

# Advanced methods for production of valuable compounds from aromatic and medicinal plants - liquefied gas and super heated water extraction

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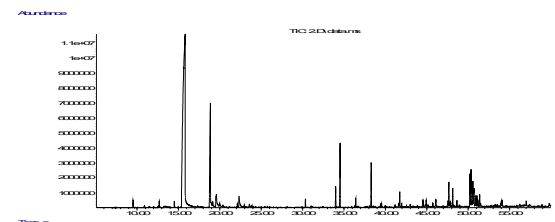
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## SUB-CRITICAL LIQUEFIED GAS EXTRACTION – KEY FIGURES

- Focus on food grade solvent tetrafluoroethane (TFE)
- Developed in start-up companies Innosolv Ltd. (Bulgaria) and Comerg LLC (USA) by team of scientists
- Patented method for effective extraction process
- Vast investigations on optimal process, product properties and applications
- Suitable for aromatic and medicinal plants
  - Industrial commercialization of method and equipment



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## PROCESS ADVANTAGES

- Lipophilic, safe, odorless, food grade solvent used in pharmacy
- Solvent selectivity to aroma and active compounds in plants
- Low extraction pressure (up to 15 bar) and temperatures (0-40° C) – high product quality
  - Low extraction pressures – high product quality
- Cost effective process – low operational and capital costs



TFE rose extract



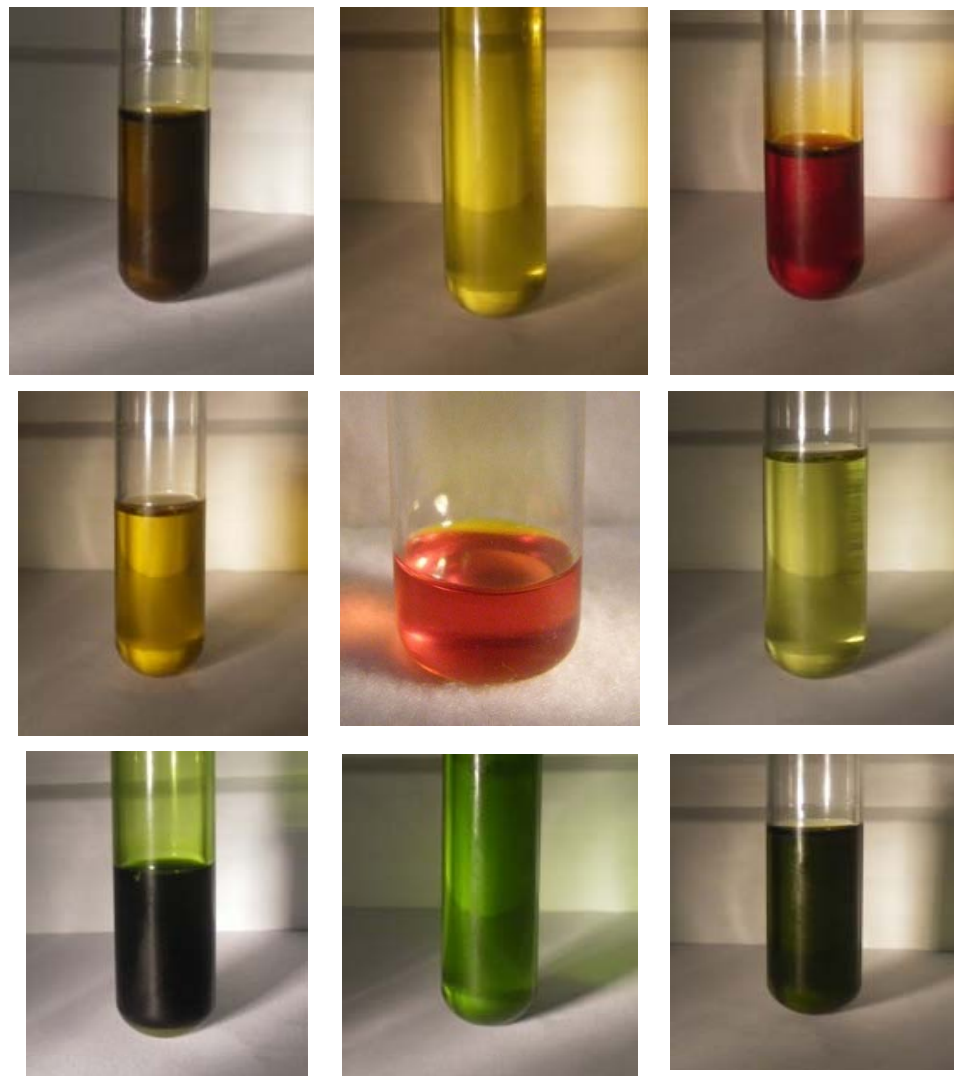
TFE lavender extract



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## PRODUCT PROPERTIES

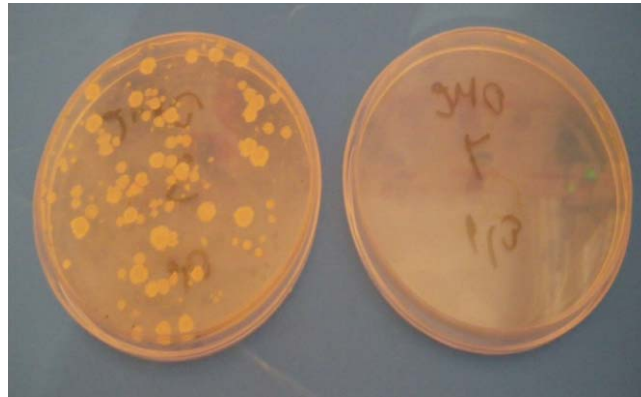
- Suitable raw materials – dried and fresh leaves, flowers, seeds, etc.
- Extract appearance – oily liquids to solid masses, colored, with strong, typical smell of raw material
  - Chemical composition – similar to essential oils plus some non-volatile compounds, very close SC CO<sub>2</sub> select extracts
- Medium to strong antimicrobial and antioxidant properties
- Neglectable amount of solvent residue in product



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## PRODUCT APPLICATIONS

- Substitutes of natural spices in food products and aroma preparations according European legislation – sausages, cheeses, ready meals, mayonnaise, chocolate, etc.
- Source of active ingredients for pharmaceutical, crop protection products, etc.
- Source of natural active ingredients for cosmetic products
  - Perfumery



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## PROCESS COMMERCIALIZATION

- Over 40 industrial, semi-industrial and laboratory scale equipment running worldwide.
- US patented method
- Focus on industrial hemp extraction applications for active ingredients
- Attempts for medium scale industrial applications for rose, lavender, etc, extraction

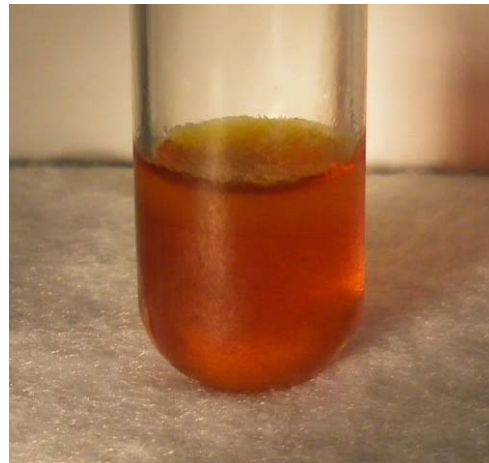


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## PRODUCT EXAMPLES

### Fresh rose petals extract:

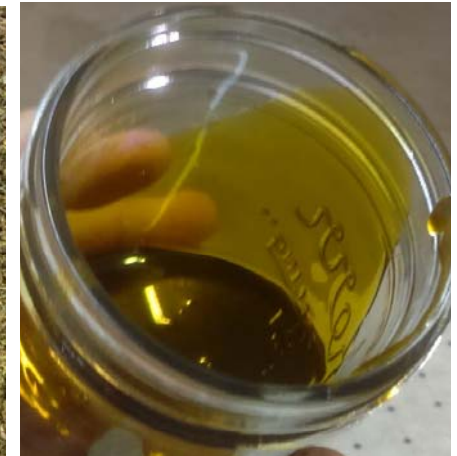
- Yield 0.15-0.25%
- Appearance – brown, thick liquid, aroma close to rose absolute
- Chemical composition:
  - Phenylethyl alcohol – 55-65%
  - $\beta$ -Citronellol – 10-15%
  - Other...



## PRODUCT EXAMPLES

### Hemp (CBD strain) extract:

- Yield 2.0-3.5%
- Appearance – dark thick liquid, typical aroma of terpenes
- Chemical composition:
  - CBD – 30-50%
  - CBDA – 0.0-1.0%
  - THC – 3-5%
  - THCA – app. 0%



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## SUPERHEATED WATER EXTRACTION

- Cheap, widespread, environmental, health and fire safe solvent - water.
  - Working principle – increase pressure to increase solvent temperature and change water selectivity to non-polar compounds
  - Perspectives – to extract non-polar molecules from biomass with water only
- Typical extraction process parameters – temperatures up to 170° C, duration – 1-3 minutes
  - Current development stage – laboratory scale, industrial application – expected soon



**Dielectric constants:**  
Pure water (@170° C) =  
Aqueous-ethanolic solution,  
@67%w/w, 20° C)







FOR YOUR ATTENTION !

