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Bridging ethnomedicine and modern science: The phytopharmacological journey of *Solanum torvum*

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ABSTRACT

Majority of the pharmaceuticals available today have their origins in plants either directly or indirectly. *Solanum torvum* Swartz, a member of the Solanaceae family, is a globally dispersed medicinal herbal plant. This review aims to highlight the correlation between the various phytochemicals possessed by *S. torvum* and their pharmacological implications. A literature search was conducted using various online resources including PUBMED, Google scholar and Science Direct. Due to its abundant phytochemical content, it is utilised in the treatment of a wide range of ailments. In traditional medicine system all over the globe, it is used as a medication against diabetes, hypertension, inflammation, microbial infections, cytotoxicity, hepatotoxicity, nephrotoxicity, immunological disorders and ulcer. The insights gained from this review should improve our understanding of the health benefits of *S. torvum* and its related phytochemicals, which could pave the way for new pharmaceuticals to treat and prevent diseases.

Key Words - *Solanum torvum*, ethnomedicine, phytopharmacological journey, phytochemical

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INTRODUCTION

Natural remedies have been an integral part of traditional medicine practices for thousands of years. Natural therapies tend to have more support from those who believe in their efficacy and safety compared to pharmaceuticals. Plants typically possess therapeutic effects because of phytochemicals, thousands of which have been identified and studied or because of the presence of basic chemical elements like selenium or chromium in plant tissues.

There are over 3000 species and 90 genera in the Solanaceae family, which are extensively scattered throughout the world. They are a great source of active secondary metabolites (Silva *et al.,* 2004). *Solanum torvum* Swartz, often known as Sundakai (Tamil), Makhua phuang (Thai), Thibbatu (Sinhala), Turkey Berry and Wild Eggplant is a member of the Solanaceae family (Ramamurthy *et al.,* 2012). Among the many phytochemical components found in plant extract of *S. torvum* are steroids, glycosides, saponins, flavonoids, phenols, vitamins C and E, iron salt and steroidal alkaloids (Jaiswal, 2012; Thenmozhi & US, 2012). Some phytochemicals are harmless whereas others are harmful. Most of them have anti-cancer, antibacterial, antiviral anti-oxidant, antidiarrheal, analgesic and anti-inflammatory, immuno-secretory, nephroprotective, antidiabetic, cardiovascular and wound-healing properties (Ajaiyeoba, 1999; Arthan *et al.,* 2002; Chah *et al.,* 2000; Gandhi, Ignacimuthu, Paulraj, *et al.,* 2011; Israf *et al.,* 2004; Mohan *et al.,* 2010; Sivapriya & Leela, 2007a). As a whole the plant has

long been used for its digestive, diuretic and sedative properties; however, decoctions made from its fruits and leaves have long been used to alleviate coughing and enlarged liver and spleen (Kala, 2005; Siemonsma & Piluek, 1994).

1. PHYSICAL CHARACTERISTICS

The spiny shrub of *S. torvum* grows to a height of 2-3 meters (Figure 1). The leaves are oval or elliptical in form and have a shallow indention that tapers to an acute to obtuse tip. The shrub also bears fruits or berries which are small and spherical in shape (Figure 3) and white bell-shaped flowers (Figure 2). The fruits are green when young and turn yellow when ripe (Jaiswal, 2012; Ogwu *et al.,* 2024). *S. torvum* can either be annual or perennial, depending on the circumstances. Plants thrive in full sunlight, mild shade or partial shade but not under a forest canopy (Little *et al.,* 1974). *S. torvum* fruits are widely available, edible and are used as a vegetable. They are also an important part of the traditional South Indian diet (Sivapriya & Leela, 2007a). In the tropics, the shrub is grown for its acrid immature fruits. It has been identified to be grown in the west Indies (Adjanohoun *et al.,* 1996).

Fig. 1: Plant of *Solanum torvum* Sw.

Fig. 2: Flowers of *Solanum torvum* Sw.

Fig. 3: Fruits of *Solanum torvum* Sw.

2. PHYTOCHEMICAL PROPERTIES

Phytochemicals are secondary metabolites produced by plant cells that fulfil the roles beyond the primary requirements of the cell, thereby aiding in the overall survival of the plant as a functional organism. The characteristic properties of phytochemicals allow us to identify the distinct biological activities of plants. *Solanum torvum* has been reported to possess phytochemicals such as flavonoids, alkaloids, tannins, saponins, carbohydrates, steroids, glycosides, proteins and amino acids (Chah *et al.,* 2000; Kalita *et al.,* 2017). Polyphenolic compounds such as phenol (160.30 mg/g), flavonoid (104.36 mg/g) and tannin (65.91 mg/g) were identified by (Kusirisin *et al.,* 2009a). Mc *et al.* (2007) also concluded that *S. torvum* had a total alkaloid content (0.12%), total glycoalkaloids (0.038%) and glycosylated compounds derived from solasodine, namely solasonine (0.0043%) and solamargine (0.0028%).

Phytochemical study revealed the presence of alkaloids, flavonoids, tannins, saponins, glycosides, oils, tocopherols (Vitamins E, B and C) and iron salts in the methanolic extracts of sun dried *S. torvum* (Amarowicz *et al.,* 2010; Koffuor *et al.,* 2011a; Sivapriya & Leela, 2007b). The Indian-native *S. torvum* leaf extract contained nine (Triacontanol, Octacosanyl triacontanoate, 5-hexatriacontanone, 3-triatriaacontanone, Tetratriacontanoic acid, Sitosterol, Stigmasterol, Campesterol, 2,3,4-trimethyltriacontane) non-alkaloid chemical compounds (Mahmood *et al.,* 1983). Along with the

well-known glycoside; torviside A, (Arthan *et al.,* 2002) discovered a new isoflavonoid sulphate called torvanol A and a new steroidal glycoside called torvoside H in fruit methanolic extracts. The nine novel compounds identified by (Y.-Y. Lu *et al.,* 2011) include neochlorogenin 6-O-β-D-quinovopyranoside, neochlorogenin 6-O-β-D-xylopyranosyl-(1→3)-β-D-quinovopyranoside, neochlorogenin 6-O-α-L-rhamnopyranosyl-(1→3)-β-D-quinovopyranoside, solagenin 6-O-α-D-quinovopyranoside, solagenin 6-O-α-L- rhamnopyranosyl-(1→3)- β-D-quinovopyranoside, isoquerectin, rutin, kaempferol and quercetin (Lakshmi *et al.,* 2013) reported the notable absence of anthraquinones and cyanides in the methanol, petroleum and chloroform extracts derived from the fruits, leaves and roots of *S. torvum*. Additionally, it was unexpectedly noted that glycosides and flavonoids were also absent. The ethanolic extract of the aerial portions of *S. torvum* yielded two new C-22 steroidal lactone saponins that are solanolactosides A and solanolactosides B, as well as two new spirostanol glycosides which are torvisides M and torvisides N (Y. Lu *et al.,* 2009). The presence of Furostanol glycoside 26-O-β-glucosidase was identified as a significant component within the methanolic extracts of leaves (Iida *et al.,* 2005).

Table 1: Phytochemicals and their therapeutic effects

Sl. No.	Phytochemicals	Therapeutics
1	Alkaloids	a. Defend the body from oxidative stress b. Chemotherapeutic treatment. c. Used as chemo preventive agents. d. Limit, stop or slow the growth of tumour.
2	Flavonoids	a. Avoiding heart related illnesses. b. Exhibit anti-ulcer characteristics.
3	Tannins	a. Prevention of heart-related disease. b. Analgesic and anti-inflammatory effects. c. Reduce and sustain the diastolic and systolic blood pressure.
4	Glycosides	a. Nutritive purposes. b. Effective for cough ailments. c. Treatment of liver and spleen enlargement
5	Tocopherols/ Vitamin E	a. Sustain metabolism and boost immune system. b. Inhibit the formation of carcinogens in the stomach. c. Prevent the growth of cataracts in the eyes.
6	Phenols	a. Lower blood cholesterol. b. Prevention of breast, colon and prostate cancers c. Used in cancer therapy.
7	Oils	a. Optimal performance of the brain, b. Regulate reproductive function c. Enhance bone health. d. Treatment of pains associated with rheumatoid arthritis e. Dermatology disease therapy.
8	Vitamin C	a. Keeps the body against oxidative stress.

3. ANTIOXIDANT ACTIVITY

Antioxidants are crucial for preventing lipid peroxidation or preventing free radicals from damaging cells. When compared to well-known traditional synthetic antioxidants, the novel protein obtained from the aqueous extract of Sundakai seed has been found to be a potent antioxidant, even at low doses (Sivapriya & Leela, 2007a). Antioxidant activity index results showed that 3.68 mg Trolox and 360.53 mg of ascorbic acid equivalents were detected in one gram of concentrated *S. torvum* extract. The phenolic and flavonoid content of *S. torvum* has been found to have inhibitory effects on the CYP2E1 enzyme and free radical scavenging capabilities, particularly in relation to the lipid peroxidation and superoxide anion activity (Kusirisin *et al.,* 2009b).

S. torvum exhibits extensive antioxidant properties, suggesting its potential application in the avoidance or therapy of Neurodegenerative diseases (Mohan *et al.,* 2017). Natural antioxidants derived from plants, including vitamin C and E, carotenes, phenolics, flavonoids, phytates and phytoestrogens are thought to disrupt the oxidation process by interacting with the free radicals, chelating catalytic metals and scavenging oxygen within biological systems (Boham & Kocipai-Abyazan, 1974; Prasad *et al.,* 2010). *S. torvum* demonstrated certain antioxidant properties and the potential to repair DNA damage induced by free radicals (Abas *et al.,* 2006). A balance between oxidation and antioxidant level is essential for maintaining healthy biological integrity (Young & Woodside, 2001).

At an oral dosage of 100 mg/kg, the methanolic extract of seeds from *S. torvum* demonstrated promising antioxidative and antidiabetic effects (Mohan *et al.,* 2020).

4. ANTI-INFLAMMATORY ACTIVITY

The species *S. torvum* is considered to be one of the most important medicinal species, since it is utilised in various traditional medicinal system as an analgesic and anti-inflammatory agent (Ndebia *et al.,* 2007). It treats inflammatory diseases like fever, wounds and tooth decay. In rats, it relieves writhing and mechanical pain (Atta & Alkofahi, 1998; Ndebia *et al.,* 2007). The aqueous extracts of tannins and phenols exhibit anti-inflammatory and analgesic properties through several mechanisms. These include the inhibition of inflammatory mediators production, such as Prostaglandin and Cyclooxygenase, as well as the synthesis of Prostaglandin E2 (PGE2) via the arachidonic acid cascade, which plays a pivotal role in inflammatory mediation (Ndebia *et al.,* 2007).

The Carrageenan-induced rat paw oedema method was used to test *S. torvum* seed and fruit methanol extract for anti-inflammatory efficacy. All extracts had anti-inflammatory efficacy, but seed methanol extract at 500 mg/kg body weight was most effective (Rammohan & Reddy, 2010). At both the 300 mg/kg and 600 mg/kg doses of aqueous extract of *S. torvum* extract, paw oedema was considerably reduced; however, the 300 mg/kg dose was more rapid in its effect (Sridevi *et al.,* 2017; Yousaf *et al.,* 2013).

5. ANTIMICROBIAL ACTIVITY

Considering the escalating challenge of microbial resistance to the majority of antibiotics, medicinal plants are increasingly being explored as potential substitutes for the conventional treatment of many diseases (Chen *et al.,* 2005; Tanaka *et al.,* 2002). Six gram-positive and nine gram-negative human pathogenic bacteria were used to assess the antibacterial activity of *S. torvum* leaves, stems, roots and flowers that had been extracted using chloroform and methanol. When tested against bacteria, the methanolic extract from the roots was more effective than the extracts from the stems, leaves and flowers (Bari *et al.,* 2010).

Lalitha *et al.* (2010) documented the antibacterial efficacy of *S. torvum* leaf extract towards the seed-borne infections of rice utilizing aqueous and other solvents including ethanol. The phytochemical components including, including terpenoids and phenolic compounds have antibacterial properties which could explain its antibacterial effect (Daglia, 2012; Neerja Gupta *et al.,* 2011).

The evaluation of the antimicrobial properties of the ethanolic extract derived from *S. torvum* fruits against six bacterial strains (*Pseudomonas aeruginosa, Klebsiella pneumoniae, Bacillus subtilis, Salmonella typhi, Staphylococcus aureus* and *Escherichia coli*) demonstrated noteworthy antibacterial efficacy against four of the analysed strains: *Staphylococcus aureus, Escherichia coli, Bacillus subtilis* and *Klebsiella pneumoniae* (Jaabir *et al.,* 2015). Correlating to its phytochemical components, the ethanolic extract of *S. torvum* leaves has the ability to inhibit the growth of all pathogenic bacteria (Gram positive - *S. aureus* ATCC 25923*, S. intermedius* DMST 11465*, S. epidermidis* ATCC 12228*, Bacillus cereus* ATTCC 11778 *and* Gram negative – *Pseudomonas aeruginosa* ATCC 11778) tested (Naimon *et al.,* 2015). Sabarinath *et al.* (2018a) measured the inhibition zone diameter in plate culture to determine the *in vitro* effects of petroleum ether extracts from *S. torvum* leaves on *Staphylococcus aureus, Klebsiella pneumoniae, Escherichia coli, Pseudomonas aeruginosa, Salmonella typhimurium, Proteus vulgaris* and concluded that the leaves possess antibacterial activity.

6. ANTICANCEROUS PROPERTY

The ethanolic extract of *S. torvum* berries showed effectiveness as an anticancer agent in an in vitro cytotoxicity study conducted by (Panigrahi *et al.,* 2014). Cytotoxicity percentages were measured for the extract at concentrations ranging from 50µg/ml to 1000µg/ml, with results ranging from 7.09% to 85.79%; which implies that the cytotoxicity effect was dose dependent. Balachandran *et al.* (2015) performed further experiments to investigate the anticancer effects of methyl caffeate isolated from fruit of *S. torvum*. The cytotoxic characteristics of hexane, ethyl acetate and methanol extract from the fruit were assessed against MCF7 cells utilising the 3-(4,5-dimethlythiazol-2-yl)-2,5-diphenly

tetrazolium bromide assay. Ethyl acetate extract demonstrated superior cytotoxic activity as compared to hexane and methanol extracts. Metyl caffeate was extracted from ethyl acetate extract to examine its efficacy against MCF-7, A549, COLO320, HepG-2 and vero cells, demonstrating significant cytotoxic effects on MCF-7 cells.

Adenocarcinoma cell lines derived from the mammary gland showed remarkable resistance to cell proliferation when treated with *S. torvum* extracts. Phytochemicals such as Polyphenols, steroidal saponin glycoside, alkaloids and flavonoids play a pivotal part in *S. torvum*'s possible antioxidant activity, which in turn explains its strong antimitotic and anticancer effects (Thenmozhi & Rao, 2011). The research conducted by (Lai *et al.,* 2024) indicated that the ethanolic extract of *S. torvum* suppresses hepatoma cell proliferation by triggering ferroptosis. *S. torvum* had an additive impact with Lenvatinib in Hep 3B cells and demonstrated significant anti-HCC efficacy in Lenvatinib-resistant Hep 3B cells.

7. ANTIDIABETIC PROPERTY

A decoction of *S. torvum* fruits was used by the Yuan community of the northern Thailand to treat diabetes and hypertension (Inta *et al.,* 2013). The regeneration of β-cells in diabetic rats is linked to the phytochemicals and amino acids found in herbal plants (Apaya *et al.,* 2020). The findings of (Gandhi, Ignacimuthu, & Paulraj, 2011) showed that streptozotocin-induced diabetic rats' blood glucose levels were lowered by methanolic extract of *S. torvum* fruit containing phenolic compounds at doses of 200 and 400 mg/kg. Additionally, it has been found to improve insulin secretion as a result of â-cell regeneration, decrease oxidative stress and regulate enzymes that are accountable for glucose metabolism. The inhibition of rat intestinal á-glucosidase (sucrase and maltase) was noted from *S. torvum* fruit extracts. Following enzyme-assay directed separation of the extract, methyl caffeate was identified as the inhibitor (Takahashi *et al.,* 2010). An anti-diabetic effect at doses of 10, 20 and 40 mg/kg of methyl caffeate, a chemical compound isolated from *S. torvum* fruit was investigated. Methyl caffeate's effect on hyperglycemia in streptozotocin-induced diabetic rats was dosage dependent and mediated by the up regulation of GLUT-4 and pancreatic β-cell regeneration (Gandhi, Ignacimuthu, Paulraj, *et al.,* 2011).

The analysis of pancreatic histopathology by ethanolic extract of *S. torvum* fruit has shown to regenerate β-cells in the Islet of Langerhans, perhaps leading to enhanced insulin output and hypoglycemia. Lower PCK1 gene expression may have lowered blood glucose in *S. torvum* fruit extract (200mg/kg)-treated rats. The activity of the phosphoenolpyruvate carboxykinase enzyme in the gluconeogenesis pathway is controlled by the PCK1 genes (Satyanarayana *et al.,* 2022).

At an oral dosage of 100 mg/kg, the methanolic extract of seeds of *S. torvum* showed promising antioxidant and antidiabetic effects. A high dose of 100 mg/kg of *S. torvum* methanolic extract had an impact comparable to that of 120 mg/kg of metformin, an oral hypoglycaemic agent (Mohan *et al.,* 2020).

8. HEPATOPROTECTIVE ACTIVITY

The availability of several phytoconstituents such as tannins, kaempferol, rutin, bergapten, psoralenes, flavonoids, coumarin and phenolic glycosides might explain the hepatoprotective, anti-inflammatory and antioxidant benefits observed by (Tripathi, 2021).

After administering CCl4 to albino rats, the hydroalcoholic extract of *S. torvum* fruits showed potential hepatoprotective effects at a dosage of 200 mg/kg on various biochemical parameters, including SGPT, SGOT, cholesterol, bilirubin, total protein and LDH (Kayalvizhi *et al.,* 2012). Diabetic rats developed using Streptozotocin and treated with *S. torvum* fruit extract exhibited reduced activity of ALT and AST enzymes, suggesting its hepatoprotective properties by preserving the functional integrity of the hepatic cell membrane and restoring impaired liver metabolism in diabetic rats (Mihailoviæ *et al.,* 2021). Additionally, a time dependent increase in AST and ALT levels was noted

in rats with diabetes in induced by STZ (Abedimanesh *et al.,* 2021).

The evidence of hepatic injury by Streptozotocin was provided by an increase in liver enzyme activity and changes seen in the histological investigation of the liver. Treatment with the *S. torvum* methanolic extract showed a restorative effect in liver function, restoring hepatic damage to normal hepatocytes and considerably reducing high transaminase activity (Gandhi, Ignacimuthu, & Paulraj, 2011).

9. NEPHROPROTECTIVE PROPERTY

The phenolic compounds derived from the various forms of *S. torvum* and their nephroprotective effects was highlighted by (Loganayaki *et al.,* 2010). *S. torvum* treatment (100 mg/kg and 300 mg/kg) substantially reduced creatinine and BUN levels and enhanced SOD and CAT levels ($p < 0.05$). *S. torvum* alleviated tubular necrosis, renal lesions and glomerular congestion produced by DOX. The findings imply that *S. torvum* may reduce doxorubicin-induced nephrotoxicity (Mohan *et al.,* 2010). The two main renal measures are serum urea and creatinine. The body excretes urea and creatinine via urine. Renal dysfunction may reduce urea and creatinine clearance and cause their accumulation (Kim & Moon, 2012). Treatment with *S. torvum* extracts considerably enhanced the clearance of urea and creatinine, while the Monosodium Glutamate treated group showed a significant rise in serum urea and creatinine compared to control group, indicating renal insufficiency. Monosodium Glutamate induced histopathological alterations were reversed by *S. torvum* treatment (Kadam *et al.,* 2019).

The water extracts from the seeds of *S. torvum* have yielded novel proteins which, when compared to established synthetic standards, have potent nephron-protective effects at low concentrations (Darkwah *et al.,* 2020; Sivapriya & Leela, 2007a). The antioxidant capacity of the vitamins C and E found in *S. torvum* prevents molecules from oxidation or the loss of electrons which is the cause of their nephro-protective function. Their structural and chemical make-up actually makes it easy for them to stabilize oxidative molecules via electron exchange. The nephro-protective potential of various vitamin C and E structures may be used to determine their efficacy (Darkwah *et al.,* 2020).

10. IMMUNOMODULATORY EFFECT

Benign prostatic hyperplasia (BPH) might be treated using the plant's immunomodulatory and antioxidant properties (Peranginangin *et al.,* 2013). *S. torvum*'s bioactive substances have a number of potential uses, including antimicrobial, antiviral and antifungal properties, along with immuno-modulatory properties (Kannan *et al.,* 2012). The delayed type hypersensitivity (DTH) reaction, a direct correlate of cell mediated immunity (CMI), was markedly and dose-dependently amplified by the aqueous extract of *S. torvum*. Levamisole also had a comparable impact. The WBC count increased significantly ($p>0.001$) in the extract and levamisole treated group compared to the dexamethasone and "No treatment" groups (Koffuor *et al.,* 2011b).

An elevation in the white blood cell and granulocytes count is one mechanism by which the aqueous extract of *S. torvum* extract its immuno-modulatory effects (Innih *et al.,* 2018; Israf *et al.,* 2004).

11. ANTIULCEROGENIC ACTIVITY

The fruits of *S. torvum* are used for treatment of ulcer (Noumi & Dibakto, 2000) and additionally the fruits are pulverized in hot water and then applied topically in Nigeria (Ajibesin *et al.,* 2008). Flavonoids, triterpenes and sterols found in *S. torvum* possess anti-ulcer properties by enhancing gastric mucosal defence (Antonio *et al.,* 2004; Ngueleface *et al.,* 2008; Télesphore B. *et al.,* 2008).

According to the research conducted by (Télesphore B. *et al.,* 2008), rats' gastric mucosal lesions brought on by HCl/ethanol, indomethacin, pylorus ligation and cold-restraint stress are significantly inhibited by the aqueous and methanolic extract of *S. torvum* leaves and an increase in mucus production, which in turn strengthens the mucosal barrier, which maybe the cause of the cytoprotective activity. The anti-ulcer activities of *S. torvum* flavonoid derivatives are achieved by increasing mucus production and neutralising the acidic content (Mendes *et al.,* 2012).

CONCLUSION

Since the beginning of time, people have turned to herbs as a source of medicine for a wide range of illnesses. One of the most significant angiosperm families in terms of both commercial and therapeutic significance is the Solanaceae family. *Solanum torvum* belonging to family solanaceae is a small shrub and is found widely in India, China, Pakistan, Philippines, Malaya and tropical America. The plant's dried stem and root have been utilized for decades by numerous ethnic groups to treat a variety of diseases.

The synthesis of several phytochemicals by *S. torvum* explains the widespread traditional therapeutic usage. According to reports, *S. torvum* contains a variety of phytochemicals including proteins, amino acids, oils, tocopherols, glycosides, alkaloids, phenols, tannins, flavonoids, carbohydrates, steroids and glycosides.

The rich phytochemical concentration attributes to varied pharmacological benefits. The various parts of plants are used to tackle illnesses such as cough, enlarged spleen, heart problems and pain. It is also effectively used for its antimicrobial, antioxidant, anti-inflammatory, anti-cancerous, antidiabetic, hepatoprotective, nephroprotective, immuno-modulatory and antiulcerogenic activities. Its significance in both traditional and alternative medicine as well as the presence of a number of chemicals with medicinal potential warrant more investigation into its effect.

There are many interesting and unidentified medicinal plants, some of which are already used clinically in medicinal formulations. Thus, Ayurvedic drugs must be reviewed for the therapeutic efficacy and standardized by chemical and biochemical assay to ensure active principal consistency in each dose.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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REFERENCES

Abas, F., Lajis, N. H., Israf, D. A., Khozirah, S., & Umi Kalsom, Y. 2006. Antioxidant and nitric oxide inhibition activities of selected Malay traditional vegetables. *Food Chemistry*, *95*(4), 566–573. https://doi.org/10.1016/j.foodchem.2005.01.034

Abedimanesh, N., Asghari, S., Mohammadnejad, K., Daneshvar, Z., Rahmani, S., Shokoohi, S., Farzaneh, A. H., Hosseini, S. H., Jafari Anarkooli, I., Noubarani, M., Andalib, S., Eskandari, M. R., & Motlagh, B. 2021. The anti-diabetic effects of betanin in streptozotocin-induced diabetic rats through modulating AMPK/SIRT1/NF-kB signaling pathway. *Nutrition & Metabolism*, *18*(1), 92. https://doi.org/10.1186/s12986-021-006219

Adjanohoun, J. E., Aboubakar, N., Dramane, K., Ebot, M. E., Ekpere, J. A., Enow-Orock, E. G., Focho, D., Gbile, Z. O., Kamanyi, A., & Kamsu-Kom, J. 1996. Traditional medicine and pharmacopoeia: Contribution to ethno-botanical and floristic studies in Cameroon. *OUA/STRC: Lagos*, *301*.

Ajaiyeoba, E. 1999. Comparative phytochemical and antimicrobial studies of *Solanum macrocarpum* and *S. torvum* leaves. *Fitoterapia*, 70(2), 184-186

Ajibesin, K. K., Ekpo, B. A., Bala, D. N., Essien, E. E., & Adesanya, S. A. 2008. Ethnobotanical survey of Akwa Ibom State of Nigeria. *Journal of Ethnopharmacology*, *115*(3), 387–408. https://doi.org/10.1016/j.jep.2007.10.021

Amarowicz, R., Estrella, I., Hernández, T., Robredo, S., Troszyñska, A., Kosiñska, A., & Pegg, R. B. 2010. Free radical-scavenging capacity, antioxidant activity, and phenolic composition of green lentil (*Lens culinaris*).

Food Chemistry, *121*(3), 705–711. https://doi.org/10.1016/j.foodchem.2010.01.009

Antonio, J. M., Gracioso, J. S., Toma, W., Lopez, L. C., Oliveira, F., & Souza Brito, A. R. M. 2004. Antiulcerogenic activity of ethanol extract of *Solanum variabile* (false "jurubeba"). *Journal of Ethnopharmacology*, *93*(1), 83–88. https://doi.org/10.1016/j.jep.2004.03.031

Apaya, M. K., Kuo, T.-F., Yang, M.-T., Yang, G., Hsiao, C.-L., Chang, S.-B., Lin, Y., & Yang, W.-C. 2020. Phytochemicals as modulators of β-cells and immunity for the therapy of type 1 diabetes: Recent discoveries in pharmacological mechanisms and clinical potential. *Pharmacological Research*, *156*, 104754. https://doi.org/10.1016/j.phrs.2020.104754

Arthan, D., Svasti, J., Kittakoop, P., Pittayakhachonwut, D., Tanticharoen, M., & Thebtaranonth, Y. 2002. Antiviral isoflavonoid sulfate and steroidal glycosides from the fruits of *Solanum torvum*. *Phytochemistry*, *59*(4), 459–463. https://doi.org/10.1016/s0031-9422(01)00417-4

Atta, A. H., & Alkofahi, A. 1998. Anti-nociceptive and anti-inflammatory effects of some Jordanian medicinal plant extracts. *Journal of Ethnopharmacology*, *60*(2), 117–124. https://doi.org/10.1016/S0378-8741(97)00137-2

Balachandran, C., Emi, N., Arun, Y., Yamamoto, Y., Ahilan, B., Sangeetha, B., Duraipandiyan, V., Inaguma, Y., Okamoto, A., Ignacimuthu, S., Al-Dhabi, N. A., & Perumal, P. T. 2015. *In vitro* anticancer activity of methyl caffeate isolated from *Solanum torvum* Swartz. Fruit. *Chemico-Biological Interactions*, *242*, 81–90. https://doi.org/10.1016/j.cbi.2015.09.023

Bari, M. A., Islam, W., Khan, A. R., & Mandal, A. 2010. Antibacterial and antifungal activity of *Solanum torvum* (Solanaceae). *Int J Agric Biol*, *12*(3), 386–390.

Boham, B. A., & Kocipai-Abyazan, R. 1974. Flavonoids and condensed tannins from leaves of Hawaiian *Vaccinium vaticulatum* and *V. calycinium*. *Pacific Sci*, *48*(4), 458–463.

Chah, K. F., Muko, K. N., & Oboegbulem, S. I. 2000. Antimicrobial activity of methanolic extract of *Solanum torvum* fruit. *Fitoterapia*, *71*(2), 187–189. https://doi.org/10.1016/S0367-326X(99)00139-2

Chen, C.-J., Huang, Y.-C., Chiu, C.-H., Su, L.-H., & Lin, T.-Y. 2005. Clinical Features and Genotyping Analysis of Community-Acquired Methicillin-Resistant *Staphylococcus aureus* Infections in Taiwanese Children. *Pediatric Infectious Disease Journal*, *24*(1), 40–45. https://doi.org/10.1097/01.inf.0000148926.112 27.1c

Daglia, M. 2012. Polyphenols as antimicrobial agents. *Current Opinion in Biotechnology*, *23*(2), 174–181.

Darkwah, W. K., Koomson, D. A., Miwornunyuie, N., Nkoom, M., & Puplampu, J. B. 2020. Review: Phytochemistry and medicinal properties of *Solanum torvum* fruits. *All Life*, *13*(1), 498–506. https://doi.org/10.1080/26895293.2020.1817799

Gandhi, G. R., Ignacimuthu, S., & Paulraj, M. G. 2011. *Solanum torvum* Swartz. Fruit containing phenolic compounds shows antidiabetic and antioxidant effects in streptozotocin induced diabetic rats. *Food and Chemical Toxicology*, *49*(11), 2725–2733. https://doi.org/10.1016/j.fct.2011.08.005

Gandhi, G. R., Ignacimuthu, S., Paulraj, M. G., & Sasikumar, P. 2011. Antihyperglycemic activity and antidiabetic effect of methyl caffeate isolated from *Solanum torvum* Swartz. Fruit in streptozotocin induced diabetic rats. *Eur. Journal of Pharmacology*, *670*(2–3), 623–631. https://doi.org/10.1016/j.ejphar.2011.09.159

Iida, Y., Yanai, Y., Ono, M., Ikeda, T., & Nohara, T. 2005. Three Unusual 22-.BETA.-O-23-Hydroxy-(5.ALPHA.)-spirostanol Glycosides

from the Fruits of *Solanum torvum*. *Chemical and Pharmaceutical Bulletin*, *53*(9), 1122–1125. https://doi.org/10.1248/cpb.53.1122

Innih, S., Agu, K., & Eze, G. 2018. Immunomodulatory and hepatoprotective properties of *Solanum torvum* (Turkey berry). *Sahel Medical Journal*, *21*(1), 13. https://doi.org/10.4103/1118-8561.232777

Inta, A., Trisonthi, P., & Trisonthi, C. 2013. Analysis of traditional knowledge in medicinal plants used by Yuan in Thailand. *Journal of Ethnopharmacology*, *149*(1), 344–351. https://doi.org/10.1016/j.jep.2013.06.047

Israf, D. A., Lajis, N. H., Somchit, M. N., & Sulaiman, M. R. 2004. Enhancement of ovalbumin-specific IgA responses via oral boosting with antigen co-administered with an aqueous *Solanum torvum* extract. *Life Sciences*, *75*(4), 397–406. https://doi.org/10.1016/j.lfs.2003. 10.038

Jaabir, M., Vigneshwaran, R., Hassan, T. M. D., & Kumar, S. 2015. Study on the antimicrobial activity of ethanolic extract of the fruits of *Solanum torvum* and its phytochemical analysis by GC-MS. *Biomedical and Pharmacology Journal*, *3*, 117–121.

Jaiswal, B. S. 2012. *Solanum torvum*: A review of its traditional uses, phytochemistry and pharmacology. *International Journal of Pharma and Bio Sciences* 3(4), 104-111.

Kadam, V., Gangurde, S., & Mohan, M. (2019). Protective effect of *Solanum torvum* on monosodium glutamate-induced hepato toxicity and nephrotoxicity in rats. *Indian J. Nat Prod Resour,* 10(1), 31-42.

Kala, C. P. 2005. Ethnomedicinal botany of the Apatani in the Eastern Himalayan region of India. *Journal of Ethnobiology and Ethnomedicine*, *1*(1), 11.

Kalita, L., Dash, B., Borah, U., Deka, J., & Dash, S. 2017. Preliminary phytochemical analysis and antimicrobial activity ethanolic extracts of dried fruits of *Solanum torvum* (Family-Solanaceae). *International Journal of Current Pharmaceutical Research*, *9*(3), 123. https://doi.org/10.22159/ijcpr.2017.v9i3.19982

Kannan, M., Dheeba, B., & Gurudevi, S. 2012. Phytochemical, antibacterial and antioxidant studies on medicinal plant *Solanum torvum*. *Journal of Pharmacy Research,* 5(5), 2418-2421.

Kayalvizhi, J., Bharathi, K., Vijayakumari, P., Kavitha, M., Bhuvaneswari, T. S., Muruganandam, G., Sethuraman, M., & Thirumurugan, V. 2012. Studies on the physico-phytochemical properties and hepatoprotective effect of *Solanum torvum* swartz in CCL4 induced experimental toxicity in albino rats. *International Journal of Pharmacy and Pharmaceutical Sciences*, 4(5), 426-429.

Kim, S.-Y., & Moon, A.-R. 2012. Drug-Induced Nephrotoxicity and Its Biomarkers. *Biomolecules and Therapeutics*, *20*(3), 268–272. https://doi.org/10.4062/biomolther.2012.20.3.268

Koffuor, G., Amoateng, P., & Andey, T. 2011a. Immunomodulatory and erythropoietic effects of aqueous extract of the fruits of *Solanum torvum* Swartz (Solanaceae). *Pharmacognosy Research*, *3*(2), 130. https://doi.org/10.4103/0974-8490.81961

Koffuor, G., Amoateng, P., & Andey, T. (2011b). Immunomodulatory and erythropoietic effects of aqueous extract of the fruits of *Solanum torvum* Swartz (Solanaceae). *Pharmacognosy Research*, *3*(2), 130. https://doi.org/10.4103/0974-8490.81961

Kusirisin, W., Jaikang, C., Chaiyasut, C., & Narongchai, P. 2009a. Effect of Polyphenolic Compounds from *Solanum torvum* on Plasma Lipid Peroxidation, Superoxide anion and Cytochrome P450 2E1 in Human Liver Microsomes. *Medicinal Chemistry*, *5*(6), 583–588. https://doi.org/10.2174/15734060 9790170443

Kusirisin, W., Jaikang, C., Chaiyasut, C., & Narongchai, P. 2009b. Effect of Polyphenolic Compounds from *Solanum torvum* on

Plasma Lipid Peroxidation, Superoxide anion and Cytochrome P450 2E1 in Human Liver Microsomes. *Medicinal Chemistry*, *5*(6), 583–588. https://doi.org/10.2174/157340609790170443

Lai, H.-C., Weng, J.-C., Huang, H.-C., Ho, J.-X., Kuo, C.-L., Cheng, J.-C., & Huang, S.-T. 2024. Solanum torvum induces ferroptosis to suppress hepatocellular carcinoma. *Journal of Ethnopharmacology*, *335*, 118670. https://doi.org/10.1016/j.jep.2024.118670

Lakshmi, D., Prasanna, N., & Ponmurugan, N. 2013. *In vitro* Interactions Between *Solanum torvum* Extracts and Microbes. *Academic Journal of Plant Sciences*, 6(1), 47-51.

Lalitha, V., Raveesha, K. A., & Kiran, B. 2010. Antimicrobial activity of *Solanum torvum swart*.

Little, E. L., Woodbury, R. O., & Wadsworth, F. H. 1974. *Trees of Puerto Rico and the Virgin islands* (Issue 449). US Department of Agriculture, Forest Service.

Loganayaki, N., Siddhuraju, P., & Manian, S. 2010. Antioxidant activity of two traditional Indian vegetables: *Solanum nigrum* L. and *Solanum torvum* L. *Food Science and Biotechnology*, *19*(1), 121–127. https://doi.org/10.1007/s10068-010-0017-y

Lu, Y., Luo, J., Huang, X., & Kong, L. 2009. Four new steroidal glycosides from *Solanum torvum* and their cytotoxic activities. *Steroids*, *74*(1), 95–101. https://doi.org/10.1016/j.steroids.2008.09.011

Lu, Y.-Y., Luo, J.-G., & Kong, L.-Y. 2011. Chemical Constituents from *Solanum torvum*. *Chinese Journal of Natural Medicines*, *9*(1), 30–32. https://doi.org/10.1016/s1875-5364(11)60015-0

Mahmood, U., Shukla, Y. N., & Thakur, R. S. 1983. Non-alkaloidal constituents from *Solanum torvum* leaves. *Phytochemistry*, *22*(1), 167–169. https://doi.org/10.1016/s0031-9422(00)80080-1

Mc, P.-A., MuÉ™z Ocotero, V., GarcÆ— Casta¿™da, J., & Gonz ‘ez Esquinca, A. 2007. Alkaloids in *Solanum torvum* Sw (Solanaceae). *Phyton*, *76*(1), 39–45. https://doi.org/10.32604/phyton.2007.76.039

Mendes, A. P. S., Borges, R. S., Neto, A. M. J. C., De Macedo, L. G. M., & Da Silva, A. B. F. 2012. The basic antioxidant structure for flavonoid derivatives. *Journal of Molecular Modeling*, *18*(9), 4073–4080. https://doi.org/10.1007/s00894-012-1397-0

Mihailovic, M., Dinic, S., Arambašic Jovanovic, J., Uskokovic, A., Grdovic, N., & Vidakovic, M. 2021. The Influence of Plant Extracts and Phytoconstituents on Antioxidant Enzymes Activity and Gene Expression in the Prevention and Treatment of Impaired Glucose Homeostasis and Diabetes Complications. *Antioxidants*, *10*(3), 480. https://doi.org/10.3390/antiox10030480

Mohan, M., Gangurde, S. K., & Kadam, V. 2018. Protective effect of Solanum torvum on monosodiumn glutamate-induced neuro toxicity in mice. *Indian Journal of Natural Products and Resources* 8(4), 351-359.

Mohan, M., Kamble, S., Gadhi, P., & Kasture, S. 2010. Protective effect of *Solanum torvum* on doxorubicin-induced nephrotoxicity in rats. *Food and Chemical Toxicology*, *48*(1), 436–440. https://doi.org/10.1016/j.fct.2009.10.042

Mohan, M., More, S., Patil, G., & Belapurkar, P. 2020. Effect of *Solanum torvum* Swartz on diabetic neuropathy in alloxan-induced diabetic rats. *Indian Journal of Natural Products and Resources*. https://doi.org/10.56042/ijnpr.v11i2.21920

Naimon, N., Pongchairerk, U., & Suebkhampet, A. 2015. Phytochemical Analysis and Antibacterial Activity of Ethanolic Leaf Extract of *Solanum torvum* Sw. Against Pathogenic Bacteria. *Agriculture and Natural Resources,* 49(4), 516-523.

Ndebia, E., Kamgang, R., & Nkeh-ChungagAnye, B. 2007. Analgesic And Anti-Inflammatory Properties Of Aqueous Extract From Leaves Of *Solanum torvum* (Solanaceae). *African Journal of Traditional, Complementary and Alternative Medicines*, *4*(2), 240–244. https://doi.org/10.4314/ajtcam.v4i2.31214

Neerja Gupta, N. G., Goldy Saxena, G. S., & Kalra, S. 2011. Antimicrobial activity pattern of certain terpenoids. *International Journal of Pharma and Bio Sciences,* 2(1), 99.

Nguelefack, T. B., Mekhfi, H., Dimo, T., Afkir, S., Nguelefack-Mbuyo, E. P., Legssyer, A., & Ziyyat, A. 2008. Cardiovascular and Anti-Platelet Aggregation Activities of Extracts from *Solanum torvum* (Solanaceae) Fruits in Rat. *Journal of Complementary and Integrative Medicine*, *5*(1). https://doi.org/doi:10.2202/1553-3840.1105

Noumi, E., & Dibakto, T. W. 2000. Medicinal plants used for peptic ulcer in the Bangangte region, western Cameroon. *Fitoterapia*, *71*(4), 406–412. https://doi.org/10.1016/S0367-326X(00)00144-1

Ogwu, M. C., Dunkwu-Okafor, A., Omakor, I. A., & Izah, S. C. 2024. Turkey berry (Solanum torvum Sw.[Solanaceae]): An overview of the phytochemical constituents, nutritional characteristics, and ethnomedicinal values for sustainability. *Herbal Medicine Phytochemistry: Applications and Trends*, 245–271.

Panigrahi, S., Muthuraman, M. S., Natesan, R., & Pemiah, B. 2014. Anticancer activity of ethanolic extract of *Solanum torvum* sw. *International Journal of Pharmacy and Pharmaceutical Sciences,* 6, 93-8.

Peranginangin, J. M., Soemardji, A. A., Adnyana, I. K., & Dhianawaty, D. D. 2013. *Therapeutic potency of Solanum torvum Swartz on benign prostatic hyperplasia treatment: A review. 3*(3), 121–127.

Prasad, K. N., Chew, L. Y., Khoo, H. E., Kong, K. W., Azlan, A., & Ismail, A. 2010. Antioxidant capacities of peel, pulp, and seed fractions of Canarium odontophyllum Miq. Fruit. *BioMed Research International*, *2010*(1), 871379.

Ramamurthy, Ch., Kumar, M. S., Suyavaran, V. S. A., Mareeswaran, R., & Thirunavukkarasu, C. 2012. Evaluation of Antioxidant, Radical Scavenging Activity and Polyphenolics Profile in *Solanum torvum* L. Fruits. *Journal of Food Science*, *77*(8). https://doi.org/10.1111/j.1750-3841.2012.02830.x

Rammohan, M., & Reddy, C. S. 2010. Anti-inflammatory activity of seed and fruit wall extract of *Solanum torvum. J Hygeia JD Med,* 2(2), 54-58.

Sabarinath, C., Sudhakar, P., & Shanmuganath, C. 2018. Phytochemical and Antibacterial screening on leaves of Solanum torvum. *Asian Journal of Research in Pharmaceutical Science*, *8*(3), 130–132.

Satyanarayana, N., Chinni, S. V., Gobinath, R., Sunitha, P., Uma Sankar, A., & Muthuvenkatachalam, B. S. 2022. Antidiabetic activity of *Solanum torvum* fruit extract in streptozotocin-induced diabetic rats. *Frontiers in Nutrition*, *9*, 987552. https://doi.org/10.3389/fnut.2022.987552

Siemonsma, J. S., & Piluek, K. 1994. Plant resources of south-east Asia (PROSEA). *Vegetables. PROSEA, Bogor, Indonesia*, 149–150.

Silva, A. C. da, Kinupp, V. F., Absy, M. L., & Kerr, W. E. 2004. Pollen morphology and study of the visitors (Hymenoptera, Apidae) of *Solanum stramoniifolium* Jacq.(Solanaceae) in Central Amazon. *Acta Botanica Brasilica*, *18*, 653–657.

Sivapriya, M., & Leela, S. 2007a. Isolation and purification of a novel antioxidant protein from the water extract of Sundakai (*Solanum torvum)* seeds. *Food Chemistry*, *104*(2), 510–517. https://doi.org/10.1016/j.foodchem.2006.11.060

Sivapriya, M., & Leela, S. 2007b. Isolation and purification of a novel antioxidant protein

from the water extract of Sundakai (Solanum torvum) seeds. *Food Chemistry*, *104*(2), 510–517. https://doi.org/10.1016/j.foodchem.2006.11.060

Sridevi, P., Vijayanand, P., & Raju, M. B. (2017). Formulation and evaluation of anti-inflammatory herbal gel containing isolated solanesol. *Annals of Phytomedicine: An International Journal*, *VI*(I), 127–131. https://doi.org/10.21276/ap.2017.6.1.19

Takahashi, K., Yoshioka, Y., Kato, E., Katsuki, S., Iida, O., Hosokawa, K., & Kawabata, J. 2010. Methyl Caffeate as an á-Glucosidase Inhibitor from *Solanum torvum* Fruits and the Activity of Related Compounds. *Bioscience, Biotechnology, and Biochemistry*, *74*(4), 741–745. https://doi.org/10.1271/bbb.90789

Tanaka, H., Sato, M., Fujiwara, S., Hirata, M., Etoh, H., & Takeuchi, H. 2002. Antibacterial activity of isoflavonoids isolated from Erythrina variegata against methicillin-resistant Staphylococcus aureus. *Letters in Applied Microbiology*, *35*(6), 494–498. https://doi.org/10.1046/j.1472-765X.2002.01222.x

Télesphore B., N., Feumebo, C. B., Ateufack, G., Watcho, P., Tatsimo, S., Atsamo, A. D., Tane, P., & Kamanyi, A. 2008. Anti-ulcerogenic properties of the aqueous and methanol extracts from the leaves of *Solanum torvum* Swartz (Solanaceae) in rats. *Journal of Ethnopharmacology*, *119*(1), 135–140. https://doi.org/10.1016/j.jep.2008.06.008

Thenmozhi, A., & Rao, U. S. 2011. Evaluation of antimitotic activity of *Solanum torvum* using *Allium cepa* root meristamatic cells and anticancer activity using MCF-7-Human mammary gland breast adenocarcinoma cell lines. *Drug Invention Today*, 3(12), 290-296

Thenmozhi, A., & US, M. R. 2012. Comparative free radical scavenging potentials of different parts of Solanum torvum. *Free Radicals and Antioxidants*, *2*(2), 24–29.

Tripathi, P. C. 2021. Medicinal and theraptic properties of minor fruits—A Review. *International Journal of Minor Fruits, Medicinal and Aromatic Plants*, *7*(2), 1–28. https://doi.org/10.53552/ijmfmap.2021.v07ii02.001

Young, I. S., & Woodside, J. V. 2001. Antioxidants in health and disease. *Journal of Clinical Pathology*, *54*(3), 176–186.

Yousafa, Z., Wanga, Y., & Baydounc, E. 2013. Phytochemistry and pharmacological studies on *Solanum torvum* Swartz. *Journal of Applied Pharmaceutical Science*, 3(4), 152-160.