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Pharmacological Properties of Scoparia Dulcis: A Review

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Abstract: The present review describes the morphological, phytochemical and pharmacology aspects of *Scoparia dulcis* (Scrophulariaceae). *Scoparia dulcis* (commonly known as sweet broomweed) is a perennial herb widely distributed in tropical and subtropical regions. Broomweed is a common annual herb in Suriname growing up to 2 m in height. Scoparia has been used as a remedy for treating diabetes mellitus in India and hypertension in Taiwan. It is traditionally used in treatment of diabetes, dysentery, earache, fever, gonorrhea, headaches, jaundice, snake bite, stomach problems, toothache, warts. So, the present paper enumerates an overview of phytochemical and pharmacological properties which may help the researchers to set their minds for approaching the efficacy and potency of herb.

Key words: *Scoparia dulcis*, pharmacognosy, morphology, phytochemistry, pharmacological profile

INTRODUCTION

Scoparia dulcis (Scrophulariaceae), commonly known as sweet broomweed is a perennial herb widely distributed in tropical and subtropical regions. In these regions, fresh or dried *S. dulcis* plants have been traditionally used as remedies for stomach trouble (Satyanarayana, 1969), hypertension (Chow *et al*., 1974), diabetes (Perry, 1980), bronchitis (Gonzalez-Torres, 1986) and as analgesic and antipyretic agents (De Farias Freire *et al*., 1993). A number of different principles such as scoparic acid A, scoparic acid B, scopadulcic acid A and B, scopadulciol and scopadulin (Hayashi *et al*., 1990) have been shown to contribute to the observed medicinal effect of the plant. These compounds were found to possess various biological activities such as inhibition of herpes simplex virus replication, gastric H^+, K^+-ATPase activation, antitumor activity, etc. (Nath, 1943), in a study of the antidiabetic effect of *S. dulcis*, obtained a glycoside named ammeline from fresh plants which relieved other ailments accompanying diabetes, such as pyorrhea, eye troubles, joint pain, susceptibility to cold, etc., within a very short period of time.

Scoparia dulcis is an erect annual herb with serrated leaves, producing white flowers and measuring up to a half meter in height when fully grown. Its ethnomedicinal uses amongst various indigenous tribes in the rain-forest zone is well-documented (Branch and Da Silva, 1983).

Some aspects of the several speculated pharmacological properties of *S. dulcis* have been validated by scientific research and includes the hypoglycaemic, anti tumour promoting and anti viral activities (Jain, 1985). Phytochemical screening of the herb revealed that it is rich in flavonoids and terpenes and the pharmacological actions of *S. dulcis* are believed to be due to the presence of these phytochemicals (Hayashi *et al*., 1990).

In Nigeria, the plant has been used in the management of sickle cell anaemia for over two decades. The widespread claims of massive boost in haematocrit or Packed Cell Volume (PCV) and Haemoglobin (Hb) levels in these patients and the apparent amelioration of the frequent and severe crisis associated with the disease prompted this study. Progressive anaemia is widely accepted as a cardinal feature of *Trypanosoma brucei* infection (Moulton and Sollod, 1976). The present paper summarizes our report on the efficacy of *S. dulcis* in the management of trypanosome induced anaemia in the rabbit.

The ethanoveterinary use of plant dates back to 1989 in Trinidad as a topical lotion to treat impetiginous and herpetic eruptions. Many of the indications for the plants use parallel those practiced in veterinary folk medicine. Mucilage is released when the whole plant is soaked in water, thus helping to protect and regenerate normal cells; it may also act as an immunostimulator.

MORPHOLOGY

Broomweed is a common annual herb in Suriname growing up to 2' in height. It has serrated leaves and many small white flowers. Flowers hermaphrodite, complete,

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usually axillary, 6-7 mm in diameters, 4-fid, rotate, regular. Sepals 4-5, gamosepalous, regular, calyx lobes oval-oblong, 2.5-3.0×0.8-1.0 mm, 3-nerved, glabrous, ciliate at the margin, persistent. Corolla pale yellow to white, corona present, tube densely hairy at the throat, lobes 2-4 mm long, apex obtuse, slightly curvy, upper lobes slightly larger than others. Stamens 4, exerted; filament inserted at the top of the corolla tube, glabrous; anthers dorsifixed. Style erect, c 2 mm long; stigma truncate to 2-partite, sometimes notched. Flowering time: Almost throughout the year.

PHYTOCHEMISTRY

The scientific literature reveals numerous chemical studies on the herb; isolated chemical constituents include coumarins, phenols, saponins, tannins, amino acids, flavonoids, terpenoids and catecholamines (Ratnasooriya *et al*., 2005). High-performance liquid chromatographic analysis of an aqueous fraction of *S. dulcis* revealed the presence of noradrenaline and adrenaline which have sympathomimetic effects (De Farias Freire *et al*., 1996). The herb's terpenoids are responsible for numerous medicinal effects. Scoparic acid A, scoparic acid B, scopadulcic acid A and B, scopadulciol and scopadulin are all biologically active. These chemical compounds have various biological activities, including inhibition of the replication of herpes simplex virus, inhibition of proton pumps, potassium Adenosine Triphosphate (ATP) ase activator and antitumor promoting activity. Additional identified terpenoids of broomweed include alpha-amyrin, betulinic acid, dulcioic acid, friedelin, glutinol and ifflaionic acid (Hayashi *et al*., 1996, 1997, 1999).

The acetylated flavone glycosides from broomweed have Nerve Growth Factor (NGF) potentiating activity or neurotrophic activity that may be useful in treating neurological disorders. The flavone glycosides, including isovitexin, also inhibit β-glucuronidas1 (Li and Ohizumi, 2004; Kawasaki *et al*., 1988). The dried roots and aerial parts of *S. dulcis* contain economically important hydroxamic acids which provide insect, fungal and bacterial resistance (Pratt *et al*., 1995).

PHARMACOLOGICAL ACTIVITIES

Antidiabetic activity: Treatment with aqueous *S. dulcis* extracts and glibenclamide significantly improved specific insulin binding in streptozotocin-induced male Wistar rats. The number of insulin receptors and affinity binding ($p<0.001$) was reduced to normal nondiabetic levels. Overall, the results suggest an increase in total Endoplasmic Reticulum (ER) membrane insulin binding sites with a concomitant increase in plasma insulin in rats treated with aqueous *S. dulcis* extract or glibenclamide. The mean specific binding of insulin to ER was lower in diabetic control rats (55+/-2.8%) than in aqueous *S. dulcis* -treated (70+/-3.5%) and glibenclamide-treated (65+/- 3.3%) diabetic rats, resulting in a decrease in plasma insulin (Pari *et al*., 2004).

An aqueous extract of *S. dulcis* plant was administered orally for 6 weeks to streptozotocin diabetic rats. The level of plasma insulin was decreased and the levels of blood glucose and plasma glycoprotein were increased in diabetic control rats. The diabetic control rats also had a decrease in the level of sialic acid and elevated levels of hexose, hexosamine and fucose in the liver and kidney. After oral administration of *S. dulcis* plant extracts, the controls had decreased levels of blood glucose and plasma glycoproteins. Plasma insulin and tissue sialic acid levels were increased and hexose, hexosamine and fucose tissue levels were near normal in controls (Latha and Pari, 2005). Similar animal experiments using aqueous *S. dulcis* extracts of 200 mg/kg/day resulted in antihyperglycemic effects, including increased hemoglobin levels, decreases in hemoglobin A1c levels, increased sorbitol dehydrogenase, lipid peroxidation and antioxidant activity in the liver of diabetic rats (Latha and Pari, 2004).

Analgesic and anti-inflammatory activity: The diterpene scoparinol demonstrated significant analgesic ($p<0.001$) and anti-inflammatory activity ($p<0.01$) in animals. Pretreatment of ethanolic extracts of *S. dulcis* (0.5 g kg^{-1}) reduced acetic acid-induced writhing in mice 47%. The extract (0.5 and 1 g kg^{-1}) also inhibited paw edema in rats induced by carrageenan 46 and 58%, respectively after 2 h. The triterpene glutinol (30 mg kg^{-1}) reduced writhing in mice induced by acetic acid 40% and paw edema in rats induced by carrageenan 73%, indicating that the analgesic activity of *S. dulcis* is most likely related to the anti-inflammatory activity of glutinol (Freire *et al*., 1991).

Antiviral activity: *In vitro* the diterpenoid scopadulcic acid B inhibited viral replication of herpes simplex virus type 1 in a hamster test model. The mechanism of action is unknown but does not involve a direct virucidal effect or inhibition of virus attachment. Topical application or intraperitoneal injections at 100 and 200 mg/kg/day prolonged the development of herpetic lesions and survival time when treatment was initiated immediately after virus inoculation (Hayashi *et al*., 1988, 1990).

Anti-malarial activity: *In vitro* the diterpenoid scopadulcic acid A has activity against various Plasmodium falciparum isolates with an IC_{50} of 27 mcM against the D6 clone (African Sierra isolate) and an IC_{50} of 19 mcM against the W2 clone (Indochina isolate). The IC_{50} against the multidrug-resistant TM91C235 (Thailand) isolate was 23 mcM. For comparison, IC_{50} values for chloroquine were 9.3, 266 and 24 nM against D6, W2 and TM91C235. The IC50 values for mefloquine were 36, 4.8 and 59 nM against D6, W2 and TM91 C235 (Riel *et al*., 2002).

Neurotropic activity

***In vitro* data:** The acetylated flavone glycosides from *S. dulcis* have NGF-potentiating activity, which may be useful in treating neurological disorders. In control experiments, following incubation, the percentages of neurite-bearing cells in PC12D cells were 27% with 2 ng mL^{-1} NGF and 71% with 30 ng mL^{-1} NGF after 48 h. After incubation with the glycosides from *S. dulcis*, neurite outgrowth in PC12D cells was increased by an additional 16 and 15%, respectively (Li and Ohizumi, 2004; Li *et al*., 2004).

Anti-cancer activity

***In vitro* and *in vivo*:** Scopadulcic acid B inhibited the effects of the tumor promoter 12-O-tetradecanoylphorbol-13-acetate (TPA). Scopadulcic acid B also inhibited TPA-enhanced phospholipid synthesis in cultured cells and inhibited the effect of TPA on skin tumor formation in mice initiated with 7, 12 dimethylbenz (a) anthracene (Nishino *et al*., 1993). Four new labdane-derived diterpenes, isolated from the aerial parts of *S. dulcis*, were cytotoxic against the following 6 human stomach cancer cell lines: SCL, SCL-6, SCL-37'6, SCL-9, Kato-3 and NUGC-4. Vinblastine sulfate and mitomycin C were used as positive controls. Scopadulcic acid C, another diterpene, enhanced the antitumor efficacy of acyclovir and ganciclovir in a HSV-TK gene therapy system. The synergistic activity was caused by the activation of viral thymidine kinase (Nkembo *et al*., 2005; Nakagiri *et al*., 2005).

Other pharmacological activity: In an animal study, an aqueous fraction of *S. dulcis* revealed the presence of 2 catecholamines, noradrenaline and adrenaline, that may account for the hypertensive and inotropic effects after parenteral administration (De Farias Freire *et al*., 1996). A significant effect on onset and duration of sleep ($p<0.05$) was caused by scoparinol on pentobarbital-induced sedation in animals. In another animal study, sleeping time induced by sodium pentobarbital 50 mg kg^{-1} was prolonged 2-fold in mice pretreated with 0.5 g kg^{-1} of an ethanolic extract of *S. dulcis*. Scoparinol has a diuretic action in animals as demonstrated by the measurement of urine volume after administration (Ahmed *et al*., 2001; Freire *et al*., 1991). The flavones glycosides, including isovitexin, inhibit activity against β-glucuronidase (Kawasaki *et al*., 1988; Hayashi *et al*., 1992).

CONCLUSION

The multiple benefits of *Scoparia dulcis* made it a true miracle of nature. Numerous studies have been conducted on different parts of *Scoparia dulcis* but this plant has not yet developed as a drug by pharmaceutical industries. A detailed and systematic study is required for identification, cataloguing and documentation of plants, which may provide a meaningful way for the promotion of the traditional knowledge of the herbal medicinal plants. The present review reveals that the plant is used in treating various ailments. It elicits on all the aspects of the herb and throws the attention to set the mind of the researchers to carry out the work for developing its various formulations which can ultimately be beneficial for the human beings as well as animals.

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