Supercritical fluid extraction – advanced technology with a delicate touch for the natural extraction of valuable botanicals

Make your products naturally better!
Supercritical fluid extraction...
“the perfect portrait of nature’s bounty“
Evonik’s timeline of supercritical fluid extraction

Industrial scale development of CO₂ extraction of hops flavor and bitter compounds for the beer industry

1982
Evonik’s timeline of supercritical fluid extraction

1982
Industrial scale development of CO₂ extraction for the decaffeination of tea and coffee

1986
Evonik’s timeline of supercritical fluid extraction

Production plant including tolling and creation capabilities focused on flavor and fragrance applications.

1982
1986
1990
2000-2007
Evonik…
a continual self-renewal

1847 goldschmidt
1908 SKW TROSTBERG
1938 hüls
1982 Degussa
1999 Degussa–Hüls
1999 skw.
2001 degussa.
2007 Evonik Industries

Berlin
Frankfurt
Munich
Trostberg

6 November 2017 | Evonik’s CO2 extracts make your products “naturally” better!
Supercritical fluid extraction technology

Process & advantages
To achieve solvent properties CO$_2$ needs to be “liquefied” or “supercritical” in its “supercritical” phase, carbon dioxide...

- retains the high solvent potency of its liquid state, and
- benefits from the lower viscosity and much higher diffusion of its gaseous form
SFE process – exposing starting material & CO$_2$ to very precise pressure & temperature settings

**Supercritical fluid extraction: process flow diagram**

- **Step 1: Extraction**
  - Botanical raw material is loaded in vessel.
  - Pressure increased to a min. threshold of 74 bars (1070 psi).
  - Temperature brought to a minimum of 31°C.
  - CO$_2$ now reaches supercritical stage.
  - Supercritical CO$_2$ flows freely through raw material capturing soluble aroma molecules.
SFE process – exposing starting material & CO₂ to very precise pressure & temperature settings

**Supercritical fluid extraction: process flow diagram**

- **Step 2: Separation**
  - The flow moves on to a separator where pressure is released, temperature is lowered.
  - Supercritical CO₂ reverts back to its gaseous state, thereby separating from the extracted liquid.
SFE process – exposing starting material & CO₂ to very precise pressure & temperature settings

Step 3: CO₂ recovery
- The spent CO₂ gas is recovered and stored in a condenser.
- CO₂ temperature is lowered further to its liquefaction point for storage.
- Recovered CO₂ can then be used in future batches.
Supercritical fluid extraction: flexibility in starting raw materials

- Extraction of aqueous & fatty liquids expands possibilities for new botanical ingredients
  
  **Oils**: hazelnut, peanut, sesame, sunflower
  
  **Dried leaves**: tea
  
  **Ground solids**: coffee beans
  
  **Roots**: ginger
  
  **Wood**: oakwood, cinnamon
  
  **Seeds**: celery
  
  **Liquids**: fruit juice distillates
Supercritical fluid extraction: completely natural advantages

• 100% FTNS extracts; clean labeling

• No regulatory limitations; GRAS

• Organic-compliant, Kosher, Halal

• Free of artifacts or solvent residues

• Gentle, low temperature extraction allows for the capture of finer aromas molecules

• Tailor-made profiles; highly flexible & selective extraction technology

• 36+ month shelf life under proper storage conditions

• Shelf stable; inert production environment protects from oxidation & off-flavors

• Highly-concentrated extracts; competitive cost-in-use
Superior capabilities are backed by strict external certification

- Food Safety System Certification / FSSC 22000 (including HACCP)
- ISO 9001 Quality
- ISO 14001 Environment
- ISO 50001 Energy
- Kosher / Orthodox Union OU
- Certified Organic / Lacon
- Halal (selected products) / Halal Control
- AEO-F / (“reliable partner”; simplified custom procedures“)
- Compliance with EU-cosmetics directive:
  Coffee, Espresso*, Espresso HR*, Peanut*, Hazelnut*, Oak*, Black Tea, Jasmin Tea, China White Tea, Green Tea*, Rooibus, Honeybush
  *: IFRA Certificates available
Flavor & fragrance extracts: standard portfolio

<table>
<thead>
<tr>
<th>Nuts</th>
<th>Teas</th>
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<tbody>
<tr>
<td>• Hazelnut</td>
<td>• Black</td>
</tr>
<tr>
<td>• Peanut</td>
<td>• China White, Pai Mu Tan</td>
</tr>
<tr>
<td>• Sesame</td>
<td>• Green</td>
</tr>
<tr>
<td>• Sunflower</td>
<td>• Green, organic</td>
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<tr>
<td></td>
<td>• Honeybush</td>
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<td></td>
<td>• Jasmine</td>
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<td></td>
<td>• Keemun</td>
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<td></td>
<td>• Rooibos</td>
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<table>
<thead>
<tr>
<th>Coffees</th>
<th>Aromatics &amp; Spices</th>
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<tbody>
<tr>
<td>• Arabica</td>
<td>• Celery</td>
</tr>
<tr>
<td>• Colombia Excelso</td>
<td>• Cinnamon</td>
</tr>
<tr>
<td>• Espresso</td>
<td>• Ginger</td>
</tr>
<tr>
<td>• Espresso Heavy Roast</td>
<td>• Oakwood</td>
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Natural CO₂ extracts bring your flavors to life!
Supercritical fluid extraction technology

Supplementary product information
CO₂ Nut extracts: true to the natural profile

- Complete flavor profile of roasted and creamy notes
- Rounds off overall aroma and enhances low-fat foods and beverages
- Highly concentrated for minimal dosing
- Available in oil- or water-soluble versions
- Low-caloric, trans-fatty acid-free
- Enriched 4X tocopherole content
CO₂ Nut extracts: smooth & creamy nut profiles

Perfect as a building block for compounded flavors or as top note to round off flavor profile in:

- **Beverages**: alcoholic, flavored syrups
- **Dairy**: ice cream, puddings, yogurts, milk shakes
- **Bakery**: energy/nutrition bars, pastries, coatings, fillings
- **Confectionary**: chocolates, pralines, fillings, creams
- **Marinades**

**Recommended dosage range**: 100 - 500 ppm

**Sensorial delivery**:

- **Peanut**: very roasted, smooth, creamy, full-bodied, red skin notes
- **Hazelnut**: creamy, delicate roasted scent
- **Sesame**: roasted, brown, savory
- **Sunflower**: peanut notes without the peanut allergens
CO₂ Tea extracts: elevating the tea experience

- Rich, floral notes provide premium aroma without astringency
- Range of fermentation available as non- and fully-fermented.
- Two herbal varieties: Honeybush & Rooibos.
- Flexibility in carrier solvents: MCT, MPG, ethyl alcohol
**Green**: Chinese tea, unfermented, floral, hay, honey, slightly buttery, unripe, very pleasant, well-rounded

**China White, Pai Mu Tan**: White tea, delicate, almost sweet, smooth, velvety

**Jasmine**: Chinese green tea with Jasmine flowers, delicate, floral, perfumey

**Black**: tea blend (Malawi, Argentina, Indonesia, Kenya), fermented, maté notes, hay-like, rich brown notes, tobacco

**Keemun**: Chinese black tea, fruity sweet with toasted touch

**Rooibos**: South African herbal tea, fermented, vanilla, butterscotch, creamy, full-bodied

**Honeybush**: South African herbal tea, fermented, floral, rose, fresh, straw, similar but sweeter than Rooibos, distinct honey scent

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November 2017 | Evonik’s CO2 extracts make your products “naturally” better!
CO$_2$ Tea extracts: tea & food are a natural pairing

Perfect as a building block for compounded flavors or as tea note enhancement in:

**Beverages:** Ready-To-Drink sector, flavored waters

**Flavored syrups**

**Dairy:** ice cream, puddings, yogurts

**Bakery:** pastries, coatings, fillings

**Confectionary:** alcoholic fillings, fruit preps, creams, jellies

**Recommended dosage range:** 100 ppm (as a top note)
CO₂ Coffee extracts: satisfying coffee cravings

- Complete flavor profile of coffee bean, fully-balanced for premium sensory sensation
- Roasted top notes
- Three degrees of roasting: regular, espresso, espresso heavy roast
- Variety of bean origins: pure arabica, blend of arabica/robusta
- Low caffeine contribution
- Available in oil- or water-soluble versions
**CO₂ Coffee extracts:**
*from mild to robust*

**Arabica:** premium blend, dark, chocolate notes, full-bodied, caramel, toffee, butterscotch, slight pyrazine-nut notes

**Arabica water-soluble**

**Colombia Excelso:** single-origin coffee, extraction of freshly ground roasted Columbian coffee beans

**Colombia Excelso water-soluble**

**Espresso:** roasted, ashy, earthy, tobacco, variety of coffee peaks

**Espresso water-soluble**

**Espresso Heavy Roast:** very roasted without the burnt character, rich, aromatic, very well-balanced

**Espresso Heavy Roast water-soluble**
CO₂ Coffee extracts: flavor beyond the coffee cup

Perfect as a building block for compounded flavors or as top note to round off flavor profile in:

- **Beverages**: Ready-To-Drink sector, iced coffees
- **Liqueurs, flavored syrups**
- **Dairy**: ice cream, yogurt, milk shakes, puddings
- **Bakery**: pastries, fillings, coatings
- **Confectionary**: alcoholic fillings, fruit preps, creams, jellies

**Recommended dosage range**: 200 – 300 ppm
CO₂ Aromatics & Spices extracts: smoky and spicy profiles

- **Oakwood:**
  - Rich, smoky, woody, oak barrel character with a medium toast quality, aromatic, very well balanced.
  - Flavor enhancer; particularly for Vanillin
  - Flexibility in carrier solvents: MCT, MPG, ethyl alcohol
  - Recommended dosage range: 10 - 20 ppm

- **Ginger:**
  - Pronounced spiciness
  - Enhanced citrus-like top notes
  - Two versions: essential oil or oleoresin
  - Recommended dosage range: 20 - 100 ppm

**Celery CO₂ Extract:** true-to-fruit, extraction of ground celery seeds

**Cinnamon CO₂ Extract:** Spicy, warm, baking cinnamon. Extraction of ground cinnamon bark
Perfect as a building block for compounded flavors or as top note to round off flavor profile in:

**Beverages:** Ready-To-Drink sector

**Dairy:** ice cream, yogurt

**Bakery:** pastries, fillings, coatings

**Confectionary:** alcoholic fillings, fruit preps, creams, jellies

**Wine**

**Tobacco**

**Vanillin enhancement**

**Marinades**