	2.9	2.9	2.9

3.1 Raising Women's Health Awareness and Knowledg

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