

Ethnobotany. Lecture 25

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March 30, 2015



Outline

- 1 From food to medicine
 - Spices
- 2 Natural product chemistry
 - Introduction
 - Polyketides and other small molecules



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From food to medicine

Spices



Spicy hot taste

- Caused from several different secondary metabolites which make a burning sensation
- These metabolites work with pain receptors, nociceptors
- One of proposed effects is the stimulation of endorphin and serotonin production in brain

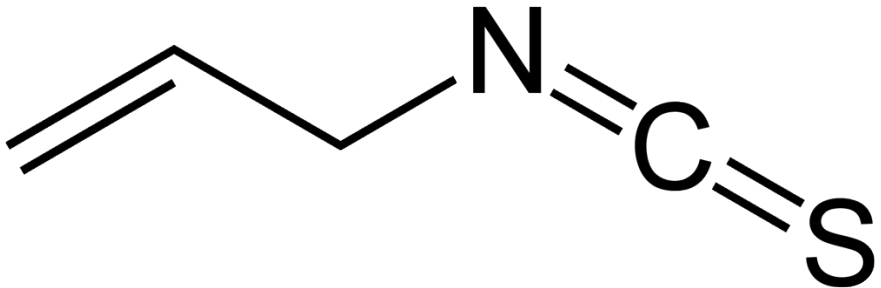


Allyl isothiocyanate plants

- Main component of mustard oils, with formula $\text{CH}_2\text{--CH--CH}_2\text{--NCS}$
- Anti-herbivore chemical, stored in glucosinolate form and released by myrosinase when cells are broken
- Toxic, strong lachrymator, stimulates nasal and eye receptors
- Plants of Brassicales order (Cruciferae and also Moringaceae like papaya and horseradish tree) are rich of allyl isothiocyanates.



Allyl isothiocyanate



Horseradish, *Armoracia rusticana*

- Perennial plant from cabbage family (Cruciferae) with European origin
- Roots are using as a spice



Wasabi, *Wasabia japonica*

- Japanese perennial from same family
- Extremely strong flavor due to multiple isothiocyanates



Iwasaki (1828) paint of wasabi

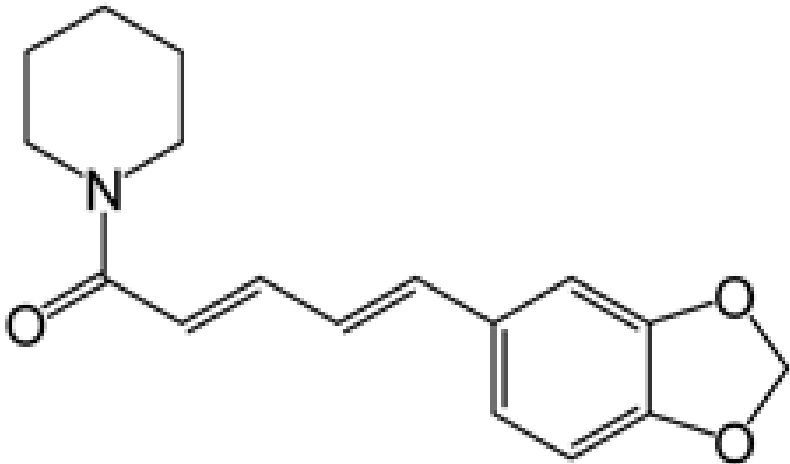


Piperine

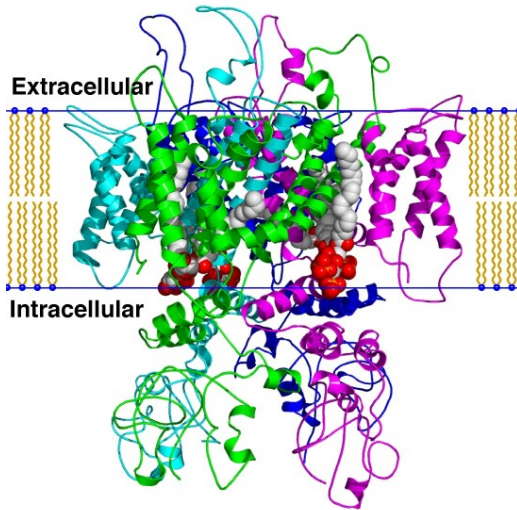
- Alkaloid
- Activates TRPV channels in nociceptors



Piperine



TRPV channel



Black pepper, *Piper nigrum*

- Perennial vine from pepper family, Piperaceae
- Has the long and rich history: was one of primary causes of Exploration Age



Piper nigrum

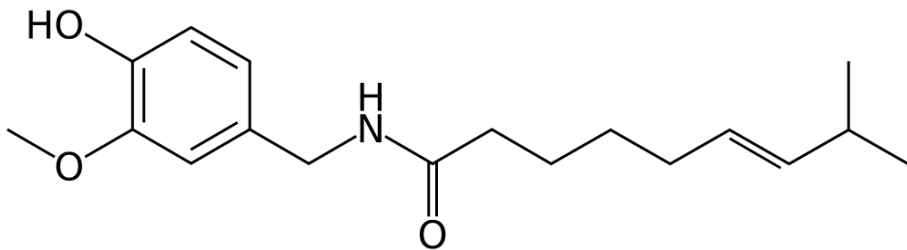


Capsaicin

- Amine, irritant for all mammals
- Binds to TRPV and provide sensation similar to burning of call damage



Capsaicin



Chili peppers, *Capsicum annuum* and other species

- Multiple species of *Capsicum*, genus of Solanaceae herbs or vines from Central America
- Important component of several tropical cuisines

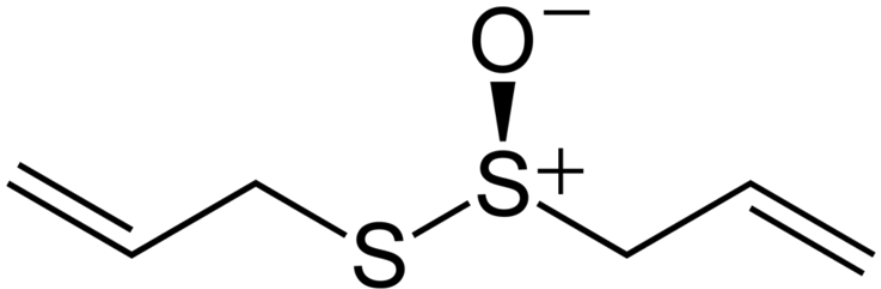


Allicin

- Organo-sulfur compound with anti-bacterial and anti-fungal effects
- Has multiple positive health effects



Allicin



Garlic, *Allium sativum*

- Cultivated species from amaryllis family, Amaryllidaceae
- Probably originated in West Asia from wild *Allium longicuspis*



Essential oil plants from umbel family, Umbelliferae

- Coriander, *Coriandrum sativum* from West Asia, known from pre-historic times
- Dill, *Anethum graveolens* from Europe
- Cumin, *Cuminum cyminum* from Mediterranean
- Caraway (*Carum carvi*), asafoetida (*Ferula asafoetida*), anise (*Pimpinella anisum*), fennel (*Foeniculum vulgare*), sea parsley (*Ligusticum scoticum*), parsley (*Petroselinum crispum*), and many others



Cumin



Essential oil plants from mint family, Labiatae

- Peppermint, *Mentha piperita* from Europe
- Basil, *Ocimum basilicum* with wide Eurasian distribution
- Wild bergamot (*Monarda fistulosa*), mint (*Mentha* spp.), majoram (*Origanum majorano*), oregano (*Origanum vulgare*), thyme (*Thymus* spp.), sage (*Salvia officinalis*), and many others

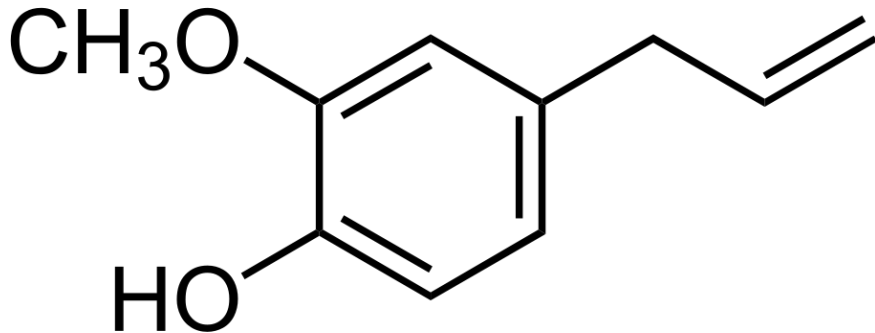


Eugenol and similar compounds

- Essential oils with phenol component
- Often provide a burning sensation similar to other spices



Eugenol



Plants with eugenol-like compounds

- Allspice, *Pimenta dioica* from Myrtaceae family, Caribbean origin
- Bay leaf, *Laurus nobilis* from Lauraceae, Mediterranean origin
- Nutmeg, *Myristica fragrans* from Myristicaceae, Indonesian origin
- Cinnamon, *Cinnamomum verum* from Lauraceae, Southwest Asian origin
- Ginger, *Zingiber officinale* from Zingiberaceae, South Asia
- Turmeric, *Curcuma longa* from Zingiberaceae, South Asia
- Vanilla orchid, *Vanilla planifolia*, Central America
- Sage, *Artemisia spp.* from Compositae, cosmopolitan



Bark of cinnamon



Nutmeg



Vanilla plantation



Natural product chemistry

Introduction



Types of drugs

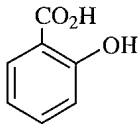
- Fully natural
- Semisynthetic
- Fully synthetic



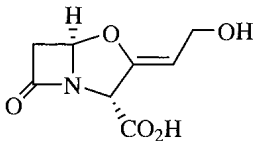
Types of medicinal agents

Medicinal agents from natural sources

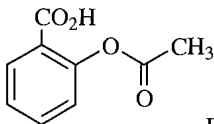
- (a) Fully natural
- (b) Semisynthetic
- (c) Fully synthetic



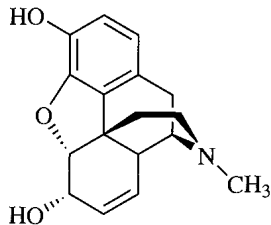
salicylic acid



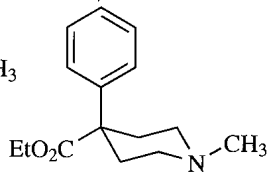
(a) clavulanic acid



(b) aspirin



morphine



(c) pethidine

Drug discovery

We need new drugs, and plant secondary compounds of plants could accidentally have medicinal value.

- Sampling: soil, markets, natural habitats
- Extraction
- Bioassay screening
- Structure elucidation
- Chemical modification
- Clinical trials
- Drug



Natural product chemistry

Polyketides and other small molecules

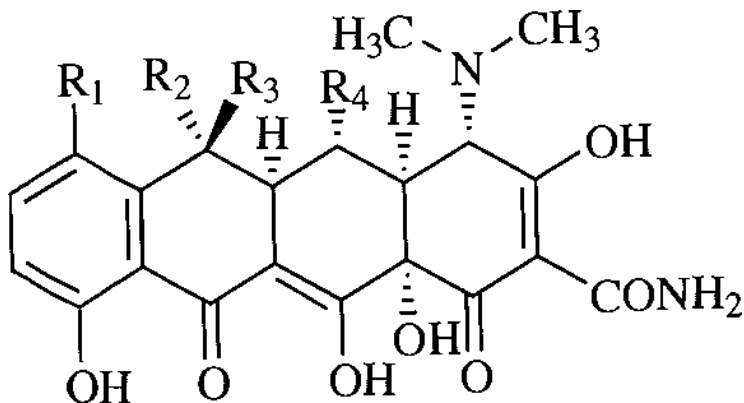


Polyketides and derived products

- Short molecules with interleaving ketogroups
- Many antibiotics (e.g., tetracycline, erythromycin)



Tetracycline



Glycerides

- Saturated fats
- Unsaturated fats, especially omega-n-unsaturated

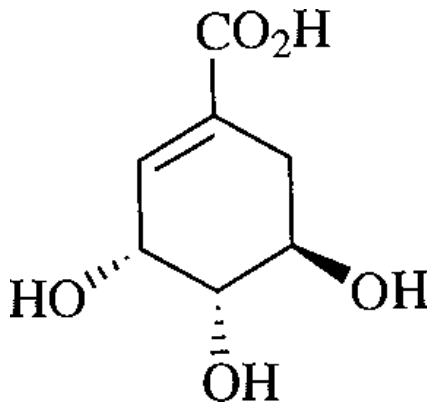


Shikimic acid and derived products

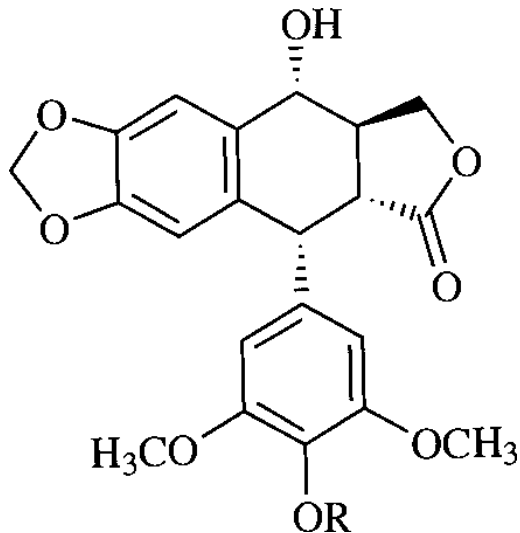
- Phenylpropenes, like eugenol
- Lignans like podophyllotoxin



Shikimic acid



Podophyllotoxin

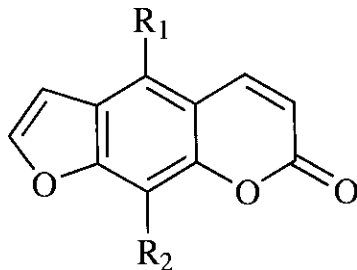


Coumarins

- Phytoalexins with anti-bacterial properties
- Some (psoralens from umbel family plants and bergapten from citrus family) are phototoxic



Psoralen



Summary

- Most of spicy plants produce chemicals with nociceptive (pain) effect
- Polyketides are source chemicals to many antibiotics
- Derivatives of shikimic acid are phenylpropenes, lignans, coumarins, flavonoids and tannins



For Further Reading



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Mode of access:

http://ashipunov.info/shipunov/school/biol_310



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Churchill Livingstone, Edinburgh.

