Valorization of apple pomace with the use of Supercritical CO_2

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1. Introduction

The world production of waste is estimated around 2 billion of tons annually but only 13.5% is either recycled or valorized. In this global waste, 44% are represented by food and greens. Apple is one of the most consumed fruit worldwide, about 70 million of tons per year (2017). The upcycling of apple residue called pomace can be of interest, as it can help to reduce the environmental impact of food industries, to obtain bioactive compounds with high added value such as polyphenols (phloridzin, phloretin)[1,2] and lipophilic compounds (ursolic acid, erythrodiol, oleic acid, linolenic acid)[3–5]. These compounds, especially for the lipophilic part, can be obtained from apple pomace with supercritical CO_2 extraction, known to be a promising green technique for high added-value extracts.

The main objectives of this study are to determine the best conditions of extraction of compounds from apple pomace with supercritical CO_2 (Sc-CO_2) or pressurized liquids, to develop an integrated method of extraction and to create a method applicable at industrial scale.

2. Materials and Methods

Sc-CO_2 extraction: The pomace is freeze-dried, grinded and sieved to obtain a mean particle size of 400 µm. The biomass is then treated with Sc-CO_2 at P: 200 - 400 bar and T: 35 – 55 °C during 90 min at 0.14 kg/h. The moisture content of the samples is between 3 - 5%. The extracts are stored at -19°C until analysis.

Figure 1. Sc-CO_2 apparatus (lab-scale)

Soxhlet extraction: 10g of the freeze-dried and grinded pomace, are mixed with 150 mL of solvent (hexane or a mixture of ethanol/water; 50 :50; w: w), during 8h under the boiling point of the solvent. The extracts are passed through a rotavapor to remove the organic solvent and a freeze-drier (for the water part) and stored at -19°C until analysis.

Analysis: GC-MS and LC-MS for qualitative and quantitative analysis.

3. Results and discussion

The extraction kinetics for apple pomace were obtained at 400 bar, 60°C, with a flow rate of 0.14 kg/h. The average mass loss obtained is about 9% of a waxy extract (Figure 2), which is above the main results obtained with apple pomace extraction[4]. These preliminary results are promising regarding the yields already published on apple pomace in similar studies with Sc-CO_2.

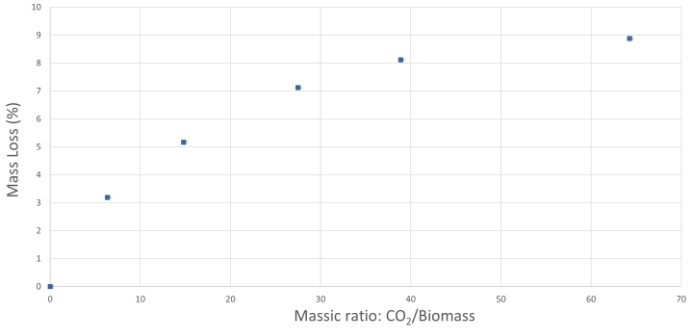

Figure 2. Kinetics of extraction for apple pomace with Sc-CO_2 (60°C, 400 bar)

Besides these results, a qualitative analysis has been done for the obtained extracts, and several compounds of interest were identified in the CO_2, hexane and EtOH: H_2O extracts. The compounds identified in CO_2 extracts and their potential applications are presented in Table 1.

LC-MS analysis of CO_2 extract from apple pomace, France (400 bar and 60°C)			**Also in hexane extract**	**Also in EtOH : H_2O**
Molecules	**% massic ratio in the extract**	**Possibles applications (data from literature)**		
Ursulolactone	20	Surfactant, emulsifier, membrane stabilizer, nutrient, energy source, energy storage		
Linolenic acid	21	Essential fatty acid, soothing	x	
(+)-erythrodiol	9	Soothing, antioxidant	x	x
Arachidic acid	6	Emollient, thickening agent		
Ethyl palmitate	4	Hair and skin conditioning agent		
Ursolic acid	3	antimicrobial, Soothing	x	
Betulinic aldehyde	3	Tyrosinase inhibitory effects	x	
Docosadienoate	3	Nutrient, energy storage, energy source, membrane stabilizer		
Oleic acid	3	Soothing, prevents from wrinkles and lines		
3-O-cis-Coumaroylmaslinic acid	2	Surfactant, emulsifier, membrane stabilizer, nutrient, energy source, energy storage		
Unknown compounds	26			

4. Conclusions

These preliminary results show the use of Sc-CO_2 as an interesting green technique to valorize lipophilic compounds of apple pomace. The next step will be to study the addition of co-solvents (such as ethanol or water) applied directly on the pomace and on the Sc-CO_2 extraction residue for the obtention of the hydrophilic part of the biomass.

References

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