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Editorial

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Application of High Power Ultrasound and Microwave in Food Processing: Extraction

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Ultrasound is defined as sound waves having frequency that exceeds the hearing limit of the human ear (~20 kHz). Ultrasound is one of the emerging technologies that were developed to minimize processing time, cost of processing, maximize quality and ensure the safety of food products [1]. Ultrasound is applied to improve positive effects in food processing such as improvement in mass transfer, food preservation, etc. High power (high energy, high intensity) ultrasound operates at frequencies between 20 and 500 kHz, and intensities higher than 1 W.cm^{-2} which are disruptive and induce effects on the physical, mechanical or chemical (biochemical) properties of foods.

The propagation of ultrasound through a material induces compressions and decompressions (rarefactions) of the medium particles, which imparts a high amount of energy. High power ultrasound with frequency higher than 20 kHz has mechanical, chemical and/or biochemical effects, which are used to modify the physicochemical properties and enhance the quality of various food systems during processing. High power ultrasound can be applied using sonication baths or ultrasonic immersion probes with different lengths, diameters and tip geometries depending on applications. These effects are promising in food processing, preservation and safety. This emerging technology has been used as alternative to conventional food processing operations for facilitating the extraction of various food and bioactive components, accelerated drying and modifying of textural characteristics of starch, fat products (sonocrystallization), emulsification, defoaming, modifying the functional properties of different food proteins, depolymerisation, inactivation or acceleration of enzymatic activity to enhance shelf life and quality of food products, microbial inactivation, freezing, thawing, freeze drying and concentration etc [1-5].

High power ultrasound has opportunity to be used as tool for extraction [6-10]. The first Soxhlet extraction assisted by ultrasound, named Ultrasound-Assisted Soxhlet (UASE) was developed in 2004 by Luque de Castro et al. Another innovative method for ultrasound assisted extraction was developed by Chemat et al. System for oil extraction, named Sono-Soxhlet system was developed by inserting an ultrasonic probe directly into the extraction chamber, i.e. ultrasound is applied directly in the extraction reactor. The lipid extracts obtained from the Sono-Soxhlet process are qualitatively the same as conventional process, and time for extraction is significantly reduced, requiring 30 minutes vs. conventional 8 h.

On the other hand, there is also promising technique of using microwaves for food processing. Microwaves are largely used in food industries for drying, pasteurization, sterilization, thawing, tempering, baking and so on. Microwaves are electromagnetic waves whose frequency varies within 300 MHz to 300 GHz. Domestic microwave appliances operate generally at a frequency of 2.45 GHz, while industrial microwave systems operate at frequencies of 915 MHz and 2.45 GHz [6].

Microwave heating is caused by the ability of the materials to absorb microwave energy and convert it to heat. Microwave heating of food materials mainly occurs due to dipolar and ionic mechanisms. Presence of moisture or water causes dielectric heating due to dipolar nature of water. When an oscillating electric field is incident on the water molecules, the permanently polarized dipolar molecules try to realign in the direction of electric field [11-16].

Several techniques of extraction, such as supercritical fluid extraction (SFE), ultrasound-assisted extractions (UAE) and microwave-assisted extraction (MAE) have been proposed. Microwave irradiation (MW) could be applied at different stages; during solvent extraction (microwave-assisted solvent extraction, MASE), directly, to heat up a solvent to aid HD (microwave-assisted HD) for direct solvent-free extraction (solvent-free microwave extraction, SFME), or combined with ultrasound extraction (US) (Cravotto et al.). The latest innovative technique is microwave-assisted hydrodiffusion and gravity (MHG), which allows the extract to be collected for it to simply drop, thanks to the force of earth's gravity, out of the MW reactor into the collector flask. Microwave-assisted extraction (MAE) is a novel and green extraction technique that can offer high reproducibility in shorter time, simplified manipulation, reduced solvent consumption and lower energy input without decreasing the extraction yield of the target species. As a new-type extraction technique, MAE is known as a more environmental-friendly process with economic advantages than the traditional extraction methods [6,7,11-16].

References

1. Mason TJ, Chemat F, Vinatoru M (2011) The Extraction of Natural Products using Ultrasound or Microwaves. Curr Org Chem 15: 237-247.
2. Virot M, Tomao V, Ginies C, Chemat F (2008) Total Lipid Extraction of Food Using d-Limonene as an Alternative to n-Hexane. Chromatographia 68: 311-313.
3. Luque-Garcia JL, Luque de CMD (2004) Ultrasound-assisted Soxhlet extraction: An expeditive approach for solid sample treatment: Application to the extraction of total fat from oleaginous seeds. J Chromatogr A 1034: 237–242.
4. Suslick KS, Hammerton DA, Cline RE (2001) Sonochemical hot spot. J Am Chem Soc 108: 5641-5642.
5. Vinatoru M (2001) An overview of the ultrasonically assisted extraction of bioactive principles from herbs. Ultrason Sonochem 8: 303-313.
6. Cravotto G, Cintas P (2007) Extraction of flavourings from natural sources. In: Modifying flavour in food. Woodhead Publishing Limited.

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7. Cravotto G, Boffa L, Mantegna S, Perego P, Avogadro M, et al. (2008) Improved extraction of vegetable oils under high-intensity ultrasound and/or microwaves. Ultrason Sonochem 15: 898-902.

8. Bousbia N, Abert-Vian M, Ferhat MA, Petitcolas E, Meklati BY, et al. (2009) Comparison of two isolation methods for essential oil from rosemary leaves: Hydrodistillation and microwave hydrodiffusion and gravity. Food Chem 114: 355–362.

9. Besombes C, Berka-Zougali B, Allaf K (2010) Instant controlled pressure drop extraction of lavandin essential oils: Fundamentals and experimental studies. J Chromatogr A 1217: 6807–6815.

10. Chemat S, Lagha A, AitAmar H, Bartels PV, Chemat F (2004) Comparison of conventional and ultrasound-assisted extraction of carvone and limonene from caraway seeds. Flavour Fragr J 19: 188–195.

11. Milestone and the Université d'Avignon et des Pays de Vaucluse, France, European patent EP 1 955 749 A1.

12. Chemat F (2009) Essential oils and aromas: Green extractions and Applications, Dehradun: HKB Publishers.

13. Vian MA, Fernandez X, Visinoni F, Chemat F (2008) Microwave hydrodiffusion and gravity, a new technique for extraction of essential oils. J Chrom A 1190: 14-17.

14. Daghero P, Cravotto G (2011) Patent Pending.

15. Grossner MT, Feke DL, Belovich JM (2005) Single-collector experiments and modeling of acoustically aided mesh filtration. AIChE 51: 1590-1598.

16. Virot M, Tomao V, Colnagui G, Visinoni F, Chemat F (2007) New microwave-integrated Soxhlet: an advantageous tool for the extraction of lipids from food products. J Chrom A 1174: 138-144.