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Pitaya Waste – Some Recent Valorization Aspects: A Mini Review

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Abstract
The goal of the current mini review paper was to present a brief overview of some modern main aspects of pitaya waste valorization possibilities. In this regard, a literature survey was conducted among publications in scientific databases using the descriptive approach on keywords "pitaya waste" and "dragon fruit waste"; book chapters and conference proceedings were not considered at all. As the main areas of intensive work regarding the valorization of pitaya waste, the following can be summarized, systematized and indicated: the isolation and characterization of pectin, the development of activated carbon and adsorbents, the conduct of studies of biological activity and various properties, the study of possibilities for inclusion as components in animal feed, for the development of food systems, as well as some other valorization aspects.
Keywords: Pitaya waste, Valorization, Highlights, Descriptive approach
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I. INTRODUCTION

Dragon fruit, also known as pitaya (Cheok et al., 2018; Jalgaonkar et al., 2022; Jiang et al., 2021), is an exotic fruit with nutritional and commercial importance, and various valuable products were obtained from it (Jalgaonkar et al., 2022). Inedible fractions as peels and seeds contain different nutritional and phytochemical compounds (Jiang et al., 2021). Pitaya peels, which account for about a third of the entire fruit, contain various valuable components and can be recycled (Jiang et al., 2021). As main bioactive compounds in dragon fruit peels can be noted betalains, phenolics, dietary fibres such as pectin and oligosaccharides (Le, 2022). According to Cheok et al. (2018), utilization of dragon fruit peels involves processing them into pectin, powder, pigment, enzyme.

The purpose of this mini review paper is to present some recent aspects of pitaya waste valorization opportunities.

II. METHOD

"Pitaya waste" and "dragon fruit waste" were the key words that were used in conducting the literature survey among various scientific databases, using the descriptive approach, in the preparation of the current mini review. Conference proceedings papers and book chapters are beyond the scope of the present work.

III. RESULT AND DISCUSSION

The scientific publications included here are far from exhausting all the existing information on the subject under consideration, but present a general picture of the main directions in which research is being carried out for the valorization of pitaya waste. The titles of 78% of the scientific publications cited in this work contained the term "peel/peels". Just under half of the articles included here have five or more authors.
In table 1, the main valorization aspects related to pitaya waste are presented in a systematized form.

Table 1. Pitaya waste valorization aspects

Valorization highlights		Reference
Pectin	properties of pectin from red pitaya peel	Alpizar-Reyes et al., 2022
	pectin from dragon fruit peels waste	Chua et al., 2020
	pectins from peels of *Hylocereus* spp.	Costa et al., 2022
	pectin-based films from white-fleshed pitaya peel waste	Jiang et al., 2022
	film based on pectin and betacyanins from peel waste of pitaya	Jiang et al., 2023
	bioplastic from pectin of dragon fruit peel	Listyarini et al., 2020

	dragon fruit peel pectin and citrus peel pectin	Muhammad et al., 2020
	pectin from dragon fruit peel	Thirugnanasambandham et al., 2014
	encapsulation of betalains from red dragon fruit peels using microcrystalline cellulose and dragon fruit peel pectin as wall materials	Tran et al., 2022
	high-methoxyl-pectin from *Hylocereus polyrhizus* peels	Zaid et al., 2020
	pectin from dragon fruit peels	Zaidel et al., 2017
	branched RG-I-rich pectin from red dragon fruit peel – probiotic properties	Zhang & Cai, 2023
Activated carbon and adsorbents	white dragon fruit peel waste – adsorbent for Congo red dye	Lim et al., 2020
	superparamagnetic cobalt ferric nanoparticles incorporated biopolymers from dragon fruit peels for nickel (II) removal	Bui et al., 2021
	dragon fruit peels –adsorption of methylene blue	Jawad et al., 2018
	dragon fruit skin – biosorbent for manganese (II) ions	Priyantha et al., 2013
	dragon fruit skin – biosorbent for methylene blue dye	Priyantha et al., 2015
	red dragon fruit waste peel extracts – various studies	Macadangdang Jr, 2022
	adsorption characteristics of carbon microparticles from red dragon fruit peel waste	Nandiyanto et al., 2020
	$CoFe_2O_4$ coated biopolymer from dragon fruit peel – nanocomposite adsorbent for removal of As (III)	Nguyen et al., 2023
Properties and activity characterization	*Hylocereus polyrhizus* and *Hylocereus undatus* peel extracts – antibacterial property	Nurmahani et al., 2012
	red pitaya extracts – nutraceutical and antioxidant properties	Tenore et al., 2012
	dragon fruit peels – phytochemical properties	Vera Cruz et al., 2022
	Hylocereus polyrhizus peel extract as a functional food colorant and nutraceutical	Putthawan et al., 2021
	red dragon fruit leaves and white dragon fruit leaves – antioxidant activity	Nerdy & Manurung, 2018
	pitaya peel – microwave assisted extraction of active compounds	Nazeri & Zain, 2018
	underutilized red pitaya peel – anti-elastase, anti-collagenase and antimicrobial activities	Vijayakumar et al., 2017
	crude aqueous *Hylocereus polyrhizus* peel extracts – antibacterial properties	Afandi et al., 2017
	inedible dragon fruit peel – waste utilization	Chen, 2018
	quality attributes of dragon fruit seeds	Nguyen et al., 2022
	pitaya peel – fiber rich powder	Sengkhamparn et al., 2013
	fresh peels of yellow pitaya and red pitaya and their flours – characterization	Morais et al., 2021
	pitaya (dragon fruit) peel supercritical carbon dioxide extracts – chemical composition, cytotoxic and antioxidant activities	Luo et al., 2014
	dragon fruit peel colour – antioxidant and stability	Lourith & Kanlayavattanakul, 2013
	pulp and peel of green and red pitayas – comparative metabolic profiling	Lin et al., 2021
	of red dragon fruit (*Hylocereus polyrhizus*) peel – anthocyanin activity	Fitriyani et al., 2022
	betalain from red pitaya peel	Faridah et al., 2015
	drum dried pitaya peel – physico-chemical properties	Chia & Chong, 2015
	dragon fruit peel waste – flours	Chumroenvidhayakul et al., 2022
Animal feed	dragon fruit peel flour – rumen fermentation in goat	Alimuddin et al., 2023
	pitaya fermentation waste – Pinnate batfish, *Platax pinnatus*	Chu et al., 2021
	dragon fruit peel – laying hens	Mahlil et al., 2018
	dragon fruit waste by-products and non-protein nitrogen source	Matra et al., 2021
	pitaya – metabolic profile – adult zebrafish	Lira et al., 2020
Food systems	wheat flour and pitaya peel flour blends – cookies preparation	Ho & Abdul Latif, 2016
	gelatin – red pitaya peel – edible coating – crayfish (*Procambarus clarkii*)	Liu et al., 2019
	dragon fruit peel – antioxidant dietary fibre – chicken nuggets	Madane et al., 2020
	peels – white pulp pitaya jellies	Magalhães et al., 2022
	pitaya peel extract and lemon seed essential oil – sodium nitrite replacement – cured mutton	Xin et al., 2022
	pitaya peel powder – dried and cooked noodles	Shiau et al., 2020
Some other valorization aspects	industrial wastes – encapsulation – betalains – red pitaya pulp	Utpott et al., 2020

	edible straw from dragon fruit peel	Darmawan et al., 2022
	amylase enzyme – red pitaya (*Hylocereus polyrhizus*) peel	Amid et al., 2014a
	protease enzyme – pitaya waste	Amid et al., 2014b
	dragon fruit foliage – cellulose nanomaterials	Anh et al., 2021
	mucilage – dragon fruit peel – flocculant – dye wastewater	Le et al., 2020
	fruit peel waste – graphene oxide – sulfamethoxazole determination	Lee et al., 2022
	electrocatalyst – waste pitaya peels – H_2O_2 electrosynthesis	Wang et al., 2022
	silver nanoparticle – photograph wastewater – *Hylocereus undatus* skin	Fatimah & Faridhatunnisa, 2017
	biogas – food waste and fruit waste (durian shell, dragon fruit and pineapple peel)	Muenmee & Prasertboonyai, 2021

From Table 1, it can be summarized that in 18% of the articles cited here, the valorization direction is the isolation and characterization of pectin from pitaya waste; 12% of the research is directed to the development of activated carbon and adsorbents from pitaya waste for the removal of various pollutants. The isolation of a variety of valuable compounds and the investigation of potentially useful properties is addressed in more than one-third of the publications used herein. Possibilities for including pitaya waste in animal nutrition as well as in the development of food systems are also being explored; and in about 15% of the articles, other valorization aspects for pitaya waste were considered.

IV. CONCLUSION

The significance of the pitaya waste valorization problem is summarized in a synthesized form in this mini review. The areas of work and research are diverse and wide-ranging. The main goal is to reduce and limit to the possible minimum the burden of waste from the production and consumption of pitaya on the environment and on the health of consumers.

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