Journal of Food Processing & Technology
ISSN: 2157-7110

Ciftci, J Food Process Technol 2012, 3:7
DOI: 10.4172/2157-7110.1000e105

Editorial Open Access

Supercritical Fluid Technology: Application to Food Processing

Ozan Nazim Ciftci*

Department of Agricultural, Food and Nutritional Science, University of Alberta, Alberta, Canada

Global trends show that 'green' products and technologies are needed. Increasing environmental concerns, government measures and population growth drive the search for 'green' processes to replace the conventional ones. One area where 'green' processes can potentially find several applications is the food processing and technology. But, is SFT is a promising alternative technology for food industry?

Major driving forces for the use of 'green' technologies in the processing of foods are the increasing environmental concerns and increasing health conscious among consumers. Developing alternative 'green' technologies and products is necessary for a sustainable processing, reduced energy use and environmental pollution, and a healthier society. SFT has received growing interest as a 'green' alternative technology in the food industry. Fluids become supercritical by increasing pressure and temperature above their critical point. Supercritical fluids have liquid-like solvent power and gas-like diffusivity. These physical properties make them ideal clean solvents for processing of natural materials. Carbon dioxide (CO_2) is the most widely used supercritical fluid due to a lack of toxicity and flammability, low cost, wide availability, tunable solvent properties, and moderate critical temperature and pressure (31.1°C and 7.4MPa). Moreover, separation of CO_2 from the product can easily be achieved by reduction of pressure, because the products do not dissolve in CO_2 at atmospheric pressure. Another unique property of supercritical fluids is their selectivity. Extraction selectivity of supercritical fluids can be changed altering density which is done by adjusting pressure and temperature. Selectivity can also be changed by the addition of a co-solvent such as ethanol, methanol, hexane, acetone, chloroform and water to increase or decrease the polarity. Ethanol is the most preferred co-solvent because it is non-toxic and meets 'green' technology criteria. Processing with SC-CO_2 has many advantages: No thermal degradation, better shelf life due to co-extraction of natural antioxidants, higher purity due to the adjustable selectivity, no residual solvent, selective fractionation, and fewer processing steps. Oxidation of sensitive compounds is also prevented due to absence of oxygen in the medium. SC-CO_2 processing adds value because products obtained may be considered as natural [1].

Extraction is the most common application of SFT in food industry. SC-CO_2 extraction has found application in the industry, and today there are several products in the markets processed with SC-CO_2. Unusual vegetable oils such as wheat germ oil, green coffee oil, rice bran oil or crude palm oil, essential oils, fatty acids, phospholipids and bioactive compounds have been extracted from fruits and vegetables using SC-CO_2. Fractionation and purification are also viable applications of SFT in food industry. Fractionation of fish oils with SC-CO_2 to obtain omega-3 enriched fractions is possible. SC-CO_2 with water as co-solvent can be employed to selectively extract caffeine from coffee and green tea while avoiding the extraction of antioxidants. Supercritical extraction has been also widely used to add value to by-products of food industry. Extraction of by-products allows the removal of valuable compounds. These include extraction of polyphenols from rice wine lees [2] and pomegranate seeds from juice production [3], and extraction of carotenoids from tomato [4] and Sea buckthorn pomaces [5].

Even though SFT offers clear advantages over traditional ones, high cost of the high pressure equipment can be thought as an obstacle to industrial scale commercialization of supercritical processes. A safety risk due to high pressures is another concern. However, operating the supercritical systems with trained staff decreases the safety risks to a minimum. Processing cost of the process could be decreased to lower levels than that of traditional ones. One of the main aspects that should be considered to decrease the processing cost is the optimization. Optimization of the process variables could significantly increase the yields and shorten the process time. The cost of large capacity supercritical plants with optimized design and operation could be comparable to that of conventional process [6]. Elimination of the energy consumption needed to evaporate the organic solvents and fewer processing steps reduces the operating costs of extraction processes significantly. One of the ways to make the extraction processes economically feasible is the extraction of feed materials at higher pressures and temperatures and using co-solvents to extract most of the compounds, and then fractionate the extract to obtain different classes of high value fractions. Consumer acceptability is also a very important factor that will accelerate the industrialization of supercritical processes. Marketing and informing consumers about the advantages of supercritical processing will increase the consumers' acceptability to buy natural products processed with environmentally friendly processes. Coupling SFT with other processes to produce novel methods to simplify the current methods that require many processing steps and energy is another way to make it economically feasible. One promising application may be coupling SFT and membrane technology for purification and fractionation purposes. Another promising application is coupling SC-CO_2 and enzymatic processes [7]. Biosynthesis in supercritical fluids is a relatively new 'green' technology attracting attention. Because of the relatively low viscosity, high molecular diffusivity and low surface tension of the system, mass transfer is improved in SC-CO_2 in comparison to liquid organic solvents, which in turn results in high reaction rates. Use of SC-CO_2 as a medium for enzymatic reactions eliminates the need of toxic organic solvents, especially for lipid modifications, and reduces the need for downstream to a minimum. Continuous operations will definitely help to reduce the operating costs. Even though there are some semi-continuous designs for intermittent loading of the feed through a lock-hopper vessel, continuous operations are not fully developed yet. Therefore, most commercial supercritical extraction plants employ batch extractors.

***Corresponding author:** Ozan Nazim Ciftci, Department of Agricultural, Food and Nutritional Science, University of Alberta Edmonton, Alberta, Canada, Tel: 780-492-6946; Fax: 780-492-4346; E-mail: ciftci@ualberta.ca

Received June 30, 2012; **Accepted** July 02, 2012; **Published** July 04, 2012

Citation: Ciftci ON (2012) Supercritical Fluid Technology: Application to Food Processing. J Food Process Technol 3:e105. doi:10.4172/2157-7110.1000e105

In conclusion, the answer of the question is "yes". Supercritical technology is a promising alternative technology with a bright future. Current interests indicate that we will see more products on the shelves of our markets processed with supercritical technology. Ongoing researches will also help us to better understand the full potential of supercritical technology. Research on fundamentals of the supercritical processes is crucial for a better understanding of the supercritical processes which will help to develop novel processes and equipment, and that will help to widen the application areas and to reduce the processing costs.

References

1. Dunford NT (2004) Utilization of supercritical fluid technology for oil and oilseed processing. In: Nutritionally enhanced edible oil and oilseed processing. AOCS Press, Champaign, IL.
2. Wu JJ, Lin JC, Wang CH, Jong TT, Yang HL, et al. (2009) Extraction of anti-oxidative compounds from wine lees using supercritical fluids and associated anti-tyrosinase activity. J Supercrit Fluids 50: 33-41.
3. Abbasi H, Rezaei K, Emamdjomeh Z, Mousavi SME (2008) Effect of various extraction conditions on the phenolic contents of pomegranate seed oil. Eur J Lipid Sci Technol 110: 435-440.
4. Shi J, Yi C, Xue SJ, Jiang Y, Ma Y, et al. (2009) Effects of modifiers on the profile of lycopene extracted from tomato skins by supercritical CO_2. J Food Eng 93: 431-436.
5. Cossuta D, Simandi B, Hohmann J, Doleschall F, Keve T (2007) Supercritical carbon dioxide extraction of sea buckthorn (*Hippophae rhamnoides* L.) pomace. J Sci Food Agric 87: 2472-2481.
6. Temelli F (2009) Perspectives on supercritical fluid processing of fats and oils. J Supercrit Fluids 47: 583-590.
7. Ciftci ON, Temelli F (2011) Continuous production of fatty acid methyl esters from corn oil in a supercritical carbon dioxide bioreactor. J Supercrit Fluids 58: 79-87.