GreenChem-26

ABSTRACTS E-BOOK

7th International Conference on Green Chemistry and Sustainable Engineering



Gran Canaria,
Canary Islands, Spain

22–24 July 2026

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www.greenchem-europe.eu

ISBN: 978-84-09-89343-0

Edited by **Sciknowledge Education**



Publication Information

Item	Details
Conference	7th International Conference on Green Chemistry and Sustainable Engineering (GreenCHEM-26)
Dates	22-24 July 2026
Venue	Gran Canaria, Canary Islands, Spain
Organizer	Sciknowledge Education
Website	https://greenchem-europe.eu/
ISBN	978-84-09-89343-0

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The abstracts included in this volume were submitted by the corresponding authors for presentation at GreenCHEM-26. The content, data, results, figures, references and scientific claims remain the sole responsibility of the authors. The Organizing Committee has performed editorial formatting and minor language corrections where necessary, without altering the scientific meaning of the contributions.

Recommended citation

Author(s). Title of the abstract. In: Abstracts Book of the 7th International Conference on Green Chemistry and Sustainable Engineering (GreenCHEM-26), Gran Canaria, Canary Islands, Spain, 22-24 July 2026, p. XX.

106 · Poster Presentation

Sustainable deep eutectic solvent extraction: isolation, structural characterisation and application of rapeseed proteins in food systems

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1. Introduction – The development of sustainable plant protein systems requires not only alternative biomass sources but also a detailed understanding of structure-function relationships governing their behaviour in complex food matrices. Rapeseed cake, a major by-product of edible oil production, represents an abundant and underutilised protein-rich resource with a favourable essential amino acid profile and high levels of sulphur-containing amino acids [1]. Valorisation of this side stream aligns with circular bioeconomy principles and waste-prevention strategies. However, conventional protein isolation from rapeseed cake relies on highly alkaline processing (pH ≥ 12), which enhances extraction efficiency but may induce irreversible conformational changes, protein fragmentation, and functional alterations that ultimately affect matrix interactions, aroma-binding capacity, and sensory performance in formulated foods [2]. From a green chemistry perspective, the replacement of chemically harsh extraction conditions with safer, tunable solvent systems is highly desirable. Deep eutectic solvents (DES) have emerged as promising green extraction media due to their low toxicity, biodegradability, negligible volatility, and capacity for rational solvent design through hydrogen-bond interactions [3]. Their compositional flexibility enables targeted modulation of solvent polarity, hydrogen-bonding capacity, and pH, allowing controlled extraction under reduced chemical severity while minimising structural disruption and preserving protein assemblies relevant for flavour-matrix interactions.

2. Experimental – In this study, protein isolates were obtained from defatted rapeseed cake using three extraction approaches: alkaline extraction at pH 12 and two deep eutectic solvent systems, choline chloride:urea (1:2 molar ratio, 10% water; pH 7.60) and betaine:citric acid (1:1 molar ratio, 20% water; pH 2.45). Extractions were performed at 60 °C with ultrasound assistance, followed by centrifugation, ethanol precipitation, washing, and freeze-drying. Protein yield and purity were determined, and structural properties were evaluated by FTIR spectroscopy together with amino acid and techno-functional analyses

3. Results and Discussion – Alkaline extraction achieved the highest protein recovery (36.9%), followed by DES2 (31.2%) and DES1 (23.2%). However, DES1 yielded the highest protein purity (95.8% on a dry matter basis), exceeding alkaline extraction (86.0%) and DES2 (70.3%). FTIR spectroscopy revealed pronounced conformational alterations and broader molecular weight distribution under alkaline conditions, whereas DES systems, particularly DES1, preserved higher-order protein assemblies such as cruciferin oligomers. Amino acid profiling confirmed a balanced composition across isolates, with enhanced preservation of sulphur-containing amino acids in DES-based systems. The improved structural preservation translated into favourable techno-functional properties, confirming the relevance of solvent-driven structure-function relationships in plant protein systems.

Importantly, the isolates were successfully incorporated into model food matrices, including omega-3-enriched pâté, crackers, and protein-enriched spreads. The results indicate that extraction-induced structural differences modulate matrix organisation and may influence flavour retention, release dynamics, and overall sensory perception, providing a physicochemical foundation for understanding protein-driven flavour behaviour in complex systems.

4. Conclusions – Deep eutectic solvents offer sustainable alternatives to harsh alkaline extraction for rapeseed protein isolation. DES systems, particularly choline chloride:urea, enabled high-purity protein recovery with improved structural preservation and favourable functional performance in food matrices. Beyond techno-functional attributes, maintaining higher-order protein organisation may contribute to controlled flavour interactions within complex matrices. This approach supports circular biomass valorisation while aligning with Green Chemistry principles of safer solvent design and reduced chemical severity, providing a sustainable platform for advanced plant protein integration with flavour-relevant functionality in food systems.

5. Acknowledgement - This research was funded by the Ministry of Science, Technological Development and Innovation, Republic of Serbia (Contract No. 451-03-33/2026-03/200222). The author participates in COST Action CA22161 FLAVOURsome (Future of plant-based food: Bridging the gap of new proteins and FLAVOURsome).

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