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A REVIEW ON PECTIN EXTRACTION FROM PASSION FRUIT PEEL AND MELON PEEL

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ABSTRACT

Pectin is a biopolymer found in plant cell walls and is plentiful in fruits and vegetables. Given its high availability and the global issue of food waste, pectin extraction plays a significant role in valorizing food processing by-products. In Brazil, passion fruit and melon are widely consumed, with a considerable portion of their mass composed of peels, often disposed of in landfills. While commercial pectin is predominantly extracted from citrus fruits and apple pomace, the peels of passion fruit and melon are emerging as promising sources due to their high pectin content. Pectin finds extensive application in the food industry due to its thickening, stabilizing, emulsifying, and gelling properties. However, its potential extends to various other fields such as pharmaceuticals and biotechnology. An emerging trend is the utilization of pectin as an edible coating and film for food packaging, due to its potential to replace petroleum-based materials. In literature, studies are focused on identifying new sources, optimizing existing extraction methods, discovering green extraction technologies, and exploring potential applications of pectin.

Keywords: Pectin 1. Passion fruit 2. Melon 3. Fruit peel 4.

1 INTRODUCTION

Numerous research efforts have been undertaken regarding the extraction of pectin from alternative sources to commercial ones, aiming to valorize these residues and promote circular economy practices [1,2]. Given that fruit peels are typically discarded after processing, leading to environmental pollution[3]. Food and its by-products waste represents a global environmental issue, with the Food and Agriculture Organization (FAO) estimating that annually, out of the 1.5 billion tons of fruits and vegetables produced, one-third is either wasted or converted into by-products[4].

Passion fruit is extensively cultivated in various regions, especially in South America, Central America, Southeast Asia, and China. Its pulp is commonly used for juice and jelly production. This production yields numerous by-products, with the primary one being the peel, which accounts for approximately 50 to 60% of the total fruit mass[5, 6, 3]. Melon is extensively cultivated in tropical countries, with its global production estimated at 40 million tons per year. Of this, 12.7 million tons come from China, the largest producer of the fruit[7]. The industrial processing of melon generates a significant amount of seeds and peels as by-products, representing one-third of its total weight[8].

Valorizing by-products is important for reducing food waste, recovering compounds by adding value to them, and creating new sources of income[7]. Pectin can be used in various applications because it is a safe, non-toxic product with low production costs and high availability[1]. However, extraction is not viable from all available sources due to cost and properties constraints[9]. Therefore, it is of utmost importance to find alternative sources that can compete with the production cost and properties of commercial pectin[9].

2 BIBLIOMETRIC ANALYSIS

The methodology applied for the development of this study involved researching scientific articles published in the last 5 years, including both literature reviews and bench research. The sources of data used were Google Scholar and ScienceDirect, employing the following keywords: pectin, passion fruit peel pectin, melon peel pectin, and food waste.

3 METHODS OF PECTIN EXTRACTION FROM PASSION FRUIT PEEL

In a comparative study, four methods of pectin extraction from passion fruit peel were evaluated, as presented in Table 1. The results demonstrated that the steam explosion pretreatment combined with acid-assisted ultrasound extraction method yielded the highest extraction efficiency. It was concluded that the steam explosion pretreatment significantly improved the pectin extraction yield, resulting in lower degree of esterification, lower molecular weight, higher protein content, increased total polyphenol content, and larger ramnogalacturonan I region. Additionally, it formed a more stable emulsion, albeit with reduced thermal stability. Therefore, the method demonstrated high extraction efficiency and good emulsifying properties of passion fruit peel pectin[5].

Table 1 Results of the Comparative Study on Methods for Extracting Pectin from Passion Fruit Peel.

Method	Parameter	Yield (%)	Author
Acid extraction	Nitric acid pH 2.0; solid-liquid ratio 1:30; 98°C; 1 hour	5,28 ± 1,57	[5]
Ultrasound-assisted acid extraction	Nitric acid pH 2.0; 15 minutes; 65°C; solid-liquid ratio = 1:30 w/v; 480 W	6,52 ± 0,48	[5]
Steam explosion pretreatment combined with acid extraction	Peel under 0.6 MPa steam for 120 s; drying at 45°C for 48 h; Nitric acid pH 2.0; 1 h; 98°C; solid-liquid ratio = 1:30 w/v	9,93 ± 0,33	[5]
Steam explosion pretreatment combined with ultrasound-assisted acid extraction	Peel under 0.6 MPa steam for 120 s; drying at 45°C for 48 h; Nitric acid pH 2.0; 15 min; 65°C; solid-liquid ratio = 1:30 w/v; 480 W	10,72 ± 0,39	[5]

Pectin was extracted from purple passion fruit peel using the microwave-assisted technique, resulting in a yield of 18.73% under optimized conditions. Applying the same conditions for conventional extraction, the yield was 13.58%, highlighting the impact of the extraction method on yield. The structure of the obtained pectin closely resembled commercial pectin obtained from citrus fruits, indicating that passion fruit peel is a valuable source of pectin that can be extracted using faster and simpler methods with quality similar to commercial pectins[10].

Table 2 Comparative Study Results for Pectin Extraction from Purple Passion Fruit Peel.

Method	Parameter	Yield (%)	Author
Ultrasound-assisted extraction	12 minutes; 75°C; pH 2.9; 218 W; solid-liquid ratio = 1:57 w/v	18,73 ± 0,06	[10]
Acid extraction	Citric acid pH 2.0; 75°C; 12 minutes; solid-liquid ratio = 1:50 w/v	13,58 ± 0,10	[10]

4 APPLICATIONS OF PECTIN FROM PASSION FRUIT PEEL

Studies indicate the potential use of composite films made from natural pectin extracted from passion fruit peel and chitosan incorporated with biosynthesized silver nanoparticles (AgNPs) in wound dressings and food packaging. The pectin-chitosan composite forms a stable film with good mechanical properties, while the AgNPs significantly enhance antimicrobial properties. The biofilm exhibits excellent antibacterial properties against *S. aureus*, *B. cereus*, *P. aeruginosa*, and *K. pneumoniae*. In vivo tests yielded promising results, with 100% wound closure after 15 days compared to only 40.89% closure in wounds treated with standard sterile gauze within the same period[11].

Another study explored the production of bioplastic from proteins extracted from by-products of mackerel (*Scomberomorus brasiliensis*) processing, a marine fish found off the Brazilian coast, along with pectin from passion fruit peel. The resulting film was smooth, homogeneous, yellowish, strong, flexible, biodegradable, and exhibited low solubility and water vapor permeability. These characteristics of the bioplastic were satisfactory, indicating its potential application as primary packaging in the food industry[12].

5 METHODS OF PECTIN EXTRACTION FROM MELON PEEL

The literature regarding technology for extracting bioactive compounds from melon peel is still limited, with most studies focusing on optimizing parameters for conventional extraction [13].

Pectin was extracted from melon peel through acid extraction using citric acid under pH 1 at 80°C for 60 minutes, resulting in a yield of 6.54%. The extracted pectin exhibited a high degree of esterification and water retention capacity. The study's findings indicate that melon peel can be utilized for pectin extraction similarly to orange peel and apple pomace[9].

Table 3 Result of Acid Extraction with Citric Acid of Pectin from Melon Peel.

Method	Parameter	Yield (%)
Acid Extraction	Citric acid pH 1.0; 1 hour; 80°C; solid-liquid ratio = 1:10 w/v	6,54 ± 0,02

Another study evaluated the optimal conditions for extracting polysaccharides from melon peel using the microwave-assisted method. Under optimal conditions, an extraction yield of 32.81% was obtained[14].

Table 4 Result of Pectin Extraction from Melon Peel using Microwave-Assisted Method.

Method	Parameter	Yield (%)
Microwave-assisted Extraction	414.4 W; 12.75 min; 75°C; solid-liquid ratio = 1:20.94 w/v	32,81 ± 0,26

6 APPLICATIONS OF PECTIN FROM MELON PEEL

The literature has investigated edible coatings made from pectin extracted from melon peel (Cucumis melo var. inodorus) combined with Aloe Vera. The edible coating based solely on melon peel pectin maintains fruit integrity for approximately 15 days at room temperature. However, when combined with Aloe Vera, which possesses antimicrobial properties, the shelf life is extended to approximately 20 days. Therefore, the combination of pectin extracted from melon peel with Aloe Vera shows potential to compete with commercial synthetic coatings[15].

Another study focused on the synthesis and characterization of a nano-hybrid composite of heterogeneous metal oxide within the structure of melon peel pectin. The pectin served as a framework for dispersing the oxide nanoparticles. This is important because metal oxides are essential for the development of electrochemical sensors and energy storage devices due to their electrocatalytic activity. However, to improve efficiency, their agglomeration must be avoided, which is the function of the pectin structure. In the conducted tests, it was observed that the synthesized composite exhibited high catalytic activity[16].

7 CONCLUSION

The extraction and application of pectin derived from passion fruit and melon peels hold significant scientific importance across various disciplines, owing to the widespread cultivation of these fruits in Brazil, resulting in substantial waste generation from their unused biomass. Thus, the exploration of methods for their valorization contributes to the advancement of circular economy principles, concurrently enhancing the utilization of erstwhile waste streams that would typically be consigned to landfill disposal.

The use of pectin as a gelling, thickening, stabilizing, and emulsifying agent is widely disseminated, particularly in the food industry. However, market expansion and high availability have spurred research into new functionalities. Within the food industry, the focus is on the development of edible coatings and packaging films, not only due to their potential to replace petroleum-derived materials but also for their ability to extend the shelf life of food products. Additionally, other fields are involved in researching the applicability of pectin. In the healthcare sector, the biosynthesis of composite films used as wound dressings has shown promising results in wound healing.

It is concluded that pectin extracted from passion fruit peel and melon peel has vast potential to be explored, with promising applications in various fields. It is necessary to further study the improvement of the extraction methods currently employed on an industrial scale and the physicochemical characteristics of pectins extracted by method and source, aiming to understand ways to modulate these properties. In this way, besides enhancing process efficiency, it will also be possible to progressively expand the applications of pectin.

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