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Biopolymer Production from Arrowroot Starch

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Abstract

A bio-based polymer is one that is created from natural sources with the addition of additives and an accelerator. It can decay at specific times and temperatures. These are environment friendly materials which are biodegradable, safer, non-toxic, lightweight, inexpensive and easy to find. The growing amount of plastic trash in landfills has prompted researchers to develop biodegradable polymers. Agricultural resources contain essential biopolymers, such as polysaccharides and proteins, which help to mitigate the aforementioned short disadvantages of petroleum-based plastics. The Arrowroot (*Maranta arundinacea*) rhizomes have emerged as powerful sources of starch and fiber. Arrowroot starch contains a significant amount of amylose (35.20 percent), making it ideal for film making. Carbohydrate is one of the most valuable elements found in arrowroot starch, which is used to make medication, biscuits, pastries, cakes, and other bakery products, whereas waste rhizome fibre is usually used to make paper, flours, tissue paper, and cardboard.

Introduction

Arrowroot (*Maranta arundinacea* Linn.) belongs to family Marantaceae and commonly known as 'West Indian arrowroot'. The crop is native to northern South America and possibly the West Indies. Arrowroot seems to be an inclusive name applied to several species of plants whose roots (rhizomes) are either eaten fresh or made into flour. The plant grows to a height of 1-1.5 m and is shallow rooted with deeply penetrating long, fleshy, cylindrical, subterranean rhizomes, which are the edible part (Figure 1). Leaves are lanceolate, about 20 cm long and 10 cm wide. White flowers develop in 3 months but seed is seldom set. It grows well at temperatures at 20-30 °C (Chauhan *et al.,* 2022). A group of two to three arrowroot rhizomes or a single arrowroot rhizome are common. The rhizome of the arrowroot plant is a valuable source of starch, bagasse fibre, and husk fibre. The biomass and leftovers are thrown away. The digestible arrowroot starch produced from the rhizomes is a common ingredient in biscuits and cookies, and many local bakeries use it to make arrowroot cookies, a popular speciality product in the Philippines' province of Marinduque. According to Sartori *et al*. (2016), starch is one of the most promising polysaccharides due to its ability to construct a continuous matrix, as well as its low cost, abundance, renewable, and availability in a variety of raw materials. Arrowroot starch has a high commercial value, and it is growing economic worth and market share in both the domestic and international markets. Environmental pollution is becoming more severe, rendering us more exposed to a variety of disasters. Arrowroot is essential in the production of biodegradable materials like bio-composites. Arrowroot fibres are a source of cellulose nanowhiskers formed from biomass wastes derived from agribusiness. The arrowroot rhizome, on the other hand, is hydrophilic. The arrowroot

fibre has a very small diameter. As a result, this fibre has a high tear resistance, making it appropriate for packaging and tissue paper. By combining arrowroot fibre with PLA, the biodegradability of the fibre can be extended. Packaging materials, biological materials, and agricultural uses can all benefit from the arrowroot rhizome product. Arrowroot starch has also good potential for hydrogel production. Hydrogel is a potential technology for enhancing the water and nutrient use efficiencies in plants, creating a congenial and nourishing rhizospheric micro-environment for better plant growth and yield (Verma *et al*., 2019).

Figure 1: Arrowroot plants and rhizomes

Arrowroot Starch

Arrowroot is a strong starch that's widely utilized in the culinary business in a variety of viscosities and textures, as well as in a variety of other uses. Amylopectin, an anhydroglucose molecule with an exceptionally branched structure, and amylose, a non-branched glucose element, make up starch, which is a polysaccharide. Amylopectin is a highly branched molecule made of numerous short chains of (1e4)-a-D-glucans linked by an a-1-6 linkage. Amylose is a linear molecule composed of glucose units linked by a-1-4 linkage. Ramifications are caused by these a-1-6 connections. The molecular weight, shape, and scale of amylose and amylopectin have a big impact on their nature because of differences in unit weight distribution and composition; these two units exhibit variable pasting, retrogradation, viscoelastic, and rheological properties. Arrowroot starch provides a number of benefits, including being versatile, non-poisonous, environmentally friendly, blood-adaptable, and bioaccumulate. As a result, arrowroot starch could be a novel alternative for many ecofriendly products formulation. It can be used for production hydrogel and nowadays it is used also improve the soil physical properties, inter alia, water holding capacity, permeability and infiltration; especially in structure less and drought affected soils (Verma *et al*., 2018).

Extraction of Starch from Arrowroot Rhizomes

The rhizomes of arrowroot are usually collected for their starch. The unit procedures necessary for arrowroot starch extraction are the same as for other roots and tubers, including disintegration, extraction, filtering, concentration, and ultimately drying. According to Sajeev *et al*. (2012), disintegration by grating/ milling is the most important because it opens up the walls of the plant cells and displays the starch granules within the plant. Graters are widely utilized in both big- and small-scale enterprises. Two techniques of starch extraction are used by arrowroot producers in the Marinduque province. The traditional method, known locally as ilod, is used in one, while a grinding system driven by a motor is used in the other. Arrowroot growers in Barangay Malbog, Buenavista, Marinduque, employ the traditional method. The recovered compounds from arrowroot are primarily water and fibre, with only a trace of starch. Fresh arrowroot rhizomes were first washed, cut, and processed in a wet milling machine until the smallest acceptable fraction was reached, and then water was added to the arrowroot pulp. The mixture was then strained through cheesecloth to remove the fibrous residue. Finally, the leftover extractive-containing solution was decanted, dried, and stored (Figure 2).

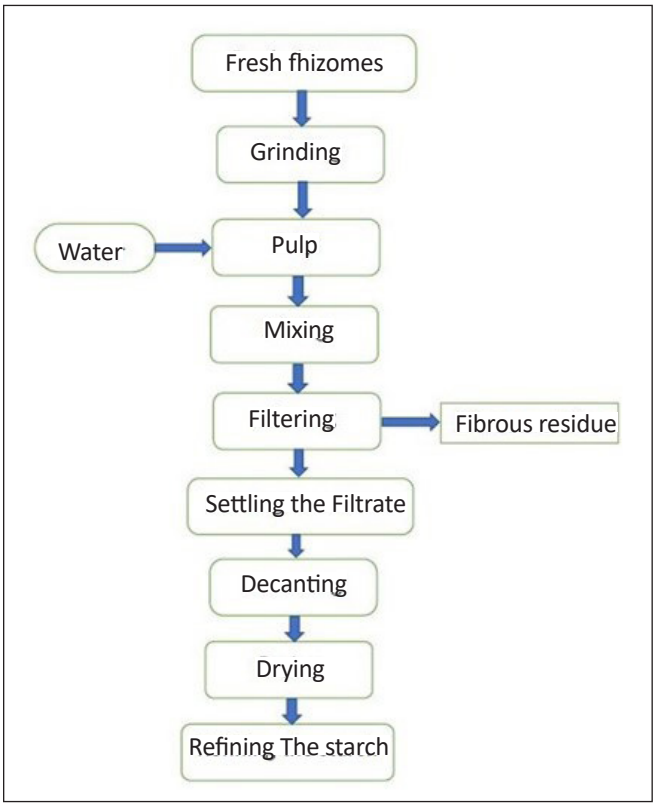

Figure 2: Extraction of arrowroot starch from rhizomes

Processing of Biopolymer from Arrowroot Starch

Starch has surfaced as a prospective green resource that could be used to replace non-biodegradable plastic. The creation of a biopolymer relies heavily on arrowroot starch. In this case, a combination of arrowroot starch and natural rubber can improve the elasticity and decomposability

of the rubber. It was also demonstrated that arrowroot starch containing glycerol may form long-lasting polymeric matrices in the membrane. Incorporating blackberry pulp into arrowroot starch also resulted in the creation of edible films with a biopolymer matrix. Fruit pulp provides a number of benefits, including functioning as natural antioxidants, antimicrobials, colourants, and flavouring agents, as well as increasing the mechanical properties of bio-polymatrix. Biopolymer can also be used with bio-based reinforcing materials to improve mechanical qualities.

Conclusion

The destructive environmental concerns produced by petroleum-based materials can be avoided or at least lessened by combining natural fibres and biopolymers in composites. The development of starch polymer composites will have a significant impact on the environment, as it will solve the problem of plastic waste recycling and reduce greenhouse gas emissions from petroleum-based products. Bio-resources are continually proving to be a viable alternative to non-biodegradable conventional items in the pursuit of a more sustainable environment. As a result, arrowroot starch or fibres derived from arrowroot plants can be concluded to be useful in a variety of applications.

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