# Extraction of active ingredients using supercritical $CO_2$

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## 1 Introduction

Solvents are usually inorganic or organic liquids which are able to extract other gaseous, liquid or solid substances from a mixture. Moreover inert gases are conceivable as solvents. To be effective as a solvent a liquid like density has to be induced at increased pressures. Especially for the separation of sensitive functional substances for pharmaceutical purposes or for foodstuff the gentle extraction process with supercritical $CO_2$ is applied.

## 2 $CO_2$-Extraction

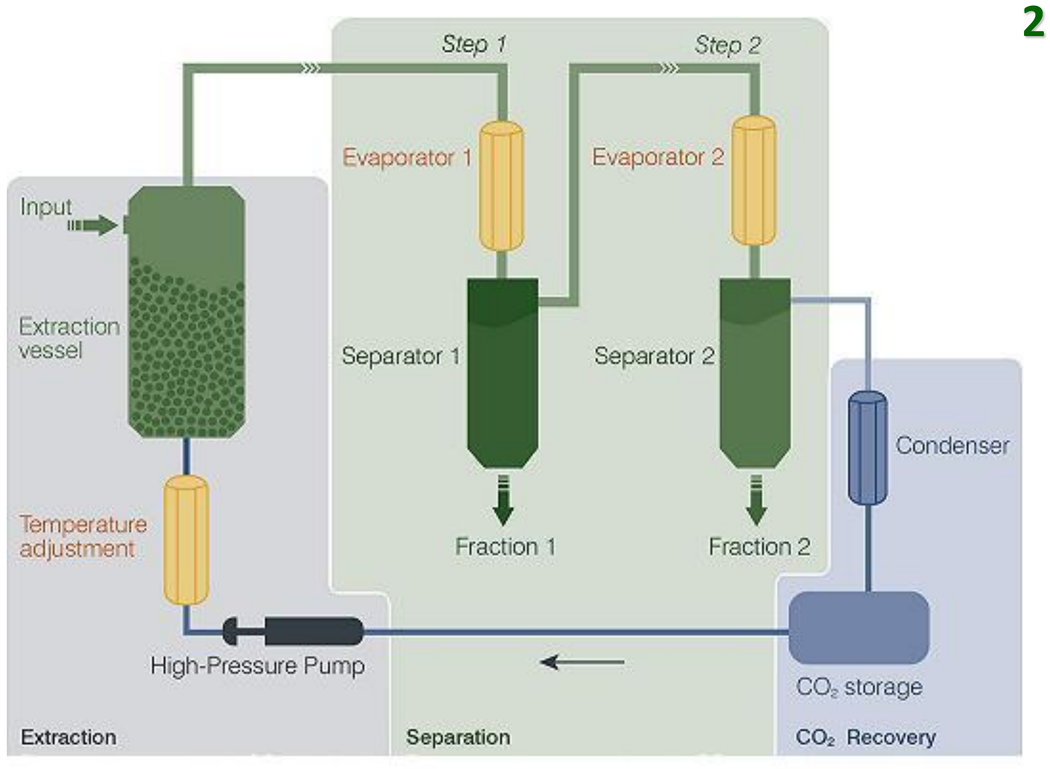


Fig. 1: Technical chart of a $CO_2$ extraction plant

To generate supercritical $CO_2$, liquid $CO_2$ is pressurized with a pump and heated up in a heat exchanger. Then the supercritical solvent is loaded with soluble substances after flowing through the extractor, which is charged with biomass. Subsequently the pressure is reduced, the extracts precipitate into separators and the $CO_2$ reverts to a vapour and is recycled.

Extraction with supercritical $CO_2$ is distinguished by a multifold of benefits:

- No residues of organic solvents remain in the products.
- The process is suited for sensitive products by applying moderate temperatures in an oxygen free atmosphere.
- The solvent $CO_2$ is neither combustible nor explosive and is available in large quantities at reasonable conditions.
- In one extraction step different extracts can be produced by fractionationated separation.

## 3 Extraction of Active Ingredients

### Hops and Xanthohumol

Fig. 2: Hop Cones

Xanthohumol is a specific Polyphenol of hops which possess anticancerogenic properties. Due to its abilities Xanthohumol could be used as preventive substance against some cancer species in the near future. But the solubility of Xanthohumol in water (similarly in beer) is very low. Thus only concentrates offer the possibility to act therapeutically. A special $CO_2$ extraction and filtration process generates extracts with up to 80 % of Xanthohumol.

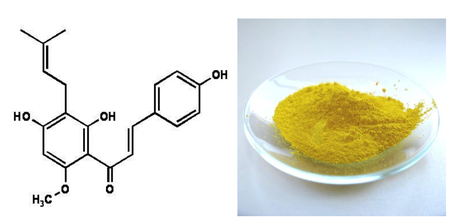


Fig. 3: Xanthohumol

### Algae and Astaxanthin

Fig. 4: Haematococcus Pluvialis

The fresh water alga Haematococcus Pluvialis comprises 2-4 % of the carotenoid Astaxanthin. Astaxanthin is a highly effective antioxidant requiring an oxygen free atmosphere during handling of the sensitive material. Consequently the enrichment of Astaxanthin with $CO_2$ provides the appropriate method. By applying pressures over 700 bar dark red oleoresins with 10-14 % of Astaxanthin are created.

Fig. 5: Astaxanthin Oleoresin

### Pepper and Piperine

Fig. 6: Pepper

Pepper conjures flavour and piquancy into meals. The initiators are essential oils and spicy substances. Pepper contains 1-4 % of oil and 5-10 % of piperine. As the solubility of the two substances in $CO_2$ differs significantly, aroma and hot components can be separated into two fractions by a commercial $CO_2$-extraction-process. Frequently the extracts are implemented to optimise aroma and flavour of standardised products.

Fig. 7: Pepper Oil and Piperine

### Saw Palmetto and Phytosterols

Fig. 8: Saw Palmetto Berries

Saw Palmetto grows in the south-east of the USA. The berries of the small palms consist of a particular high proportion of free fatty acids and phytosterols. By $CO_2$ extraction these components are enriched in a pleasant dark yellow to orange oil. The oil is added to nutraceuticals and is effective in preventing prostate hyperplasia.

Fig. 9: Sabal Oil

## 4 Conclusions

By its multiple advantages of moderate temperatures, absence of oxygen and organic solvents, production of different fractions in a single step $CO_2$ extraction is convenient for separating active substances. The extracts and also the residues are mainly applied as additives in food, cosmetics or pharmaceuticals. There are a multitude of additional examples of active ingredients engendered by $CO_2$ extraction.