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Review Article

A Mini Review of *Desmodium incanum* - An Underutilized Herb in Jamaica

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Abstract

The potential of *Desmodium incanum* has long been overshadowed by more popular plants within and outside of its genus. However, there are records of its significance in medicine, food, and agriculture. Scrutiny of publications from 1972–2023, has confirmed that the *D. incanum*is underutilized worldwide despite documented phytochemicals and some superior characteristics. Medicinal applications of *D.incanum* included both ethnomedical and potential modern medicinal application. Prominent uses found were in tonic formulations promoting appetite, sleep, stamina, to alleviate pain and potential treatment of high blood sugar. The use of the plant as food for animals is probable on account of its high protein levels and the presence of α-tocopherols and tannins, but more research is needed for this application. Although not widespread, the usage of this plant as a natural defense against pests and bacteria has been demonstrated.

Keywords

Desmodium incanum; Desomidium canum; Beggarweed; Strong back; Sweetheart.

Introduction

Medicinal properties have long been ascribed to many plants located in Jamaica. In many instances, 'medicines' are prepared from plants by boiling the leaves or roots and drinking it as tea. Colds were amongst one of the most treated ailments.[1] However, the application of plants have been reported in the treatment of more complicated ailments related to essential organs such as the heart, liver, kidney, bladder, as well as uses in cosmetics, agriculture and food. Due to the seemingly high regard given to the medical profession, a rapid replacement of herbal remedies with modern medicine was predicted by Steggerda[1] following his 1929 anthropological tour of Jamaica. Contrastingly, since then much greater emphasis has been placed on qualifying many of these natively accepted plants as medicinally and/or biologically relevant, and the use of medicinal plant remains popular in Jamaica to this day.[2] Additionally, the use of plants is practiced worldwide; for example, between 1946 and 1980, 53% of cancer treatments were natural plants or botanical drugs derived from plants.[3] As stated by Maridass and John De Britto[4], medicinal plants rose in prominence and became the principal object of many researchers in chemistry, biochemistry, and pharmaceuticals.

From their 2016 review of all new drugs approved by the United States Food and Drug Administration (US FDA) over a 34-year time span from 1998–2014, Newman and Cragg[5] revealed that 6% were made from natural unaltered products; 1% were made from a mixture of botanical drugs and 26% were natural product derivatives.

Of about 35% medicines originating from natural products and its derivatives, plants were the primary raw material used in roughly 25% of the medicines available on the global market.[6]

Plant-based medicines associated with less side effects than synthetic drugs and are touted as more affordable, more accessible and convenient due to the abundance and availability of plants worldwide.[7] According to Mitchell and Ahmad[8], a large portion of a country's wealth may be hidden in its growing plant varieties – be it recently introduced, naturalized or endemic. This is relative to considerations of 1.1 trillion USD earnings of the pharmaceutical industry and the vested interest in natural products, particularly plants, as resources in the development of new medicine and other products in the food and beverage, cosmetics and agricultural industries.[6]

In Jamaica alone, there are 3218 distinct plant species where approximately 40% of the plants are endemic to Jamaica, and more than half of the flowering plants found in Jamaica's Blue and John Crow Mountains have been declared non-existent outside of the island.[2,9] Furthermore, Lowe et al. [7] estimated that 52% of the plants that have been approved for medicinal applications are growing in Jamaica. Some of these plants however remain underutilized, while others are under-investigated or remain undiscovered due to widespread concentration on more popular plants such as *Cannabis sativa* (ganja), *Moringa oleifera* (moringa), *Cola acuminate* (bissy), *Petiveriaalllicaea* (guinea hen weed) and *Alysicarpus vaginalis* (medina). The purpose of this paper is to explore one of the underutilized plants in Jamaica. Specifically, the uses, chemical composition and bioactivity of the plant *D. incanum* in comparison to more popular plants in its genus will be discussed.

Nomenclature

D. incanum has many common names including local references as 'sweetheart', 'tick clover'and 'bees-bush'.[8,10,11] In many publications the plant is referred to as *Desmodiumcanum.* This is because this was accepted as the original name and was frequently used by many authors in their articles. However, Nicholson[12] indicated that the name *D. incanum* (1813) is the official name and described *Desmodiumcanum* Schniz and Thellung (1913) as an "illegitimate basionym". Furthermore, he alluded to an official reinstatement of *D. incanum* as the specie name and simultaneous rejection of *D. canum*. Nevertheless, many papers, both old and new, refer to the specie as the latter. Other common aliases of the plant species are creeping beggar weed, Kaimi clover, Spanish clover, Spanish tick trefoil, hitch hikers, zarzabacoacomun and sticky weed.[13]

Taxonomy

The *D. incanum* ("Sweetheart") herb belongs to the Fabaceae family (also referred to as Leguminosae or Papilionaceae). This family of plants is considered as economically and medicinally valuable and consists of a large number of leguminous plants.[14] These plants are generally rich sources of dietary fiber, protein, carbohydrates, fats, oxalate, phytic acid, vitamins and minerals.[15,16] Antiproliferative, antifeedant, anticancer, anti-atherogenic, antibacterial, antioxidant, antifungal and anti-inflammatory properties have been linked to this plant family.[14,16]

The *D. incanum* "sweetheart" plant is further classified as a member of *Desmodium* genus. *Desmodium* plants most often exist as herbs and shrubs, but seldom as trees and consist of pink or lilac flowers, unifoliate, bifoliate or trifoliate leaves, stamens formed from one or two filaments fused together, and fruit pods covered in uncinate hairs containing seeds.[17,18]

The *Desmodium* genus is reportedly large with approximately 350 different plant species, which are primarily used as food and herbal remedies. According to Ma et al.[17], only a few *Desmodium* plants – roughly 30 species – have been investigated to determine their phytochemistry.The *in vivo* and *in vitro* analyses of these species have resulted in the isolation of 212 phytochemicals from 15 plants: flavonoids and alkaloids were most abundant among the isolated compounds, which also included glycosides, phenols, phenylpropanoids, steroids and terpenoids, as well as volatile oils.The presence of these compounds is likely to attribute medicinal properties to the *Desmodium*plants and enable their use as anti-inflammatory, antibacterial, antidiabetic and anticancer agents.

Distribution

Desmodium species are known to thrive in the tropics and subtropics. *D. incanum* is native to Mexico, Central America, the Caribbean and South America, and possibly to Texas and Florida in the United States of America.[19] *D. incanum* is one of twelve *Desmodium* species that have been documented in Jamaica.[20] Specimens of plants have been located at unplanted lands, on the sides of roads, on rough terrain, pastures, in volcanic soils and in dry to wet areas with low vegetation. Adams[21] detailed

the morphology of *D. incanum* plants as observed in Jamaica: heights were approximately 70 cm (~28 in.; 2 ft); stems and petioles were reddish in colour; corollas were reddish purple (or light pink) and about 5 mm; leaflets were green, firm and had distinct veins with pubescents having whitish hairs; and fruits were slightly curved with segmentations of about 3-4 mm long (Figure 1).

Figure 1. *Desmodium incanum*

D. incanum is an extremely persistent herb and is able to withstand drought, fire, grazing and even regular herbicidal treatments.[19, 21, 22] The plant reproduces via sticky seeds and stolons and may be spread by people, animals, and machinery.[13,19] In years gone by *Desmodium* species, such as *D. incanum* were valued in agriculture on account of their persistence; however, these plants became too invasive and are often regarded as weeds.[23]*D. incanum* is viewed as a problematic weed that occasionally affects banana, coffee and rice crops.[19] This may possibly form part of the reason why *D. incanum* is underutilized in Jamaica. Nevertheless, given the medicinal properties of its genus and wider family, it is hypothesized that the *D. incanum* plant has a much wider scope of application than what is currently executed.

Ethnobotanical features of *D. incanum*

Medicine: The *Desmodium* genus has a wide range of reported medicinal applications – of which *D. incanum* is rarely referenced compared to other members of the genus. De Padua, et al. [24] reported the highest diversity in *Desmodium* plants in a stretch between India, from east to west, and South-East China, followed by second highest diversity in Mexico. Although, *D. incanum* is amongst the identified species in East Asia, reports of its use in folklore medicine is non-existent. Conversely, the leaves of the major species of *D. gangeticum* (L.) DC, *D. styracifolium* (Osbeck) Merr., *D. triflorum* (L.) DC had many prominent uses in South-East Asia: either in treating diarrhea, dysentery, stomach ache; healing wounds, ulcers and other skin problems; alleviating headache, toothaches and other pains; treating stones in gall bladder, bladder and kidney; or may be used as a galactagogue, expectorant and mouthwash; while the whole plant is reportedly used in Taiwan to counteract gonorrhea, fever, rheumatism and jaundice.[24]

Reports of medicinal use of *D. incanum* outside the *Desmodium* rich location of Asia were from Central America with uses of the plant as diuretic, stomachic, febrifuge and hemostatic.[24] In the Caribbean region, *D. incanum* is employed in treating colds, kidney problems, menstrual pain, headaches, as well as its use as a tonic and a sleep-inducing agent.[8] The tonic popularly made in Jamaica that incorporates *D. incanum* is commonly referred to as 'strong back'. In this mixture *D. incanum* is combined with various other herbs, such as "chainy root", ginger, medina, "red gal", strong back and is often drank by men to boost their stamina or treat impotence.[7,10] The *D. incanum*is able to spread rapidly and may be abundant in unreported areas; considering this, it is likely that this species has been used for more ethnomedicinal purposes, but these occurrences remain undocumented. The currency of information about *D. incanum* in medicinal application is a concern and the lack of more recent studies indicates that further research needs to be done.

Agriculture: *D. incanum* was previously promoted as a forage crop. However, due to its accidental spread to major crops, such as rice and coffee, it is no longer highly regarded as forage in many countries. Instead, *D. incanum* is regarded as weedy both within and outside of its native range.[19] The *D. tortum* plant, commonly referred to as the Florida beggarweed also shared a similar fate in the late 1900s and early 2000s. In the southeastern coastal plain of United States, Florida beggarweed transitioned from an essential forage component to a bothersome weed that affected peanut crops in North and South Carolina, Alabama, Florida, and Georgia.[23]

Despite its invasiveness, the planting of *D. incanum* is continuously encouraged by the United States Department of Agriculture (USDA) as a means to establish ground cover, to maintain biodiversity and for soil conservation measures.[19] This is because *D. incanum* plants have demonstrated nitrogen fixing capabilities. This application is viable because *D. incanum* has a symbiotic relationship with the

nitrogen-fixing bacteria in root nodules, *Bradyrhizobium elkanii*.[19] Nitrogen-fixation impacts the nutrient profile of soil and could either benefit or hinder plant growth. Therefore, the use of *D. incanum* in pastures amplifies the nitrogen in the areas it is located, which will subsequently increase the concentration of protein in soil. However, reports on the quantification of the nitrogen fixation ability of *D. incanum* remains absent even in literature directly discussing its use as forage.[19] The symbiotic compatibility and nodulation efficiency of rhizobia taken from a few plants, including *D. incanum* by cross inoculation was evaluated. It was found that inoculation with rhizobia from all plants investigated could cause seeds of different plants to grow nodules and leaves; therefore *D. incanum* was demonstrated as an effective nitrogen fixer.[25] This research shows the potential of *D. incanum* as beneficial to soil, but more quantitative bodies of research may be more convincing.

Owners of ranches in Hawaii often welcome the growth of *D. incanum* plants in their pastures as it steadily persists for roughly two years even with heavy cattle grazing.[19] This is a major advantage of *D. incanum* over other less invasive species in the genus; for instance, *D. inortum* will become exhausted from constant grazing and will die if not rested and given time to regrow.[18,26] Furthermore, Tropical Forages proclaim that next to grass, *D. incanum* is preferred by grazing livestock.[27]

*D. incanum*also displays resistance to parasitic roundworms that have root-knotting capabilities.[22] From a study in Sub-Saharan Africa, *D. incanum* showed positive results in controlling the parasitic weeds of the genus *Striga*, which is known to constrain the yield of cereals, namely maize and sorghum. Generally, *D. unicatum* and *D. inortum* effectively hinder *Striga* infestation of cereal crops, but the functionality of these *Desmodium* species fail during harsh changes in climate: elevated temperatures, extended droughts and reduced rainfall.[28,29] Therefore, the use of *D. incanum*, which is described as a more drought-resilient member of the genus was explored. Following intercropping of maize with *D. incanum*, there was suppression in *Striga* infestation and increase in grain yield. Similarly, West African cereal farmers in their observations of select plant species in pest control, classified *D. incanum* as good to very good in flowering, seed setting, very good in drought tolerance, but fair in forage quantity and quality; while *D. inortum* though rated as very good in forage quantity and quality, was only good in drought tolerance, and poor in flowering and seed setting.[30] Again, *D. incanum* specie displays superiority in some characteristics relative to more common members of its genus.

Food: The USDA promotes the *D. incanum* plant as a protein-rich, fodder product with high palatability for browse and grazing animals. The palpability of *D. incanum* for humans is reported as extremely low by the USDA, and there was no accessible literature reporting its use as human food. On the other hand, *D. torturum* was apparently mixed with dry fish to prepare an Indian meal in the 1990s and was relied up on in the 1960s during times of famine in China, with the bitter leaves of the plant reportedly being mixed with something else.[31] Although high in protein, the presence of condensed tannins in the *Desmodium* species lowers their digestibility in humans. Cattle and livestock animals are more able to digest these compounds. Buddenhagen[19] also list the use of *D. incanum* as a food source for adult *Tilapia busumana* fishes, but this application was not supported in other sources.

Chemical composition and biological activity

The concentrations of alpha tocopherol and condensed tannin in tropical plant species widely used for grazing were determined using established laboratory methods.[32] Most of the plant species examined had similar levels of alpha-tocopherol. However, among the common pasture plants of guinea grass, bermudagrass, pigeon pea, soybean, macrophaylastylo and pinto rhizome peanut, *D. incanum* was found to have the highest concentration of condensed tannin (66.5 ±13.8 g/kg dry matter) and it was the only plant where condensed tannin illustrated biological activity in the form of protein precipitation by phenols. Both tocopherol and condensed tannins have antioxidant properties. Specifically, condensed tannins are flavonoids that improves feeding and performance of animals by metabolizing proteins. Following their analysis, the researchers highlighted the necessity for further studies to elucidate the relationship between condensed tannins and the nutritive value of the plant.[32]

D. incanum also exhibited hypoglycemic activity. The milled *D. incanum*plant was effective in retarding the blood glucose levels of euglycaemic Sprague Dawley rats. Following chromatographic separation and analysis via gas chromatography and Fourier transform infrared spectroscopy; oleic acid and succinic acid were characterized as the two chemical compounds responsible for this observed bioactivity. Although both compounds have hypoglycemic activities, their synergistic interactions

in *D. incanum* provides an added potency. It was postulated that the heightened activity may be as a result of the combined mechanisms of action.[33] The use of *D. incanum*in the treatment of diabetes is viable, however there needs to be additional research done on this particular application before its execution to evaluate dosage, side effects and possible toxicity in humans.

Desmodium root exudates were isolated from *D. incantum, D. inortum,* D. *ramosissimum* and *D. unicinatun* to study their action against the hemi-parasitic plant, *Striga hermonthica.*[28] All species included in the study demonstrated allelopathic characteristics and were found to be very similar to each other. It was concluded that the production of isoschaftoside and di-C-glycosylflavonoids was common to all *Desmodium* species. Isoschaftoside had been previously linked to *Striga* suppression in the cultivation of cereal, however analysis of *D. incanum* exudates showed relatively low levels of the compound compared to the other *Desmodium* species. As such, the role of *C*-glycosylflavonoids was investigated. Further elucidation of *C*-glycosylflavonoid components using Liquid Chromatography-Mass Spectrometry (LC-MS) showed differences in the specific chemicals present in the root exudates of each *Desmodium* plant (Table 1). *D. incanum* was found to contain significant levels of *C*-hexosyl-C-pentosylapigenin sinapinate, *C*-hexosyl-*C*-pentosylapigen inferulate, and 6-*C*-arabinosyl-8-*C*-galactosylapigenin.

Table 1. C-glycosylflavonoids from *D. uncinatum, D. intortum, D. incanum* and *D. ramosissimum*[28]

Compound	MW
6-*C*-galactosyl-8-*C*-glucosylapigenin	594
6-*C*-glucosyl-8-*C*-glucosylapigenin (vicenin-2)	594
6-*C*-glucosyl-8-*C*-galactosylapigenin	594
6-*C*-galactosyl-8-*C*-arabinosylapigenin	564
6-*C*-arabinosyl-8-*C*-glucosylapigenin (isoschaftoside)	564
6-*C*-arabinosyl-8-*C*-galactosylapigenin	564
2″-*O*-glucosyl-8-*C*-glucosylapigenin	432
8-*C*-glucosylapigenin (vitexin)	432
6,8-di-*C*-hexosylapigenin sinapinate	800
6,8-di-*C*-hexosylapigenin ferulate	770
C-hexosyl-*C*-pentosylapigeninsinapinate	770
C-hexosyl-*C*-pentosylapigeninferulate	740

From ethanolic root extracts of *D. incanum*, the isolation of three isoflavones (desmodianones A, B and C) (Figure 2) were reported.[24] These compounds have shown *in vitro* activity against *Bacillus subtilis*, *Mycobacterium smegmatis*, *Staphylococcus aureus* and *Streptococcus faecalis*. The leaves of *D. incanum* also demonstrated antimicrobial activity against *Klebsiella pneumoniae*, *Staphylococcus aureus* and *Group D Streptococcus*. Therefore, extracts from *D. incanum* may be used to treat bacterial infections.[11]

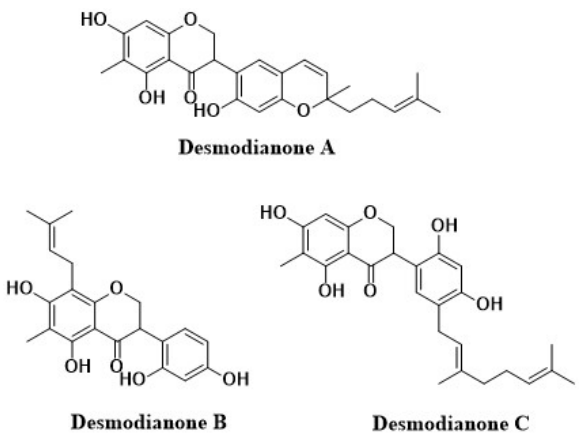

Figure 2. Isoflavones isolated from the roots of *D. incanum*

Conclusion

D. incanum was found to have medicinal, food and agricultural applications. Folklore usage in treatment of ailments is very diverse and includes uses as a diuretic, stomachic, febrifuge, hemostatic, pain reliever, soporific and tonic. However, there remains major gaps in the scientific and systematic validation of the ethnomedicinal uses of this plant. Analyses to characterize the phytochemicals in *D. incanum* have noted oleic acid, succinic acid, condensed tannin, flavonoids and isoflavones as bioactive compounds in plant. Combination of oleic and succinic acid was deemed effective in altering blood glucose levels in rats under experimental conditions. This suggests that *D. incanum*could provide leads in the treatment of diabetes.

A major prospect for *D. incanum* is its application in agriculture. The presence of condensed tannins with bioactivity to metabolize proteins in animals qualifies its usage as plant feed, but research in its application as forage due to nitrogen fixing capabilities has been underexplored. Also, the plant is a source of resistant genes. This is on account of its demonstrated resilience against parasites and drought conditions. The emergence of food crops with similar persistence and pest resistance as *D. incanum* would prove beneficial to food security- a wider range of crops would be able to withstand harsh conditions and could possibly release pesticidal chemicals or oils to hinder their own infestation.

However, given the bitterness and general low palatability of the plant, this undertaking would take conscious effort and expertise to culture the superior qualities only. It is important to acknowledge that closer studies on this plant's taxonomy and genetic material would be promising.

In conclusion, *D. incanum* has great potential for future application in medicine, food and agriculture. However, additional studies of its phytochemistry are necessary.

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Disclosure Statement

The authors declare that there are no conflicts of interest to the present work.

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