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Utilization of residual fruit peels as functional ingredients in sustainable food products

Viorica-Mirela Popa[1], Ersilia Calina Alexa[1], Ileana Cocan[1], Aurica Breica Borozan[3], Delia-Gabriela Dumbrava[1*], Corina-Dana Misca[1], Camelia Moldovan[1], Diana-Nicoleta Raba[2], Petru-Bogdan Radoi[1], Ducu-Sandu Ștef[1]

1 Faculty of Agrofood Processing Technology, University of Life Sciences "King Mihai I" from Timișoara, Calea Aradului 119A, 300645, Romania
2 Faculty of Management and Rural Turism, University of Life Sciences "King Mihai I" from Timișoara, Calea Aradului 119A, 300645, Romania
3 Faculty of Engineering and Applied Technologies, University of Life Sciences "King Mihai I" from Timișoara, Calea Aradului 119A, 300645, Romania
*corresponding author, e-mail: deliadumbrava@usvt.ro

Abstract: *This research aims to enhance the value of apple, pear, peach, and apricot peels by transforming them into natural nutritional additives for the modern food industry. The scientific approach is based on the premise that by-products of the fruit processing industry constitute an underutilized source of bioactive substances with therapeutic and technological potential. The methodology involved stabilization through controlled dehydration and grinding of the peels, followed by a rigorous physicochemical characterization of the resulting powders. Laboratory analyses confirmed a remarkable pectin content in apple and pear peels, as well as a high density of polyphenolic compounds and carotenoids in peaches and apricots. The study investigates how these functional ingredients influence the rheology of doughs and the oxidative stability of high-fat products. The results demonstrate that incorporating these plant residues not only increases the intake of insoluble fiber but also acts as a natural preservative, extending the shelf life of foods by inhibiting oxidation processes. From the perspective of sustainable development, this study proposes a circular economy model that minimizes the environmental impact of organic waste and optimizes production costs for fortified foods. Consequently, fruit peel powders represent a viable solution for clean labeling, providing natural colorants and antioxidants in a bioavailable form. Thus, the research underscores the importance of reintroducing residual biomass into the human food chain in the form of sustainable and innovative food products. This integrated approach simultaneously addresses global challenges regarding food security and environmental protection.*

Introduction

The fruit-processing industry generates considerable amounts of plant residues each year, with peels accounting for a significant proportion, ranging from 15% to 40% of the total fruit mass. Traditionally, these materials have been treated as waste; however, numerous studies have shown that they are valuable sources of bioactive compounds, dietary fibers, pectins, vitamins, and natural antioxidants. Apple, pear, plum, apricot, and peach peels stand out for their rich phytochemical profile, with the potential to enhance the nutritional, functional, and technological value of food products.

In the current context, marked by growing concerns about sustainability, food waste reduction, and the transition toward a circular economy, the valorization of these peels as functional ingredients represents an effective and responsible strategy. Their use in sustainable food products contributes both to reducing environmental impact and to the development of foods with high added value.

Material and method

This review is based on scientific literature published over the past two decades, including articles from international databases. It examines studies investigating the chemical composition of apples, pears, plums, apricots, and peach peels, the processing methods applied to them, and their use in food products.

Results and discussions

Apple, pear, plum, apricot, and peach peels are notable for their high content of bioactive compounds — from quercetin and pectin in apples to flavonoids in pears, anthocyanins in plums, carotenoids in apricots, and vitamin C in peaches. These phytochemical profiles provide antioxidant, prebiotic, or antimicrobial properties, making the peels valuable as functional ingredients in bakery products, pastries, beverages, dairy items, and supplements. Overall, they enhance fiber content, improve oxidative stability, support beneficial microbial cultures, intensify color, and extend shelf life.

Processing fruit peels involves steps such as washing, drying (by hot air or freeze drying), milling into fine powders, and, in some cases, extracting bioactive compounds. Powders are most used due to their stability and ease of incorporation into food matrices. Their high pectin and fiber content enhances water holding capacity, emulsion stability, viscosity, and gelling properties.

In food applications, peel powders and extracts are incorporated into bakery products, functional beverages, dairy items, dietary supplements, and vegan formulations. Reported benefits include increased nutritional value, improved oxidative stability, reduced glycemic response, and prebiotic potential. However, challenges remain, such as possible sensory changes (bitterness, astringency), compositional variability linked to cultivar and ripeness, and the need for standardized processing methods.

Conclusions

Residual apple, pear, plum, apricot, and peach peels represent a valuable and sustainable resource for the food industry. Owing to their high content of bioactive compounds, fibers, and pectins, they can be used as functional ingredients in a wide range of food products, enhancing both nutritional and technological value. Their valorization supports food waste reduction, promotes the circular economy, and opens new pathways for developing functional and sustainable foods.

However, their incorporation into food products requires optimization of processing methods and assessment of sensory acceptability to ensure effective large scale industrial implementation.