

# A Review of the Multifaceted Plant, *Desmodium canum*: The Traditional and Ethnopharmacological Applications and its Potential Use in Medicine

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## ABSTRACT

*Desmodium canum* is a perennial herb that grows wild in many territories. In these regions, the leaves, stems and roots of the plant are employed in traditional tonics and teas for their potential medicinal properties. This review aims at compiling and documenting the botany, traditional uses, phytochemistry and pharmacological effects of the plant, along with its potential medicinal applications. A literature review and analysis was conducted to report on the studies that highlighted the traditional and pharmacological applications of the plant, *D. canum*. The use of the plant is based on folkloric claims with a wealth of anecdotal reports on its health benefits. Recently, studies have added credence to its use in the treatment of a variety of illnesses. There is overwhelming evidence that supports several pharmacological properties of the plant, including its hypoglycaemic, anti-diabetic, antimicrobial, hypotensive androgenic and antioxidant properties. Furthermore, bioactive compounds have been isolated from the plant's extracts with potencies rivaling that of modern medicine. Given the numerous bioactivities of the plant, it is being postulated that compounds (or their derivatives) may be effective in combatting both physiological and pathogenic diseases such as diabetes and pneumonia, respectively. The review underscores the multifaceted pharmacological nature of *Desmodium canum* and reports on its potential applications in medicine. Potentially, with additional studies, the naturally isolated compounds can be incorporated in both nutraceuticals and pharmaceuticals to improve the availability of treatment options for several illnesses.

**Keywords:** Traditional medicine, *Desmodium canum*, *Desmodium incanum*, Strong Back Weed, Phytochemical, Hypoglycaemic, Antimicrobial, Antioxidant, Hypotensive.

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## INTRODUCTION

*Desmodium canum*, also referred to as *Desmodium incanum* is an herbal plant that is used worldwide for its various health benefits. The perennial plant flourishes in the dry, woodland regions of Central America, South America, Caribbean countries among other areas, where it has gained several common names such as Creeping beggarweed, Strong Back, Spanish clover, Spanish and Wild Granite. It is traditionally consumed as a tea or a tonic to alleviate diabetes, asthma, joint pain and menstrual disorder, back pain, erectile dysfunction, vaginal infections, fever, among others.<sup>[1-4]</sup> Due to the plant's multiple traditional benefits, it has piqued the interest of researchers and has been studied to elucidate the pharmacological activities and responsible phytochemicals. The existing literature suggests that *D. canum*

possesses antioxidant, antidiabetic, antimicrobial activities and hypotensive properties.<sup>[5-7]</sup> In this paper, a background on the traditional usages of *D. canum* is initially provided, followed by scientific findings regarding its medicinal benefits and ultimately, the potential application in medicine. The use of medicinal plants to treat various diseases allow for more affordable measures in combating illnesses, whereas synthetic drugs tend to be more expensive. Pharmaceuticals are often associated with the development of multiple side effects when compared with medicinal herbs. Therefore, many individuals are leaning towards plant-based alternatives as a source of treatment for various health challenges.<sup>[8]</sup>

## Traditional Medicine (TM)

Traditional Medicine (TM), commonly called folklore medicine, tells the tale of varying plants, animal parts or minerals being a source of treatment for varying ailments.<sup>[8]</sup> Many of these practices are indigenous to their respective cultures and have been accepted as an important primary care resource for these populations. In many developing societies, the practice is extensive and is passed



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down through generations to achieve a healthy lifestyle. Some of these practices have been accepted worldwide with a wealth of supporting literature to justify their claims. To date, many plants have been studied and bioactive molecules isolated and identified and have been integrated in clinics and hospitals for the treatment of diseases.<sup>[9-11]</sup>

With the implementation of modern treatment agents, the use of TM has declined in many first-world societies.<sup>[12]</sup> However, several developing societies still rely on the use of folklore medicine as their main source of treatment and remain confident in its efficacy. This has prompted many researchers to delve into ethnopharmacological research to isolate bioactive compounds to improve current treatment regimes. To date, numerous plants have been investigated and phytochemicals isolated that demonstrate pharmacological properties.

Many plants have added credibility to the credence in folklore medicine. In fact, as much as 25% of modern medicines have been derived either directly or indirectly from extracts of plants.<sup>[10]</sup> This is even more obvious in the treatment of cancer (with approximately 60% of therapeutic agents being plant-derived) and infectious diseases (approximately 75% being plant-derived).<sup>[10]</sup> Some local folkloric medicinal plants include *Smilax ornate* (Sarsaparilla), *Peperomia pellucida* (Pepper Elder, Man to Man), *Rivina humilus* (Dog blood) and several species of the *Desmodium* genus, including *D. canum*.<sup>[13]</sup>

### Desmodium Genus

Having over 455 known species, the *Desmodium* genus exists as a large member of the Fabaceae family. These leguminous plants are typically short shrubs or sub-shrubs that grow in the subtropical and tropical regions of the world. A little over 20 species are found in China where they have been extensively integrated into the medical genre.<sup>[14]</sup> Water from fountains and ponds decorated with *Desmodium* plants is widely incorporated in the treatment of illnesses such as asthma, typhoid fever, inflammations, malaria, lifestyle diseases and arthritis in China.<sup>[14]</sup> Also, approximately 25 species are found in India where they have been integrated into the indigenous medicinal system. *Desmodium gangeticum*, for example, has been demonstrated to be an emperor within the genus. Qualitative analysis of the extracts from the plant has demonstrated the presence of various classes of phytochemicals including flavonoids, isoflavanoids, alkaloids, N-oxides, glycosides. These have been illustrated to possess a wide range of pharmacological activities. These include smooth muscle stimulations, Central Nervous System (CNS) stimulations,<sup>[15]</sup> and anti-diabetic and hypolipidemia activities.<sup>[16]</sup> Phytochemicals derived from many species of the genus are being used to treat ailments across the world.

In Jamaica, much of the local culture is rooted in TM which is often termed, 'bush medicine', regardless of the nature of the plant.<sup>[17]</sup> Many locals are considered to be 'bush doctors' based

on their knowledge of the medical importance of certain plants. The literature reports that several Jamaican plants have been explored and the scientific justification for the use of the plant, whether as a tea, tincture or as a part of the traditional root tonic has been established. *D. canum* commonly known as Strong Back (in Jamaica), is one of the common medicinal plants that is integral to the Jamaican people. The plant is generally consumed as a tea or blended with other plants as a root tonic to improve vitality, strength and improve the immune system. These are some of the less common uses as it is also believed to improve male sexual function and relieve pain.<sup>[4,9]</sup> There are many other scientific claims to the use of the plant in treating illnesses which warrant research. This review aims to describe some of the traditional uses of the *D. canum*, scientific justification of the uses and potential clinical applications of phytochemicals identified or extracted from the plant. To the best of our knowledge, there has been no extensive review of the plant and as such, we will be providing systematically organized information on the ethnopharmacological properties of *D. canum*.

### METHODOLOGY

Several scientific databases (Google scholar, PubMed, Scifinder) were used to retrieve relevant information based on literature published before June 2022. These were organized to represent the review of the ethnomedicinal properties of *D. canum*. The keywords related to the retrieval of the data were '*D. canum*', '*D. incanum*', 'Strong Back Weed', 'phytochemical', 'pharmacological activity of *Desmodium canum*', 'anti-diabetic', 'antioxidant', 'traditional medicine', 'Traditional medicine in Jamaica', 'Botany of *Desmodium canum*'.

### RESULTS AND DISCUSSION

#### Botany

*D. canum* belongs to the *Fabaceae* family of plants and like most members of the family, *D. canum* has multiple common names based on differing cultures. The plant exists as a perennial herb that grows up to about 70 cm with red stems and petioles (Figure 1A). The leaves are usually mostly 1-foliolate narrow, with an average length of 6.65 cm and width of about 13 mm.<sup>[18]</sup> The stem is covered with short soft hair and bilaterally symmetrical flowers that are arranged in a racemose inflorescence of approximately 5-12 cm long (Figure 1B). Additionally, the stem bears flowers' stalks at short intervals which are densely pubescent with minute hooked hairs. The pedicels produced in the inflorescence are approximately 3-10 mm long which persist after the articles fall which is also covered with small, hooked hairs. Figure 1B shows the calyx and corolla of the plant have 5 fused sepals and 5 pink or pink-violet petals, respectively.<sup>[19]</sup> The lower 2 petals of the papilionaceous flower are fused into a keel and the upper is enlarged to form an ovate standard which is approximately 5-6 mm long, similar to the length of the keel. *D. canum* has an

alternate leaf arrangement where the leaves are trifoliolate and the leaflets are 3-9×0.8-3.8 cm. The shape and form of the leaves involves but not limited to the following elliptical, oblong, ovate, lanceolate, or exceptionally rounded (Figure 1C). The base of the leaves is obtuse or rounded with entire margins; the upper surface is dark green in appearance covered with fine soft hairs while the lower surface is grayish green in appearance, with prominent venation.<sup>[20]</sup>

It occupies roadsides, rough places, pastures, unplanted grasslands, volcanic soils and in dry to wet areas with low stature vegetation. In crop lands such as banana and rice fields, the plant is a well-recognized weed.<sup>[21]</sup> Furthermore, *D. canum* can be found growing on island groupings within the tropical and subtropical regions throughout the world. More specifically, the plant grows among weeds in human-disturbed environments such as yards, gardens and abandoned fields; it may also be found growing in Pine Woodlands (open scrublands). The plant does not flourish well over long increments of wet conditions, preferring well-drained soils, with parched conditions.<sup>[22]</sup>

The fruit is a legume at maturity that is about 2-4 cm long and is highly constricted between the seeds and is considered a loment. The seeds produced are 2.5-3.5 mm long, of an oblong elliptical shape and a light brown colour.<sup>[19]</sup>

### Traditional Uses

*D. canum* is a multifaceted plant, having been used for the treatment of a myriad of illnesses. In folklore, the plant is reported to improve several health complications and numerous studies have confirmed the pharmacological properties of the plant.<sup>[5,7,23]</sup> In the Caribbean, the plant is generally prepared as a tea or tonic, where in the former, the tea is prepared by drying the plant's leaves and stem followed by adding warm-boiled water to the plant material. This is then mixed with a sweetener and consumed as a tea beverage. In the latter, the plant is allowed to be boiled in water, along with several other plants. The boiling process facilitates an extraction of phytochemicals to form a concoction which is concentrated through the removal of excess water via evaporation. The tea or tonic is orally consumed to alleviate pains in the back regions, asthma, bronchitis, joint pain, renal injuries,



**Figure 1:** Photographs of *D. canum* (A) The plant growing in the fields, (B) Stem and flower, (C) Leaves, (D) Harvested from field.



**Table 1: The traditional uses of *D. canum* in various countries.**

Location	Common Names	Traditional uses	References
Central and South America	Creeping beggarweed, Spanish clover, or Spanish tick-trefoil.	Used in the treatment of haemorrhages and can be applied externally for the treatment of wounds and cuts.	[24]
Hawaii	Kaimi or Kaimi clover.	Used for dietary purposes; as a source of protein.	[25]
Caribbean islands	Strong Back, Man Back, Bee Bur, Amor seco or Bush.	Pains in the back region of the body, Erectile dysfunction, Diabetes, Common cold, Asthma, impotence, Relieves Abdominal, stops postpartum abdominal pain, reduces fever, treat vaginal infections.	[1-4]
China		The treatment of various ailments including rheumatism, pyrexia, dysentery, wounds, cough, malaria, hepatitis, hemoptysis, among others. In the theory of Traditional Chinese Medicine, many species are believed to have the effect of relieving internal heat or fever, neutralizing toxins, inhibiting pain, invigorating blood circulation, suppressing cough and alleviating dyspnea.	[14]
Eastern Nicaragua	Strong back, Amor seco	The roots are used in the form of a medicinal mixture which is used to treat asthma and impotence. Relieves abdominal and back pain; stops postpartum abdominal pain; reduces fever; vaginal infections.	[26]

menstrual disorder, diabetes, muscular pain, rheumatism urinary problems, purifying blood, among others.<sup>[3,4,9,14]</sup> However, one of the most common ethnopharmacological practices is the use of the plant as an aphrodisiac amongst men. In Jamaica, the plant is called 'Strong Back Weed', a colloquial term that refers to plants that are believed to increase male sexual prowess. It is, therefore, extensively used in herbal tonics that are made to improve libido and erectile functioning.<sup>[4]</sup>

There are several other reported traditional uses of the plant and are summarized in Table 1 below. The literature reports several common folklore uses of the plant across the globe, which may be indicative of the true potential of the plant.

### Phytochemistry of *D. canum*

The scientific evidence of many herbal medicines lies within the secondary metabolites produced by these plants, generally to assist with thriving against predators and pathogens. In recent times, these secondary metabolites have been exploited and isolated/identified for new therapies in disease control. Like many of the other species in the *Desmodium* genus, *D. canum* has been found to be an affluent source of varying classes of phytochemicals. Alexander-Lindo and colleagues (2020) screened three crude extracts of the plant and highlighted the presence of phenols, tannins, flavonoids, saponins, terpenoids, steroids,

organic acids, alkaloids and reducing sugars.<sup>[5]</sup> Additionally, the presence of isoflavonones was reported by Delle Manocche *et al.*, (1996).<sup>[7]</sup> These phytochemicals can be classified into three major classes; terpenoids, alkaloids and phenols.<sup>[27]</sup> Studies have reported the beneficial use of several terpenes and in particular, terpenes isolated from other species of *Desmodium* have been shown to potentiate smooth muscles. Moreover, several alkaloids isolated from species such as *D. gangeticum* and *D. adscendens* have been reported to be potent pharmacological agents including tryptamine, phenylamine amine and their oxides. The pharmacological properties include activators and depressors of the central nervous system, smooth muscle relaxation and anticholinesterase properties.<sup>[9]</sup> No literature has reported the properties of the alkaloids present within *D. canum*; however, given the similarity of the members of the *Desmodium* genus and the traditional uses of the plant, it is possibly that alkaloids may be potent contributor to bioactivity of the plant.

A number of isoflavonones purified from the ethanolic extract of the roots of the plant has been identified, some of which offer antimicrobial properties. Isoflavanones are members of the phenolic class that generally serve as phytoestrogen in the vacuole of plant cells.<sup>[28]</sup> To date, the following isoflavonones have been isolated from the plant: 2,3-dihydro-5,7-dihydroxy-6-methyl-3-(1a,2,3,3a,8b,8c-hexahydro-6-hydroxy-1,1,3a-trimethyl-1H-4-

oxabenzof[cyclobut[c,d]inden-7-yl)-4H-1-benzopyran-4-one, 2,3-dihydro-5,7-dihydroxy-6-methyl-3-(6a,7,8,10a-tetrahydro-3-hydroxy-6,6,9-trimethyl-6H-dibenzo[b,d]pyran-2-yl)-4H-1-benzopyran-4-one, 3-dihydro-5,7-dihydroxy-6-methyl-3-(3-hydroxy-6,6,9-trimethyl-6H-dibenzo[b,d]pyran-2-yl)-4H-1-benzopyran-4-one, 5,7,2'-trihydroxy-6,6''-dimethyl-6''-enylpyrano(2'',3'';4',5')isoflavanone, 5,2',4'-trihydroxy-7-methoxy-6-methyl-8-(3-methylbut-2-enyl)-isoflavanone and 5,7,2',4'-tetrahydroxy-6-methyl-5''-(3,7-dimethylocta-2,6-dienyl)-isoflavanone.<sup>[7,29]</sup> The presence of tannins and other phenols may offer other pharmacological properties as seen in other *Desmodium* spp. For instance, the anticancer and antioxidant properties of phenolic compounds present within *D. caudatum* were demonstrated.<sup>[30]</sup> Other studies have shown the anti-inflammatory, antiproliferative and hypocholesterolaemic in various *Desmodium* sp.<sup>[9,31-33]</sup>

## Pharmacological properties of *D. canum*

### Antioxidant

Oxidative stress has been linked to a myriad of known complications and continues to provoke deleterious effects in human health. The elevation of free radicals disrupts physiological homeostasis and promotes several health conditions including diabetes mellitus, hypertension, Alzheimer's disease, cancer, among others. Any agent that is capable of reducing the oxidative stress may, therefore, offer potential in reducing the incidence of several health complications. The antioxidant properties of the crude extracts of *D. canum* were investigated.<sup>[5]</sup> This was achieved through an *in vitro* assay using the stable free radical, 2,2-Diphenyl-1-Picrylhydrazine (DPPH). It was observed that the crude methanolic extract of the whole plant showed a relatively high antioxidant effect which had no statistical difference when compared with ascorbic acid, a known antioxidant, at concentrations of 200 and 100 µg/mL. The hexane and the ethyl acetate extracts were also investigated but showed low potency in reducing the free radical and thus low antioxidant property. The presence of the phenolic compounds within the methanolic extract as shown by Alexander-Lindo *et al.* (2020) are key components that allow for the antioxidant properties of the plant.<sup>[5]</sup> They further concluded that consumption of the plant may reduce oxidative stress and reduce the morbidity and mortality of diseases associated with oxidative stress.

### Antimicrobial Activities

A bio-guided fractionation of the extracts of the roots of the plant led to the isolation of antimicrobial isoflavonones.<sup>[7]</sup> The root was obtained and extracted with ethanol, which was suspended in water and fractionated using hexane, dichloromethane and ethyl acetate. All three of these fractions showed antimicrobial

activity with the dichloromethane fraction showing the highest potency and representing the highest yield. This fraction was then subjected to column chromatography which yielded three isolated compounds, desmodianones I, II and III. Desmodianones I and II showed the highest potency in inhibiting the growth of *Bacillus subtilis*, *Streptococcus faecalis* and *Staphylococcus aureus* with concentrations as low as 1-10 µg/mL. They also inhibited the growth of *Mycobacterium smegmatis* with inhibitory concentration of 10-30 µg/mL and *Candida albicans* (50 - 100 µg/mL). On the other hand, only desmodianone II showed inhibitory effect against *Escherichia coli* (50-100 µg/mL) and *Neurospora crassa* (50-100 µg/mL).

In a previous study, a team of researchers demonstrated the genotoxicity of the aqueous extract against three different strains of *Salmonella typhimurium* (TA98, TA100 and TA102), indicating the mutagenic property against these bacteria.<sup>[34]</sup> These studies underscore the usefulness of the extracts and compounds isolated from the plant in mitigating the growth of several microbes. Further studies may highlight other antimicrobial effects of other regions of the plant.

### Hypoglycaemic and Anti-Diabetic Effect

The elevation of blood glucose levels within diabetics is responsible for many of the complications associated with the metabolic disease. Several studies have highlighted the association between diabetes and kidney failure, non-traumatic amputation, blindness and both macro and microvascular complications.<sup>[35]</sup> Consequently, many of the therapeutic approaches to diabetes promote a reduction in blood sugar level to achieve glucose homeostasis. This includes several classes of anti-diabetic agents such as biguanides, sulfonylureas, glitazones and Dipeptidyl Peptidase 4 (DPP4) inhibitors. Additionally, there are several phytochemicals that have been isolated for medicinal plants that have been dominant in retarding blood sugar levels with potential to be employed as a pharmaceutical in combatting the ailment. In fact, metformin, one of the most common antidiabetic agents is derived from a plant, alluding to other phytochemicals with similar potential.<sup>[6]</sup>

The hypoglycaemic property of many members of the *Desmodium* genus has been demonstrated. Similarly, *D. canum* has also been shown to reduce blood sugar levels in rats following intravenous administration at 50 mg/kg body weight.<sup>[5]</sup> Through a bio-guided assay, the principal hypoglycaemic agents within the ethyl acetate extract were identified as oleic acid and succinic acid. This was achieved through several chromatographic purifications which yielded a bioactive fraction that significantly reduced blood glucose levels following intravenous administration. When administered orally, the synergy of these compounds is an excellent supplement in retarding blood glucose level in normal Sprague-Dawley rats. In fact, the potency of the cocktail of the two organic acids rival that of metformin administered at 25

mg/kg bw as demonstrated by Lattibeaudiere *et al.* (2020).<sup>[23]</sup> In this, the ratio used was similar to the naturally occurring ratio of the two compounds in the plant. The presence of these hypoglycaemic agents may be responsible for the attenuating symptoms of diabetes as alluded to by TM.

Further studies showed that the synergistic effect of the compounds mitigates type 2 diabetes in streptozotocin induced diabetic rats. This was achieved through a reduction of gluconeogenesis whilst improving insulin sensitivity. The cocktail of organic acids was comparable to glibenclamide, a known insulinotropic agent, indicating a high potency of these naturally occurring compounds.<sup>[36]</sup>

### Androgenic Property

As mentioned, *D. canum* is traditionally used as an aphrodisiac where it is believed to be able to alleviate impotence and increase libido. The extracts from the plant were investigated for the ability to increase serum testosterone levels. These extracts were dissolved in appropriate solvents and administered to male Sprague-Dawley rats, at a dose of 250 mg/kg bw. Following daily treatment for a period of 28 d, the hexane extract resulted in a significant increase in the serum testosterone levels, which was approximately 2.5 times higher than that of the untreated animals. Though the phytochemicals responsible for this pharmacological effect has not been elucidated, it may be due to the high levels of steroids present in the hexane extract.<sup>[5]</sup>

It is also important to note that the hexane extract had no effect on the relative organ weight of the testes of the animals used, however, the methanolic extracts significantly increased the weight of the testes. The mechanism of this remains unknown and requires additional research to elucidate this underlying pharmacological effect of the methanolic extract.<sup>[5]</sup>

### Hypotensive Property

The hypotensive property of the ethyl acetate of the aerial parts of *D. canum* has also been documented. The crude extract contains phytochemicals that are capable of lowering the Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and the Mean Arterial Pressure (MAP). This was reported by Alexander-Lindo *et al.*, 2020, where animals were administered the ethyl acetate extract at 50 mg/kg bw (iv).<sup>[5]</sup> The extract rapidly reduced the blood pressure of the animals as early as 10 min post-administration. This was seen in all three parameters measured, with the pharmacological effect lasting until the end of the experiment. The high potency perhaps could be explored following different routes of administration and a dose dependency incorporated to ascertain the effect that the dose of the extract plays in this property observed. Though the rats used in the study were normotensive, the evidence points to the plant possessing hypotensive property. Several other species within the genus have displayed this property. Seriki (2020) suggested this

property of *D. adscendens* following his study where it was shown that consumption of the extract of the plant significantly reduced serum electrolytes such as sodium, chloride and bicarbonate ions whilst increasing potassium ions.<sup>[37]</sup> Furthermore, the hypotensive nature of *D. styracifolium* was previously reported by Ho, Wong and Chi (1989), thus highlighting the hypotensive potential for other members of the genus.<sup>[38]</sup>

### Potential Application

It is well established that many plants or phytochemicals derived from TM have found their way in clinical treatments. These often show high efficacy in combating ailments, whether physiological or infectious. With the studies done on *D. canum*, there is a potential for the multifaceted plant or agents derived from the plant material to be employed in the treatment of several illnesses. The literature is overwhelmingly supportive of various classes of phytochemicals being employed in the health sector. In fact, as mentioned, many current pharmaceutical agents are derived either directly or indirectly from the plant's secondary metabolites. This has been the case in many current medicines where phytochemicals or phytochemical derivatives are used in medicine. For instance, common medications such as metformin, aspirin, digitalis and morphine are all plant derived.<sup>[5,10]</sup> This underscores the need for fervent research into the pharmacological properties of TM.

In the study of *D. canum*, several potent pharmacological effects were identified. Purification and chemical analysis led to the identification of two organic acids, oleic acid and succinic acid.<sup>[23]</sup> The importance of these in maintaining glycaemic control was established in improved glycaemic in type 2 diabetic rats. The potency of the cocktail, as discussed, rivaled the common insulinotropic agent, glibenclamide, indicating its potential use in the treatment of type 2 diabetic patients. Moreover, the low toxicity and reduced risk of provoking hypoglycaemic shock are further evidence as to the possibility of these naturally occurring compounds being employed in medicine. Further research is required to document the implications of these in the treatment, however, observations made so far are quite convincing and may be used in the development of nutraceutical agents in the treatment of diabetes. Perhaps, the organic acids can be incorporated into natural tonic, tea, snack or sublingual agents for a therapeutic approach to the metabolic condition.

Furthermore, the evidence of the presence of polyphenolic compounds and the corresponding antioxidant potential indicates the possibility of modulating the degeneration of reactive species. This process is paramount as oxidative stress is highly correlated with several physiological diseases including diabetes, chronic inflammation-related illnesses (eg. Alzheimer, rheumatoid arthritis, atherosclerosis, among others) and cardiovascular diseases.<sup>[5,30]</sup> Any substance that suppresses the production or reactivity of these species may add protective role to tissues and

organs. Consumption of the plant or its extracts may, therefore, be important in alleviating several complications associated with the oxidative stress. Additionally, though the research is limited, sufficient evidence is present to add credence to the plant as an aphrodisiac.<sup>[5]</sup> The hexane extract possesses androgenic properties, potentially through the presence of phytosteroids. These ultimately resulted in an elevation of testosterone levels in male rats. Further studies will elucidate the structure(s) of the bioactive compound(s) responsible for this activity. The plant or compounds derived from the plant may therefore have a potential to be incorporated in nutraceuticals designed to improve male libido.

Moreover, the evidence suggests that the plant is also rich in antimicrobial and hypotensive agents. In an era where bacteria have evolved to become resistant to many antibiotics, the need for antibacterial substitute is a global phenomenon. The World Health Organization (WHO) has reported on over 30,000 plant derived compounds that possess defined antimicrobial properties.<sup>[39,40]</sup> The report recognizes the efficacy of these compounds as potential substitutes. Consequently, the antimicrobial property of *D. canum* and the compounds isolated may be incorporated for the treatment of against the established microbes as documented. However, it is prudent to note that further studies are required to establish the efficacy of these phytochemicals in humans. Similarly, though the plant displayed hypotensive properties, much more work is needed to establish the efficacy of its application in hypertensive patients. Despite this, the plant has the potential to be a source of medicine used for the treatment of varying illnesses and thus requires more studies to document these findings.

Overall, the literature supports the plant as a multifaceted medicinal source which may be used for the treatment of varying illnesses. The findings add credence to many of the traditional uses, however, there are still medicinal properties that remain unlocked. Notwithstanding this, the current knowledge indicates that naturally occurring compounds found in or derived from the plant may pave the way for the development of novel therapeutic agents. These may be useful in countering the incidence of diseases, whether pathogenic or physiological. It is, therefore, the authors' recommendation that further research be done on the plant in order to elucidate pharmacological agents that may have potential to reduce the morbidity of many illnesses.

## CONCLUSION

*D. canum* is very diverse in its usage both traditionally and scientifically and is primarily found in the subtropical and tropical regions of the world. The multipurpose nature of this plant enhances its medicinal potential exponentially. Even though many of the plant's medicinal benefits stem from folklore claims, there are indeed scientific reports to support the therapeutic effects of *D. canum*. It is a known remedy for conditions such

as diabetes, asthma, joint pain and menstrual disorder, among others where it is traditionally consumed in the form of tea. The therapeutic use of the plant varies based on its locality. Studies have shown that the medicinal benefits of *D. canum* are greatly due to the varies classes of phytochemicals it possesses. The phytochemicals identified in the plant are known to aid in treating the different illnesses that the plant is traditionally used for; such as tannins and phenols which are often used to treat diabetes. This gives the customary usage of the plant scientific merits. The pharmacological properties of *D. canum* includes antioxidant, antimicrobial activities, hypoglycaemic and anti-diabetic effect androgenic property and hypotensive property. It can then be proposed for the plant's materials or its phytochemicals to be incorporated into natural tonics, teas, snacks, or sublingual agents for a therapeutic approach to treating various health conditions.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

## ABBREVIATIONS

**CNS:** Central Nervous System; **BW:** Body weight; ***D. canum*:** *Desmodium canum*; **DBP:** Diastolic blood pressure; ***D. gangeticum*:** *Desmodium gangeticum*; ***D. adscendens*:** *Desmodium adscendens*; **DPP4:** Dipeptidyl peptidase; **DPPH:** 2,2 diphenyl-1-picrylhydrazine; **IV:** Intravenous; **MAP:** Mean arterial pressure; **SBP:** Systolic Blood Pressure; **TM:** Traditional medicine.

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