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A Review on the Medicinally Important Plants of the Family Cucurbitaceae

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ABSTRACT

The family Cucurbitaceae includes a large group of plants which are medicinally valuable. It is a family of about 130 genera and about 800 species. Seeds or fruit parts of some cucurbits are reported to possess purgatives, emetics and antihelmintics properties due to the secondary metabolite cucurbitacin content. A number of compounds of this group have been investigated for their cytotoxic, hepatoprotective, anti-inflammatory and cardiovascular effects. Cucurbitacins constitute a group of diverse triterpenoid substances which are well known for their bitterness and toxicity. They are highly oxygenated, tetracyclic triterpenes containing a cucurbitane skeleton characterized. The cucurbitacins are arbitrarily divided into twelve categories, incorporating cucurbitacins A-T. A lot of work has been done by the researchers throughout the world on various plants of the family Cucurbitaceae. Some of the important plants that have been extensively studied are *Momordica charantia, Cucurbita pepo, Cucurbita andreana, Cucurbita ficifolia, Cucumis sativus, Cucumis melo, Citrullus colocynthis, Luffa echinata, Trichosanthes kirilowii, Lagenaria siceraria, Benincasa hispida* etc.

Key words: Cucurbitaceae, cucurbitacins, *Citrullus, Cucumis, Benincasa*

INTRODUCTION

Many researchers have paid attention towards the Cucurbitaceae family because the fruits, seeds and vegetables are traditionally consumed in various Ayurvedic preparations and confectionary. The family Cucurbitaceae includes a large group of plants which are medicinally valuable. It is a family of about 130 genera and about 800 species distributed mainly in tropical and subtropical regions of the world. The plants of the family are collectively known as cucurbits (Kocyan *et al*., 2007). The important genera belonging to the family are *Trichosanthes, Lagenaria, Luffa, Benincasa, Momordica, Cucumis, Citrullus, Cucurbita, Bryonopsis* and *Corallocarpus* (Pandey, 1969).

Cucurbits are among the largest and most diverse plant families, cultivated worldwide in a variety of environmental conditions. Although cultivated cucurbits are very similar in above ground development and root habit, they have a large range of fruit characteristics. Fruits are eaten when immature or mature. Fruits can be baked, pickled, candied, or consumed fresh in salads or dessert. The fruits of cucurbits are very useful in terms of human health, i.e., purification of blood, removal of constipation and good for digestion and give energy. Also seeds, flowers and roots are consumed by humans. Seeds or fruit parts of some cucurbits are reported to possess purgatives, emetics and antihelmintics properties due to the secondary metabolite cucurbitacin content (Bisognin, 2002; Rahman *et al*., 2008).

CUCURBITACINS

Cucurbitacins constitute a group of diverse triterpenoid substances which are well known for their bitterness and toxicity. They are highly oxygenated, tetracyclic triterpenes containing a cucurbitane skeleton characterized as 19-(10→9β)-abeo-10α-lanost-5-ene (also known as 9β-methyl-19-nor lanosta-5-ene) (Fig. 1) (Pryzek, 1979).

The cucurbitacins are arbitrarily divided into twelve categories, incorporating cucurbitacins A-T. The various cucurbitacins differ with respect to oxygen functionalities at various positions. The structures of a few cucurbitacins (A, C, B and D) are given in Fig. 2. These cucurbitacins are also present in their glycosidic forms such as cucurbitacin B glucoside containing glucose as the glycone moiety (Chen *et al.*, 2005).

The cucurbitacins are of great interest because of the wide range of biological activities they exhibit in plants and animals. They are predominantly found in the family Cucurbitaceae but are also present in several other families of the plant kingdom (Guha and Sen, 1975). Despite their toxicity, species of the plants in which they are found have been used for centuries in various pharmacopoeias. A number of compounds of this group have been investigated for their cytotoxic, hepatoprotective, anti-inflammatory and cardiovascular effects (Miro, 1995). Previous reports have

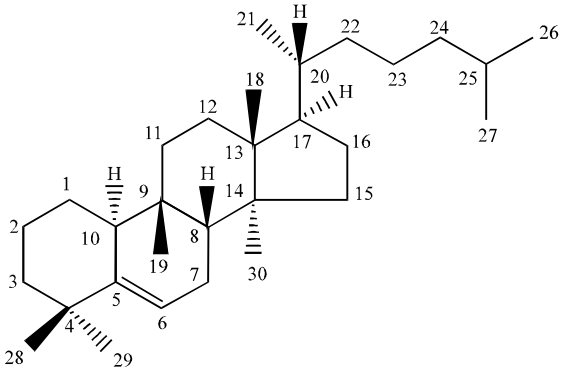
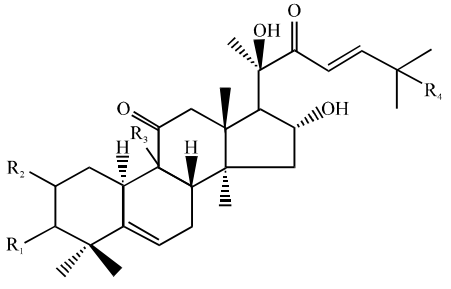


Fig. 1: Basic structure of cucurbitacins (19-(10→9β)-abeo-10α-lanost-5-ene)



(1)	R_1= =O	R_2= OH	R_3= CH_2OH	R_4= $OCOCH_3$
(2)	R_1= =O	R_2= OH	R_3= H	R_4= $OCOCH_3$
(3)	R_1= OH	R_2= H	R_3= CH_2OH	R_4= $OCOCH_3$
(4)	R_1= =O	R_2= OH	R_3= H	R_4= OH

Fig. 2: Structure of Cucurbitacin A (1), Cucurbitacin B (2), Cucurbitacin C (3) and Cucurbitacin D (4)

shown that the anti-inflammatory activities of some of the cucurbitacins are linked with the inhibition of the cyclooxygenase (COX) enzymes (Peters *et al*., 1997; Yesilada *et al*., 1998).

A lot of work has been done by the researchers throughout the world on various plants of the family Cucurbitaceae. Some of the important plants that have been studied.

***Momordica charantia* (Bitter melon):** Its local name is Karela. It is cultivated throughout the tropics, particularly in India, China, East Africa and South America and used in many countries as a folk remedy for various ailments. The fruits are used traditionally used as anthelmintic, antiemetic, carminative, purgative and for the treatment of anaemia, jaundice, malaria, cholera, etc. (Ross, 1999). Unripe fruits of the plant are mainly used for diabetes and extensive investigations have shown that an extract of the fruits has marked hypoglycemic properties both in animals and humans. It has been reported that the extracts of *Momordica charantia* show antihyperglycemic effects upon oral administration in diabetic rats (Virdi *et al*., 2003). The water extracts increase glucose uptake and adiponectin secretion in adipose cells (Roffey *et al*., 2007). The seed extract normalize the impaired antioxidant status in streptozotocin induced diabetes by scavenging of free radicals there by reducing the risk of diabetic complications (Sathishsekar and Subramanian, 2005). The antioxidant and free radical scavenging activities of aqueous and ethanol extracts have been evaluated using 2,2-diphenyl-1-picrylhydrazyl (DPPH), metal chelation, cytochrome C and Xanthine Oxidase Inhibition (XOI) assays (Wu and Ng, 2008). Several constituents such as charantin (mixture of sterol glucosides) (Fig. 3), vicine (pyrimidine nucleoside) and insulin like polypeptides responsible for hypoglycemic properties are present (Raman and Lau, 1996).

The mature fruits are used externally for the rapid healing of wounds and internally for the treatment of peptic ulcers in Turkish folk medicine. The ethanol extract of the fruits has shown significant and dose-dependent anti-ulcerogenic activity against various ulcer models (Gurbuz *et al*., 2000). The fruit extracts decrease serum and liver triglyceride levels in rats (Senanayake *et al*., 2004). Several phytochemicals such as kuguacins F-S (cucurbitane triterpenoids) have been isolated (Fig. 4) (Chen *et al*., 2009).

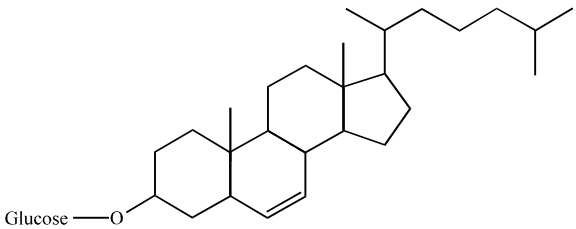


Fig. 3: Structure of charantin

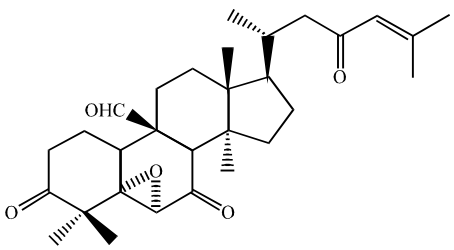


Fig. 4: Structure of kuguacin F

***Cucurbita pepo* (Pumpkin):** It locally known as Konda, Kumra and Safed kadu. It is a climbing herb which is considered to be a native of America and cultivated in many parts of India. The fruit is cooling and astringent to the bowels, increases appetite, cures leprosy and purifies the blood. Seeds cure sore chests, haemoptysis, bronchitis and fever. The seed extracts of *Cucurbita pepo* modulate immunobiochemical pathways induced by interferons (Winkler *et al.*, 2005). The seeds are claimed to be useful in the management of benign prostatic hyperplasia (Abdel-Rahman, 2006). It has been reported that the seed extract has antioxidant capacity against DPPH free radical formation and lipoxygenase inhibitory activities, respectively (Xanthopoulou *et al.*, 2009). Several cucurbitane and hexanorcucurbitane glycosides and other types of triterpenoids have been isolated from the fruits (Ge *et al.*, 2006). Anti ulcer cucurbitane type triterpenoid has been isolated from the Seeds of *Cucurbita pepo* (Gill *et al.*, 2011).

***Cucurbita andreana*:** It is a mesophytic annual from South America that displays rapid growth and prolific fruiting. Its roots and fruits are very bitter. Phytochemical investigations on this species have yielded cucurbitacins as feeding stimulants for diabrotica (Metcalf *et al.*, 1980). *Cucurbita andreana* exhibited potent anticancer and cyclooxygenase-2 (COX-2) inhibitory activities. Bioassay-guided purification of the fruit extract yielded cucurbitacins B, D, E and I. These cucurbitacins were evaluated for their anti-inflammatory and inhibitory effects on the growth of human colon, breast and lung cancer cell lines (Jayaprakasam *et al.*, 2003).

***Cucurbita ficifolia* (Fig leaf gourd):** It is a cultivated plant whose fruit can be used in many ways. Immature fruits are used to prepare different dishes for human consumption, while highly mature fruits are used to prepare crystallized candies. The fruits have also been used as remedies. The plant has been reported to cure wounds and used to treat hemorrhoids and fever. The current medical use of *Cucurbita ficifolia* is for the treatment of diabetes type 2. It has shown acute hypoglycaemic activity in temporally hyperglycemic rabbits, in alloxan-diabetic rabbits and recently, in type 2 diabetic patients (Roman-Ramos *et al.*, 1992; Acosta-Patino *et al.*, 2001).

***Cucumis sativus* (Cucumber):** Its local name is Khira or Sasha. The fruits are edible and very much used as salad. Its fruits help in removing constipation and aid indigestion. The fruits are much used during summer as a cooling food. Fruit is demulcent. Seeds are cooling, tonic, diuretic and anthelmintic. Flavone glycosides such as isovitexin (Fig. 5), saponarin and various acylated flavone C-glycosides are present in the leaves of *Cucumis sativus* (Abou-Zaid *et al.*, 2001). Antiulcer 9-beta-methyl-19-norlanosta-5-ene type Glycosides have been from *Cucumis sativus* Seeds (Gill and Bali, 2012).

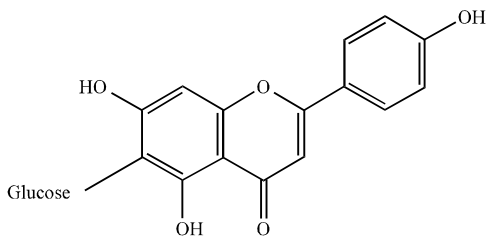


Fig. 5: Structure of isovitexin

***Cucumis melo* (Musk melon):** It is locally known as Kharbuja. The whole fruit is useful in chronic eczema. The fruit is tonic, laxative, galactagogue, diuretic and diaphoretic. The fruit extract has a high Superoxide Dismutase Activity (SOD). The SOD activity is responsible for the *in vitro* and *in vivo* antioxidant and anti-inflammatory properties of the extract (Vouldoukis *et al*., 2004). The composition of fatty acids and amino acids present in seeds has been determined. A number of phenolic glycosides have been isolated from the seeds of *Cucumis melo* var. *inodorus* (Marino *et al*., 2001).

***Citrullus colocynthis* (Bitter apple):** It is locally known as Makkal. It is a wild native plant growing in arid areas. The fruits are bitter, acrid, cooling, cathartic, carminative, antipyretic, anthelmintic and are useful in hypoglycemia, tumors, ascites, leucoderma, ulcers, asthma, bronchitis and constipation. This plant contains cucurbitacins A, B, C and D, α-elaterin and various other constituents (Adam *et al*., 2001). The aqueous extracts of the roots, stems, fruits and seeds of *Citrullus colocynthis* have been reported to possess analgesic and anti-inflammatory activities (Marzouk *et al*., 2010). The antioxidant and free radical scavenging potential of the methanolic fruit extract has been evaluated by various methods (Kumar *et al*., 2008). The seeds of *Citrullus colocynthis* possess antiulcer potential of extract (Gill *et al*., 2011).

***Luffa echinata* (Bitter sponge gourd):** It is popularly known as Bindal. It is a slender herb which grows widely in India. In the indigenous system of medicine it has been recommended for the treatment of liver ailments. *Luffa echinata* is reported to contain echinatin, saponins, cucurbitacin B and E, β-sitosterol, echinatol A and B, oleanolic acid (Fig. 6). The liver protective effects of the different extracts of the fruit against CCl_4 induced hepatotoxicity in rats have been studied. The degree of protection was measured by using biochemical parameters like serum glutamic oxalacetic transaminase (SGOT), serum glutamic pyruvate transaminase (SGPT), alkaline phosphatase (ALKP), total protein and total albumin (Ahmed *et al*., 2001).

***Trichosanthes kirilowii* (Chinese cucumber):** The seeds of *Trichosanthes kirilowii* have been used in Chinese medicine as an anti-inflammatory agent, a cough medicine and an expectorant. Several multiflorane triterpenoids have been isolated from the seed extract. The most predominant ones include karounidiol (Fig. 7) and its 3-O-benzoate derivative. These triterpenoids are expected to be potential anti-tumor promoters. Evaluation of the cytotoxic activity of karounidiol against human cancer cell lines exhibited cytotoxicity especially against a human renal cancer (Akihisa *et al*., 2001).

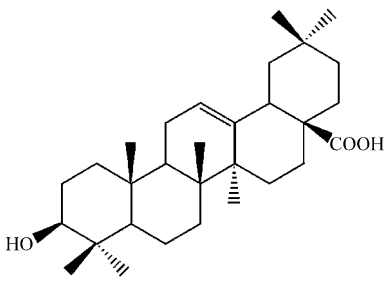


Fig. 6: Structure of oleanolic acid

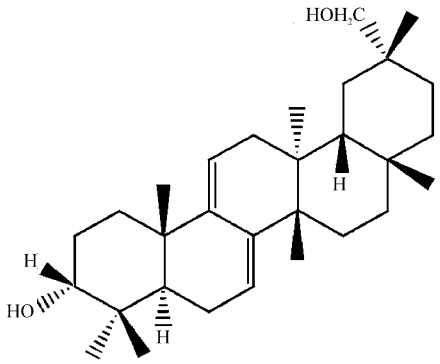


Fig. 7: Structure of karounidiol

***Trichosanthes cucumerina* (Snake gourd):** It is an annual, dioecious climber. It is widely distributed in Asian countries such as Sri Lanka and India. The whole plant including roots, leaves, fruits, seeds have medicinal properties. The root is used as a cure for bronchitis, headache and boils. Both the root and fruit are considered to be cathartic. The fruit is used as an anthelmintic. The seeds are used for stomach disorders and are also considered as antifebrile and anthelmintic. Studies on the pharmacological activities have shown the presence of anti-inflammatory activity in root tubers and antidiabetic activity in seeds of *Trichosanthes cucumerina* (Kolte *et al*., 1996-1997; Kar *et al*., 2003). In addition, to these pharmacological activities studies have been conducted to investigate the properties of galactose specific lectin isolated from seeds (Kenoth *et al*., 2001). The hot water extract of *Trichosanthes cucumerina* exerts a significant protection against ethanol or indomethacin induced gastric damage. Increasing the protective mucus layer, decreasing the acidity of the gastric juice and antihistamine activity are probable mechanisms by which the hot water extract mediates its gastroprotective actions (Arawwawala *et al*., 2010).

***Trichosanthes tricuspidata* (Indrayan):** It is a vine which is found in the southern China and throughout south and south-east Asia. In Thai traditional medicine, the plant is used as a laxative, anthelmintic and in the treatment of migraine. The root extract has shown antioxidant effect in Sildenafil induced migrane in albino mice (Nithiya and Mohan, 2009). From the fruits of *Trichosanthes tricuspidata* 14 cucurbitane glycosides such as cucurbitacin K 2-O-**β**-glucopyranoside, a hexanorcucurbitane glucoside and octanorcucurbitane glucosides were isolated along with two known cucurbitane glucoside (Kanchanapoom *et al*., 2002).

***Wilbrandia ebracteata*:** The roots and tubers of *Wilbrandia ebracteata* have been used in traditional medicine. Pharmacological studies have shown that roots and tubers produce anti-inflammatory, analgesic and antitumor effects and significant inhibition of arthritis (Rao *et al*., 1991). The hydromethanol extract of leaves was investigated to determine its anti-ulcerogenic (ethanol and indomethacin induced gastric damage) and analgesic (writhing and tail-flick tests) activities in mice (Gonzalez and Di Stasi, 2002).

***Sechium edule* (Chayote):** It is a subtropical vegetable with potent diuretic action. It is used in the relief of diseases related to the kidneys, circulatory system and inflammation. The antihypertensive effect of *Sechium edule* has has been described (Gordon, 2000). The extract of

Sechium edule is capable of altering the biodistribution of sodium pertechnetate in rats. The fruit extracts alter radiolabeling of blood elements with technetium-99m (Dire *et al*., 2003). Antioxidant activities of the extracts have been evaluated by various methods such as DPPH radical-scavenging method (Ordonez *et al*., 2006).

***Lagenaria siceraria* (Bottle gourd):** It is a commonly used vegetable in India. It is described as a cardiotonic and as a general tonic in Ayurveda. The ethanolic extract of the fruit has been evaluated against the disorders where free radicals play a major role in pathogenesis (Deshpande *et al*., 2008). It possesses cardioprotective effect against doxorubicin induced cardiotoxicity in rats (Fard *et al*., 2008). The methanol extract of the fruits has been evaluated for diuretic activity in albino rats (Ghule *et al*., 2007). The constituents isolated from the fruits show antihyperlipidemic activity in albino rats (Mohale *et al*., 2008). It cures pain, ulcers and fever and used for pectoral cough, asthma and other bronchial disorders-especially syrup prepared from the tender fruits. The fruit is reported to contain the triterepeniode cucurbitacins B, D, G, H and 22-deoxy cucurbitacin the bitter principle of cucurbitaceae (Shah *et al.,* 2010). A. The fruits of *Lagenaria siceraria* have protective effects in myocardial infarction (Upaganlawar and Balaraman, 2010).

***Benincasa hispida* (Wax gourd):** *Benicasa hispida* commonly known as wax gourd is a widely used vegetable in India and other tropical countries. It is the only member of the genus *Benincasa*. It is cultivated for its edible fruits which have a high medicinal value. In *Ayurveda, Benincasa hispida* is recommended for management of peptic ulcer, hemorrhages from internal organs, asthma, cough, diabetes, epilepsy and other nervous disorders. Acid neutralizing and ulcer healing activities of *Benincasa hispida* have also been described (Warrier *et al*., 1994). Methanol extract of *Benincasa hispida* showed excellent protection in guinea pigs against the histamine-induced bronchospasm (Anil Kumar and Ramu, 2002). α-and β-benincasins, arginine/glutamate-rich peptides with translation-inhibiting activity have been purified and characterized from wax gourd seed (Ng *et al*., 2003). The methanolic extract of fruit has been evaluated for its antidiarrheal potential against several experimental models of diarrhea in rats (Mathad *et al*., 2005). Hispin, a novel ribosome inactivating protein with antifungal activity has been isolated from the seeds (Ng and Parkash, 2002). The fruit extract shows renoprotective activity on ischemia/reperfusion induced renal damage in Rats (Bhalodia *et al*., 2009). The seed extract possess anti-angiogenic effect (Lee *et al*., 2005). The fresh juice was effective in preventing morphine withdrawal in mice (Grover *et al*., 2000). The fruit extracts prevent the development of experimental ulcers (Grover *et al*., 2001). Effect of *Benincasa hispida* on high glucose-induced vascular inflammation of human umbilical vein endothelial cells has been studied (Moon *et al*., 2009). Seeds of *Benincasa hispida* possess free radical scavenging, anti-inflammatory and analgesic potential (Gill *et al*., 2010).

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