Capsicum

Species (Family)

Capsicum species (Solanaceae) including *C. annum* L., *C. baccatum* L., *C. chinense* Jacq., *C. frutescens* L., *C. pubescens* Ruiz & Pavon, *C. minimum* Roxb.

Synonym(s)

Cayenne, Chilli Pepper, Hot Pepper, Paprika, Red Pepper, Tabasco Pepper

Part(s) Used

Fruit

Pharmacopoeial and Other Monographs

BHP 1996[G9]
Complete German Commission E (Paprika)[G3]
Martindale 32nd edition[G43]
PDR for Herbal Medicines 2nd edition[G36]
USP24/NF19[G61]

Legal Category (Licensed Products)

GSL[G37]

Constituents[G22,G41,G64]

Capsaicinoids Up to 1.5%, usually 0.11%. Major components capsaicin (48.6%), 6,7-dihydrocapsaicin (36%), nordihydrocapsaicin (7.4%), homodihydrocapsaicin (2%) and homocapsaicin (2%).

Volatile oils Trace. Over 125 components have been isolated with at least 24 characterised.

Other constituents Carotenoid pigments (capsanthin, capsorubin, carotene, lutein), proteins (12–15%), fats (9–17%), vitamins including A and C.

Other plant parts The plant material contains solanidine, solanine and solasodine (steroidal alkaloidal glycosides) and scopoletin (coumarin).

Food Use

Capsicum (chilli) peppers are widely used as a spice. Capsicum is listed by the Council of Europe as a natural source of food flavouring (category N2). This category indicates that capsicum can be added to foodstuffs in small quantities, with a possible limitation of an active principle (as yet unspecified) in the final product.[G16] In the USA, capsicum is stated to be GRAS (Generally Recognised As Safe).[G41]

Herbal Use[G4,G7,G64]

Capsicum is stated to possess stimulant, antispasmodic, carminative, diaphoretic, counterirritant, antiseptic and rubefacient properties. Traditionally, it has been used for colic, flatulent dyspepsia without inflammation, chronic laryngitis (as a gargle), insufficiency of peripheral circulation and externally for neuralgia including rheumatic pains and unbroken chilblains (as a lotion/ointment). The German Commission E approved external use for treatment of painful muscle spasms in shoulder, arm and spine; arthritis, rheumatism, lumbago and chilblains.[G3]

Dosage

Fruit 30–120 mg three times daily.[G7]

Capsicum Tincture (BPC 1968) 0.3–1.0 mL; capsaicin content 0.005–0.01%.[G4]

Stronger Tincture of Capsicum (BPC 1934) 0.06–2.0 mL.

Oleoresin 0.6–2.0 mg.[G44]

Oleoresin, internal 1.2 mg (maximum dose), 1.8 mg (maximum daily dose).[G37]

Oleoresin, external 2.5% maximum strength.[G37]

Creams, ointments 0.02–0.05%.[G4]

Pharmacological Actions

The action of capsaicin on nervous, cardiovascular, respiratory, thermoregulatory and gastrointestinal systems has been reviewed.[1] Capsaicin has been used as a neurochemical tool for studying sensory neurotransmission.[1]

In vitro and animal studies

Infusion of capsaicin (200 µg/kg, by intravenous injection) has been reported to evoke dose-dependent catecholamine secretion (adrenaline, noradrenaline) from the adrenal medulla of pentobarbitone-anaesthetised rats.[2]

The addition of capsaicin (0.014%) to a high-fat (30%) diet fed to rats was found to reduce serum-triglyceride concentrations but to have no effect on serum cholesterol or pre-β-lipoprotein concentrations.[3] Capsaicin was thought to stimulate lipid mobilisation from adipose tissue. Lipid absorption was unaffected by capsaicin supplementation.[3]

Activities of two hepatic enzymes, glucose-6-phosphate dehydrogenase and adipose lipoprotein lipase, were elevated in rats when capsaicin was added to the diet.[3] Capsicum extracts fed orally to hamsters have been reported to significantly decrease hepatic vitamin A concentrations.[4] Serum vitamin A concentrations were not affected.[4]

Both the gastric and duodenal mucosae are thought to contain 'capsaicin-sensitive' areas which afford protection against acid- and drug-induced ulcers when stimulated by hydrochloric acid or by capsaicin itself. Stimulation causes an increase in mucosal blood flow and/or vascular permeability, inhibits gastric motility, and activates duodenal motility.[5] Desensitisation of these areas, using a regimen involving subcutaneous or oral administration of capsaicin, is thought to remove the protection.[5] However, capsaicin desensitisation was found to have little effect on peripheral responses to stress (i.e. ulcer formation) but did enhance central responses (increase in plasma corticosterone concentration) in rats.[6] The increase in plasma corticosterone concentration observed in capsaicin-desensitised rats was similar in stressed and non-stressed animals.[6]

Capsaicin was found to influence adrenal cortical activity independently of the presence of a stress factor and may represent a stressor in itself.[6] Capsaicin desensitisation was not found to influence basal gastric acid secretion in non-stressed rats, but did lower pentagastrin-stimulated gastric output.[6] However, other results have reported that capsaicin desensitisation does increase acid secretion.[6]

Capsicum (leaf and stem) has been reported to exhibit uterine stimulant activity in animal studies.[G30]

Pharmacokinetic studies in rats have reported that capsaicin is readily transported via the gastrointestinal tract and absorbed through non-active transport into the portal vein.[2] Capsaicin is partly hydrolysed during absorption and the majority is excreted in the urine within 48 hours.[2,7] Dihydrocapsaicin-hydrolysing enzyme is present in various organs of the rat but principally in the gastrointestinal tract and the liver. The biotransformation pathway of dihydrocapsaicin in the rat has been studied.[7] Metabolites are mainly excreted as glucuronide conjugates in the urine.[7]

Clinical studies

Ingestion of red chillies (10 g in wheatmeal) by controls and duodenal ulcer sufferers has been reported to have no significant effect on acid or pepsin secretion, or on sodium, potassium and chloride concentrations in the gastric aspirate.[8] There was reported to be no apparent change (qualitative or quantitative) in mucous and no gastric mucosal erosion was evident.[8] However, in contrast, capsicum has been shown to increase acid concentration and DNA content (indicating exfoliation of epithelial cells) of gastric aspirates in both control subjects and patients with duodenal ulcers.[1] A study involving 18 healthy volunteers suggested that chilli (20 g in 200 mL water) protected against aspirin-induced gastroduodenal mucosal injury, compared with control (water).[9]

Capsicum is applied externally as a counter-irritant in many preparations used for rheumatism, arthritis, neuralgia and lumbago. Clinical studies of topical preparations containing capsaicin have investigated its effectiveness in the treatment of chronic post-herpetic neuralgia, shingles, diabetic neuropathy, rhinopathy and neuropathic pain in cancer patients.[G4,]

A systematic review of randomised, double-blind, placebo-controlled trials of topical capsaicin included 13 trials involving patients with diabetic neuropathy, osteoarthritis, post-herpetic neuralgia, postmastectomy pain and psoriasis.[10] All the included trials reported that capsaicin was superior to placebo. However, the review drew cautious conclusions because blinding may have been compromised by the irritant effects of capsaicin.

Side-effects, Toxicity

Capsicum contains pungent principles (capsaicinoids) that are strongly irritant to mucosal membranes. Inhalation of paprika can produce a form of allergic alveolitis.[G51]

Chronic administration of capsicum extract (0.5 µg capsaicin/kg body weight) to hamsters has been reported to be toxic.[4] Treated animals did not survive beyond 17 months whereas all untreated controls survived beyond this period. In addition, eye abnormalities were observed in the treated animals. This effect was attributed to the depletion of

substance P in primary afferent neurons by capsaicin, causing a loss of corneal pain sensation and subsequently the loss of protective corneal reflexes.[4]

It is thought that metabolism of capsaicin and related analogues may reduce their acute toxicity.[7] LD_{50} values stated for capsaicin in mice include 0.56 mg/kg (intravenous), 7.56 mg/kg (intraperitoneal), 9.00 mg/kg (subcutaneous) and 190 mg/kg (oral). In rats, an intraperitoneal LD_{50} of 10 mg/kg has been reported for capsaicin.[7] The toxicity of capsaicinoids has reportedly not been ascribed to any one specific action but may be due to their causing respiratory failure, bradycardia and hypotension.[7]

Contra-indications, Warnings

Capsicum may cause gastrointestinal irritation, although it has been stated that capsicum does not influence the healing of duodenal ulcers and does not need to be avoided by patients with this condition.[1] Excessive ingestion may cause gastroenteritis, hepatic or renal damage.[G42] Capsicum may interfere with monoamine oxidase inhibitors (MAOIs) and antihypertensive therapy (increased catecholamine secretion), and may increase the hepatic metabolism of drugs (glucose-6-phosphate dehydrogenase and adipose lipoprotein lipase activity elevated).

Pregnancy and lactation There are no known problems with the use of capsicum during pregnancy, although it may cause gastrointestinal irritation and should therefore be used with caution. Doses should not greatly exceed amounts normally ingested in foods. It is not known whether the pungent components in capsicum are secreted into the breast milk.

Pharmaceutical Comment

Capsicum is commonly used in both foods and in medicinal products. The capsaicinoids are principally responsible for the biological activity of capsicum. These pungent principles are thought to stimulate and aid digestion and to act as a counter-irritant when applied externally. Capsaicin has also been used as a neurochemical tool for studying sensory neurotransmission. Topical creams containing capsaicin 0.025% and 0.075% are licensed in the UK for the treatment of pain in osteoarthritis, and painful diabetic neuropathy and post-herpetic neuralgia, respectively.[11] Capsicum oleoresin and capsaicin are ingredients of a number of over-the-counter (OTC) topical preparations for relief of pain in muscle, tendon and joints.[11]

Conflicting reports have been documented concerning the effect of capsicum on acid secretion and on ulcer healing. Capsaicin-sensitive areas of the gastric and duodenal mucosa are thought to provide protection against mucosal damage. It has been suggested that this protection is lost if the sensory fibres are desensitised. Whether oral consumption of capsicum by humans can cause desensitisation is unclear. The toxicity of capsicum extracts observed in animals is considered to be due to the capsaicinoid components. However, ingestion of capsicum in the diet is not thought to represent a health risk. Capsicum should not be ingested in doses greatly exceeding amounts normally used in foods.

References

See also General References G3, G5, G9, G12, G16, G22, G30, G31, G32, G33, G36, G37, G41, G43, G48, G51, G56, G61 and G64.

1 Locock RA. Capsicum. *Can Pharm J* 1985; 118: 517–519.
2 Watanabe T *et al.* Capsaicin, a pungent principle of hot red pepper, evokes catecholamine secretion from the adrenal medulla of anesthetized rats. *Biochem Biophys Res Commun* 1987; 142: 259–264.
3 Kawada T *et al.* Effects of capsaicin on lipid metabolism in rats fed a high fat diet. *J Nutr* 1986; 116: 1272–1278.
4 Agrawal RC *et al.* Chilli extract treatment and induction of eye lesions in hamsters. *Toxicol Lett* 1985; 28: 1–7.
5 Maggi CA *et al.* Capsaicin-sensitive mechanisms and experimentally induced duodenal ulcers in rats. *J Pharm Pharmacol* 1987; 39: 559–561.
6 Dugani A, Glavin GB. Capsaicin effects on stress pathology and gastric acid secretion in rats. *Life Sci* 1986; 39: 1531–1538.
7 Kawada T, Iwai K. *In vivo* and *in vitro* metabolism of dihydrocapsaicin, a pungent principle of hot pepper in rats. *Agric Biol Chem* 1985; 49: 441–448.
8 Pimparkar BND *et al.* Effects of commonly used spices on human gastric secretion. *J Assoc Physicians India* 1972: 20: 901–910.
9 Yeoh KG *et al.* Chili protects against aspirin-induced gastroduodenal mucosal injury in humans. *Dig Dis Sci* 1995; 40: 580–583.
10 Zhang WY *et al.* The effectiveness of topically applied capsaicin. *Eur J Clin Pharmacol* 1994; 46: 517–522.
11 British Medical Association and Royal Pharmaceutical Society of Great Britain. *British National Formulary, number 41*, 2001. London: British Medical Association and Royal Pharmaceutical Society of Great Britain, 2001.