Review Article

Potential Bio-Resources of *Momordica dioica* Roxb: A Review

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Received: 11-06-2017; **Revised:** 02-08-2017; **Accepted:** 16-08-2017.

ABSTRACT

Momordica dioica is a perennial, dioecious; cucurbitaceous climbing creeper (commonly known as kakrol, spiny gourd or teasle gourd) plant is used both in the prevention and cure of various diseases and in the food of humans. It is necessary that we should have full knowledge regarding the therapeutically use and pharmacology activities for their proper utilization. This review aims to take an attempt to evaluate the phytochemical, ethno botanical, phytotherapeutical and pharmacological properties of *Momordica dioica* according to the view of traditional medicinal plant based treatment including ayurveda along with recent scientific observations. *Momordica dioica* is considered as an underutilized vegetable, although having significant presence of certain compounds containing higher nutritional value than many frequently consumed vegetables. Moreover, as a traditional medicinal plant, it is still potential for its phytochemical components that increase the demand of further extensive evaluation to justify its other therapeutical roles. Therefore, this effort will be helpful to researchers who interested to disclose the unjustified phytotherapeutical role of *Momordica dioica*. We believe this study of *Momordica dioica* medicinal plant presented in this review will be useful to researchers, as well as practitioners.

Keywords: *M. dioica*, Phytochemical, Ethno botanical, Phytotherapeutical, Pharmacological.

INTRODUCTION

Cucurbitaceae is a plant family commonly known as melons, gourds or cucurbits and includes crops like cucumbers, squashes (including pumpkins), luffas, and melons (including watermelons). (Sivasudha et al 2012) the family is predominantly distributed around the tropics, where those with edible fruits were amongst the earliest cultivated plants in both the old and new world. Major genera under this family are *Trichosanthes* (100 species), *Cayaponia* (60 species), *Momordica* (47 species), *Gurania* (40 species), *Sicyos* (40 species) and *Cucumis* (34 species). This is one of the most genetically diverse groups of food plants in the plant kingdom. The plants belonging to this family are forst-sensitive, drought tolerant, and intolerant to wet and poorly drained soils, production of cucurbits seems to have increased over the time due to high demand and consumer. They are well known for the bitter taste due to the presence of phytochemical (alkaloid) and have a wide range of medicinal values.[1-3]A *Momordica* species is an annual or perennial climber that contains about 80 species **(**Raj et al 1993). This is generally found throughout India, Pakistan, Bangladesh, and also extends from Himalayas to Ceylon. Reported up to an altitude of 1500m in Assam, Garo hills of Meghalaya (Ram et al 2002) and Western Ghats, one of the mega diversity hotspots, hold a rich treasure of diversity in Momordica L, it comprises *M. charantiavar. muricata*, *M. charantia var. charantia, M. dioica and M. sahyadrica* (Joseph & Antony, 2008). The revival of interest in natural drugs started in last decade mainly because of the wide spread belief that green medicine is healthier than synthetic products. Nowadays, there is manifold increase in medicinal plant based industries. Due to the increase in the interest of medicinal plants throughout the world which are growing at a rate of 7-15% annually, despite the major advances in the modern medicine, the development of new drugs from natural products is still considered important. Medicinal plants as a possible therapeutic measure has become a subject of active scientific investigations. The *Momordica* species have been used in indigenous medical systems in various countries in Asia and Africa. Based on the indigenous knowledge, wild plant foods play a vital role in the complex cultural system of tribal people for reducing various disorders. Research has shown that many edible wild plants are rich in specific constituents, referred as phytochemical, which may have health promoting effects.

So far no review has been covered from the literature encompassing valuable attributes of *M. dioica* in all dimensions. Its versatile utility as a nutritious vegetable, folk medicine and functional food ingredient provoked us to compile a comprehensive review of this multipurpose fruit on the distribution, nutritional attributes and phytochemical composition and its medicinal properties.

Biogeography and Botanical description

Based on the both historical literature and recent analysis *Momordica dioica* Roxb is a perennial dioecious climber with tuberous roots. Taxon *Momordica dioica* Roxb has been verified by US Department of Agriculture as member of family Cucurbitaceae, subfamily cucurbitoideae. Genus *Momordica* could perhaps refer to sculptured seed or uneven appearance of fruit, which look as if they have been bitten. The plant commonly

known as 'Kakora' in Gwalior Chambal Division of M.P., is supposed to have originated in Indo- Malayan region (Rashid, 1976 & Singh, 1990). In India, it is distributed widely from Himalayas to Southern peninsula and amongst other parts of Indian subcontinent including Pakistan, Bangladesh, Myanmar and Srilanka, growing wild and mostly cultivated for its fruit which is used as a vegetable (Sastri 1962, Singh et al 2009). The fruit is oval with soft spines; aerial part of the plant dies at the beginning of winter. Plant perennates through sprouting of tubers at the onset of survival of the plant and creates a big production loss. The species is cultivated by vegetative propagation method from underground tuberous roots.

Nutritional values

Momordica dioica contains Lectins, proteins, triterpenes and vitamins (Naik 1951). The fruit contains a high amount of vitamin C (Bhuiya 1977). The fruit is rich in ascorbic acid and contain iodine (Rao 2001). The fruit also contains alkaloid, flavonoids, glycosides and amino acids (Kushwahet al 2005) *Momordica dioica* also contains an alkaloid, a fragment extractive matter and ash 3 to 4p.c. Ash contains a trace of manganese (Data 2010). *Momordica dioica* as the average nutritional value per 100g edible fruit was found to contain 84.1% moisture, 7.7g carbohydrate, 3.1g protein, 3.1g fat, 3.0g fibre and 1.1g minerals. It also contained small quantities of essential vitamins like ascorbic acid, carotene, thiamine, riboflavin and niacin (singh 2006). It also content protein in the leaves and dry weight of aerial plant parts remained higher in male as compared to female defruited and monoecious plants (Ghosh 2005) from *Momordica dioica*.

Bioactive compounds

Momordica dioica is as dioeciously climbing herb belonging to family Cucurbitaceae. It contains many phytoconstituents. Phytoconstituents of *Momordica dioica* are traces of alkaloids, steroids, triterpenoid, flavonoids, glycosides, saponin, triterpenes of urisolic acid dark brown semidrying oil and saturated fatty acids, ascorbic acids, vitamin A, thiamine, riboflavin's, niacin, protein carbohydrates, lectins, ascorbic acids, carotenes, bitter principles, oleanoic acid, stearic acid, gypsogenin, α-spiranosterol hederagenin, *Momordica ursenol*. The alkaloid present in seed called momordicin and present in root called *Momordica foetida*.

Table 1: Proximate and mineral composition of *Momordica dioica* Behera et al., [4] &JyotsnaSalvi and S. S. Katewa (2015)

Composition	*M. dioica*
Moisture /%	84.1
Ash /%	6.7
Lipids /%	4.7
Fibre /%	21.3
Protein/%	19.38
Carbohydrate /%	47.92
Energy k cal/100 g	311.50
Calcium m g/100 g	33
Sodium m g/100 g	1.51
Potassium m g/100 g	8.25
Iron m g/100 g	4.6
Phosphorus m g/100 g	42

Table 2: Vitamin composition of fruits of *Momordica dioica*

Vitamins (g/100g)	*M. dioica*	*Recommended dietary allowances (mg/day)**
Vitamin A	2.5	-
VitaminB1 (Thiamine)	1.8	1.7
Vitamin B2 (Riboflavin)	3.5	1.7
Vitamin B3 (Niacin)	1.9	18
Vitamin B5 (Pantothenic Acid)	18	-
Vitamin B6(Pyridoxine)	4.3	2.0
Vitamin B9 (Folic Acid)	3.6	0.2
Vitamin B12 (Cyanocobalamin)	4	0.001
Vitamin C (Ascorbic Acid)	-	40
Vitamin D2 & 3 (Cholecalciferol)	3	-
Vitamin H (Biotin) g/100g	6.5	-
Vitamin K (Phytonadione)	15	-

Table 3: Fatty acid composition of fruits of *Momordica dioica*

Fatty Acids	*Momordica dioica*
Myristic Acid (%)	3.589
Palmitic Acid (%)	12.157
Stearic Acid (%)	3.547
Oleic Acid (%)	56.253
Linoleic Acid (%)	22.511
Alpha-Linolenic Acid (%)	1.943

Cucurbitacins and cucurbitane glycosides; structures Sadyjatha et al examined the chemical constituents ofthe rhizome of *Momordica dioica* revealed the presence of β-sitosterol saponin glycosides and alkaloids. *Momordica dioica*, fruit isolated 6-methyl tritriacont-50 on -28-of and 8-methyl hentracont-3-ene along with the known sterol pleuchiol. *Momordica uresenol*, an unknown pentacylic triterpene isolated from the seeds, had been identified as urs-12, 18 (19) - dien-3 beta-ol on. Phytochemical investigations have revealed the presence of traces of alkaloids and ascorbic acid in fruits. Lectins, β-sitosterol, saponin, glycosides, triterpenes of ursolic acids, hederagenin, oleanolic acids, α-spiranosterol, stearic acid, gypsogenin, two novel aliphatic constituents (Ali andSrivastava 1998, Sadyojatha and Vaidya 1996, Ghosh et al 1981, Luo et al 1998) from the dry root of *Momordica dioica* isolated three triterpenes and two steroids compounds. These were α-spinasteroloctadecanonate (I), α-spinasterol-3-O-β-D-glucopyranoside (II), 3-O-β-D-glucuronopyranosylhederagenin (V). Constituent III was a new compound.

Accomplish of physiological bioactivities of *Momordica dioica* Roxb on human health

Figure 1: *Momordica dioica* Roxb

The plant is used for the treatment of eye diseases, against fever, snake bite, inflammation caused by lizard; is also used as medicine for diabetes (Khare 2004, Kirtikar 1999, Nadkarni 2004). While investigating the spermatogenic properties of the ethanolic extract of the fruit extract of *M. dioica* on the animal, the behavioral observations led us for sedative activity of the extract. Not much work is available about the pharmacological and other activities of the plant. Juice of root of *M. dioica* is immune stimulant and antiseptic. Its fruit are used as vegetable (Sadyojatha and Vaidya 1996). The fruit leaves and tuberous roots of *M. dioica* have long been used in India as a folk remedy for diabetes and other health problems (Chakravarty 1959).The juices appear toxic and abortifacient. The whole plant is used for treatment of eye disease and against fever (Satyavati et al 1987). Mishra 1991 and Gupta 1993 reported antimalerial and antiallergic activity, respectively. In *M. dioica* Roxb ex. Thirupathi et al 2006 reported protective effect of *M. dioica* against hepatic damage caused by carbon tetrachloride in rats.

Nephroprotective activity in *M. dioica* fruits extract (200mg/kg) was studied by the Jain & Singhai 2010. In their study, in DPPH free radical scavenging activity, the ethanolic extract has shown maximum inhibition (84.2%), followed by aqueous (74.8%), ethyl acetate (69.4%) and chloroform (59.7%) extract. On the other hand, in total antioxidant activity, the ethanol extract has shown 80.1% inhibition, followed by aqueous (71.9%), ethyl acetate (67.2%) and chloroform (53.2%) extracts due to presence of phenolics, flavonoids and amino acids. Blood urea and serum creatinine were analysed as biochemical markers of nephrotoxicity. Reduced glutathione and the product of lipid peroxidation were also measured in kidney tissues. A single dose of cisplatin resulted in significant reduction in body weight and increased the urea and creatinine levels. Extract administration has shown significant recovery in the levels of these biochemical in curative and protective groups.[5]

Antibacterial activity of methanolic extract of fruit pulp of *M. dioica* Roxb was investigated for in vitro antibacterial activity studied by Ilango et al 2012. In their study revealed the presence of secondary metabolites such as steroids, fatty acids in hexane extract and proteins, saponin glycosides and triterpenes in ethyl acetate soluble portion of methanolic extract were found to be effective mostly against *Salmonella typhi* and *Shigella dysenteriae* in the 100 to 500µg/ml concentrations.[6]

Compounds derived from natural sources are capable of providing protection against free radicals.[7] The alcoholic extract of *M. dioica* inhibited the formation of oxygen derived free radicals in vitro with 4000μg/ml ascorbic acid.[8] In another work, the free radicals scavenging potential of the tuberous roots was studied by different in vitro methods, namely DPPH radical scavenging, ABTS radical scavenging, iron chelating activity, total antioxidant capacity, and haemoglobin glycosylation assay. Total antioxidant capacity of ethanolic extract was found to be 26μg/ml which is equivalent to ascorbic acid. Moreover, its ethanol extract showed percentage inhibition of haemoglobin glycosylation as 66.63 and 74.14 at conc. of 500 and 1000μg/ml, respectively, while that of standard DL α-tocopherol was 61.53% and 86.68%

inhibition at same concentration.[9]The antioxidant activities of methanol and aqueous extract of fruits were analysed and the presence of phenolic compounds, flavonoids, sterol, alkaloids, amino acids, and so forth, were found.[10]Among those compounds, due to the presence of flavonoids, its fruit was reported as a potent antioxidant.[11]

Analgesic activity (Ilango and Vaidya et al) reported that both extract and soluble portion of methanolic extract of *M. dioica* fruit pulp exhibited analgesic activity when compared to standard drug.[12, 13] Petroleum ether, ethyl acetate, and methanol extracts exhibited significant analgesic activity in acetic acid induced writhing syndrome when compared to the vehicle treated control group. But among them ether and methanol extract gave more significant analgesic activity than ethyl acetate extract.[14]

Antidiabetic specifically oral hypoglycaemic effects of *M. dioica* in rat model were screened by Fernandopulle et al[15]Reddy et al and Singh et al showed aqueous, chloroform, ethyl acetate and ethanolic extract of fruit mediated antidiabetic activity in alloxan induced experimental rats.[16, 17] Moreover, Sharma and Arya reported ethyl acetate and ethanol extract containing steroids, triterpenoid had potential role in alloxan induced diabetic rats and broadly type 2 diabetes[18]Gupta et al investigated the antidiabetic and renal protective effect of *M. dioica* methanolic extract in STZ treated diabetic rats. Methanolic extract of *M. dioica* markedly reduced serum glucose and increased serum insulin and urea levels. Furthermore, histological observation of kidney of diabetic rats showed degenerative changes in glomerulus and renal tubules.[19]

CCl_4 induced hepatotoxicity prevention of methanol extract of *M. dioica* was observed by Chaudhary et al[20] Although Govind and Kumar C 2011 reported the hepatoprotective and antihepatotoxicity effect of leaf, Kumar et al specifically mentioned the role of aqueous and methanol extract of leaves against it.[21, 22]Jain et al examined leaf as a potent hepatoprotective agent against CCl_4induced hepatic damage in rats by in vivo antioxidant and free radical scavenging activities. They were positive for both ethanolic and aqueous extracts although ethanolic extract was found more potent hepatoprotective.[23] Kushwaha et al evaluated the flavonoidal fraction from ethanolic extract of fruit mediated hepato protective activity in wistar albino rats of either sex against CCl_4 induced hepatic damage.[24]Rakh et al reported that the alcoholic extract of roots significantly reduced CCl_4 induced hepatotoxicity in rats by inhibiting the formation of radicals in vitro.[25] The saponin fraction of *M. dioica* (27.5 and 55mg/kg) administered to the CCl_4 treated rats to protect the liver cells from liver damage on hepatocytes. Saponin *M. dioica* showed normal parenchymal architecture with cords of hepatocytes, portal tracts and central veins without noticeable alterations. The result revealed that Saponin *M. dioica* protect the liver cells from CCl_4induced liver damages, by its antioxidative effect on hepatocytes.[26] The hexane extract and ethyl acetate soluble fraction of the methanolic extract of the fruit pulp at a dose of 400mg/kg administered for 7 days in rat exhibited a significant therapeutic effect.[27]Sato et al observed significant lowering of liver cholesterol and triacylglycerol levels in rats. Fecal lipid excretion was increased and lymphatic transport of triacylglycerol and phospholipids were decreased in rats which were fed the kakrol after permanent lymph cannulation. Moreover, n-butanol extract caused a significant reduction in the pancreatic lipase activity in vitro and liver lipids by inhibiting lipid absorption.[28]

Mishra et al reported the role of *M. dioica* seed oil as insecticide and found satisfactory level of natural insecticidal activity up to 100% mortality at 4% concentration in 24 hours. Moreover, its lower concentration up to 2% was found to be effective but for 100% mortality longer time was required. They suggested the presence of alkaloid momordicin in oil was responsible for it.[29]Ahire and Deokule observed the leaf extract of *M.dioica* mediated allelopathic activity on seedling growth as well as seed germination of P. aconitifolius and found major toxicity at a dose of 2.0% and 2.5% w/v of phytoextracts.[30]

Conceivable physiological action of *M. dioica*

Hepatoprotective activity of *Momordica dioica* may be due to presence of its phytoconstituents like presence of the traces of alkaloids, lectine, β-sitosterol, saponin, glycosides, triterpenoid, long chain aliphatic hydrocarbons, tannins and fixed oil. Increase in the total antioxidant levels causes the inhibition of lipid peroxide formation and significantly reduced the AST, ALT, Lipid peroxide levels and total serum bilirubin level. Oxidation stress is an important contributor to the pathophysiology of a variety of pathological conditions such as cardiovascular dysfunctions, atherosclerosis, inflammation, carcinogenesis, drug toxicity, reperfusion injury and neurodegenerative diseases. Human body has multiple mechanisms especially enzymatic and non enzymatic antioxidant systems which protect the cellular molecules against reactive oxygen species induced damage. The methanolic extract of *M. dioica* showed the presence of phenolic compound, flavonoids and sterol. Total phenolic content was expressed as gallic acid equivalent in mg/gm dry weight of sample and showed more promising antimicrobial activity. The presence of antioxidants in the extract of *M. dioica* causes the reduction of Fe^{3+}/ferric cyanide complex to ferrous form and showed antioxidant activity. Radical scavenging activity of *M. dioica* due to presence of phenolic contents appears to function as good electron and hydrogen atom donors and therefore should be able to terminate radical chain reaction by converting free radicals and reactive oxygen species to more stable products. Blood urea, glutathione, lipid peroxidation and serum creatinine were

analysed as biochemical markers of nephrotoxicity. Many antioxidants have shown protection against antitumoural-induced perooxidative damage in the renal tissue, such as isoeugenol (Rao, Kumar and Rao 1990), dimethylthiourea (Matsushima et al 1998), vitamin C (Antunes, Darin and Bianchi 2000) and the iron-chelating deferoxamine that markedly reduced the peroxidative damage induced in the renal tissues a phytochemical study has revealed the presence of phenolic compounds and flavonoids. These compounds are very well known for their antioxidant potential. So the possible mechanism of the nephroprotective and curative activities of *M. dioica* may be due to antioxidant activity, thus preventing the damage produced by reactive oxygen species. Amino acids, glutamic acid, cysteine and glycine are important precursors for the synthesis of the endogenous antioxidant GSH. Glutamine has been reported to have a protective effect in renal injury due to its antioxidant activity (Mora, Antunes, Francescato and Bianchi 2003). So the presence of these amino acids in the ethanol extract of *M. dioica* fruits probably increases the concentration of GSH, as these are precursors for synthesis and inhibit lipid peroxidation. Antiulcer activity (Vijay Kumar et al 2011) of *M. dioica* may be due to its phytoconstituents showed augmenting gastric defence mechanism. A decreased the level of H^+ - K^+ ATPase, volume of gastric juice and acid output. Gastric wall mucosa and pH increased significantly and showed antiulcer properties.

Table 4: Pharmacological evaluation of *M. dioica*

Pharmacological activity	Part of Plant	Extract/Preparation	Detail effect
Neuroprotective activity	*Fruit*	*Methanol and aqueous extract*	*Methanol and aqueous extract of fruit pulp (100mg/kg and 200mg/kg) had neuroprotective activities.*[31]
Antiallergic activities	*Seed*	*Alcoholic extract*	The antiallergic activity of extract in mice was observed. Found its efficacy to inhibit passive cutaneous anaphylaxis in mouse and rat. [32, 33]
Anticancer activity	*Root*	*Methanol extract*	*The growth inhibitory index (%) of α-spinasterol-3-o-β-D-glucopyranoside was shown to be 50%, at the dose of 4 μg/ml while testing on cancer cell (L1210).*[34]
Antimicrobial activity	*Fruit*	*Methanol, aqueous extract*	*Found methanolic extract had more promising antimicrobial activity.*[35]
	Root, Leaf	*Ethyl acetate extract*	*The concentration of 200μg/disc was more active against E. coli compared to, S. paratyphi, and P. mirabilis bacteria.* [36]
Antimalarial activity	*Not specified*	*Alcoholic extract*	*Screened extract in vivo and in vitro against NK65 strain of Plasmodium berghei, Jurineamacrocephala, Aeglemarmelos and found to possess schizontocidal activity.*[37]
Anti-inflammatory activity	*Root*	*Alcoholic extract*	*Significantly reduced carrageenan-induced paw edema when administered orally (200mg/kg) and the activity was comparable with ibuprofen (200mg/kg, p.o.)* [38]
	Fruit	*Hexane, methanol extract.*	*Both extracts exhibited anti-inflammatory activities when compared to standard drug.* [39]
Antifertility activity	*Root*	*Ethanol, aqueous extract*	*Found moderate estrogenic activity including significant increase in uterine weight and abortifacient activity.* [40]
	Fruit	*Ethanolic extract*	*Found antifertility activities of female rats but no male antifertility activity at the dose of 250mg/kg.* [41]
Antiedemic activity	*Root*	*Alcoholic extract*	*Showed significant reduction of carrageenan-induced paw edema.* [38]

CONCLUSION

The traditional use of medicinal plants has a long history. Ancient people as well as our ancestors were mainly dependent on plants for their recovery against diseases. But the recent tendency to avoid natural sources rather than artificial source against disease is frustrating. Because continuous reports of antibiotic resistance as well as the side effects of synthetic drugs all over the world are indicating a global health alert. The higher occurrence rate of worldwide diabetes, cancer, obesity, hypertension, and neurodegenerative diseases becomes alarming to all. Huge researches are carried out to find the causes and remedies of them. Therefore, to search for a better alternative than synthetic drug becomes the demand of time. Medicinal plants may be a good option to play pivotal role against such complications. The paper has mainly focused on the phytotherapeutical and pharmacological potential of *Momordica dioica* Roxb. As

it contains significant amount of antioxidant, vitamin, secondary metabolites, and other important ingredients, these may be helpful to fight against several diseases including diabetes, cancer, and neurodegenerative diseases.

Acknowledgements: I would like to express heart full thanks to my beloved Parents, guide for their support and blessings.

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Source of Support: Nil, **Conflict of Interest:** None.