EXTRACTION OF CAROTINOIDS WITH SUPERCRITICAL CO_2

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1 INTRODUCTION

"We live in a world of mixtures - the air we breathe, the food we eat, the gasoline in our automobiles ...:" [1]. Therefore raw materials as well as synthetic products have to be separated into desired and undesired components for further use. Since 1979 CO_2 as solvent for the separation of high-graded products at moderate conditions has been used at NATECO$_2$.
With the help of supercritical CO_2 NATECO$_2$ produces- amongst a variety of other things- hop- extracts, decaffeinated tea and defatted cocoa. Design pressures of the production plants are below 350 bars. With ascending pressure the density as well as the dielectric constant of CO_2 is increasing. Thus the solubility for different substances is rising and molecules, which are difficult to dissolve at lower pressure, are present in the extracts then. So higher pressure enables the extraction of high grade and expensive specialties. One example is the extraction of the anticancerogenic Polyphenol Xanthohumol from hops at approx. 800 bars.
Also the extraction of carotinoids with CO_2 in an effective and economical way is possible at higher pressures. Carotinoids have many physiological functions. They are efficient free-radical scavengers and enhance the vertebrate immune system.

2 MATERIAL AND METHODS

The poster demonstrates the applications for the production of extracts with high concentrations of carotinoids out of different raw materials by the use of supercritical CO_2 (Fig. 1):

Raw Materials	Carotinoids
Marigold	Lutein/ β-Carotene
Red Algae	Astaxanthin
Tomato Skins	Lycopene
Maize	Zeaxanthin
Carrots	α/β-Carotene

For the test series a CO_2-plant with a design pressure of 1000 bars and a volume of the extraction basket of 2 l was used. The flow sheet of the plant is presented in figure 2. To reach a high yield, extraction pressures were varied from 100 to 800 bars and temperatures from 40 to 80 °C.
The carotinoid content of the raw materiel and extracts has been analyzed with HPLC.

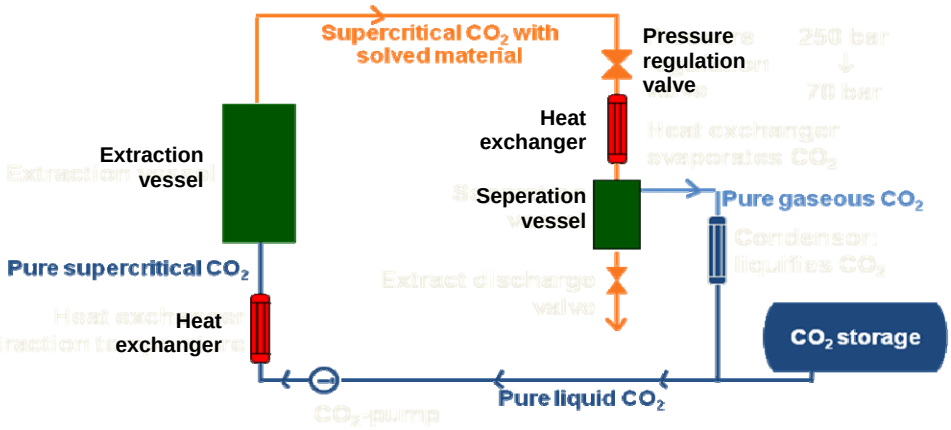

Fig. 2: Flow sheet of the CO_2-extraction plant

3 RESULTS

During the whole extraction process the absence of oxygen and the moderate temperature protect the sensible, carotinoide-rich extracts in an excellent way. Also the remaining content of CO_2 in the extract, after filling the products from the extraction plant into the final packaging, builds a protective atmosphere and avoids oxidation.

Yields up to 90-95 % related to the carotinoid content in the raw material can be reached with an economical CO_2 quantity.
The belonging poster presents detailed information about the extraction conditions and the resulting carotinoid contents. Two examples are sorted out:

By optimizing the milling process and the parameters during the CO_2-extraction, enrichment from approx. 4 % of Astaxanthin in the raw material up to 14 % in the extract is achievable. Nearly no Astaxanthin could be detected in the algae residues after extraction.

The Lutein content in Marigold is approx. 1,8 g/kg. Through CO_2- extraction the content of Lutein in the extracted material was enriched to approx. 30 % provided the optimal parameters are chosen.

With the applied parameters the recovery of valuable, high stable red carotinoid-extracts is feasible.

4 CONCLUSIONS

With higher pressures the extraction of carotinoids with supercritical CO_2 becomes effective and economic. The resulting products are mostly applied as additives in functional food. Up-scaling to small-scale-productions has already been performed successfully at NATECO$_2$. For this purpose a plant with an extraction volume of 50 l and pressures up to 1000 bars exists in the facility. Two separators allow the manufacturing of two fractions with different carotinoid contents in one extraction step. Also procurement for an additional plant with an extraction volume of 3 x 1 m³ is ongoing at the moment.

[1] Prausnitz, J.M. Molecular Thermodynamics of Fluid-Phase Equilibria. Prentice-Hall, Engelwood Cliffs, N.J. Library of Congress Catalog Card NO. 69-16866