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Some current options of papaya waste management: an overview

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Abstract
This overview paper aimed to present some current options for papaya waste management based on a brief literature research using a descriptive approach. Publications have been selected, with the help of which the main highlights in the research trends regarding the reduction and recovery of papaya waste as part of the effective management were shown. The present paper did not aim to systematize and describe in detail bibliographically the entire scientific production on the issue under consideration, but only to outline the main trends in this current direction.
Keywords: *papaya waste, papaya peels, papaya seeds, utilization possibilities.*

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I. INTRODUCTION

As noted in the review article [37], papaya peel and seeds, commonly considered as waste, are the main by-products of papaya processing. According to [47], dietary fiber and carotenoids were contained in papaya peels; in papaya seeds were found proteins, lipids, dietary fibers, glucosinolates, as well as other polyphenols. Due to its high lipid content, papaya seeds can be considered as a new source of edible oil [53]. Papaya seeds can be utilized as adsorbents and coagulants in wastewater treatment [26]. According to [49], papaya waste peels were used as animal feed, in biofuels, in ceramics as a binder, in wastewater treatment, in cosmetics.
The aim of this overview paper is to present briefly some current utilization options and research trends regarding papaya waste management.

II. PAPAYA WASTE UTILIZATION ASPECTS

For the preparation of this paper, several databases were used (Scopus, Web of Science, PubMed, Google Scholar). The limitation set by the author of the present paper was the selection of scientific publications only from the last four years with keywords "papaya waste", not considering conference proceedings and book chapters.

The research does not aim to collect all the scientific production that came out during the specified period on the set topic. The articles included here aim to present some major current research trends regarding the opportunities of papaya waste utilization.

From the systematic presentation of the articles cited here (Table 1), it is clear that the most frequent words in the titles of the publications (occurring in 21%, respectively) are "waste" and "seeds", followed by "peels" (approximately 18%).

Table 1. *Systematization of the scientific publications used in this paper by main words presented in their title*

Main words in the title of the article	Reference
"waste/wastes"	[8], [23], [24], [30], [39], [41], [42], [43], [44], [45], [55], [56]
"peel/peels"	[13], [14], [27], [28], [31], [33], [36], [38], [50], [51]
"seed/seeds"	[1], [2], [3], [4], [5], [9], [10], [12], [17], [22], [29], [53]
"utilization" and "residue/residues"	[6]
"valorization" and "waste/wastes"	[7], [34], [47]
"valorization" and "peel/peels"	[11]
"seed/seeds" and "residue/residues"	[16], [32]

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"seed/seeds" and "waste/wastes"	[18], [25], [40], [46], [52]
"peel/peels" and "waste/wastes"	[20], [35], [37], [48]
"seed/seeds" and "peel/peels"	[21]
"valorization", "seed/seeds" and "waste/wastes"	[26]
"waste/wastes" and "utilization"	[49]

In Table 2, the articles cited in the current overview paper are systematically presented according to some main potential usage observed.

Table 2. *Summarizing of the scientific publications cited in this paper on papaya waste utilization aspects observed*

Utilization highlights	Reference
Compounds extraction and/or bioactivity characterization	[1], [7], [10], [8], [16], [19], [27], [29], [32], [34], [36], [46], [50], [5]
Adsorption	[17], [20], [22], [30], [33], [40]
Treatment of water turbidity	[2], [3]
Coagulant	[12]
Corrosion inhibition	[13]
Seed oil extraction	[18]
Single cell protein	[55]
Alginate-pectin microcapsules	[57]
Propagation of *C. nutans*	[54]
Substrate	[51]
Alginic acid	[45]
Drying characteristics	[31]
Green synthesis	[35], [39], [38]
Synthesis of fluorescent carbon dots – a natural carbon originator	[48]
Bioelectricity generation	[24], [42], [43], [44]
Bioethanol	[6], [56], [4]
Biodiesel	[14], [52], [15], [25]
Foods	[9], [21], [23], [28]
Fertilizer	[11], [41]

After the literature research, possible ways to recover papaya waste can be mentioned: extraction of bioactive compounds, natural antioxidants, pectin, oil; usage as bio-coagulants, bio-adsorbents, substrate for bioelectricity generation; production of bioethanol; synthesis of organic fertilizers; usage as corrosion inhibitors, biocatalysts for biodiesel production, ingredients in biscuits or pancakes and some others. The limited number of articles used in this work showed the diverse possibilities of applying different means to reduce papaya waste and turn it into value-added products.

III. CONCLUSION

It can be concluded, as a result of the brief literature review of scientific publications available in the most widely used world-renowned databases, that numerous studies are being carried out on the recovery of papaya waste. The directions in which the work is done are diverse and wide-ranging, which shows the great commitment of the researchers to the problem, as well as the importance of the topic in relation to the reduction of fruit waste in a global aspect.

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