Lecture 9

Medicinal Plant

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Active phytochemicals in families

Table 1: Active phytochemicals reported in families of assorted herbs (adapted from Craig (1999), Lister (2003).

Family	Common name	Active phytochemicals
Alliaceae	Chives, garlic	Sulphur compounds, flavonoids
Asteraceae	Tarragon	Terpenoids
Apiaceae (=Umbelliferae)	Chervil, coriander,dill, fennel, lovage, parsley	Polyacetylenes, terpenoids
Boraginaceae	Borage	Terpenoids
Brassiciaceae (=Cruciferae)	Horseradish, wasabi	Glucosinolates/isothiocyanates, flavonoids
Lamiaceae	Basil, lemon balm, marjoram, mint, oregano, rosemary, sage, savory, thyme	Terpenoids, flavonoids, phenolic acids,
Lauraceae	Bay leaf	Terpenoids

Phenolics compounds in families

- **See lecture 4 (Function – types)**

Phenolics compounds in families

Table 2: Phenolic compounds in selected herbs from the Lamiaceae family (mg GAE/100 g fresh weight). From Zheng & Wang 2001.

Phenolic compound	Sage *(Salvia officinalis)*	Marjoram *(Origanum × majoricum)*	Thyme *(Thymus vulgaris)*	Rosemary *(Rosmarinus officinalis)*
Vanillic acid	2.27			1.73
Caffeic acid	7.42	10.4	11.7	2.95
Luteolin	33.4		39.5	
Rosmarinic acid	117.8	154.6	91.8	32.8
Hispidulin	16.3	48.7	20.8	19.7
Cirsimaritin	14.3			24.4
Carnosic acid				126.6
Apigenin	2.4	3.5		1.1
Naringin (naringenin-5-rhamnosidoglucoside)				53.1
Rosmanol				124.1

Phenolics compounds in families

Table 3: Total phenolic content and antioxidant activity (ORAC) in various herbal extracts (from Zheng & Wang 2001).

Common name	Botanical name	Total phenolic content (mg GAE/g fresh weight)	ORAC(μmol Trolox equivalents (TE)/ g fresh weight)
Chives	*Allium schoenoprasum*	1.05	9.15
Dill	*Anethum graveolens*	3.12	29.12
Fennel	*Foeniculum vulgare*	0.68	5.88
Garden sage	*Salvia officinalis*	1.34	13.28
Garden thyme	*Thymus vulgaris*	2.13	19.49
Greek mountain oregano	*Origanum vulgare* ssp. *hirtum*	11.80	64.71
Hard sweet marjoram	*Origanum* × *majoricum*	11.65	71.64
Lemon balm	*Melissa officinalis*	1.26	9.54
Lemon thyme	*Thymus* × *citriodorus*	1.78 ±	13.28

Phenolics compounds in families

Lovage	*Levisticum officinale*	2.63	21.54
Orange mint	*Mentha aquatica*	2.26	19.80
Parsley	*Petroselinum crispum*	1.12	11.03
Pineapple sage	*Salvia elegans*	1.31	11.55
Rosemary	*Rosmarinus officinalis*	2.19	19.15
Salad burnet	*Sanguisorba minor*	0.99	8.33
Spearmint	*Mentha spicata*	0.94	8.10
Sweet basil	*Ocimum basilicum*	2.23	14.27
Sweet bay	*Laurus nobilis*	4.02	31.70
Vietnamese coriander	*Polygonum odoratum*	3.09	22.30
Winter savory	*Satureja montana*	3.16	26.34

Phenolics compounds in families

Table 4: Total phenolic content in assorted fruit and vegetables (from Wu et al. 2004).

Food	Total phenolics (mg GAE/g fresh weight)
Fuji apple	2.11
Apricot	1.33
Blueberry, low bush	7.95
Kiwifruit	2.78
Orange, navel	3.37
Raspberry	5.04
Watermelon	1.42
Broccoli	3.37
Carrots	1.25
Lettuce, iceberg	0.5
Peppers, red	4.24
Spinach	2.17
Tomatoes	0.8

Carotenoids

The carotenoids are a group of yellow-orange-red pigments found in a variety of fruits and vegetables as well as in algae, fungi and bacteria. Carotenoids cannot be synthesised in the body and are present solely as a result of ingestion from other sources, either ingestion of the plant itself or a product from an animal that has consumed that plant source, e.g. egg yolks are yellow because of the carotenoids they contain. Often, the colours of the carotenoids present in plants are masked by chlorophyll, to the extent that some of the highest levels of carotenoids are found in dark green leafy vegetables such as kale and spinach.

Carotenoids are lipids and consist of a long-chain hydrocarbon molecule with a series of central, conjugated double bonds. These conjugated (alternating) double bonds not only confer colour, but also give the compounds their antioxidant properties. These compounds are especially effective in quenching singlet oxygen and peroxyl radicals. They appear to act synergistically with other carotenoids and other antioxidants. In plants, these pigments assist in the light-capturing process in photosynthesis and protect against damage from visible light. In humans one of their various benefits is believed to be protecting both the skin and the macula lutea of the eye against the same photoxidative damage (Sies & Stahl 2003).

Carotenoids

Some carotenoids can be converted into vitamin A by the body (pro-vitamin A activity). Besides their radical scavenging activity, they have anti-cancer properties such as inhibiting tumour growth and aiding cell communication, as well as enhancing the immune system and recycling vitamin E (Lister 2003).

There is little research available on this aspect of their composition, perhaps because the small quantities consumed means that their dietary contribution is minor, or because carotenoids contribute less to antioxidant activity than do the more studied phenolics. It is nonetheless interesting to note that in comparison with many other fruit and vegetables, which are considered to be major dietary sources of the main carotenoids, they are particularly concentrated in certain herbs (Table 5).

Table 5: Carotenoid content of assorted raw herbs and yellow/orange fruit and vegetables (micrograms/100 g) from USDA National Nutrient Database for Standard Reference Release 18, 2005 and USDA National Nutrient Database for Standard Reference Release 19, 2006 (USDA 2005, 2006).

Food	β-carotene	Lutein + zeaxanthin
Basil	3142	5650
Chives	2612	323
Coriander	3930	865
Parsley	5054	5561
Thyme	2851	N/A
Apricot	1094	89
Capsicum, red, raw	1624	51

Carotenoids

Parsley	5054	5561
Thyme	2851	N/A
Apricot	1094	89
Capsicum, red, raw	1624	51
Carrot, raw	8285	256
Carrot, boiled	8332	687
Corn (sweet), raw	52	764
Persimmon	253	834
Pumpkin, raw	3100	1500
Spinach (raw)	5626	12198
Sweet potato, raw	8506	0

Chlorophyll

Chlorophyll

Chlorophyll, the pigment that gives plants their green colour and which is of major importance in photosynthesis, is also present in herbs. Two different types of chlorophyll (chlorophyll a and chlorophyll b) are found in plants, each absorbing light at slightly different wavelengths.

Relatively little is known of the health effects of chlorophyll. Some research suggests that it may be important in protecting against some forms of cancer by binding to mutant DNA to prevent it proliferating. A recent study found that chlorophyll had phase 2 enzyme-inducing potential and, although its activity was relatively weak, its high concentrations in so many edible plants might cause some of the protective effects observed in diets rich in green vegetables (Fahey et al. 2005).

Essential oils

Essential oils

The term “essential oil” is frequently encountered in relation to herbs. In fact, it is somewhat misleading. First, rather than being vital or indispensable, as in the sense of “essential fatty acids”, the term “essential” describes how the oil represents the unique nature of the plant material – particularly its smell and taste – its essence. Second, these compounds are not food oils, which comprise a glycerol backbone and three fatty acids. Rather, they are composed of terpenes, alcohols, aldehydes, ketones, acids, esters, oxides, lactones, acetals and phenols. Like other oils, however, they are not soluble in water and are liquid at room temperature. They are also known as volatile oils.

Essential oils are complex mixtures of a large number of components. For example, in a recent study of the composition of various essential oils, Sacchetti et al. (2005) listed over 60 individual compounds identified in thyme essential oil. Terpenoids are particularly important components, responsible for many of their biological activities, including their antioxidant activity (especially phenolic terpenoids) and their anti-microbial activity, e.g. thymol, carvacrol and eugenol (Joseph et al. 2002; Edris 2007). Table 6 lists various terpenoids and some of their sources.

Essential oils

Table 6: Important bioactive terpenoids found in herbs (Craig 1999; Joseph et al. 2002; Shan et al. 2005; Edris 2007).

Compound	Herb sources
Carvone	Mint, dill
Cineole	Coriander, rosemary, sage, thyme
Farnesol	Lemon grass
Geraniol	Lemon grass, coriander, lemon balm, basil, rosemary, thyme
Limonene	Mint, dill, coriander, fennel thyme
Linalool	Rosemary, lemon grass
Menthol	Peppermint
Perillyl Alcohol	Mint, sage, lemon grass
A-Pinene	Coriander, fennel, rosemary, thyme
Eugenol	Basil, bay leaf
Myristicin	Parsley, dill
Citral	Lemon grass
Thymol	Thyme
Carvacrol	Savory, basil, oregano
Carnosol, carnosic acid	Rosemary, sage
γ-Terpinine	Thyme, rosemary

Essential oils

Although essential oils have been mostly studied for their antioxidant and anti-microbial activity, they and their components also have various anti-cancer effects, such as preventing interactions between carcinogens and DNA, inducing endogenous protective enzymes, inhibiting cancer cell proliferation and increasing apoptosis. Potential cardiovascular-protective properties include preventing lipid peroxidation, lowering levels of plasma cholesterol and triglycerides and reducing blood pressure through vasodilatory or smooth muscle-relaxing effects. Some antidiabetic properties have also been observed. An interesting new area of research relates to the ability of some of their compounds, particularly terpenoids, to be absorbed through the skin, suggesting a possible role as vectors for transdermal drug delivery (Edris 2007).



THANKS
FOR
LISTENING