IL-2: Some Applications of Ultrasound in Extraction Technology

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A quick search on a database containing publications from science journals and edited books using the simple keywords of ultrasound and extraction resulted in a wealth of information regarding food processing. Extraction of active and target molecules from natural products is a very important area for many pharmaceutical and chemical industries. Ultrasound has been proven to be an effective low temperature method of extraction for a wide variety of products. These areas will be examined alongside the possibility of large scale extraction processes for scale up.

1. Extraction for Food Processing

This area is well established with ultrasound being used to extract a range of natural products for a variety of purposes. It is well known that the cavitation effects of ultrasound are particularly beneficial for low temperature extraction and also result in efficient mixing of solvent and solid materials. This is particularly useful for natural products which can often degrade or denature on heating and is also beneficial to processing on a large scale simply because of the economic benefits resulting from low temperature processes. As far back as 1963 papers were being published on the continuous extraction of natural products from various plants using a simple ultrasonic bath (Lott, Demaggio 1963). Since those early days a whole range of products and materials have been extracted using various types of ultrasonic systems. Much more recently (Achat et al. 2012) used ultrasound to enrich olive oil with oleuropein both on a laboratory and pilot plant scale. They were able to enhance extraction of the target phenolic compounds above those obtained using conventional methods. (Gaete-Garretón et al. 2011) used ultrasound to extract bioactive principles from the chips of branches and the bark of the Quillaja Saponaria Molina. Ultrasound was shown to enhance the extraction ratio alongside a reduction in extraction time. (Sivakumar, Vijaeeswarri & Anna 2011) have also used ultrasound to extract natural dyes from different plant materials. They indicated a significant improvement of dye extracted (up to 100% enhancement) using ultrasound from plants such as green wattle bark, pomegranate rinds and marigold flowers. (Shirsath, Sonawane & Gogate 2012) recently published a comprehensive review investigating the extraction of natural products using ultrasound. Target molecules covered range from phenol based natural products, medicinal compounds to natural dyes and pigments. Other people have taken a different approach in using ultrasound to extract natural oils from algae for use in biofuels with once again ultrasound proving itself to be very beneficial in the extraction process (Šoštarič et al. 2012, Prabakaran, Ravindran 2011, Araujo et al. 2011).

2. Extraction of Medicinal Agents

The advantage of ultrasound is that it is clearly able to enhance extraction at lower temperatures thus aiding the perception of a greener more economical process and reducing costs attributed to heating, necessary for most extraction processes. In addition to enhanced extraction at lower temperatures is the additional advantage of ultrasound being able to extract wanted materials over and above the unwanted contaminants which are often extracted at higher temperatures alongside the target molecules. This allows ultrasound to aid in the purification of the extracts by producing a less contaminated crude product in the first place. This is evidenced clearly in the work involving extraction of the anti-malerial active component artemisinin from the Artemisia annua plant (Paniwnyk & Briars 2012), the production of medicinal tinctures from the roots of the valerian plant (Hromádková, Ebringerová & Valachovič 2002) and the use of ultrasound in the production of medicinal tinctures (Valachovic, Pechova & Mason 2001) are some examples.

3. Possibility for Scale Up

There is a range of equipment available to scale up extraction processes. However the first decision must be the frequency to use for the process requirement. Lower frequencies such as 20 and 40 kHz are most beneficial for extraction if a physical, mechanical extraction process is required. Higher frequencies such as 850 kHz appear to be beneficial for oxidative effects. Equipment ranges from simple small scale baths and probes to larger scale extraction devices dealing with 30L to 1000L as batch bath type systems (Chemat, Zill-E-Huma & Khan 2011).

The range of materials that benefit from ultrasonic extraction is vast. It has been shown to increase yields, reduce processing times and provide a cleaner crude extract thus reducing both treatment times and post-treatment purification processes. With a range of ultrasonic equipment now available for scale up industry is now seriously considering the use of ultrasound as a real process to enhance their own existing practices.

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