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Sea buckthorn pomace and seed extracts as natural antioxidants for sustainable food applications

Andreea GHITULESCU[1], Diana MOIGRADEAN[1], Ersilia ALEXA[1], Daniela STOIN[1], Corina MEGYESI[1], Viorica-Mirela POPA[1], Despina BORDEAN[1], Sofia POPESCU[1], Marioara DRUGA[1], Aurica BOROZAN[2], Mariana-Atena POIANA[1*]

[1] University of Life Sciences "King Mihai I" from Timisoara, Faculty of Food Engineering, Aradului Street 119, 300645 Timisoara, Romania
[2] University of Life Sciences "King Mihai I" from Timisoara, *Faculty of Engineering and Applied Technologies*, Aradului Street 119, 300645 Timisoara, Romania

* Corresponding author: marianapoiana@usvt.ro

Abstract: *Sea buckthorn by-products, particularly the pomace and seeds, are a valuable source of bioactive compounds that have significant antioxidant properties. These residues contain phenolic compounds, flavonoids, carotenoids, tocopherols and polyunsaturated fatty acids, supporting their use as natural ingredients in sustainable food products. The method of extraction has a significant impact on the recovery of these compounds. Hydroalcoholic systems favour the extraction of phenolic compounds, whereas supercritical CO_2 and other non-polar techniques are more effective for extracting lipophilic compounds, such as carotenoids and sterols. Green technologies, including ultrasound-assisted extraction, improve extraction efficiency while reducing processing time and solvent use. Due to their antioxidant and functional properties, sea buckthorn extracts have great potential for use in food systems as natural antioxidants and clean-label ingredients.*

Introduction

Sea buckthorn by-products are rich in valuable bioactive constituents, including phenolic compounds, flavonoids, carotenoids, phytosterols, tocopherols and polyunsaturated fatty acids. Figure 1 shows the main stages of processing sea buckthorn pomace, including the production of fresh pomace, dried material, separated seeds and pulp obtained after drying.


Raw sea buckthorn pomace


Dried sea buckthorn pomace


Sea buckthorn pomace-derived seeds


Sea buckthorn pomace-derived pulp/peel

Figure 1. Sea buckthorn pomace and its main fractions: seeds and pulp/peel

These constituents support the use of sea buckthorn by-products as natural antioxidants in food systems. The composition and antioxidant potential of sea buckthorn pomace extracts depend largely on the extraction technique and solvent used. Extraction is a fundamental step in analytical processes and subsequent product development. Since ancient times, humans have been searching for methods of extracting valuable compounds from natural resources.

Hydroalcoholic extraction systems are particularly effective at recovering phenolic compounds, resulting in extracts with greater antioxidant activity than those obtained using pure solventsConversely, non-polar extraction methods and supercritical CO_2 technologies are better suited to the selective recovery of lipophilic compounds, such as carotenoids and phytosterols. Under optimised conditions, supercritical extraction can produce fractions with distinct phytochemical compositions and enhanced biological activities, including antioxidant and antimicrobial effects.

The use of emerging green technologies, particularly ultrasound-assisted extraction, has improved the efficiency with which bioactive compounds are recovered from sea buckthorn by-products, reducing processing time and enhancing extraction yield. These techniques also allow edible oils to be enriched with carotenoids, facilitating the production of sustainable, clean-label food products. As well as pomace, sea buckthorn seeds are a valuable but under-explored source of antioxidants. Seed extracts, particularly those obtained using polar solvents, demonstrate potent antioxidant and antibacterial properties while remaining stable during thermal processing.

Conclusions

Sea buckthorn by-products, particularly the pomace and seeds, are a valuable source of natural antioxidants and have significant potential for use in sustainable food production. Advanced extraction technologies improve the recovery of bioactive compounds, enabling the production of clean-label, functional and nutraceutical products that offer enhanced health and preservation properties.