CO_2 Extracts in Cosmetic Care

Society of Cosmetic Chemists, MN, Mar. 2019

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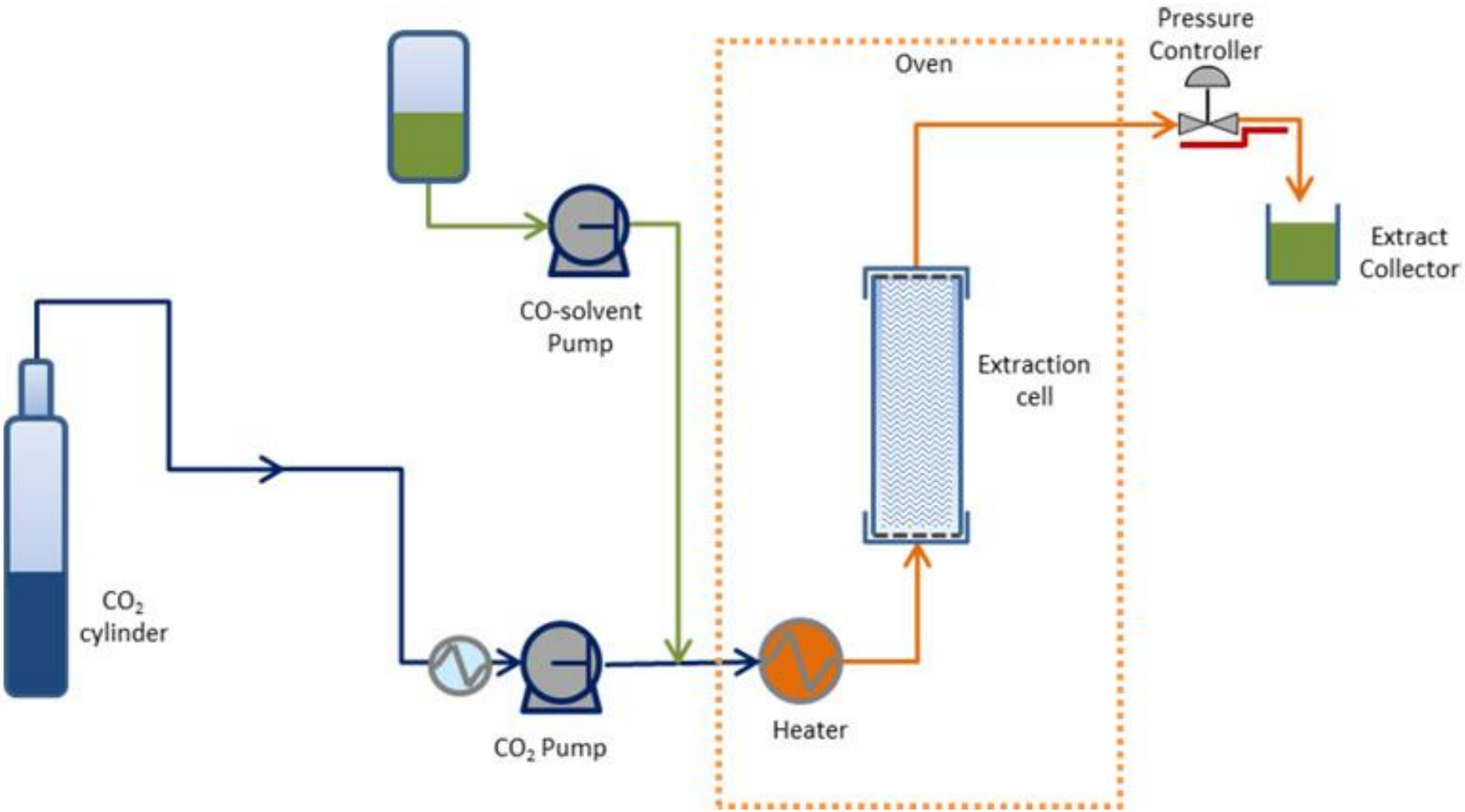
Overview

- Influences on the skin
- Extraction differences
- CO_2 processing
- Examples of functionality
- A few choice examples
- Research citations, where available
- Resource

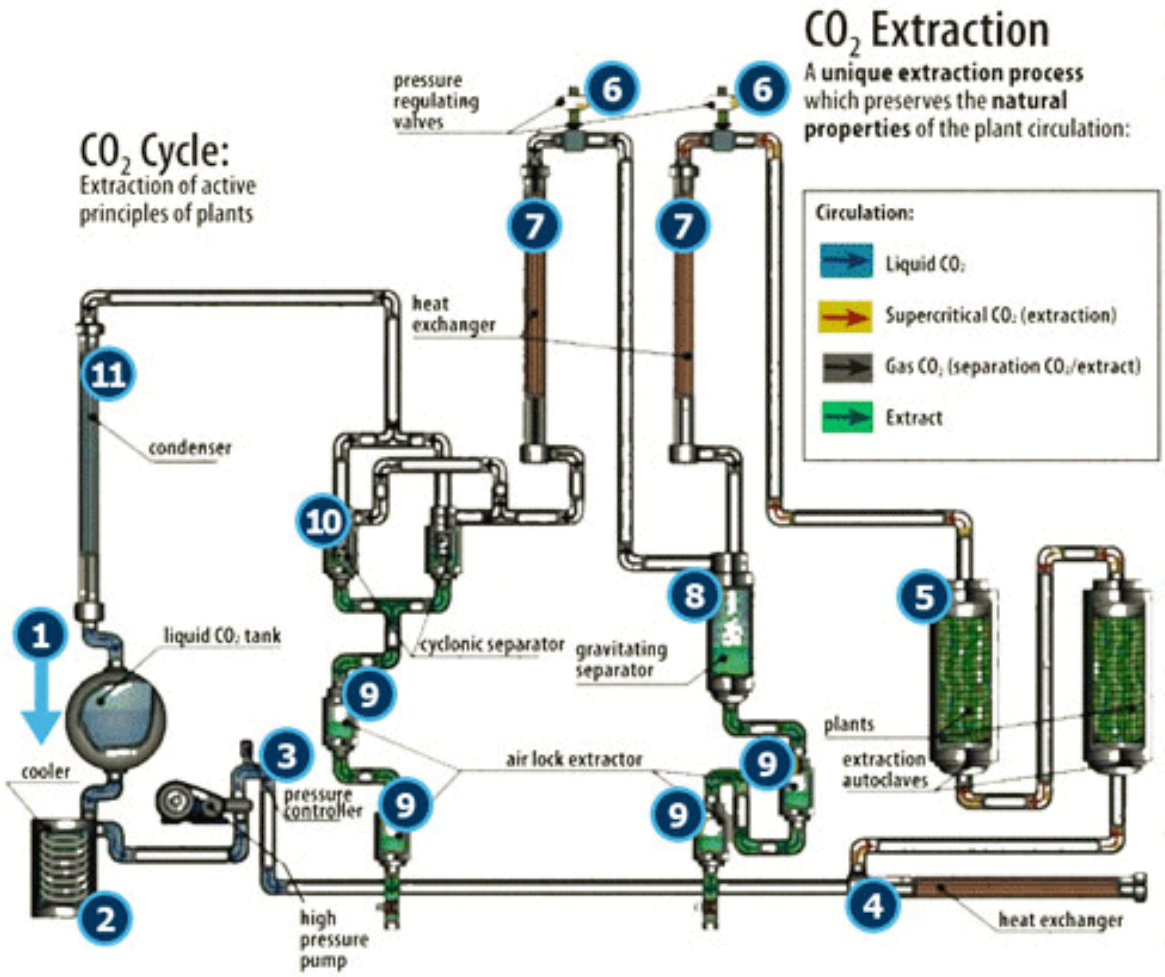
Botanical Ingredient Functions

- Stimulate new skin cell production in dermal layer and increase cell turn over time
- Influence sebaceous secretions for dry or oily skin
- Reduce inflammation to soothe sensitive, delicate, burned or irritated skin
- Balance hormone related skin problems
- Affect elastin and collagen production
- Help prevent and heal acne, wounds and skin infections
- Antioxidant, antibacterial, anti-inflammatory, antifungal properties
- General immune support (affect the ‘terrain’)

CO_2 Extraction (simple)



THE SUPER CRITICAL EXTRACTION PROCESS



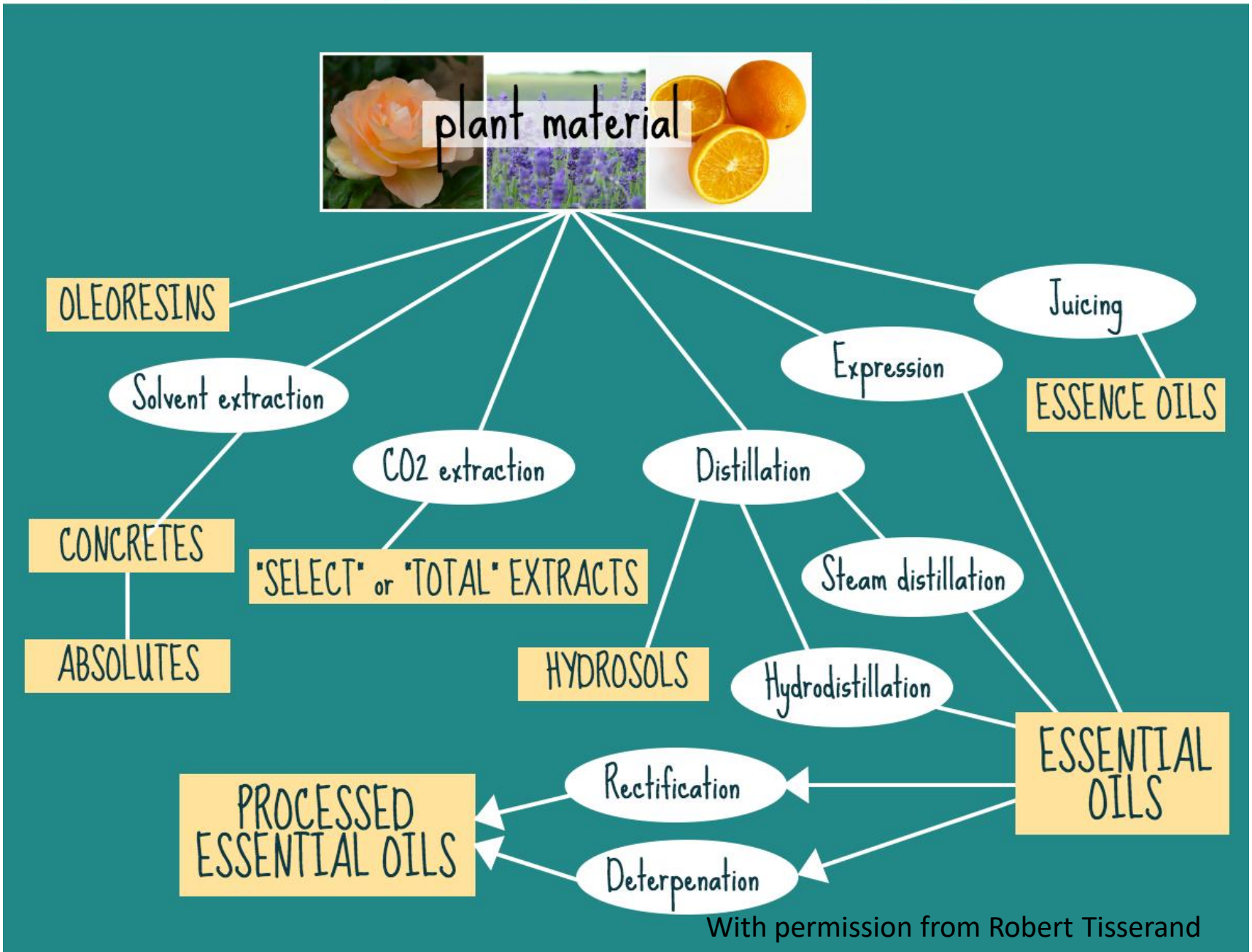
CO_2 Extraction

A **unique extraction process** which preserves the **natural properties** of the plant circulation:

1. **CO_2 storage**
2. **Cooling:** CO_2 passes into a cold exchanger to maintain its liquid state before entering into the high pressure pump.
3. **Pressurization:** the pressure is raised to 300 bars.
4. **Reheating:** the temperature is raised to 31° C. CO_2 is supercritical.
5. **Extraction:** CO_2 supercritical is used as solvent to extract active plant ingredients without denaturing them.
6. **Relaxation:** Lowering of the pressure and thus return of the CO_2 to a gas state allows the separation of the extract from CO_2.
7. **Reheating:** The temperature is maintained at 30° C.
8. **Separation:** 1st separation stage: separation of CO_2 from the extract by gravity.
9. **Under pulling:** The extract is decompressed gradually to be under drawn in total safety.
10. **Cyclonic separation:** 2nd stage separation: Separation of CO_2 extract by centrifugal force.
11. **Liquefaction:** still in a gas state, CO_2 is cooled for liquefaction.


apeks
PolyScience

aromatic plants are processed in many ways?



With permission from Robert Tisserand

CO_2 Super Critical Extracts (SCE)

Popularized in the last 3 decades; mostly food and flavoring industries; increased interest in the AT industry

1. Liquid SCE (C_5-C_{20}) Captures mostly volatile compounds: 350 mw; <80 bar pressure
2. Select SCE (C_5-C_{25}) Selectively captures aromatic compounds: 400 mw; 80-100 bar pressure (1&2, most like EOs)
3. Total (aka Complete SCE) (C_5-C_{60}) Captures aromatics and heavier non volatiles such as lipids, pigments, waxes, resins: 200-550 mw - may be liquid, thick or solid; (beta carotene mw: 537); 200-500 bar pressure

CO_2 Advantages vs Extracts/EOs

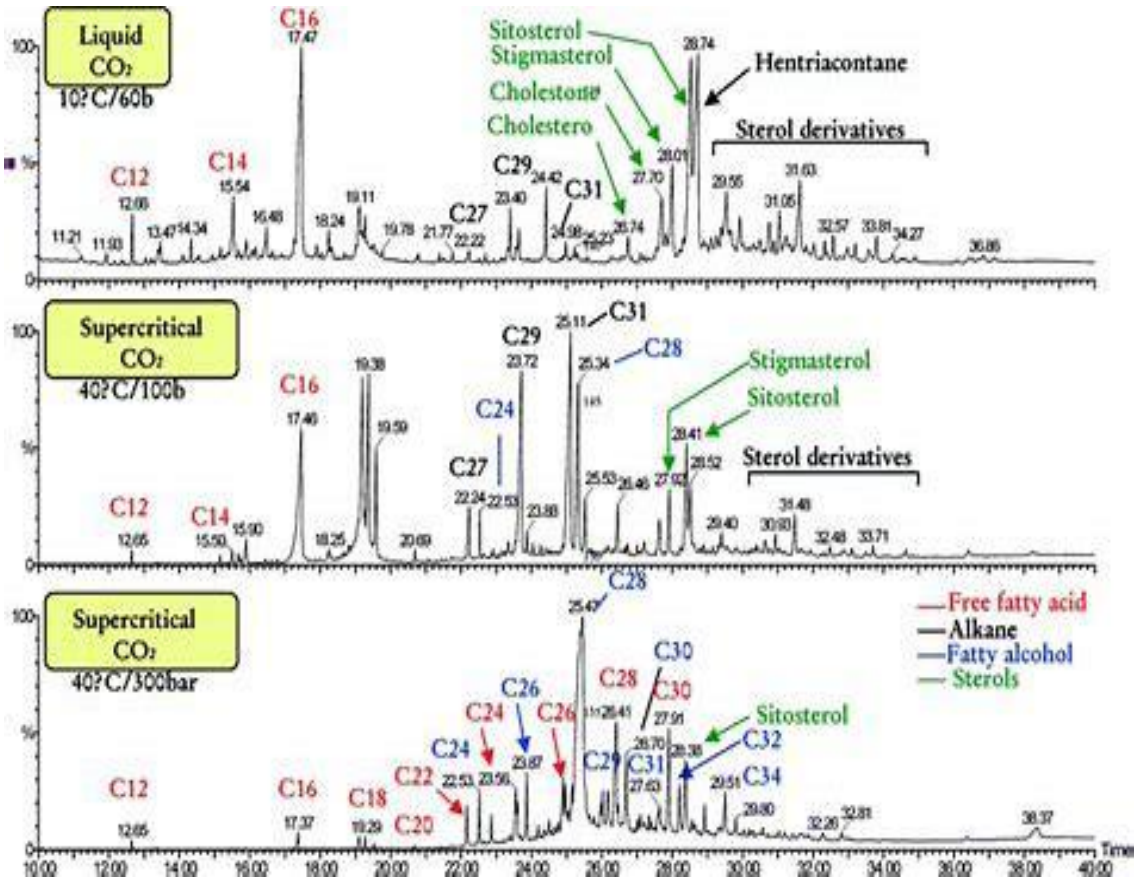
- Truer to the scent of the fresh plant; improved aroma; no heat degradation
- Rapid, effective solvent uses low temp and high pressure
- Green alternative to hexane or other solvent extracts; CO_2 is recovered and reused; phytonutrients intact
- Yields both volatiles and lipid antioxidants with greater aromatic and chemical complexity
- Concentrated; cost effective, longer shelf life (?)
- Captures diterpene phenolics –ie: Rosemary, Sage, Ginger, Frankincense, etc; not bioavailable in EOs
- Can be fractionated
- Widely applicable

  [hydrophilic compounds excepted]

Analysis of CO_2 Extracts

Often analyzed with HPLC (with proper calibration) to identify larger molecules beyond volatiles, especially with Total SCEs.

Can be combined with GCMS

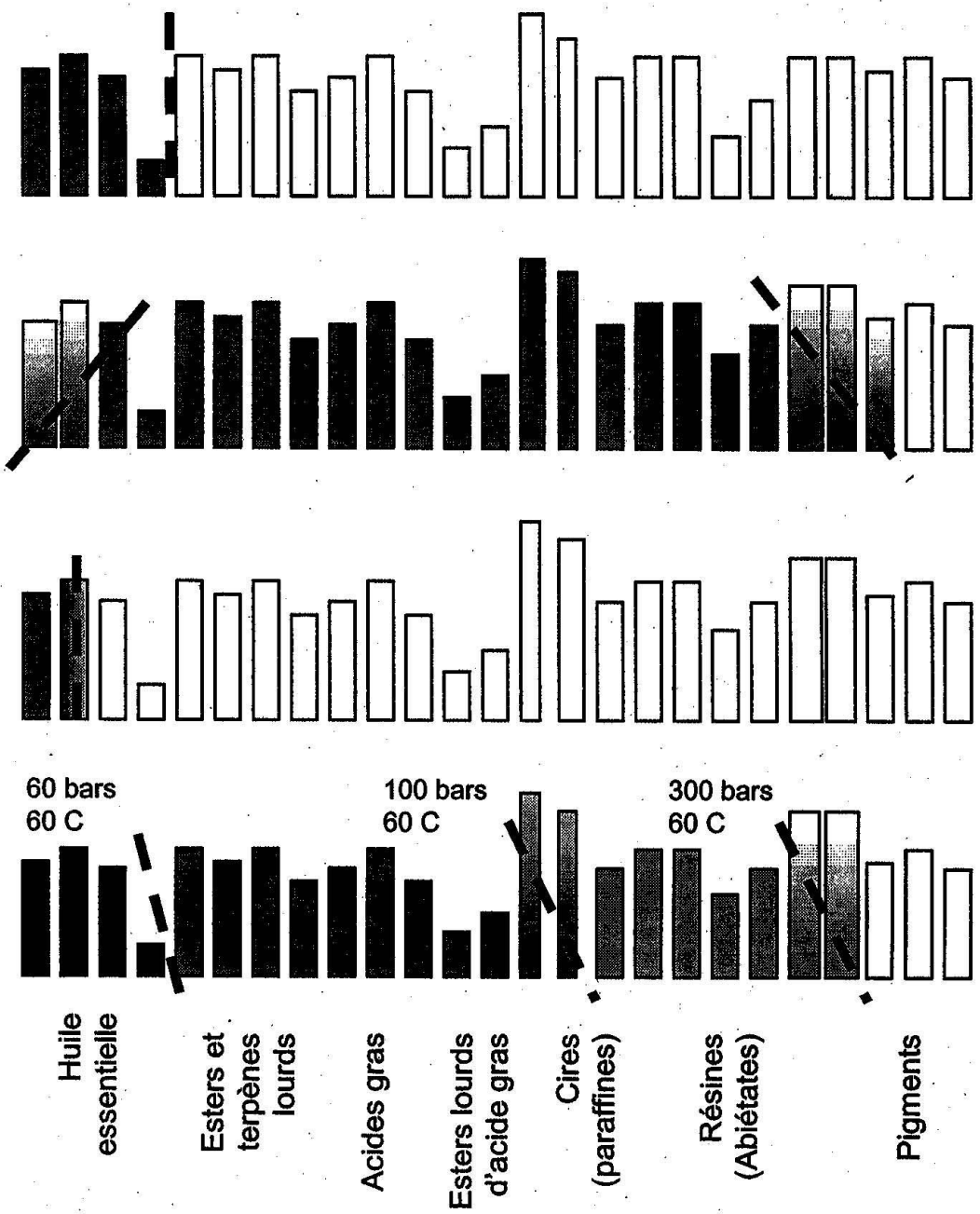


HYDRODISTILLATION

EXTRACTION
SOLVANTS VOLATILS

HEAD SPACE

EXTRACTION AU CO2



Product Applications for CO_2

- Personal care products- soaps, lotions, skincare
- Perfumes (full spectrum isolates)
- Flavors- food industry
- Dietary supplements (anti-inflammatories)
- Preservative systems
  - Rosemary/Sage: antioxidant, antibacterial, antiaging; stabilize carotenoids and colors
- Myrrh/Sage/Cinnamon/Ginger: toothpaste, mouthwash, bath, antiinflammatory massage oils

German Chamomile

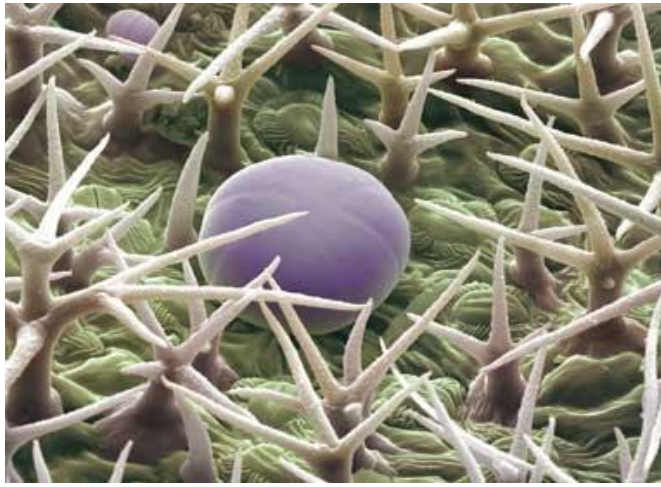
Matricaria chamomilla; M. recutita

- antiinflammatory, antiseptic, spasmolytic, soothing
- chamazulene vs matricin
- Chamazulene in EO; bioavailable only upon exposure to heat
- Matricin in SCE – the precursor to chamazulene; 10x more antiinflammatory that chamazulene; use 0.1%-0.3%
  - Kaiser, et al. Supercritical carbon dioxide extraction of chamomile flowers: extraction efficiency, stability, and in-line inclusion of chamomile-carbon dioxide extract in beta-cyclodextrin. *Phytochem Anal*. 2004 Jul-Aug;15(4):249-56.
  - Ompal, Singh, et al. Chamomile (*Matricaria chamomilla* L.): An overview. *Pharmacogn Rev.* 2011 Jan-Jun; 5(9): 82–95.
  - Klimaszewska E., et al. The effecto of chamomile extract obtained in supercritical carbon dioxide conditions on physiochemical and usable properties of pharmaceutical ointments. *Pharm Dev Technol.* 2018.

Lavender

Lavandula angustifolia, L. vera, L officianalis

- antimicrobial, antioxidant, antiinflammatory, analgesic; wound healing, calming, cognition, dementia, depression, dysmenorrhea: +49 research papers
- Higher antimicrobial action in CO_2 compared to EO
  - Chen W, Jin JZ. Antimicrobial activity and GC-MS analysis of essential oil from lavender extracted by supercritical CO2 extraction and hydrodistillation. *Zhongguo Zhong Yao Za Zhi.* 2008 Aug;33(15):1821-4. Article in Chinese



Carrot Seed *Daucus carota*

- Antimicrobial
  - Marzouki H, et al. Essential oils of Daucus carota subsp. carota of Tunisia obtained by supercritical carbon dioxide extraction. *Nat Prod Commun.* 2010 Dec;5(12):1955-8
- Increase skin elasticity, burn healing, scars, eczema, psoriasis, rosacea
- Antifungal (carotol 30%); antiinflammatory (sesquiterpenes)
- Blends well with Rosehip CO_2 carrier oil
- Antiaging blend with cistus, rosemary verbenone, frankincense, neroli

Rosehip oil

Rosa canina, R rubiginosa, R. moschata

- Transretinoic acid, flavonoids, unsaturated fatty acids including 41-59 % linoleic acid (C18:2, omega-6), 20-35 % alpha-linolenic acid (C18:3, omega-3), 12-22 % oleic acid (C18:1, omega-9), trace of stearic and palmitic acid, tocopherol and carotenoids
- Acne, mature skin, dry, chapped skin; cicatrizant, protective, emollient; supports elasticity & barrier repair
  - Szentmihalyi, K. et al. Rose hip (Rosa canina L.) oil obtained from waste hip seeds by different extraction methods. *Bioresour Technol.* 2002 Apr;82(2):195-201.
  - https://www.centerchem.com/Products/DownloadFile.aspx?FileID=7106
  - +10 research papers

Sea Buckthorn *Hippophae rhamnoides*

- Fruit, seed, leaf – ingested products
- Antiinflammatory cosmetic aid with nourishing, revitalizing and restorative action; burns, sun damage, acne, rosacea, scars, post laser recovery
- Wound healing
  - Upadhyah NK, et al. Safety and healing efficacy of Sea buckthorn (Hippophae rhamnoides L.) seed oil on burn wounds in rats. *Food Chem Toxicol*. 2009 Jun;47(6):1146-53
- Contains carotenoids, tocopherols, phytosterols, Palmitoleic acid (rare in plant oils), a component of skin lipids; Unique Omega 7 fatty acids
  - Zielinska A., Nowak. Abundance of active ingredients in sea-buckthorn oil. *Lipids Health Dis.* 2017 May 19;16(1):95.

+ 14 research papers

Calendula *Calendula officinalis*

- Thick orange colored tar; rich in flavonoids, sterols, carotenoids, faradiol esters, monols, diols, triols and lipophilic triterpene esters & acids, aromatics
- Antiinflammatory, antioxidant, antiseptic, analgesic, cicatrizant; supports collagen synthesis; lipid membrane & varicosity protection, wound healing
- Proven effective against SLS induced dermatitis
- Dilute in carrier oil before use in product
- Non irritating, non toxic; CIR: safe up to 6%; >1%?
- "The perfect blend of bioactive components makes the supercritical *Calendula* extract an ideal ingredient for natural cosmetics with protective and restorative efficacy."
  - May, P, et al. Supercritical Marigold Flower CO2-Extract - Evergreen in Evidence Based Cosmetic Application. *Cosmetic Science Technology* 2014 [Flavex]

- Della Loggia, R, et al. The role of triterpenoids in the topical anti-inflammatory activity of Calendula officinalis flowers. *Planta Med.* 1994 Dec;60(6):516-20.
- + 38 research papers

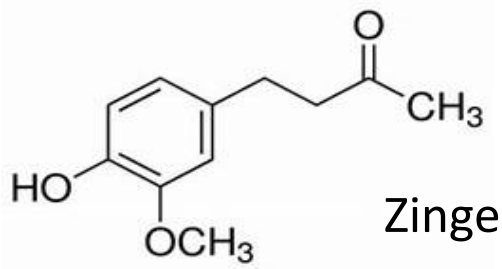
Rice Bran *Oryza sativa*

- Supercritical CO_2 extraction is a green alternative method for producing rice bran oil
  - Sookwong P, Maahatheeranont S. Supercritical CO_2 Extraction of Rice Bran Oil -the Technology, Manufacture, and Applications. *J Oleo Sci.* 2017 Jun 1;66(6):557-564.
- Hair growth products: “increased hair density and diameter” using Folliscope®
  - Choi JS, et al. Safety and Efficacy of Rice Bran Supercritical CO_2 Extract for Hair Growth in Androgenic Alopecia: A 16-Week Double-Blind Randomized Controlled Trial. *Biol Pharm Bull.* 015;38(12):1856-63.

Ginger *Zingiber officinale*

- SCE contains Gingerols, Shogaols, Zingerone
  - Antiinflammatory, circulatory tonic, analgesic
  - In CO2 only; giving ginger pungent flavor; may be skin irritants; use low %
  - High odor intensity for scenting soaps, lotions, etc.

[redacted]

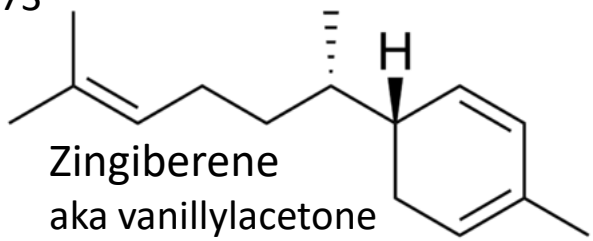


Zingerone

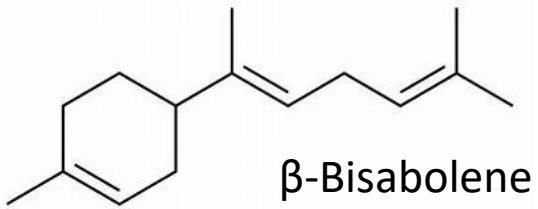
Chen Y, et al. Assay of 6-gingerol in CO_2 supercritical fluid extracts of ginger and evaluation of its sustained release from a transdermal delivery system across rat skin. *Pharmazie*. 2014 Jul;69(7):506-11.

(EO: sesquiterpenes: Zingiberene and β-Bisabolene)

Pantea Shirooye, et al. Volatile Constituents of Ginger... *Afr J Tradit Complement Altern Med*. 2016; 13(6): 68–73



Zingiberene
aka vanillylacetone



β-Bisabolene

Frankincense *Boswellia spp.*

Boswellia spp. SCE: compounds not in EO:

- Octyl acetate 2-7%
- Serratol 15%
- Incensol 2-10%
- Incensyl acetate 1-12%
- Cembrene A 1-2%
- Isocembrene 0-2%
- EO mostly diterpenes, hig
- Generally, heavy compou
  roots are better extracted w CO_2

  - Zhou J, et al. Parameters optimization of supercritical fluid-CO2 extracts of frankincense using response surface methodology and its pharmacodynamics effects. *J Sep Sci.* 2013 Jan;36(2):383-90.
  - + 14 research papers

Anti-inflammatory activity of *Boswellia*

- the extract binds cathepsin G, a protease that breaks down extracellular matrix
- inhibits elastase which breaks down elastin in the skin
- inhibits the enzyme, 5-LOX (arachidonic acid pathway of inflammation)
- Inhibits COX2 and PLA2, chemotaxis (inflammation due to migration of white blood cells), and other important enzymes of the arachidonic acid pathway
- the whole extract is more active and bioavailable than isolated a-boswellic acid (found in commercially available products)

Burning Incense Is Psychoactive: New Class Of Antidepressants Might Be Right Under Our Noses

- Researchers from Johns Hopkins/Hebrew Univ, "…burning frankincense activates poorly understood ion channels in the brain to alleviate anxiety or depression."
- Incensole acetate, in *Boswellia* resin, lowers anxiety and causes antidepressive behavior in mice.
  - Moussaieff, A. et al. Incensole acetate, elicits psychoactivity by activating TRPV3 channels in the brain. *FASEB J*. 20, May 2008.
  - https://www.fasebj.org/doi/abs/10.1096/fj.07-101865

CO_2 Examples

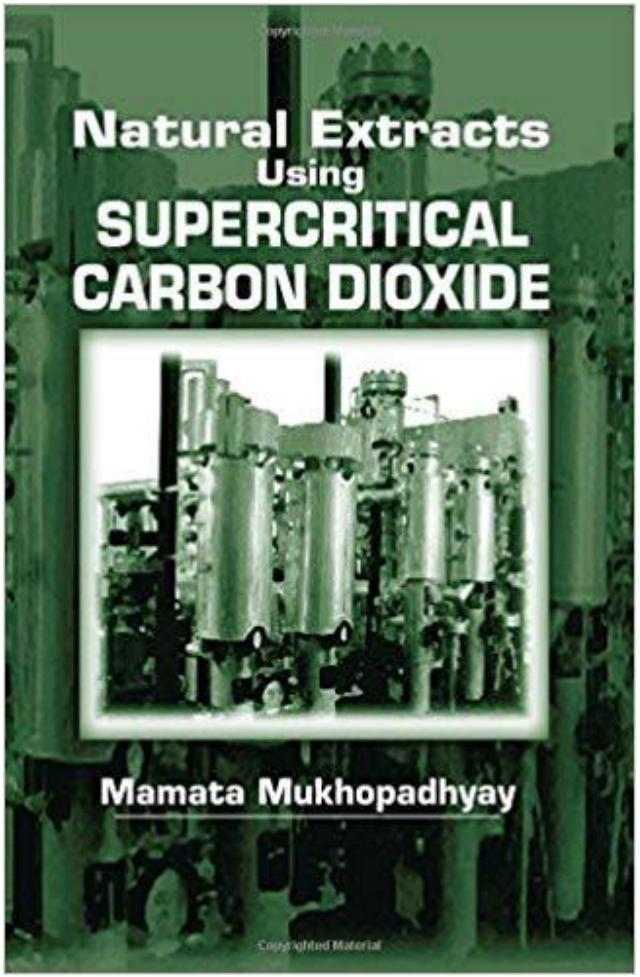
- Agarwood
- Ambrette
- Angelica
- Black pepper
- Calendula
- Chamomile
- Frankincense
- Jasmine
- Myrrh
- Patchouli (beware Synbios)
- Rose
- Rosemary
- Sandalwood
- Spikenard
- Seed oils: sea buckthorn, rosehip, nigella, raspberry, EPO, pomegranate
- Spices: ginger, cinn, clove, turmeric, vanilla, coffee, choc, coconut, cardamom

http://www.synbiowatch.org/commodities/patchouli-oil/

Other Available CO_2s

Amaranth, Arnica, Ashwagandha, Bakul, Black Currant, Black Cumin, Borage, Butter, Calendula, Caraway, Cardamom, Champaca, Chia, Cinnamon Bark, Coconut, Coffee Bean, Coriander Seed,Cranberry, Davana, Dill, Elemi, Evening Primrose, Galbanum, Ginger, Gotu Kola, Hazelnut, Jasmine, Juniper, Mace, Marjoram, Massoia Bark, Melissa Leaf, Millet, Myrrh, Neem, Orris rhizome, Parsley, Pomegranate Seed, Raspberry Seed, Rhatany Seed, Rosemary, Sage, Sarsaparilla Root, Saw Palmetto Seed, Schisandra Fruit/Seed, Star anise, Turmeric, Usnea, Vanilla, Wheat Germ + many more.

Cannabis

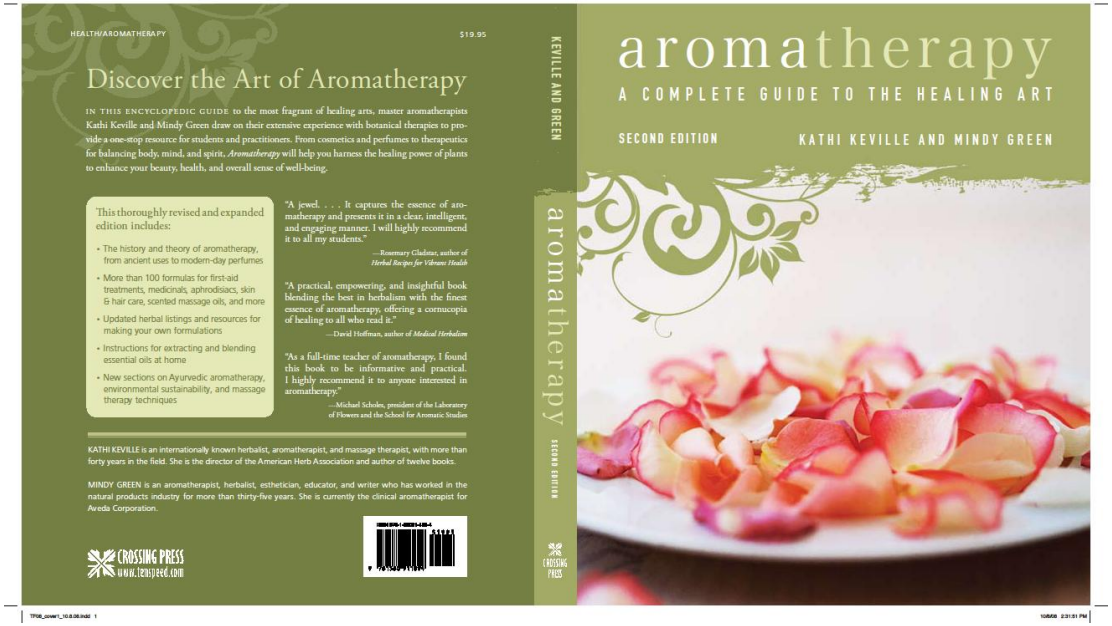


CRC Press, 2000

Madeleine Kerkhof, RN

large suppliers: Flavex, Pioneer Herbex, Nisarga

Thank you



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