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ETHNOBOTANICAL USES, PHYTOCHEMISTRY & PHARMACOLOGICAL ACTIVITIES OF *STACHYTARPHETA JAMAICENSIS* (L.) VAHL. – AN UPDATED REVIEW

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ABSTRACT: Aim: The objective of the present review is to compile & explore published literature on ethno botanical uses, pharmacognostic studies, phytochemicals, and pharmacological activities of *Stachytarpheta jamaicensis* (L.) Vahl from 2016 to till date. **Background:** *Stachytarpheta jamaicensis* (L.) Vahl, an under shrub belongs to the family Verbenaceae. The plant is native to the tropical Americas and has been used traditionally by various ethnic groups of this region. Though regarded as a weed or invasive species in many parts of the world, research works report the plant being used for medicinal purposes, as animal feed and as ornamental or hedge plant. **Material & Methods:** The review was undertaken by literature search through electronic databases such as PubMed and Google scholar, reported from 2016 to till date. **Review results:** The different parts of the plant are used in various ailments like fever, skin diseases, diabetes and respiratory problems. Flavonoid, tannins, saponins, glycosides are the chief bioactive constituents reported to be present which are responsible for several pharmacological activities. Pharmacological studies report wound healing, antibacterial, anticancer, anti-trypanosomal, anti-inflammatory, antidiabetic activities. **Conclusion:** Published literature reports numerous ethno botanical uses of *Stachytarpheta jamaicensis* (L.) Vahl. A few of which have been experimentally evaluated through *in-vitro* and *in-vivo* studies. Further systematic clinical studies may be taken up to evaluate the plant to develop effective drugs and introduce into the community.

INTRODUCTION: *Stachytarpheta jamaicensis* (L.) Vahl. (Verbenaceae) is commonly known as Brazilian tea, Verbena cimarrona, Horse whip, Rooter comb, snake weed, Blue porter weed, blue snake weed, Aaron's rod and grows as a weed along road side, barren land fields, open land surfaces & also grown in gardens ^{1, 2, 3}.

The plant is native to Mexico, Central America (Beliza, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama), tropical South America (*i.e.* French Guiana, Guyana, Surinam, Venezuela, Brazil, Colombia, Ecuador, Peru and Argentina), south-eastern United States of America (Alabama & Florida), the Caribbean and the Galapagos Islands ².

Previous review on *S. jamaicensis* had incorporated phytochemical, pharmacological activities like antimicrobial, antifungal, antioxidant, anti-inflammatory, antinociceptive, antidiarrheal, antihypertensive, antidiyslipidaemia, hepato-protective and wound healing investigated on

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various parts of the plant⁴. The present review focuses on the ethno botanical uses, pharmacognostic, phytochemical, pharmacological activities of *S. jamaicensis* undertaken from 2016 to till date.

REVIEW RESULTS:

Classification⁵:

Kingdom: Plantae

Subkingdom: Tracheobionta

Super division: Spermatophyta

Division: Magnoliophyta

Class: Magnoliopsida

Subclass: Asteridae

Order: Lamiales

Family: Verbenaceae

Genus: *Stachytarpheta*

Species: *Jamaicensis* (L.) Vahl

Morphology: It is an annual plant, reaching about 0.3- 0.9 m. high; stems erect, dichotomously branched & nearly glabrous, the young branches are quadrangular. Leaves 5-10 by 2.5-3.8 cm. elliptic, obtuse or acute, coarsely serrate, glabrous or nearly so, base much tapering and decurrent into the petioles which are consequently obscure. Flowers sessile, in long, slender glabrous spikes reaching 30cm long; bracts 5 mm long, lanceolate-subulate, scariously margined near the base. Corolla deep blue, tube 1 cm. long, slightly curved. Ovary glabrous; style long & filiform. Fruit 3-4 mm. long, oblong, ribbed, splitting into 2 pyrenes **Fig. 1**⁶.

Distribution: Though the plant is native to south-eastern United States of America, Central America, the Carribean and tropical South America, it is found growing in various parts of the world as a weed or an invasive species. Various surveys reveal the diverse distribution of *S. jamaicensis*. Survey studies found *S. jamaicensis* as a part of the riparian vegetation in the Bonandolok River in North Sumatra and found to support the life of Ihan fish (*Tor* sp.)⁷ a dominant species in the

understorey of rubber agroforestry in Central Tapanuli District, North Sumatra, Indonesia,⁸ along the mangrove in Tidung Kecil Island, Thousands Island National Park Jakarta⁹ in the production forest in Eremerasa, Bantaeng reGENCY¹⁰ an invasive alien species in Cibodas Biosphere Reserve, Indonesia but used by local communities for its medicinal purpose¹¹ a goat feed¹². *S. jamaicensis* was one of the weed species most prevalent in the maize-sweet potato intercrop fields in the southern Guinea savanna of Nigeria¹³.

In India as well, various surveys have revealed that this plant is found in different regions as a weed and also grown as ornamental in gardens. In a phytosociological study, *S. jamaicensis* was found in natural forest and plantation area in Wildlife sanctuary II of Wayanad, Kerala¹⁴ also found as an invasive species during a taxonomic survey in the districts of Bhopal¹⁵ including Bhopal city¹⁶ in the Warangal district of Telangana¹⁷ Achanakmar-Amakantak biosphere reserve of Bilaspur district of Chhattisgarh and in Anuppur and Dindori districts of Madhya Pradesh states¹⁸. The plant is very common in the residential localities of Purba Medinipur district, West Bengal growing in gardens & nurseries¹⁹. In another survey in the wetland and lake area of Denkanikottai taluk, Krishnagiri district of Tamilnadu, *S. jamaicensis* was found as an emergent anchor in Krishna Reddy lake and Peddaseruvu lake²⁰.



FIG. 1: STACHYTARPHETA JAMAICENSIS (L.) VAHL. PLANT

Ethnobotanical uses: The plant is used medicinally in the Gold Coast, La Reunion, Brazil and the West Indies. In Brazil, it is used externally for purulent ulcers, and given internally for fevers and rheumatic inflammations. In Guiana, it is much used in the treatment of dysentery.

In La Reunion, the leaves are used as a maturant. In the Gold Coast, the leaves are crushed and the juice is used in the cure of eye troubles, such as cataract, and for open sores in children's ears. They are also said to cure heart trouble⁶ leaf used in fever, especially typhoid²¹. A native of Americas, this plant is introduced in many countries, naturalised in many gardens^{2,3}. Though regarded as an invasive species²² various ethnic groups across the world,

use *S. jamaicensis* for varied ailments and in different forms **Table 1**. A cross sectional survey among patients presenting for care at 8 different clinics at St. Mary Parish, Jamaica reported that 18.60% (8 subjects) used *S. jamaicensis* for medicinal purposes²³ and during the covid pandemic, *S. jamaicensis* found an increasing popularity for its medicinal purposes²⁴.

TABLE 1: ETHNOMEDICINAL CLAIMS OF *STACHYTARPHETA JAMAICENSIS* (L.) VAHL. (I- INTERNAL; E- EXTERNAL)

Ethnic group/region	Plant part	Ethnobotanical use	Method of use	Ref.
Nsukka South east, Nigeria	leaves	Malaria	-	25
Ogurugu community of Southeast Nigeria	aerial parts	Malaria	-	26
Abidjan district in Côte d'Ivoire, West Africa	leaves & flowering axis	Diabetes	several glasses of decoction/ infusion throughout the day (I)	27
Inhabitants of Holguín, Eastern Region, Cuba	whole plant	Hepatitis, kidney infection, depurative, blood circulation, skin rash	orally and topically as decoction (I & E)	28
Q'eqchi' Mayas of Southern Belize in Central America	leaves	Skin diseases	-	29
Chaoshan region of China	leaves	Heat-clearing and detoxification, rheumatism, conjunctivitis	herbal tea (I)	30
Inhabitants of Mayotte island, France.	flowers	Used for its cosmetic value, in redness	-	31
Tribals of Anantagiri hills, Telangana state, India	stem and root bark	Dysentery	Paste is applied topically (E)	32
Pulaiyar tribes of Gopalswamy Hills, Anamalai Tiger Reserve, Western Ghats, India	leaves	Blood cleanser and in asthma	-	33
Bagata Tribe Of Andhra Pradesh, India	Whole plant	Fever	one spoonful of whole plant paste is administered daily twice	34
Ondae Sub-ethnic of Poso District in Indonesia	Other parts of the herb	Appendicitis, kidney disease, cyst	-	35
ethnic groups in Indonesia	root	Pre and post-natal care in women	Ten cm of majau stems (<i>Quercus infectoria</i>), tero root (<i>S. jamaicensis</i>), dried betel fruit (<i>Piper betle</i>), pinang fruit (<i>Areca catechu</i>) are boiled in a litre of water & reduced to half quantity. This half cup decoction is given internally (I)	36
Karonese tribe from North Sumatra, Indonesia	leaves	Diarrhoea	-	37
Mon people in Myanmar	leaf	Cough	decoction given orally (I)	38
Mon people in Myanmar	leaf	Antidote	roasted leaves or leaf juice applied topically (E)	38
Agusan Manobo tribe, Bayugan City, Philippines	Leaf, root	Ascariasis, boils, bruises, fever, sprain	-	39
Ati tribe in Tobias Fornier, Antique, Philippines	leaf	Cuts/wounds, lump, black eye	crushing and applying the leaf extract (E)	40
Ati tribe in Tobias Fornier, Antique, Philippines	leaf	Fever	leaf pounded and the extract rubbed over body (E)	40

Subanen tribe in Ozamis city, Mindanao, Philippines	Leaf and stem	Joint inflammation and beriberi	Leaves pounded thoroughly, scrape the stem. Both are mixed and rubbed on the affected part. (E)	41
Saramaccan and Aucan Maroons in Suriname, South America	leaves	Strength promoting, skin diseases, respiratory ailments	Herbal bath or steam (E)	42
<i>Raizeiros</i> of southern Pantanal Mato Grosso, Brazil	leaves and flowers	Parasites & bronchitis	Infusion (I)	43
Thailand	entire plant	Diabetes	decoction used orally (I)	44
Songkhla and Krabi provinces of Southern Thailand	whole plant	Haemorrhoids & gall stones	Decoction (I)	45

Pharmaceutical Products & Patents:

Immunologically active phyto - mixture containing *S. jamaicensis* has been patented for its use in the prevention and treatment of efflorescence⁴⁶. A pharmaceutical product containing standardised extracts, fractions or isolate molecules from plants of *Stachytarpheta* genus, *S. cayennensis*, *S. jamaicensis* & *S. eliotis* species for its use in the treatment of vitiligo is applied for US patent⁴⁷.

Phytochemistry: Preliminary phytochemical evaluation of *S. jamaicensis* in various solvents, have revealed the presence of multiple bioactive components **Table 2**. Further investigations on the extraction & separation of phytoconstituents from different parts of the plant has led to the isolation of

various compounds. 6 β -hydroxyipolamiide was isolated from the leaves of *S. jamaicensis*¹. Three compounds, Ursolic acid, Apigenin and Luteolin were isolated from the leaf extract⁵⁰.

A total of 30 compounds were identified in the leaf methanolic extract of *S. jamaicensis*, accounting for 99.4% of the total extract and the main constituents identified were 3-methyl-2H-indazol-2-ol (5.8%), 4,5-dihydro - 5 - methoxy - 4 - (2, 3-dimethyl-2buten-4-yl)-2(3H)-furanone (6.4%), α -[5ethyl-2-furyl]glycine (6.8%), 1,3-cyclopentadione (8.9%), 2- benzyl-idenemalonic acid (11.9%), D-arabinitol (13.5%), 3,5-dihydroxy-6-methyl-2,3dihydro-4H-pyran-4-one (13.7%)⁵⁴.

TABLE 2: PHYTOCHEMISTRY OF VARIOUS EXTRACTS & FRACTIONS OF *S. JAMACIENSIS*

Part	Extract	Phytoconstituents	Ref.
leaf	Crude powdered sample	Alkaloids, carbohydrates, saponins, phenolics, flavonoid	48
Leaf	crude Methanol extract	Carbohydrates, alkaloids, reducing sugars, glycosides, saponins, tannins, flavonoids, resins, proteins, oils, steroids, terpenoids	49
Leaf	N-Hexane fraction from methanol extract	Alkaloid, resin, oils, steroids, terpenoids	49
Leaf	Ethyl acetate fraction from methanol extract	Alkaloids, glycosides, saponins, tannins, flavonoids, resins, protein, steroids	49
Leaf	N-Butanol fraction from methanol extract	Carbohydrate, reducing sugars, alkaloid, glycosides, saponins, tannins, flavonoids, proteins, steroids	49
leaf	water fraction from methanol extract	Carbohydrates, reducing sugar, alkaloids, glycosides, saponins, tannins, protein, steroids	49
leaf	dichloromethane: methanol (1:1)	Glycosides, flavonoids, saponins, alkaloids, tannins and terpenoids.	50
leaf	ethanolic crude extract	flavonoids, phenol, phytosterol, terpenoid, tannin, carbohydrates, coumarin, saponin, amino acid anthraquinone.	51
plant	Super critical CO ₂ extract	gallic acid, p-coumaric acid, caffeic acid, catechin, quercetin	52
leaf	Methanol extract	reducing sugars, alkaloids, glycosides, saponins, tannins, flavonoids, resins, steroids, terpenoids, and. protein	53

The GC-MS study of water extracts of *S. jamaicensis* leaves showed the presence of some important biomolecules such as, N-t-Butylpyrrole, 1-hexanol, 4-methyl-, 3-methyl-2-(2-oxopropyl) furan, butanoic acid, 3-methyl-, 3,7-dimethyl-6-

octenyl ester, methyl ester, 11,14,17-eicosatrienoic acid, hexadecanoic acid, methyl ester, 2-methylheptanoic acid and 2-propenoic acid, 3-(dimethylamino)-, methyl ester, sulphurous acid, 2-ethylhexyl hexyl ester, pentanoic acid⁵⁵.

In a study it was found that *S. jamaicensis* had a predominance of dolichols over polyprenols⁵⁶. Quantitative analysis of methanolic extract of *S. jamaicensis* leaves was investigated and found that total Phenolic Content was 1,882.80 μmg^{-1} (GAE) gallic acid equivalent, Total Flavonoid Content was 29.29 μmg^{-1} QE (quercetin equivalents), total tannin content was 126.47 μmg^{-1} TAE (tannic acid equivalent), total ascorbic acid was 53.75 \pm 0.01 μmg^{-1} AAE (ascorbic acid equivalent), carotenoid content (β -carotene and lycopene) of the extract was observed to be 0.17 and 0.14 mg^{-1} respectively⁵⁴. In another study, the total phenolic content and total flavonoid content in leaves, twigs & inflorescence of *S. jamaicensis* using water, 50% ethanol & 95% ethanol was determined and was found that the total phenolic content was highest in leaves and the total flavonoid content was highest in twigs extracted using 95% alcohol⁵⁷. In another study, the acetone extract of *S. jamaicensis* revealed the presence of 40 phytochemical constituents, which included cyclopropane, pyranone, coumarin, tricosane, neophytadiene, squalene⁵⁸.

Microscopic Features: A study reported that in the leaf midrib & petiole of *S. jamaicensis*, the epidermal cells are sinuous with anticlinal walls, amphistomatic in nature, mucilage cells in the cortex parenchyma, sclerenchyma cells densely or sparsely scattered around the vascular bundle, while collenchyma cells present in the abaxial and adaxial leaf surfaces, vascular bundles open with a continuous ring of vascular bundles, 2 extra vascular bundles⁵⁹ unicellular and multicellular uniseriate trichomes, irregular/prism calcium oxalate crystals⁴⁹. In another study, quantitative microscopy revealed Palisade ratio (4.42 \pm 2.55), Stomatal number: upper epidermis (105.67 \pm 2.73), Lower epidermis (277.00 \pm 17.08), Stomatal index: upper surface (28.00 \pm 2.31), Lower surface (21.00 \pm 2.51), Vein-islet number (15.67 \pm 0.66), Veinlet termination number (3.50 \pm 0.00)⁴⁹. In a research work, the pollen grains of *S. jamaicensis* were studied to identify potential adulterants and pollens of *S. jamaicensis* were reported to be elliptical, rod, rounded, circular in outline, white, psilate exine ornamentation and with porate, colpate apertures⁶⁰.

Physical Standards: In a pharmacognostic study, the organoleptic properties such as colour, odour and taste of the plant material were recorded to be

green, characteristic and tasteless respectively⁴⁹. Analytical standards of *S. jamaicensis* leaf were reported as Total ash- 11.85 \pm 0.06%, Water soluble ash- 2.17 \pm 0.00%, Sulphated ash - 8.80 \pm 0.14 %, Acid insoluble ash- 2.04 \pm 0.02 %, Alcohol soluble extractive value 2.51 \pm 0.15%, Water soluble extractive value- 4.85 \pm 0.22%, Moisture content 4.30 \pm 0.02%⁴⁹. These standards may be used as diagnostic indices for its identification and standardisation.

Pharmacological Activities:

Wound Healing Activity: In a study, ethanolic extract of *S. jamaicensis* leaf was evaluated for wound healing in albino rats using excision wound model. The study revealed that 0.5ml extract applied for 20 days, accelerated wound healing in albino rats compared to control in scab formation, better wound contraction and faster wound closure⁵¹.

Antibacterial Study: In an antimicrobial study, ethyl acetate extract of *S. jamaicensis* at a dose ranging from 25- 400 μg was investigated for its anticandidal activity using agar well diffusion method and was observed to have the highest activity with an inhibition value of 39-57% among the 19 medicinal plants investigated⁶¹. While in another study, the antibacterial potential of methanolic leaf extract of *S. jamaicensis* at different concentrations (1000, 500 and 250 μgml^{-1}) was investigated using agar well diffusion method against Gram-positive & gram- negative bacteria & was reported that the extract gave a wide range of zones of inhibition ranging from 14.0–25.0 mm as compared to Gentamicin⁵⁴.

In another study, ethanolic-aqua extract of *S. jamaicensis* leaves was active against *Salmonella typhi*, *Bacillus cereus*, *Proteus vulgaris* and *Streptococcus pyogenes* with the zone of inhibition of 11.503 \pm 0.005 for *B. cereus*, 14.766 \pm 0.0033 for *P. vulgaris* and 13.566 \pm 0.033 for *S. pyogenes* which was larger than the positive control, Penicillin except in *Salmonella typhi* (10.766 \pm 0.033)⁶². Polyisoprenoid extracted from leaves of *S. jamaicensis* at a dose of 100mg/mL had moderate inhibitory effects on the growth of *Escherichia coli* and *Staphylococcus aureus*, with a zone of inhibition of 9.99 \pm 0.80 mm & 11.35 \pm 0.18 mm respectively⁶³.

In a study Zinc oxide (ZnO) and Cu- doped ZnO nanoparticles (1% and 5%; Cu-doped ZnO) synthesized using aqueous leaf extract of *S. jamaicensis* were screened for its antibacterial potential and was found that it was active against two gram-positive bacterial strains (*Bacillus subtilis* and *Staphylococcus aureus*) at a concentration of 500mg/ml⁶⁴.

Anticancer Activity: In an effort to evaluate the cytotoxic activity of *S. jamaicensis*, a study was conducted using ethanolic and dichloromethane extract of leaves, stems and flowers of *S. jamaicensis* at various concentrations and were evaluated on HeLa and T47D cancer cell lines. The study reported that only dichloromethane extract of leaves showed cytotoxicity against both cell line with IC₅₀ values 84,198 µg/ml and 64,198 µg/ml on HeLa and T47D cells respectively⁶⁵. Polyisoprenoids extracted from *S. jamaicensis* was evaluated for its cytotoxic activity by *in-vitro* MTT assay using WiDr human colon cancer cells & the study showed cytotoxicity with IC₅₀ values 285.492 µg/ml⁶⁶. In another study, dichloromethane extract of aerial parts of *S. jamaicensis* was subjected to cytotoxicity test against human oral squamous carcinoma cell lines (CLS-354/WT and CLS-354/DX) and cell viability using MTT assay and the extract exhibited a potent cytotoxicity against both cancer cell lines⁶⁷.

Effect on Uterine Smooth Muscle: In an attempt to investigate the effect of *S. jamaicensis* on uterine smooth muscles, a study was conducted to evaluate the effect of methanol leaf extract at a dose of 0.41mg/ml and 4.01 mg/ml on oxytocin and CaCl₂ induced uterine contractions in non-pregnant adult female Sprague-Dawley rats and the study revealed that *S. jamaicensis* exert inhibitory effect in oxytocin induced uterine contractions which could be possibly through inhibition of calcium influx⁶⁸.

Anti-trypanosomal Activity: In an experimental study, methanolic leaf extract of *S. jamaicensis* at various concentrations of 100, 250 and 500mg/bw was evaluated on the weight and packed cell volume (PCV) of mice experimentally infected with *Trypanosoma brucei* and was found that the methanolic extracts was capable of increasing the PCV value significantly which shows its anti-trypanosomal activity⁶⁹.

Anti-inflammatory Activity: Methanolic extract of *S. jamaicensis* leaves at various concentrations of 1000, 500, 250 and 125 µg ml⁻¹ was investigated for its in-vitro anti-arthritic and anti-inflammatory activities on Inhibition of protein denaturation using egg albumin assay & bovine serum albumin assay and was found to have significantly high (22-80%) potential with IC₅₀ values of 0.04 and 0.15 mgml⁻¹ respectively as compared to standard Aspirin⁵⁴.

In an experimental study on rat animal models of systemic lupus erythematosus, oral administration of *S. jamaicensis* water extract at a dose of 11.25 mg/kg bw for 6 weeks could inhibit the inflammatory response, reduce the possibility of thrombocytopenia and kidney damage but decreased erythrocyte, haemoglobin and haematocrit⁷⁰.

Anti-oxidant Activity: In an antioxidant study using hexane, dichloromethane, methanol, and water extracts of aerial parts of *S. jamaicensis*, the highest antioxidant activity was observed in methanolic crude extract⁶⁷ while in another study highest antioxidant activity was found in *S. jamaicensis* twigs extracted using 95% ethanol.⁵⁷ The antioxidant and free radical scavenging activity of *S. jamaicensis* methanolic leaf extracts at various concentrations (10-750 µgml⁻¹) were measured using 2,2'-diphenyl-1-picryl-hydrazyl (DPPH) & Phosphomolybdate Total Antioxidant Capacity (PTAC) and was found to be moderately high with a percentage inhibition between 51.30-78.99%, IC₅₀ value of 5.0 µgml⁻¹, with an Antioxidant Activity Index (AAI) value of 8.0⁵⁴. While in another antioxidant study using 1,1-diphenyl-2-picrylhydrazine (DPPH) radical scavenging assay revealed concentration-dependent radical scavenging effect with IC₅₀ values of 16.95 µg/mL and 33.12 µg/mL, for the methanol extract and ethyl acetate extract, respectively⁴⁸.

Antidiabetic Activity: A preliminary anti-diabetic study of methanolic extract of *S. jamaicensis* leaf, revealed a non-dose dependent reduction in the blood glucose level in alloxan-induced diabetic rats. The study also demonstrated that at a dose of 200mg/kg b.w, methanolic leaf extract of *S. jamaicensis* leaf had a significant hypoglycemic effect in normoglycemic rats⁵³.

In another experimental study, oral administration of 200mg/kg and 400mg/kg b.w of methanol & ethyl acetate extracts of *S. jamaicensis* leaves daily for a week significantly lowered the blood glucose levels in streptozocin- induced diabetes in experimental rats as compared to the untreated diabetic animals⁴⁸. *S. jamaicensis* leaf was also evaluated against streptozocin- induced diabetic rats fed on a high fat diet. Various doses of ethanolic extract (30, 50 and 100mg/kg p.o) significantly reduced blood glucose levels along with significant changes in lipid profile⁷¹.

In another study the ethyl acetate extracts of *S. jamaicensis* was screened for dipeptidyl peptidase IV (DPP-IV) inhibitory activity but the results showed no inhibitory effect by the extract⁷².

Toxicity Studies: Study conducted on acute toxicity of methanolic extracts of *S. jamaicensis* leaves in albino rats revealed that the extract showed no toxic effect towards rats even up to the dose of 5000mg/kg b.w and LD 50 was thus established as 5000mg/kg, which also implies that the extract is non toxic⁵³.

Protective Effect: Protective effect of ethyl acetate extract of *S. jamaicensis* was investigated by inducing oxidative stress by H₂O₂ on human umbilical vein endothelial cells (HUVECs). The study revealed that at a dose of 75 ug/mL, the extract had a protective effect against the induced damage⁷³. In another study, the protective effects of *S. jamaicensis* on liver and kidney of lipopolysaccharide-induced endotoxemia in ICR mice was evaluated by determination of lipid peroxidation and histology assessment and it was reported that ethyl acetate extract at a dose of 150mg/kg b.w had significant protective potential in kidney⁷⁴.

Gastro-protective: The methanolic extract of the aerial parts of *S. jamaicensis* was evaluated for its gastro-protective and therapeutic potential against ethanol induced gastric ulcers. The extract at a dose of 250mg/kg b.w revealed anti- ulcerative and protective effect⁷⁵.

Immunomodulatory: The water extract of *S. jamaicensis* plant at a dose of 50,100 and 200mg/kg.b.w was evaluated for its specific immunomodulation using hemagglutination

antibody titer test and delayed type hypersensitivity tests. The study showed that the extract had the potential to increase the value of antibody titre⁷⁶.

Pharmaceutical Innovations: A nano composite hydrogel containing Indole-3- acetic acid, extracted from the leaves of *S. jamaicensis* was found effective as antibacterial, antioxidant, wound healing & anticancerous⁷⁷. A formulation containing *S. jamaicensis* leaf aqueous extract (1, 2.5, 5g) in the form of film forming polymeric solutions (FFPS), an advance drug delivery system was developed and evaluated for its physicochemical properties. Aucubin, a chief phytoconstituent of *S. jamaicensis* known for its anti-inflammatory activity was evaluated in the study and was reported that the composition of the FFPS affected physicochemical properties of the formulation⁷⁸.

DISCUSSION & CONCLUSION: The review highlights the wide distribution of the plant across the world and its use by various ethnic groups for therapeutic uses. Various ethnobotanical claims have been reported, of which a few are supported by experimental studies. There is a need for further experimental evaluation on other uses like, Malaria, kidney infection, gall stones. Various studies support the antioxidant potential of *S. jamaicensis* and could be probably due to the flavonoid and non-flavonoid components present in the plant. The supportive experimental works on the therapeutic potential of *S. jamaicensis* in Hepatitis, cancer, diabetes, wounds and antioxidant opens up new clinical research areas to develop new effective and safe drugs.

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