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SOLANUM TORVUM: A REVIEW OF ITS TRADITIONAL USES, PHYTOCHEMISTRY AND PHARMACOLOGY

BS JAISWAL*

SOS in Pharmaceutical Sciences, Jiwaji University, Gwalior, India.

ABSTRACT

Solanum torvum Swartz (family: Solanaceae) is commonly known as turkey berry. This plant is found in tropical Africa, Asia and South America. *S. torvum*, is an important medicinal plant in tropical and subtropical countries is widely used like food and in folk medicine around the world. This aims a comprehensive of the chemical constituents, pharmacological, and clinical uses. A number of metabolites are in good yield and some have been shown to possess useful biological activities belonging mainly to steroid glycosides and saponins, flavonoid, vitamin B group, vitamin C, iron salts and steroidal alkaloids. Extracts and metabolites of this plant, particularly those from leaves and fruits possess useful pharmacological activities. A survey of the literature shows *S. torvum* is mainly used for the treatment of fever, wounds, tooth decay, reproductive problems and arterial hypertension. Many pharmacological studies have demonstrated the ability of this plant to exhibit Anti-oxidant activity, cardiovascular, immunomodulatory and nephroprotective activity supporting its traditional uses. This review attempts to highlight the available literature on *S. torvum* with respect to ethnobotany, chemical constituents and summary of various pharmacological activities.

KEYWORDS: ***Solanum torvum*, Cardiovascular, Antioxidant, pharmacological activities.**

BS JAISWAL

SOS in Pharmaceutical Sciences, Jiwaji University, Gwalior, India.

INTRODUCTION

Solanum torvum Sw. (Solanaceae), commonly known as Turkey berry is native and cultivated in Africa and West Indies[1]. The fruits and leaves are widely used in Camerooninan folk medicine. It also occurs commonly in the moist farms of India. The fruits of *S. torvum* are edible and commonly available in the markets. They are utilized as a vegetable and regarded as an essential ingredient in the South Indian population's diet. A decoction of fruits is given for cough ailments and is considered useful in cases of liver and spleen enlargement[2]. The plant is sedative and diuretic and the leaves are used as a haemostatic. The ripened fruits are used in the preparation of tonic and haemopoietic agents and also for the treatment for pain[3]. It has antioxidant properties[4]. It is intensively used worldwide in the traditional medicine as poison anti-dote and for the treatment of fever, wounds, tooth decay, reproductive problems and arterial hypertension[5]. *S. torvum* also possesses Antimicrobial[6,7], Antiviral[8], Immuno-secretory[9], Antioxidant[10], Analgesic and Anti-inflammatory[5], Anti-ulcerogenic activities[11], Cardiovascular[12], Nephroprotective[13], Antidiabetic[14], Angiotensin and Serotonin receptor blocking activities[15].

BOTANICAL CLASSIFICATION[16]

(i) Scientific classification:

Kingdom: Plantae
Devision: Magnoliophyta
Class: Magnoliopsida
Order: Solanales
Family: Solanaceae
Genus: Solanum L.
Species: *Solanum torvum* sw

(ii) Vernacular names:

Region/Language	Vernacular Name
Sanskrit	Brihati
Marathi	Marang
Hindi	Bhurat, Bhankatiya
English	West Indian Turkey Berry
Tamil	Sundaikkai
Folk	Ran-Baingan, goth-begun

BOTANICAL DESCRIPTION

Leaves- Leaves simple, alternate, broadly ovate elliptic, variable in size, 10-15 cm long, 8-10 cm wide, margins with broad lobes, deeply cut in juvenile phases, shallow in mature leaves, apex acute to obtuse, base somewhat sagittate to auriculate, equal or oblique, petioles 2-5 cm long.

Flowers - The small, white flowers occur in large clusters, with simple, mostly glandular hairs on axes; corolla bright white, to 2.5 cm (1 in) across, lobed about 1/3 of its length; lobes not recurved; stamens with prominent anthers.

Fruits - The fruits are berries that are yellow when fully ripe. They are thin-fleshed and contain numerous flat, round, brown seeds.

Seeds - Seeds numerous, drab brownish, flattened, discoid, 1.5-2 mm long slightly reticulate, Self-compatible.

Odour - Pepper-like

Taste - Bitter and acrid

Parts used - Plant, leaves, fruits and root.

PHYSICAL CHARACTERISTICS

S. torvum is an erect spiny shrub that is usually 2 or 3 m in height and 2 cm in basal diameter, but may reach 5 m in height and 8 cm in basal diameter[17]. It grows on all types of moist, fertile soil at elevations from near sea level to almost 1,000 m. It grows best in full sunlight and does well in light shade or shade for part of the day, but cannot survive under a closed forest canopy[18].

***CHEMISTRY*:** Phytochemical screening of methanolic extract of sun dried *S. torvum* fruits gave positive tests for alkaloids, flavonoids, saponins, tannins, glycosides, fixed oil, vitamin B group, vitamin C and iron salts[10, 19]. It also has number of chemical constituents like neochlorogenin 6-O-β-D-quinovo-pyranoside[20], neochlorogenin 6-O-β-D-xylopyranosyl-(1→3)-β-D-quinovopyranoside[21], neochlorogenin 6-O-α-L- rhamnopyranosyl-(1→3)-β-D-quinovopyranoside[22], sola-genin 6-O-β-D-quinovopyranoside[23], solagenin 6-O-α-L-rhamnopyranosyl-(1→3)-β-D-quinovopyranoside[24], isoque-rcetin[25], rutin[26], kaempferol[27] and quercetin[28]. Recently studies reveal that its flavonoid content is mainly responsible for its Antioxidant, Antihypertensive, Metabolic correction and Nephroprotective activities.

PHARMACOLOGICAL ACTIVITIES:

***ANTI-OXIDANT ACTIVITY*:** *S. torvum* was found to be a very potent antioxidant. The previous results suggest that *S. torvum* extract was the most potent as it exhibited Outstanding reducing power, scavenging activity against DPPH and hydrogen peroxide. Good co-relation was observed with radical scavenging activity of extracts and total phenolics. A potent scavenger of free radicals may serve as a possible preventive intervention for many diseases as the involvement of free radicals in the Pathogenesis of a large number of diseases is well known[29, 30].

***ANTIFUNGAL ACTIVITY*:** The antifungal activity of aqueous and solvent extracts of *S. torvum* was tested against ten important seed borne fungal pathogens of paddy. The antifungal activity was tested by poisoned food technique. The results revealed a significant inhibitory activity. The percentage inhibition of test pathogenic fungi in aqueous extract at 25% concentration was 100% for (*P. oryzae*), 47.44 for (*B. oryzae*), 60.47 for (*A. alternata*), 71.50 for (*T. padwickii*), 56.11 for (*D. tetramera*), 63.33 for (*D. halodes*), 66.66 for (*F. moniliformae*), 47.44 for (*F. oxysporum*) and 46.26 for (*F. solani*). In case of solvent extract Chloroform, Methanol and Ethanol extracts also showed antifungal activity. The activity was highly significant in Methanol and Ethanol extracts against *Xanthomonas campestris pv oryzae*[31, 32].

***ANTIBACTERIAL ACTIVITY*:** The leaves of *S. torvum* has reported for its antimicrobial activity. The antibacterial activity of aqueous and solvent extracts was tested against *Xanthomonas campestris pv oryzae* by cup diffusion method[33]. Streptomycin disc, Gentamycin and Co-trimaxazole antibiotics were also tested for comparative efficacy. Only Methanolic and Ethanolic extracts of *S. torvum* showed the activity against *Xanthomonas campestris pv oryzae* at different concentrations[34].

***ANTIULCER ACTIVITY*:** The antiulcer activity of *S. torvum* leaves was investigated against Ethanol, Indomethacin, Pylorus ligation and cold-restraint stress-induced gastric ulcer in Rat. The gastric mucosal protection of *S. torvum* can be mediated through a number of mechanisms that include enhancement of the gastric mucosal defense through increase in

mucus and/or bicarbonate production, reducing the volume of gastric acid secretion or by simply neutralizing the gastric acidity[35]. Phytochemical studies of the methanol extract of Solanum torvum revealed the presence of flavonoids, sterols and triterpens which may be responsible for the anti-ulcer properties[36].

ANTIHYPERTENSIVE AND METABOLIC-CORRECTION ACTIVITY: The fruits of *S. torvum* are used commonly in traditional medicine as antihypertensive[37]. Mohan and colleagues have recently described that, Wistar rats maintained on a high fructose diet developed high systolic blood pressure and increase in body weight, Serum insulin, glucose, triglycerides, cholesterol and uric acid levels. Results of studies were so appreciable because ethanolic extract of *S. torvum* (100 and 300 mg/kg/day, p.o.) treatment significantly reduced SBP and all biochemical parameters in fructose-fed animals. The results were comparable to standard drug Nifedipine (10 mg/kg/day, p.o.). These data indicate that *S. torvum* presents a clear antihypertensive activity[38]. Recently Jaiswal proved that ethanolic extract of *S. torvum* also have the 5-HT and adrenergic α_1- receptor blocking activity on isolated tissue preparation[15]. Nguelefack and colleagues also proved that the aqueous and methanolic extract of *S. torvum* also possess hypotensive activity which may partially result from their bradycardic effect. Anti-platelet aggregation effect of aqueous extract may be a benefit for its cardiovascular effect. These results support the use of the plant in the treatment of arterial hypertension and haemostatic ailments[11].

***NEPHROPROTECTIVE ACTIVITY*:** The Nephroprotective activity of fruit of *S. torvum* was investigated against Doxorubicin (DOX) induced nephrotoxicity in rats. DOX have been proposed to be nephrotoxic due to its ability to destruct kidney cells by overproduction of Semiquinone type free radicals. The renal tissue damage caused by DOX in humans is similar. In the phytochemical studies it is proved that *S. torvum* is rich in flavonoid content[29]. Vaclavikova recently proved that anti-oxidant properties of flavonoids and their ability to chelate free iron could be effective in reducing toxicity of DOX[39]. Histopathological changes showed that DOX caused significant structural damages to kidneys like tubular necrosis, renal lesions and glomerular congestion which were reversed with *S. torvum*[40].

***CARDIOPROTECTIVE ACTIVITY*:** Cardiotoxicity induced by DOX is usually mediated through lipid peroxidation and inhibition of long fatty acid oxidation in cardiac tissues[41]. Thus, oxidative stress, lipid peroxidation, and mitochondrial dysfunction have been associated with DOX induced cardiomyopathy[42-44]. Cardiotoxicity was assessed by recording changes in ECG, heart rate and measuring the levels of cardiac marker enzymes- lactic acid dehydrogenase (LDH) and creatine phosphokinase (CK-MB). The antioxidant defense enzymes superoxide dismutase (SOD) and catalase (CAT) for heart tissue were also measured. The results of this analysis revealed the fact that *S. torvum* fruit extract has Cardioprotective activity mainly attributed by its potent antioxidant property[45].

***ANTIDIABETIC ACTIVITY*:** Oral administration of methyl caffeate, isolated from *S. torvum* fruit showed a dose-dependent (10, 20 and 40 mg/kg) anti-hyperglycemic effect in glucose fed hyperglycemic and streptozotocin diabetic rats (60 mg/kg IV). The effect was moderate in fasted normal rats but more in diabetic rats. Methyl caffeate at 40 mg/kg significantly prevented the increase in blood glucose level after glucose administration at 60 min in comparison to the hyperglycemic control group. In Streptozotocin induced diabetic rats, methyl caffeate produced significant reduction in blood glucose and increased body weight. Authors hypothesized that the Methyl caffeate increased activity of GLUT4 and regeneration of β-cells in the pancreas[46]. Recently some research also proved that its Antidiabetic action

is also contributed by α glucosidase inhibitor activity[47].

ANALGESIC AND ANTI-INFLAMMATORY ACTIVITY**:** *S. torvum* is used in Cameroonian traditional medicine for the management of pain and inflammation. *S. torvum* has also been used for the treatment of fever, wounds and tooth decay. Aqueous extract of *S. torvum* offers analgesic and anti-inflammatory effects through inhibition of production of inflammatory mediators like Prostaglandin and Cyclooxygenase. Prostaglandin E2 (PGE2) is a critical inflammatory mediator that is produced through the arachidonic acid cascade. The result of study was showed that *S. torvum* posses analgesic activity against Writhing and mechanically induced pain in rat[48]. The antiinflammatory role of *S. torvum* is also mediated through own regulation of cyclooxygenase through suppression of Prostaglandin E_2 activation[5].

IMMUNOMODULATORY AND ERYTHROPOIETIC ACTIVITY**:** *S. torvum* was found to be a very potent immunomodulatory and erythropoietic. Aqueous extract of the fruits of *S. torvum* enhanced delayed type hypersensitivity (DTH) response, increased haemagglutination antibody titer and white blood cells (WBC) count. After Phenylhydrazine induced anemia, the number of RBCs and the hemoglobin concentration decreased in animals but the group which was cotreated with *S. torvum* (37.5-150 mg/kg) the number of RBCs and hemoglobin concentration was increased significantly. The WBCs provide the major defense against pyogenic (pus-forming) bacteria and are the first on the scene to fight infection. This suggests that the innate immunity was enhanced by *S. torvum*. This effect may probably be due to its high vitamin B complex and vitamin C content since vitamins are known to boost the body's immune system[9, 19].

CONCLUSION

The present review discusses the significance of *S. torvum* as a valuable source for medicinally important compounds besides its edible fruit which is a store house of minerals, vitamins, antioxidants and other nutrients. The antioxidant constituents present in the fruits play important role in scavenging free radicals and reactive oxygen species which are responsible for number of human disorders. The qualitative analysis revealed the presence of the biomolecules such as alkaloids, flavonoids, saponins, tannins, glycosides and phenolic compound. Crude extracts and phytochemicals isolated from *S. torvum*, as reviewed here have been found to have Anti-oxidant activity, antifungal activity, antibacterial activity, antiulcer activity, antihypertensive and metabolic-correction activity, nephroprotective activity Cardioprotective activity, antidiabetic activity, analgesic and anti-inflammatory activity, immunomodulatory and erythropoietic activity.

The Phytomedicines are complex mixtures of compounds and exert more pronounced effects than individual compounds. The role of such complex mixtures and the 'ideal' composition of an active extract needs to be investigated first using a combination of *in vitro* (or *in vivo* animal) techniques in combination with phytochemical or metabolomic techniques. On the basis of biological activities of *S. torvum*, crude extract and derived phytochemicals and their uses as neutraceuticals and pharmacological agents in traditional and modern research are possible but will first require clinical trials and product development. The current evidence is large limited to *in vitro* data. *S. torvum* is a very important part of biodiversity and it's sustainably use for future generations. The *S. torvum* still is a rather an untapped source for isolation and characterization of novel useful products; however, at the same time it also opens up new avenues for novel therapeutics for fighting dreaded disease.

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