

Original Research

Phytochemical and pharmacological properties of certain medicinally important species of Cucurbitaceae family – a review

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ABSTRACT:

Cucurbits are edible crops, belonging to the family Cucurbitaceae. They are climbers with reserves in roots and are distributed mainly in tropical zones. They are mostly moist vines and are distributed in both the eastern and western hemispheres. The member of this family are excellent fruit crops having most of the essential nutrients, vitamins and minerals required for the good health of humans. All parts of the Cucurbitaceae plants (leaf, stem, root or tuber, fruit and seeds) are used in the traditional system of medicine. Wide research is going on to search a new active compound and to analyze their medicinal properties. The present review of Cucurbitaceae family deals with the very large amount of updated information of scientific research and report in the field of phytochemistry and pharmacology. In this study, we have documented some of the important plants viz., *Mukia maderaspatana*, *Solena amplexicaulis*, *Citrullus colocynthis*, *Citrullus lanatus*, *Coccinia indica*, *Cucumis sativus*, *Cucurbita pepo*, *Lagenaria siceraria*, *Luffa acutangula*, *Trichosanthes cucumerina*, *Corallocarpus epigaeus*, *Luffa cylindrica*, *Momordica charantia*, *Trichosanthes dioica* and *Kedrostis foetidissima*.

Keywords:

Cucurbitaceae, traditional uses, phytochemicals, pharmacological activities

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INTRODUCTION

Cucurbitaceae family is also called vine family which consists of 825 species under 125 genera. The plants of this family are mainly grown around the tropics and to some extent in temperate areas also. In human food conception, this family contributes highest rank among the plant families and the major crop species are cucumber, melon and water melon. In nutritional point of view, cucurbits are one among the prime dieting foods. They contain vitamins, large amount of other nutrients and 96% of water. Many researchers are attempting to confirm the traditional medicinal uses by analyzing the phytochemical constituents, biological and pharmacological activities etc. This review reports on the medicinal values of certain species of the family Cucurbitaceae for proper understanding.

Some of the important plants that have been extensively studied in this family are *Mukia maderaspatana*, *Solena amplexicaulis*, *Citrullus colocynthis*, *Citrullus lanatus*, *Coccinia indica*, *Cucumis sativus*, *Cucurbita pepo*, *Lagenaria siceraria*, *Luffa acutangula*, *Trichosanthes cucumerina*, *Corallocarpus epigaeus*, *Luffa cylindrica*, *Momordica charantia*, *Trichosanthes dioica* and *Kedrostis foetidissima*.

Mukia maderaspatana (L.) Roem. (headache vine, madras pea pumpkin) is a prostrate or climbing annual monoecious herb. The Irula tribes of Hasanur hills of Eastern Ghats of Erode district, Tamil Nadu used this plant for curing asthma by mixing the leaf juice with gingelly oil and applying it topically on forehead before taking bath (Revathi and Parimelazhagan, 2010). The whole plant juice is prescribed against cough. The roots of the plant, when masticated, relieves toothache and decoction is consumed for flatulence (Pullaiah, 2006). Pandey et al. (2013) isolated an active compound ergosterol (Fig. 1a), from the whole plant methanolic extract of *M. maderaspatana*. Ergosterol, a sterol which occurs in animal and plant tissues are potent agent for the prevention of rickets. This compound also exhibits

anticancer (Takaku et al., 2001), anti-inflammatory (Kobori et al., 2007) and antidiabetic (Daisy et al., 2009) properties. Ethanolic and aqueous extracts of aerial and whole plant parts were reported for antihyperglycemic property (Kumar et al., 2010; Hemalatha et al., 2010). Dhanaraj et al. (2012) and Dhanaraj and Jegadeesan (2013) investigated the most prominent antiulcer activity of its aqueous leaf extract and ethanolic root extract respectively. The chloroform and methanolic extracts of the *M. maderaspatana* leaves were determined to be toxic to cancer cells (Fathima et al., 2013). The methanolic extract of the whole plant of the *M. maderaspatana* exhibited prominent anti-inflammatory activity tested against the carrageenan induced paw oedema (Mallikadevi et al., 2012).

Solena amplexicaulis (Lam.) Gandhi (creeping cucumber) is a climber with tuberous roots found in dry deciduous forests and scrub jungles of tropical zones in Asia. The tubers, leaves and seeds of the plant are widely prescribed as appetizer, cardiogenic and diuretic (Kritchevsky, 1978). Karthika (2014) isolated two compounds such as forskolin and isoquercetin (Fig. 1c and 1d) from the methanolic extract of leaf and tuber parts of *S. amplexicaulis*. Forskolin is a labdane diterpene, being used as a pharmacologically active substance with antihypertensive (Souza et al., 1983), anti-inflammatory (Hayashida et al., 2001) and antidiabetic (Ríos-Silva et al., 2014) properties. Kabir et al. (2014) investigated different pharmacological properties viz., anti-inflammatory, antinociceptive and antidiabetic of the ethanolic root extract of *S. amplexicaulis*. Anti-inflammatory activity of the aqueous extract of the leaves has also been reported by Arun et al. (2011). Parameshwar et al. (2010) investigated the hepatoprotective activity of methanolic tuber extract of *S. amplexicaulis* against carbon tetrachloride [CCl₄] intoxication in rats. The results of their study revealed that the pretreatment with higher doses of (500mg/kg) methanolic extract possessed potent hepatoprotective

activity and also could effectively control the aspartate aminotransferase (AST), alanine amino transferase (ALT) and Alkaline phosphatase (ALP) levels and increased protein levels.

Citrullus colocynthis L. (bitter apple) grows abundantly in the Arabian countries and other parts of the world. It is a purgative, anti-inflammatory, antidiabetic, analgesic, hair growth promoter, abortifacient and antiepileptic used in traditional medical practices. Srivastava et al. (2013) isolated two compounds with antimicrobial activity viz., ursolic acid and cucurbitacin E 2-O- β -D-glucopyranoside from the methanolic fruit extract of this species. Two new cucurbitane type triterpenoid saponins were isolated from the ethylacetate fruit extract by Song et al. (2015). From this species, Abbas et al. (2006) isolated flavones, and cucurbitacin glycosides. Mukerjee et al. (2014) isolated the compounds, cucurbitacin and colocynthin from the ethanolic root extract of this species which have been proved to be hepatoprotective against carbon tetra chloride induced [CCl₄] toxicity in experimental animals. Belsem et al. (2011) examined the anti-inflammatory activity of the aqueous extract of immature fruit and seeds. Gill et al. (2011a) reported the antiulcer activity of the methanolic seed extract of *C. colocynthis*. Houcine et al. (2011) assessed the antidiabetic activity of the crude extract of the whole plant of *C. colocynthis*. Shawkey et al. (2013) evaluated the anticancer activity of ethanolic extract of the different parts of this plant. The results revealed that the fruits had significant antitumour activities against all tested cell lines and the IC₅₀ values were 24.6, 16, 18.5 and 19.7 μ g/mL for HCl-116, MCF-7, Hep-G₂ and Caco-2 respectively.

Citrullus lanatus (Thunb. Matsum and Nakai) (watermelon) is widely distributed in Africa and Asia. It is used as anthelmintic, anticancer, antibacterial, demulcent and diuretic (Deshmukh et al., 2015). Siddig et al. (2011) demonstrated the anti-inflammatory activity of cucurbitacin E isolated from *C. lanatus* var. *citroides*

and the activity is due to the inhibition of production of nitric oxide in LPS/IFN γ -stimulated macrophages by this compound. This species is also reported to have many pharmacological activities like antiulcer (Lucky et al., 2012), hepatoprotective (Madhavi et al., 2012) and antidiabetic (Omigie and Agoreyo, 2014).

Coccinia indica Wight and Arn. (Ivy gourd) is a climbing or prostrate perennial herb found throughout India, both in warm and humid conditions. The whole plant is used to treat diabetes in the indigenous system of medicine (Nadkanrni, 1976). The leaves of this species are sweet, acrid, cooling and astringent, cures kapha and pitta (Kirtikar and Basu, 1935). Shivaji and Chandrashekar (2012) isolated antiheptotoxic compound β -sistosterol from the fruits and leaves of this plant. Rudrapratap et al. (2013) evaluated the anti-inflammatory activity of the methanolic extract of *C. indica* fruit. The extract exhibited significant reduction in cotton pellet induced granuloma in rats at the dose level of 200mg/kg p.o. Kumar and Kumar (2013) demonstrated the hepatoprotective activity of the aqueous fruit extract in rats. Similarly, Bambal et al. (2011) evaluated wound healing activity of the ethanolic extract of *C. indica* fruits. Ramakrishnan et al. (2011) and Ahmed and Manoj (2012) investigated the antidiabetic, antiobesity and atherogenic diets property of this plant.

Cucumis sativus L. (cucumber) is found widely in the lower Himalayas and also cultivated throughout India. The leaf juice is emetic and used to treat dyspepsia in children. The plant is traditionally prescribed as depurative, diuretic and vermifuge (Panda, 1999). From the chloroform fraction of the crude methanol extract of *C. sativus* stem, Tang et al. (2010) isolated three antimicrobial sphingolipids by bioassay-guided isolation. The fruits of the plant is reported to have many pharmacological activities. In wistar rats, Mithun et al. (2011) found the ameliorative effect of the aqueous extract of the fruit of *C. sativus* by inhibiting the

inflammatory mediators. Antiuro lithiatic activity of this species was tested in the ethanolic extract of ripe and mature fruits (Krishnaveni et al., 2013). Kumar et al. (2010) reported the free radical scavenging and analgesic activities of the aqueous fruit extract. The methanolic fruit pulp extract had significant hypoglycemic activity (Abubakar et al., 2014). On the other hand, the aqueous extract of the fruit pulp has the activities of wound contraction and elevated the rate of epithelization in wound healing process (Mithun et al., 2012). The crude methanol extract of leaves is reported to have antidiarrhoeal activity (Nasrin and Nahar, 2014). Vetrivelan et al. (2013) found prominent anti-inflammatory activity of *C. sativus* seeds in carrageenan induced paw edema model and xylene induced ear edema model in albino rats.

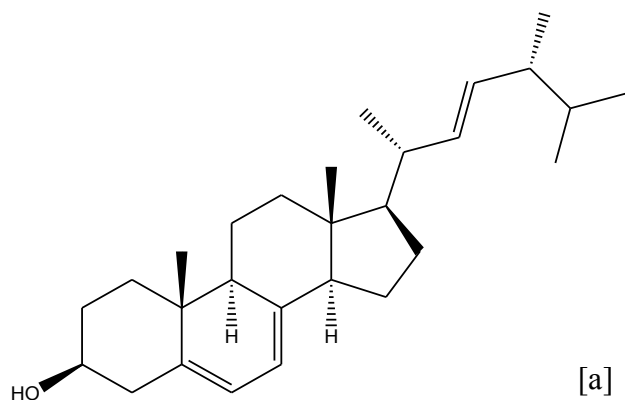
Cucurbita pepo L. (pumpkin) is used as a vegetable for human consumption and prescribed for curing ailments in the traditional medicine (Cailli et al., 2006). The ripe fruit pulp is used to treat liver disorders like jaundice (Sezik et al., 2004). A new tetracyclic triterpenoid compound, 19-(10→9β)-abeo-10α-lanost-5-ene was isolated (Fig. 1e) from the seeds (Gill and Bali, 2011). The isolated compound showed greater antioxidant and antiulcerogenic activities. Sayed (2014) reported that pumpkin oil has protective role against alcohol-induced hepatotoxicity and oxidative stress in albino rats. The fruit powder of pumpkin have hypoglycaemic and hypolipidemic activities on alloxan-induced diabetic rats (Asgary et al., 2011). The fresh fruit aquo-ethanolic (50:50) extract of *C. pepo* significantly inhibited the growth of cancer cell and cytokines involved in inflammation (Sharma et al., 2015). Further, the intake of aqueous extract of ripe fruit pulp for 14 consecutive days enhanced the alkaline phosphatase activity and mucosal thickness with concomitant decrease in ulcer index (Sarkar and Buha, 2008). The tocopherol isolated from raw pumpkin seeds of *C. pepo* is reported to have significant amelioration in

diabetes (Kumar et al., 2013). Seed oil from pumpkin is used to treat inflammation (Oliveira et al., 2013).

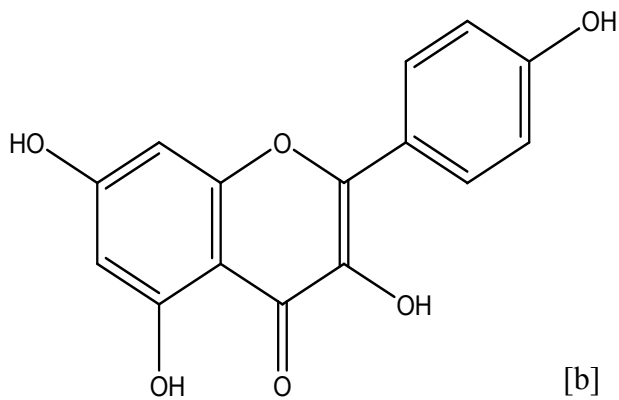
Lagenaria siceraria (Mol.) Standley (Bottle gourd) is cultivated in the tropical areas of India and as a common edible vegetable. In traditional medical practice, the fruit of the plant is prescribed as cardiogenic, aphrodisiac and general tonic (Vaidya, 1953). Rajput et al. (2011) isolated kaempferol (flavonol) (Fig. 1b) from the fruits of *L. siceraria* and it has fibrinolytic potential. Ethanolic fruit extract of *L. siceraria* significantly inhibited the fat amassment in high-fat diet-induced obese rats and related metabolic disorders (Nadeem et al., 2012). In addition, the ethanolic extract of the fruit possessed different pharmacological properties like antihyperglycemic, cardiogenic, hepatoprotective and immunomodulatory (Deshpande et al., 2008). Anti-inflammatory and antinociceptive properties have been demonstrated for aerial parts of this plant (Saha et al., 2015). The fruit juice is reported to prevent acute lung injury induced by oleic acid in rats (Fahri et al., 2013).

Luffa acutangula Linn. (ridge gourd) is a perennial climber, native to Southern and Western India. It is prescribed by the local healers for curing various ailments like jaundice, splenic enlargement, carminative and laxative. Vanajothi and Srinivasan (2014) isolated a new bioactive compound 1,8 dihydroxy-4-methylanthracene 9,10-dione which showed significant antiproliferative activity against non-small cell lung cancer cells (NCI -H460). The fruits has been reported to have antiulcer (Pimple et al., 2012), antidiabetic and antihyperlipidemic activities (Pimple et al., 2011), and is a cardiogenic with nephroprotective activity (Vishal et al., 2013). The significant anti-inflammatory and analgesic potential of *L. acutangula* was reported in 70% aqueous ethanol extract of seeds by Gill et al. (2011b).

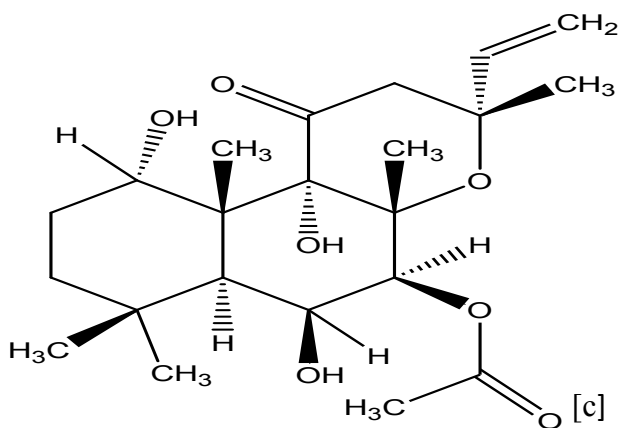
Trichosanthes cucumerina L. (snake gourd) is a climbing monoecious herb and widely distributed in the southern parts of India. In traditional health care system,



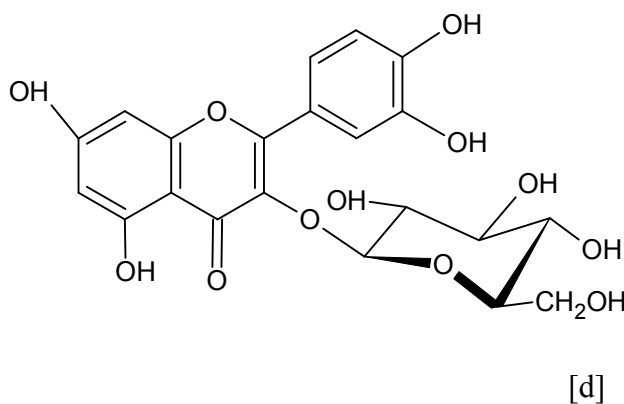
Ergosterol (*Mukia maderaspatana*) Pandey et al. (2013)



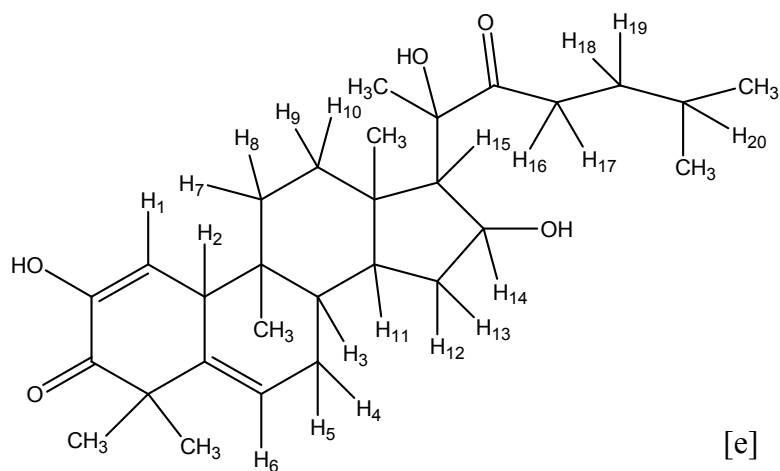
Kaempferol (*Lagenaria siceraria*) Rajput et al. (2011)



Forskolin (*Solena amplexicaulis*) Karthika (2014)



Isoquercetin (*Solena amplexicaulis*) Karthika (2014)



Tetracyclic triterpenoid compound, 19-(10-9β)-abeo-10α-lanost-5-ene (*Cucurbita pepo*) Gill and Bali (2011b)

Figure. 1 Isolated compounds from certain medicinally important plant species of Cucurbitaceae family

it is used to cure various ailments viz., headache, fever, abdominal tumors, bilious, boils, acute colic, diarrhea, hamaturia, skin allergy etc., and used as vermifuge, abortifacient, purgative and anthelmintic (Kritikar and Basu, 2006). This species was reported to have many pharmacological properties also viz., antidiabetic (Kirana and Srinivasan, 2008), hepatoprotective (Kumar et al., 2009), anti-inflammatory (Menuka et al., 2010) and as a hair growth promoter (Sandhya et al., 2012).

Corallocarpus epigaeus (Rottler) C.B. Clarke (Indian byonia, akash garudand) is a climbing monoecious herb found in India and other tropical countries. The tuber is prescribed for treating snake bite, body heat and psoriasis due to the presence of sesquiterpene lactone, a bitter principle bryonin (Kritikar and Basu, 1996). The traditional healers from the rural areas of Mysore district, Karnataka are prescribing the extracted juice of the entire vine for curing eczema. It is applied on the surface of the affected area of skin for three to four days (Chandra et al., 2014). The tuber extract of *C. epigaeus* was reported to have significant antihelmintic (Kirubha et al., 2011), antisnake venom activity (Chandrakala et al., 2013; Hemalatha et al., 2014), antidiabetic (Gnananath et al., 2013), analgesic, antipyretic and antiinflammatory (Naik et al., 2012; Jayaseelan et al., 2014) activities. Chandra et al. (2015) found that the ethanolic extract of the whole plant of *C. epigaeus* has appreciable ameliorative effect on the growth activity on K562 (chronic myeloid leukaemia) cancer cell lines.

Luffa cylindrica (L.) Roem (sponge gourd) is an annual climbing or trailing herb and distributed mainly in tropical to warm-temperate areas. The seeds are used to treat asthma, sinusitis and fever (Stephens, 2003). Xiong et al. (1994) isolated six compounds viz., lucyosides C, E, F, H a mixture of alpha-spinasterol and stigmasta-7, 22, 25-trien-3 beta-OH; and a mixture of alpha-spinastery glucoside and delta 7, 22, 25-stigmasterly-beta-D-glucoside from the fruits of this species. Isamil et al.

(2010) isolated two important antimicrobial compounds viz., 3-hydroxy-1-methylene-2,3,4,4-tetrahydroxynaphthalene-2-carbaldehyde and 22,23-dihydroxy spinasterol from petroleum ether extract of the fruits of *L. cylindrica*. The fruits are widely used as hypoglycemic (Manjusha et al., 2011), antiemetic, anti-inflammatory (Kanwal et al., 2013), analgesic, antipyretic and antidiabetic (Balakrishnan and Sharma, 2013), antidiarrhoeal and antiulcer activities (Naidu et al., 2014). The seed extract and oil obtained from this species are reported to have antiinflammatory, bronchodilator and antimicrobial properties (Muthumani et al., 2010). The whole plant ethanolic extract at the dosage level of 50 mg/kg has significantly inhibited carrageenan induced rat paw edema and also more prominent in healing the wound (Abirami et al., 2011). The methanolic extract of the leaves of *L. cylindrica* has significant hepatoprotective activity in paracetamol intoxicated wistar rats (Sharma et al., 2014).

Momordica charantia L. (bitter gourd) is pantropical in distribution. It originated in the Indian subcontinent and spread into China in the 14th century (Indrani, 2005). The fruit is edible and extremely bitter. Tan et al. (2008) isolated four cucurbitane glycosides, momodicosides Q, R, S and T from this species. These compounds and their aglycones stimulated GLUT4 translocation to the cell membrane in both L6 myotubes and 3T3-L1 adipocytes. This was associated with the increased activity of AMP-activated protein kinase, a key pathway mediating glucose uptake and fatty acid oxidation. Liu et al. (2009) isolated three new cucurbitane triterpenoids and one new steroidal glycoside with ten known compounds from the methanolic fruit extract of *M. charantia*. Oragwa et al. (2013) isolated didecanoate compound (4 a-phorbol-12, 13-didecanoate) from the seed extract. Patel et al. (2010) isolated charantin from its fruit which showed prominent antimicrobial activity against the bacteria, *Bacillus subtilis* and *Pseudomonas aeruginosa* and the fungal

species, *Saccharomyces cerevisiae*. Jutamas *et al.* (2015) isolated plumericin, an iridoid lactone with high yield from the whole plant of *M. charantia* and it exhibited good antibacterial activity against *Enterococcus faecalis* and *Bacillus subtilis* with Minimum Inhibitory Concentration (MIC) values better than the standard, cloxacillin. Further, this compound potentially inhibited proliferation of two leukemic cancer cell lines *viz.*, acute NB4 and chronic K562 at the Effective Doses (ED₅₀) of 4.35 and 5.58 µg/mL respectively.

Trichosanthes dioica Roxb. (pointed gourd) is a perennial dioecious vine, cultivated in the eastern and some northern parts of India. The leaf juice is used to treat febrifuge and in subacute cases for the enlargement of liver and spleen (Nadkarni, 1982). In Indian tradition system of medicine, the leaf and fruit are used for treating alcoholism, jaundice, odema and alopecia (Khare, 2007). Mukesh *et al.* (2011) studied the hepatoprotective activity of ethanolic and aqueous extracts of *T. dioica* against paracetamol induced hepatic damage in rats. The hydroalcoholic root extract exhibited significant antiproliferative effect at lower concentrations against ehrlich ascites carcinoma cells (Sanjib *et al.*, 2011). The aqueous leaf extract of this species effectively reduced blood glucose in glucose loaded, normoglycemic and streptozotocin induced hypoglycemic rats (Shalini *et al.*, 2010). The methanolic fruit extract of *T. dioica* is reported to have potent antioxidant, anti-inflammatory and antipyretic properties (Alam *et al.*, 2011; Kharbanda *et al.*, 2015).

Kedrostis foetidissima (Jacq.) Cogn. (appakovai) is a prostrate or climbing life-form distributed in India, Africa, Srilanka and Western Malesia. It is commonly used to treat skin diseases, measles, chest pain, asthma and urinary tract infections (Giday, 2001). Amutha and Lalitha (2013) investigated the most prominent wound healing property of petroleum ether extracts of leaf and stem parts of *K. foetidissima*. Choene and Motadi (2012)

studied the antiproliferative effects of the methanolic extracts of *K. foetidissima* in breast cancer cell lines. Results of their study revealed that the crude extract induced apoptosis in both MCF 7 and YMB-1 cancer cells and there by suggested for treating breast cancer. Saravana and Manokaran (2012) found that this species holds more effective anti-anaemic activity in wistar rats. Their results reported that the higher dose of (300mg/kg) hydroalcoholic extract significantly (P<0.01) enhanced the RBC count from the first week of treatment to 4th week of treatment in comparison to that of the standard drug, Vitamin B₁₂ syrup (1ml/kg). Ramzi *et al.* (2014) explored the crude extract of *K. foetidissima* for antiparasmodial, antileishmanial and antitrypanosomal properties.

CONCLUSION

In the present report, we reviewed phytochemical constituents and pharmacological properties of certain important medicinal plant species of Cucurbitaceae family. Different parts of the plants such as leaf, stem, root, tubers, immature and ripen mature fruits, fruit pulp, fresh fruits and seeds of the various members of this family have been studied extensively by many researchers. Interestingly, most of the studies were carried out in the fruit part only. The phytochemical and pharmacological review undertaken in this plant family displayed multidisciplinary usage of these plants in curing various types of diseases. Considering its huge phytochemical and variety of pharmacological activities, the Cucurbitaceae members could be proposed as good candidates for discovering new drugs.

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