

# CO<sub>2</sub> APPLIED TO COMMERCIAL EXTRACTION OF PEPPER: PERFORMANCE AND ECONOMICS

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## 1 INTRODUCTION

Pepper conjures flavour and piquancy into foodstuffs. The initiators are essential oils and spicy substances. Pepper contains some 1-4 % of oil and 5-10 % of Piperine. As the solubility of the two substances in CO<sub>2</sub> is significantly different, aroma and hot components have been separated into two fractions by a commercial CO<sub>2</sub>-extraction-process at NATECO<sub>2</sub>.

The poster presents the benefits, performance and economics by extracting different varieties of pepper with CO<sub>2</sub>.

## 2 MATERIAL AND METHODS

Black and white pepper grains were crushed by cold grinding with a hammer mill. Extraction with supercritical CO<sub>2</sub> was performed in a plant comprising three extraction vessels of 500 l each. The principal flow sheet of a CO<sub>2</sub> extraction plant is demonstrated in figure 1.

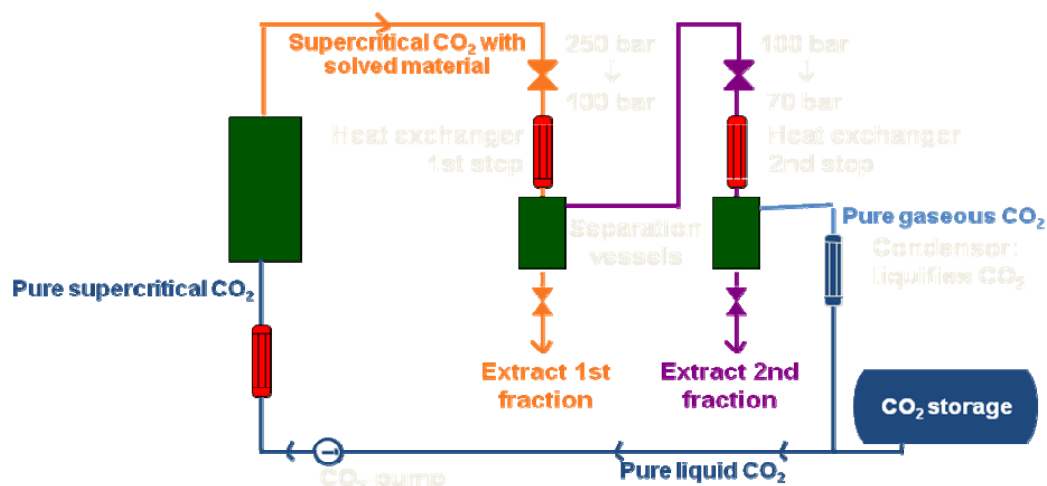


Figure 1: Flow sheet of a CO<sub>2</sub>-extraction plant for pepper

The total amount of extractable quantity in the raw material was analyzed by a Soxhlet extraction with Dichloromethane. In the extracts the Piperine concentration was determined spectro-photometrically at 304 nm and the oil content was established by a volumetric analysis.

### 3 RESULTS

#### 3.1 Performance of the extracts

Applying CO<sub>2</sub> as extraction solvent for pepper offers multiple advantages.

- By adjusting the extraction and separation parameters (fig. 1) high yields can be realised. Thus more than 90 % of the extractable material (compared to extraction with Dichloromethane) is recovered. The yield of the spicy constituent even sums up to 95 %.
- Frequently extracts are implemented to standardize products. Also the two different fractions of pepper enable an accurate standardization of products concerning flavour and piquancy.
- Quality and intensity of the essential oils and the spicy fraction at the CO<sub>2</sub> process is excellent. Consequently the required amount of CO<sub>2</sub>-extract to create a peppery aroma is significantly lower in comparison to water distillates.
- Furthermore a decrease of the microbial contamination from high numbers at untreated pepper to nearly sterility in the extract and spent material can be achieved by CO<sub>2</sub>-extraction.

#### 3.2 Economics

In average 12 %w/w of Piperine extract has been recovered in the first separation step and 7 %w/w of the pepper oil in the second separation step, respectively. For the raw material a pepper price of 1.30 € per kg has been adopted. The economical figures are illustrated in table 1.

Tab. 1 Yields and Costs

Yields and Costs		20 tons batch	100 tons batch
Milling costs	[€/kg]	0.32	0.32
Extraction costs	[€/kg]	2.70	2.32
Processing costs	[€]	60,400	264,000
Pepper costs	[€]	26,000	130,000
Total costs	[€]	86,400	394,000
Quantity of Piperine extract	[kg]	2,400	12,000
Quantity of oil extract	[kg]	1,400	7,000
Costs of Piperine and oil extract	[€/kg]	<b>22.74</b>	<b>20.74</b>

### 3 CONCLUSIONS

The extraction of pepper with CO<sub>2</sub> is an effective and economic process. The paper shows evidence by presenting the extraction costs and the resulting product prices. The figures are based on batch sizes from 20 to 100 metric tons of pepper which have already been extracted successfully several times at NATECO<sub>2</sub>.