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Review article:

Hyptis suaveolens: a neglected weed with health promoting phytochemicals - A review

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ABSTRACT

Hyptis suaveolens, (family: Lamiaceae) commonly known as bushmint is considered as a weed plant of plains. Plant grows widely in open land segments, road sides and covers almost all available areas in certain parts of the plains. The plant is highly aromatic and reported to have Eucaliptol (47.64 %) as the major constituent; the other main components of the oil were α-caryophyllene (26.0%); α-elemene (10.4%); trans-α-bergamotene (7.7%); spathulenol (7.0%); bicyclogermacrene (6.5%) etc. Traditionally, the plant is known for the treatment of diabetes mellitus, fever, eczema, flatulence, cancers and headache, infective diseases and management of chronic wounds, affections of the uterus, parasitic cutaneous diseases, for headache and as snuff to stop bleeding of the nose; colic and stomachaches (leaf juice). In experimental set up the plant exhibited antimicrobial, antinflammatory, antifungal and antioxidative properties. It's treated as a weed which being non palatable to animals and not utilized for any potential use. But Hyptis suaveolens does possess a variety of beneficial biological activities, thus, needs a systematic evaluation for human acceptability and use.

INTRODUCTION

Hyptis suaveolens is a member of family Lamiaceae, commonly known as 'Bushmint' or 'VilayatiTulsi'. It grows widely as an uncontrolled weed in the plains of northeast India and is an ethnobotanically important medicinal plant [49]. The Plant is distributed throughout the tropics and subtropics. Locally at Lucknow the plant has occupied most of the open lands, road sides of highways and sides of rail tracks. *Hyptis* is unpalatable to livestock. It is a fast growing plant. The growth of other weeds and many important naturally growing flora of medicinal importance is suppressed by it. Observations of last 4-5 years, particularly made in the trans-Gomti area of Lucknow (India) suggested the specific suppression of the wild *Calotropis, Dhatura, Cassia Tora, Solanum nigrum* etc. because of the over growth of *Hyptis suaveolens* (personal observation). Traditionally, it is known to be beneficial for a variety of human health problems like appetizing agent, to combat indigestion, nausea, flatulence, colds, and infection of the gall bladder. Most parts of the plant are being used in traditional medicine systems for the treatment of various

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diseases [42]. The plant oil has terpenoids and aromatic oil like caryophyllene, sabinene etc. Due to the uncontrolled spreading, it's considered as an obnoxious weed by the U.S. federal government or a state [57]. The leaves of *H. suaveolens* harbors properties of a stimulant, diaphoretic, lactation promoter and used as a cure for parasitic cutaneous diseases [30]. The crude leaf extract is used as a medication in cases of colic and stomachache. Leaves and twigs are considered to be anti-spasmodic, anti-rheumatic, anti-soporific in baths, anti-inflammatory, anti-fertility and also applied as an antiseptic in burns, wounds, and various skin complaints. The broth prepared from the roots of the plant is highly valued and consists of urosolic acid, a natural HIV-integrase inhibitor. Fumes of the dried leaves are used to repel mosquitoes and control insect pests of stored grains. Despite having various medicinal properties, the plant is still not considered palatable. Recently, we have established its ant repellent efficacy [40, 41]. In this review, we discuss the use and the possible merits of *Hyptis suaveolens*, examining its historical use and biological activity of various phytochemicals to explore the possibilities of its use for human welfare.

History

The plant is a native of South America and was first recorded in the Northern Territory (NT) by the explorer Leichhardt in about 1845 AD. It favors disturbed areas such as roadsides and overgrazed areas open and barren land. *Hyptis suaveolens* grows in most soil types, except those which become waterlogged [36].

Plant description and nomenclature

Hyptis suaveolens is an annual or perennial, upright, branched plant with a characteristic minty aroma. It needs full exposure to sunlight. Plants generally grow to 1.0 m. -1.5 m. In height, but reach up to 2 m. Stems are shaped like a square. Young plants have green stem covered with fine hairs. Stems on mature plants are unlikely to exceed 5 mm. in diameter. They spread in hispid fashion. Petiole is slender in shape. Hyptis has hairy, opposite leaves; adaxially olive green and abaxiallypillose. They are broad at the base and pointed at the tip with toothed margins (serrulate). Apex ranges from subacute to obtuse. The size of the leaves generally varies from 2.5cm. -7cm. long and 1cm.-5cm. wide. Flowers are small lavender blue in color, occur in cluster of 2-5 at the leaf joints in raceme or panicles. Corolla is puberulent with the base tube 2mm wide at throat, upper lip lobes are reflexed, middle lobe of the lower lip is shorter, lateral lobe is similar to upper lobes. Hyptis produces an obvious capsule, which is generally green in color. It dries to become brown in color, flattened, dotted with two basal white scars. Each capsule has 5 stiff bristles. Seeds are dark brown to black in color, shield shaped and 3-3.5mm. in size. Fruits are villous, yellowish glandular, throat tufted villous, veins very elevated; teeth broadly triangular, long subulate.

There are various common names for *Hyptis suaveolens* in various parts of the world for Ex: In Hindi its known as 'vilayatitulsi'. In the Akan language, its known as 'BrongPeeah'. In English it has several names like 'Horehound', 'Mumutun', 'Pignut', 'Wild Spikenard', '*Hyptis suaveolens*'. In French 'Gros Baume',' Hyptis α Odeur'. In Malay 'SìlaséhHutan'. In Portugese 'Mentrasto Do Grande'. In Spanish 'Chao', 'Hierba De Las Muelas', 'Hortela Do Campo'. In Sudanese 'Babadotan'. In Tagalog 'KablíngKabαyo' [4, 14, 17-23, 35, 54-58].

Chemical constituents

The soluble solvent extract of the plant was investigated for its chemical constituents. It confirmed the existence of various compounds like terpenoids, flavonols, flavones, flavanones, alkaloids, tannins, aldehydes, ketones. The hydro distilled essential oil obtained from the fresh leaves of *Hyptis suaveolens (L.) Poit*. was analyzed by Gass Chromatography/Mass Spectroscopy. Twenty-four compounds representing 90.3% of the oil. Eucaliptol (47.64%) was the most abundant component in the oil [12]. The other components of the oil were α-caryophyllene (26.0%); α-elemene (10.4%); trans-α-bergamotene (7.7%); spathulenol (7.0%); bicyclogermacrene (6.5%); Limonene; Thujane; α-Pinene; β-pinene (6.55%); α-Phellandrine; 3-Cyclohexen-L-ol; 4-Methyl-L-

(L-Methyl Ethyl)-3-Cyclohexen-L-ol; 3-Cyclohexen-1-Carboxyaldehyde; Elemene; gama-ellemene (8.15%); 4, 11, 1 L-Trimethyl-8-Methylene Bicyclo Undec-4-Ene; Octahy-Dro-1, 4-Dimethylazulene; 5α, 8β, H-9β, H-10a- Labd-14-Ene; (+)3-carene (5.16%); 5α-Androst-9(L L)-En-12-One; (+)3-carene (5.16 %); germacrene (4.86 %); p-mentha-2,4(8)-diene; and 5α-Androstan-2,11-Dione [8,29, 32]. Triterpenoidsbetulin and betulinic acid were also found [50]. Alkaloids and flavonoids range from 10.44% to 14.32% [4]. Repeated column chromatography and preparative thin layer chromatography done showed the presence of suaveolol and methyl suaveolate from leaves [16]. The steam volatile oil from the arial parts of the plant was examined and detected to have 1,8-cincole, terpinen-4-o 1, α-bergamotene, sabinene and α–copaene [12]. Bioactivity-guided fractionation of petroleum ether extract of the leaves led to the isolation of an abietane-type diterpenoiden-doperoxide i.e. 13 alpha-epi-dioxiabiet-8(14)-en-18-ol [10].The acidic polysaccharide extracted from the seed-coat mucilage of *Hyptis*is a highly branched L-fuco-4-O-methyl-D-glucurono-D-xylan. It is supposed to have a structure with 4-linked beta-D-xylan backbone carrying side chains of single 4-O-methyl-alpha-D-glucuronic acid residues at O-2 and 2-O-L-fucopyranosyl-D-xylopyranose units at O-3. The isolated compound's structure was analyzed by base-catalyzed beta-elimination of uronic acid residues from the methylated glycan. This was followed by degradation using Svensson oxidation-elimination sequence with some modifications. Essential oil composition of the plant also varies according to the geographic locations. It indicated that the sesquiterpenes are mainly produced in the samples grown at lower latitudes [33]. *Hyptis suaveolens* is devoid of saponins, anthraquinones and steroids [13]. Still researches are going on to decipher more useful compounds present in the plant which could be beneficial for the mankind.

Extraction methods

Various kinds of extracts of the plant have been used until now in diverse field of experiments. Following are their methods:

Steam distillate preparation by Dean and Stark apparatus

A sample of the air dried aerial parts of the plant was steam distilled in an all glass Dean and Stark apparatus modified to give lower phase return, to give a mobile pale yellow. The pale yellow part was separated as extract [12].

Aqueous extract preparation

The plant material was sun dried for 7 days before milling into powder with a clean blender. 20 g of powder was mixed in 100 ml of distilled water for 24 h at room temperature to obtain the aqueous extract. The aqueous mixture was filtered using Whatman filter paper No. 1 and lyophylised to obtain the dry solid residue [13].

Methanolic extract preparation

150g of the powdered leaves of *H. suaveolens* was macerated in 750ml of methanol for 72 hours. The mixture was filtered and the filtrate was evaporated to dryness on a water bath, which gave a reddish-brown, semi-solid residue [13].

Soxhlet extraction

Clean boiling flasks (250 ml) were dried in the oven at 105º - 110º C for about 30 minutes. They were then transferred to a dessicator and allowed to cool. Two grams of pulverized and sun dried leaves of *H. suaveolens* was weighed separately in labeled tubes. 200ml of ethanol was taken in the boiling flask. Cotton wool was tightly plugged in the extraction flask. The soxhlet apparatus was assembled to allow reflux for about 6 hours. The sample was removed from tubes with care after the reflux time. The ethanol from the top container of the set up was drained out for re-use. Water bath was used to concentrate the extract. The ethanol was removed and greenish viscous oil was recovered [31].

Ethanolic extract preparation

Air dried ground plant sample (600g.) was percolated in 2,200 ml. of 96% ethanol at room temperature for two weeks with intermittent shaking. The percolate was evaporated to dryness

at room temperature and a crude extract (ethanol soluble) was obtained. 0.1 g of crude extract was then transferred into a vial and kept at a lower compartment of the refrigerator until required for use [33].

Powder preparation

The plant materials (seeds and leaves) were collected. The seeds and leaves were dried in an oven at 60°C for 4 hours and pulverized in a Thomas-Willey milling machine. The fine powdered parts were kept in separate brown envelopes until ready for use [37].

Petroleum ether leaf extract

The completely dried leaves of the *Hyptissuaveolens* were grounded with Binatone MX10 blender and sieved to get a fine powder of the leaves. Leaf powder was sieved after grinding. Soxhlet apparatus was used. 20 gm of grounded and sieved leaves were wrapped in a plain white sheet of paper and then put in a vial of the soxhlet apparatus compartment. Thereafter, the condenser was carefully and efficiently connected. An initial 250 ml volume of the solvent (Petroleum ether) was added with the aid of a funnel by passing it through the vial containing the sample to the round bottom flask system of the soxhlet. Inlet and outlet of the condenser were connected to a hose respectively, for recycling the cold water during the extraction. The framework of retort stand and clamps was used to support the entire apparatus. Finally, the hot plate (heat source) was switched on for the extraction. As the extraction continued, the yellow-green colored solution in the soxhlet body (vial) became pale, while the color of the solution in the round bottom flask turned brown. This continued until the color in the soxhlet body became colorless while the solution in the flask deep brown. The boiling point of the solvent (petroleum ether) was 80ºC. The extraction process lasted for 6 hrs. This process was done at room temperature (28±1ÚC) [34].

Hydro-distillation of oil

Oil of *Hyptis suaveolens* was extracted by hydro-distillation for 5 hrs using Clevenger apparatus. Two distinct fractions comprising an upper oily layer and a lower aqueous layer were obtained which were separated carefully by regulating the stopper of the apparatus. The anhydrous sodium sulphate was used as a treatment for the upper oily layer in order to obtain the pure essential oil. To isolate the oil from the aqueous portion, a separating funnel was used to extract the oil with solvent ether. The ether was removed at reduced pressure. An oily residue was formed which was added to the oil collected earlier. The remaining odorless aqueous fraction was stored separately. Thus, the hydro-distilled volatile fraction of the leaves of *Hyptis suaveolens* was collected as two fractions, an oil fraction and an aqueous fraction. The essential oil acquired was stored in sealed glass tube at 4ºC [49].

Traditional uses

Traditionally, the plant is used in the treatment of diabetes mellitus, fever, eczema, flatulence, cancers and headache. The Natural products are a source of synthetic and herbal medicine and are still the primary health care system as they are used in treating certain infective diseases and management of chronic wounds. It's also used in catarrhal conditions, affections of the uterus, parasitical cutaneous diseases, headache, as a snuff to stop bleeding of the nose; colic and stomachaches (leaf juice) [51]. In America the uses range from the treatment of the rheumatism to the therapy of the stomach problems and other gastrointestinal parasitic diseases. The infusion prepared from the leaves or the inflorescence are employed for their stimulant, carminative, diuretic and anti-pyretic property. The decoction of the whole plant is used to alleviate diarrhea and other kidney ailments. Hyptis along with Salvia hispanica L. and Salvia polystcyea ort.is a part of so called "chia" complex in Mexico. Aztecs cultivated "chains" or "chiantozotzolli". Its seeds are extensively used for the treatment of urinary obstruction and various fevers. In modern Mexico and Central America the seeds are prepared to make refreshing drinks and for the cure of constipation. The root is prepared as a bitter tea by the rural population of Michoachan and Guererro in the Balsas River drainage and

drunk before breakfast to cure malarial fevers [5]. In India 100g of leaves are ground and mixed with one spoonful of turmeric powder. It's warm and applied on head thoroughly. After an hour, head bath is taken with warm water. The process is repeated for 3-4 days to get relief from cold and cough [28].

Health benefits

Antimicrobial activity

To detect the antimicrobial activity the steam distillated (yield: 0.24%), petroleum ether extract (yield: 1.6%) and ethanol extract (yield: 2.64%) were prepared separately from fresh leaves. The ethanol and petroleum ether extracts were dried in a vacuum. All the extracts (v/v) were mixed with 10% DMSO (dimethylsulfoxide). Positive control was made by using Chloramphenicol (10 ìg/ml) and miconazole (25 ìg/ml). Well-diffusion assay method was used to screen the extracts for anti-microbial activity against *Bacillus subtilis, Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa and Micrococcus luteus, Candida albicans,* Cryptococons and Fusarium [45]. Culture plates of the organisms were prepared respectively by using nutrient agar plates swabbed with the respective broth. These plates were kept for 15 min in the laminar chamber for absorption to take place. With the help of a sterile cork borer wells were made in agar (5 mm diameter). Then, 10ìl of the extract was applied to each well. The diameters of the inhibition zones were measured (unit in mm) after an incubation period of 24 h at 37ºC. The steam distillate and petroleum ether extract showed more activity than the ethanol extract. Molten potato dextrose agar medium was used for the assessment of the anti-fungal activity of the extracts against *Fusariumoxysporum, Aspergillusniger, Helminthosporiumoryzae*. The protocol used to be similar to anti-bacterial assay. Various activity indices of the organisms were observed against chloramphenicol (10ìg/ml). Maximum antifungal and antibacterial activity against *Aspergillusniger* and *Micrococcus luteus* was noticed in the presence of the steam distillation extract. Mucorsp was inhibited quite efficiently by the hydro-distillate oil of hyptis [29]. A wide variety of essential oils found in the extract are known to possess anti-microbial properties. The monoterpene content is responsible for the activity in most cases. They cause membrane-damaging to microbial strains and also stimulates leakage of cellular potassium ions. This provides affirmation of deleterious effect related to cytoplasmic membrane damage.

In conclusion, observations validated that the anti-microbial activity of the steam distillation extract was better than the ethanol and petroleum ether extracts. The growth of gram-positive and gram-negative bacterias were arrested by the plant's essential oil [25]. This activity makes it a promising indigenous drug [30].

Antifungal activity

The safeguarding of crops, grains and pest control still has heavy reliance upon the use of chemicals. The history of pesticide development indicates both the positives as well as the negatives, accompanied with the indiscreet use of these poisons. The volatile matter obtained from higher plants are functional in controlling biodetioration as they form an amassment of beneficial chemicals, toxicant and antimicrobial agents [49]. Bioactivity of essential oil extracted from *Hyptis suaveolens* was examined against some potential pathogenic *Aspergilli* species (*A. flavus, A. parasiticus, A. ochraceus, A. fumigatus and A. niger*). It revealed an intriguing anti-Aspergillus property characterized by a Minimum Inhibitory Concentration and Minimum Fungicidal Concentration of 40 and 80µL/mL, respectively. The oil at 40 and 80 µL/ml concentrations strongly prohibited the mycelial growth of *A. parasiticus* and *A. fumigatus* for 14 days. In addition, at 10 and 20 µL/ml concentrations the oil caused morphological changes in *A. flavus* as conidiation reduction, cytoplasm leakage, pigmentation loss and cell wall disruption. This suggests the application of the oil in aspergillosis treatment [32,43]. The effectiveness of the oil remained stable with the high inoculum densities, during storage period of 250 days, after exposure to 1000ÚC and autoclaving [49].

The leaf powder of *Hyptis suaveolens* interrupted aflatoxinB (1) production by a

deleterious strain of *Aspergillus flavus* isolated from soybean seeds. The seeds were administered with the powder and fungicide captain. They were inoculated with *A. flavus* and observed after different periods. The results were affirmative [25]. This natural plant product may provide a successful alternative for chemical fungicides used to protect soybean and other agricultural commodities from aflatoxinB (1) produced by *A. flavus* [27]. 20% ethanolic solution of *Hyptis suaveolens* had the equivalent anti-fungal activity as that of 6% Boric acid, 2% Benzoic acid or 2% Salcylic acid but more than 4% Phenol [25].

Anti-oxidant and wound healing activity

Anti-oxidants reduce the damage caused to the cells by free radicals. These free radicals are generated as a result of oxidation, which in turn stimulates a chain of reactions. These reactions cause removal of an electron from a molecule and distorting its structure. Antioxidants help by removing them (free radicals). Thus, they intervene with the swift progression of oxidation reactions; that play a part in atherosclerosis, some types of cancer, and reperfusion injury stimulation. Due to such crucial significance of anti-oxidants the ethanolic and methanolic extract of hyptis were tested for the property. An ethanolic extract from the leaves was assessed for its dexamethasone suppression and wound healing activity in ether-anesthetized Wistar rats. Two different doses (400 and 800 mg/kg) were observed, using incision, excision, and dead space wound model. There was detected a substantial rise in skin breaking strength, granuloma breaking strength, wound contraction, hydroxyproline content, dry granuloma weight and decrease in epithelization period as compared to dexamethasone alone treated group. An auxiliary analysis done on granuloma tissue to calculate the levels of catalase and superoxide dismutase was done. An appreciable increment in the level of these anti-oxidant enzymes was quantified. Histopathological examination of granuloma tissue was done to evaluate the lay-down pattern of collagen using Van Gieson and Masson Trichrome stains. It led to the assumption that augmented wound healing activity may be due to the free radical scavenging action of the plant and boosted levels of anti-oxidant enzymes in granuloma tissue. Better collagenation was maybe because of improved antioxidant studies [52, 44]. The extract has shown to have anti-oxidant property and also significantly improved the wound healing.

After testing the ethanolic extract, the anti-oxidant activity of the methanolic extract of leaves of *Hyptis suaveolens* was evaluated. *Invitro* experimentation with 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity was performed. Gallic acid and butylatedhydroxyanisole (BHA) were used as reference standards. They demonstrated strong antioxidant radical scavenging activity with IC_{50} (half maximal inhibitory concentration) value of 0.4, 1.15 and 14.04 ÃŽB¼g mL-1 for Gallic acid, BHA and Hyptissuaveolens, respectively. Presence of Flavanoids was presumed to be the reason for the methanolic extract's activity [15].

Antiplasmodial activity

Surveys and interviews were conducted to gather information about the plant species, products and methods utilized by people to get rid of the sinister mosquitoes. Hyptis was found to be an effective repellent. Two field experiments were carried out for evaluation of the plant's efficiency with two other commercially available mosquito repellents. Commercial repellents were used as control. In both the experiment Smouldering *H. suaveolens* (85.4% and 83.6%); fresh *H. suaveolens* (73.2% and 66.5%) were more effective than the control [48,50].30 houses in a rural village, Mandinka-Rα in central Guinea Bissau were selected and accounted for the number of mosquitoes. All the houses were provided with bed nets which were treated with six kinds of repellent such as: lambda-cyhalothrin, permethrin, fumes of H. suaveolens, fumes of the bark of D. oliveri, fresh H. suaveolens, and control group with untreated bed nets. It was concluded that the first four groups had a remarkably lower mean number of mosquitoes compared to the control. The results indicated that the fumes from *H. suaveolens* can contribute significantly in reducing the prevalence of endophagic mosquito diseases. It may be useful

in keeping check on other diseases contagion by house-frequenting, nocturnally blood-feeding arthropods [39].

Dehydroabietinol (an abietane-type diterpenoidendoperoxide, 13 alpha-epi-dioxiabiet-8(14)-en-18-ol27) obtained from *Hyptis suaveolens* (L.) Poit.inhibited the growth of chloroquine-sensitive as well as chloroquine-resistant strains of Plasmodium falciparum cultured in vitro erythrocytes (IC_{50} 26-27 µM). However, erythrocytes exposed to dehydroabietinol were transformed in a dose-dependent manner into spherostomatocytic forms with the associated formation of endovesicles. The phenomenon was monitored using transmission electron microscopy. These modifications of erythrocyte structure caused by dehydroabietinol corresponded well with its apparent IC_{50} value. Thus, the dehydroabietinol was incorporated into erythrocyte membrane, and since the life cycle of Plasmodium parasite depends on the function of the erythrocyte membrane, the detected antiplasmodial effect was considered an indirect effect on the host cell [59].

Insecticidal effect

The powder of leaves and seeds of hyptis was examined to control *Sitophiluszeamais, Callosobruchus maculates* and *T. granarium* infesting stored maize grain (Zea mays), cowpea seeds (*Vigna aunguiculata*) and stored groundnut respectively. The powder was evaluated at 1.5, 2.5 and 3.5/80 g of the respective food materials. Adult mortality rate and emergence rate parameters of the insect species were compared. The test revealed more adult mortality and adult emergence of *C. maculatus* 93.4 to 96.6%, while 13.3 to 30% for *S. zeamais*. After 42 days of treatment adult emergence of *C. maculatus* was significantly high as that of *S. zeamais* within the same incubation period. The activity of methanolic extract of leaf and seed along with powder form was also compared. The adults of *T. granarium* (1 male and 2 female) were exposed to three concentrations (1%, 2% and 3%) for a period of 72 hours. Hyptis seed extract was more effective than other forms. It enhanced adult mortality, reduced egg-laying and suppressed larval and adult emergence. Increase in the death rate of *T. granarium* was directly proportional to the increase treatment rates. This suggests that botanical insecticide from *Hyptis suaveolens* can be very promising and its effectiveness varies with the species [24, 33].

Larvicidal effect

Natural plant products with insecticidal properties have been tried to arrest the growth of a variety of insect pests and vectors. Essential oil of *Hyptis suaveolens* showed repellence responses to *Amblyomma cajennense* nymphs. It has good repellence index of 66% when applied in high concentrations. Increased activity could be obtained at greater concentrations but for an abated time period [53].

Ant repellent activity

To test the ant repellent activity of *Hyptis suaveolens*10% aqueous extract of the mature leaves was prepared. The filtered leaf extract was tested for insect repellent efficacy using housefly and sugar syrup model. The results were encouraging and suggested the significant fly repellent action. In another experiment a floor area wiped with aqueous extract and some food stuff was kept to attract ants. In comparison to normal water, wipe, the extract wipes restrained the aggregation of ants significantly [4].

White A4 sheets were wiped with 5.0, 2.5, 1.25 and 00 % extract on both sides. After being air dried the sheets were placed on a surface with some food material spread on it to attract the ants. The sheets were monitored for comparative aggregation of ants on food substance. After 2 hours, it was found that no ants were attracted to any of the concentration of Hyptis. However, there were ants on the control. Camera recording was done to enumerate the results. To check the shelf life of extract 60 and 30 days old extracts were used along with fresh one. It was found that all stored extracts restored the similar repellent efficacy for ants [40].

Anti-inflammatory effect

Suaveolol and methyl servlet extracted from the leaves of *Hyptis suaveolens* Poit. were

evaluated for anti inflammatory property. Repeated column chromatography and preparative thin layer chromatography were done for the purpose. Their chemical structures were detected by MS, 1H NMR, 13C NMR and 2D-NMR experiments. Croton oil-induced dermatitis of the mouse ear was treated using these compounds for the first time. The dose-dependent topical anti-inflammatory activity of reference drug indomethacin was only two to three times higher than that of Suaveolol and methyl suaveolate. This property could also lead to the anti-phlogistic activity of Hyptis species. Thus, can assure the perspicacious application of *the Hyptis suaveolens extract* in dermatological diseases [16].

Anti-ulcer effect

The phytochemical and pharmacological effect of the *Hyptis suaveolens* whole plant (ethanolic and aqueous extract) was tested on duodenal ulceration model (rats). Cysteamine hydrochloride (450 mg/kg) treatment was used to induce duodenal ulcers. Ranitidine (20 mg/kg) was used as a control; aqueous (500 mg/kg) and ethanolic extract (500 mg/kg) of the plant as the test drug. Both extracts of *Hyptis suaveolens* were remarkably effective in healing the ulcers. Aqueous extract was found more active than the ethanolic extract. So, it was summed up as the plant is capable of increasing the healing the duodenal ulcerations and arrests their maturation [11].

Hypoglycemic effect

Hyptis suaveolens has been used as an anti-diabetic agent since time immemorial in the rural and tribal areas of the world. To corroborate this property, methanolic extract was studied in alloxan-induced diabetic rats. It showed an indicative reduction in the blood glucose concentration. The conclusion drawn was that the methanolic extract of Hyptis leaves possesses anti-diabetic activity and may advocate the claim by the traditional healers [10].

Protease inhibitor

Protease inhibitors form an integral class of drugs used for precluding infection caused by viruses such as HIV, Hepatitis C, etc. Seeds of Hyptis were purified and characterized for the test. This led to the extraction of a novel trypsin inhibitor. Its molecular mass was 8700 Da with an isoelectric point of 3.4. High amino acid content (seven out of eighteen residues) was revealed at the N-terminal sequence of the inhibitor. All trypsin-like proteases isolated from the gut of the insect *Prostephanus truncates*, a malevolent maize pest was checked. This activity was unique as it arrested the growth of only those from *P. truncatus* and *Manducasexta* (Lepidoptera: Sphingidae). As a result of this test *Hyptissua-veolens* enhanced the defense mechanism of maize against *P. truncates* [2].

Antineoplastic responses

Plants have been the basic source of anti cancer agents since ages. Approximately 6000 medicinal plant species were studied, including *Hyptis suaveolens.* A multifactorial plant selection method was designed to select substitute sources for cancer treatment. A random score system was attributed to the species on the basis of chemotaxonomy, traditional medical uses and published scientific data. Plausible herbs around fifty in number, were compared based on the addition of the scores accredited. The assorted plants were examined for cytotoxic activity. Liquid chromatography-mass spectroscopy (LC-MS) was used to find the compounds accountable for the property. Six plants from the group of above fifty assortment were picked out and their extracts were prepared. Three out of the remaining extract revealed high cyto-toxicity against three distinct cancer cell lines. As, a result of chromatography (LC-MS) podophyllotoxin-like lignans were pinpointed by analyzing the fragmentation pattern on mass spectra. *Hyptis suaveolens* was one of the two identified species [55]. Thus, boosts our hope to continue further research in the field.

Effect on honey bees

It's discovered lately that aphids can be restrained by exposure to low concentrations of the *Hyptis suaveolens* (L.) oil. To check whether this oil was effective in the case of honey bees experiments using both harnessed and free-flying foragers were conducted. Similar concentration as

that for aphids was used for bees. It demonstrated that honey bees smoothly differentiated between the odors and were not repulsed. However, it was marked that they did not consume the sucrose mixed oil in order to create an unconditioned stimulus. In another experiment harnessed bees assimilated several concentrations which led to the result that concentration greater than 50% were detrimental. The tests have stipulated the fact, thus favoring the use of Hyptis oil on honey bee behavioral pattern study [1].

Adverse Effect

To evaluate the toxic effects of the plant two studies were performed. The effect of aqueous extract of *Hyptis suaveolens* was assessed for a 6 - month chronic toxicity in Wistar rats. The control group received distilled water orally 10 ml/kg/day. The extract was administered orally to five treatment groups at the doses of 5, 50, 250, 500 and 500 mg/kg/day for a duration of six months. The last group was marked as the recovery group. All the groups did not show changes in the body weights, actual and relative organ weights significantly. The results of hematological, biochemical parameters and histopathological lesions represented that the extract did not cause any remarkable dose related changes [7].

In the second study, the aqueous extract of Hyptis leaves was examined for its anti-nociceptive property in chemical and thermal nociception models in mice. Here, the oral administration of the aqueous extract (100, 200, and 400 mg/kg) reduced the number of writhings induced by acetic acid, decreased the licking activity of the early phase in formalin test and increased the reaction time in hotplate test in a dose-dependent manner. An acute toxicity study revealed that no animal death up to 5 g/kg dose was observed [46]. Therefore, it was concluded that the extract of *H. suaveolens* at the given doses did not produce any significant toxic effects.

CONCLUSION

Hyptis suaveolens has been used as an essential herb in traditional system of treatment for a very long time. Experimentally, the essential oil activity of the plant has been determined to be useful in many current research areas such as cancer, diabetes, virus infections, duodenal ulceration cure, anti-inflammatory agents, etc. Phytochemicals isolated from the plant registered multiple activities like antibacterial, antifungal, antiparasitic and strong antioxidant activity. Its cytotoxic effects are being studied at various centers. However, because of its categorization as a weed and non- palatable nature annuls the possibility for preparation of palatable therapeutics. But local applications such as ointments, massage oil supplemented with rich phytochemicals can yield to desired results. Still, there persists a strong need for proper attention towards the utility of the plant. Thus, with profound potentials this obnoxious weed can turn into an effective remedy for many ailments and afflictions.

REFERENCES

1. Abramson CI, Wanderley PA, Wanderley MJ, Silva JC, Michaluk LM. 2007. The effect of essential oils of sweet fennel and pignut on mortality and learning in Africanized honey bees (*Apismellifera* L.) (Hymenoptera: Apidae). *Neotrop Entomol* **36**: 828-35.

2. Aguirre C, Valdés-Rodríguez S, Mendoza-Hernández G, Rojo-Domínguez A, Blanco-Labra A. 2004. A novel 8.7 kDa protease inhibitor from corn seeds (*Hyptis suaveolens* L.) inhibits proteases from the larger grain borer *Prostephanustruncatus* (Coleoptera: Bostrichidae), *Comp Biochem Physiol B Biochem Mol Biol* **138**:81-89.

3. Amusan AA, Idowu AB, Arowolo FS. 2005. Comparative toxicity effect of bush tea leaves (*Hyptis suaveolens*) and orange peel (*Citrus sinensis*) oil extract on larvae of the yellow fever mosquito *Aedesaegypti.*,*Tanzania Health Res Bul* **7**: 174-178.

4. Arizona State University Vascular Plant Herbarium, Website: http://nhc.asu.edu/vpherbarium/

5. Arnason JT, Mata R, Romeo JT. 1995. *Phytochemistry of medicinal plants*, New York, Plenum Press.

6. Aspinall GO, Capek P, Carpenter RC, Gowda DC, Szafranek J. 1991. A novel L-fuco-4-O-methyl-D-glucurono-D-xylan from Hyptissuaveolens, *Carbohydr Res* **214**: 107-113.

7. Attawish A, Chivapat S, Chavalittumrong P, Phadungpat S, Bansiddhi J, Chaorai B. 2005. Chronic toxicity study of *Hyptis suaveolens* (L.) Poit in rats. *Songklanakarin J Sci Technol* **27**: 1027-1036.

8. Azevedo NR, Campos IF, Ferreira HD, Portes TA, Santos SC, Seraphin JC, Paula JR, Ferri PH. 2001. Chemical variability in the essential oil of *Hyptis suaveolens*, *Phytochem* **57**: 733-736.

9. Chukwujekwu JC, Smith P, Coombes PH, Mulholland DA, van Staden J. 2005. Antiplasmodialditerpenoid from the leaves of *Hyptis suaveolens*, *J. Ethnopharmacol* **102**: 295-297.

10. Danmalam UH, Abdullahi LM, Agunu A, Musa KY. 2009. Acute toxicity studies and hypoglycemic activity of the methanol extract of the extract of the *Hyptis suaveolens* Poit. (LAMIACEAE). *Nigerian J Pharm Sci* **8**: 87-92.

11. Das P K, Sahoo S, Sethi R, Nayak PS, Nayak S, Joshi A. 2009. Phytochemical and pharmacological investigation of the protective effect of plant *Hyptis suaveolens* against duodenal ulceration. *J Global Pharma Tech* **1**: 82-87.

12. Din BL, Zakaria Z, Samsudin MW. 1998. Composition of the steam volatile oil from *Hyptis suaveolens* Poit. *Pertanika* **11**: 239-242.

13. Edeoga HO, Omosun G, Uche LC. 2006. Chemical composition of hyptissuaveolens and *Ocimum gratissimum* hybrids from Nigeria, *African J Biotech* **2**: 892-895.

14. Fairchild Tropical Botanic Garden Virtual Herbarium Darwin Core format,http://data.gbif.org/datasets/resource/202

15. Gavani U, Paarakh PM. 2008. Antioxidant Activity of *Hyptissuaveolens*Poit. *Int J Pharm* **4**: 227-229.

16. Grassia P, Reyesb TSU, Sosac S, Tubaroc A, Hoferd O, Eglseera KZ. 2006. Anti-inflammatory activity of two diterpenes of *Hyptis suaveolens* from El Salvador. *Z Naturforsch* **61**:165-170.

17. Herbaria of the world. 2014. Botanical Research Institute of Texas, http://www.brit.org/herbarium

18. Herbarium of the University of Aarhus, the AAU Herbarium Database, http://herb42.bio.au.dk/aau_herb/search_results. php?collector=&number=&number_min=&number_max=&sp_set=all&country=&family=lamiace&identification=hyptis&typeOf=&order=collectorReverse&order_dir=ASC&search_log=true&Sub mit=search.

19. *Hyptis suaveolens* - Zip Code Zoo. 2014. http://zipcodezoo.com/Plants/H/Hyptis_suaveolens/

20. *Hyptis suaveolens* -Institute of National Biodiversity. 2012. http://www.inbio.ac.cr/en/

21. *Hyptis suaveolens*-Missouri Botanical Garden. 2012. http://www.mobot.org/

22. *Hyptissuaveolens* -Australian National Herbarium. 2013. http://keys.trin.org.au:8080/key-server/data/0e0f0504-0103-430d-8004-060d07080d04/media/Html/taxon/Hyptis_suaveolens.htm

23. *Hyptis suaveolens* -National Bank of Vegetal Germ plasm, Mexico, http://data.gbif.org/species/browse/taxon/13746342?qs=Hyptis%20suaveolens

24. Iloba BN, Ekrakene T. 2006. comparative assessment of insecticidal effect of *Azadirachta indica, Hyptis suaveolens* and *Ocimum gratissimum* on *Sitophiluszeamais* and *Callosobruchus maculates*, *Journal of Biological Sciences* **6**: 626-630.

25. Iwu M, Ezeugwu C, Okunji C, Sanson DR, Tempesta MS. 1990. Antimicrobial activity and

terpenoids of the essential oil of *Hyptis suaveolens. Pharmaceutical Bio* **28**: 73-76.

26. Kéïta SM, Vincent C, Schmit J, Ramaswamy S, Bélanger A. 2000. Effect of various essential oils on *Callosobru chusmaculatus* (F.) (Coleoptera: Bruchidae). *J Stored Prod Res* **36**: 355-364.

27. Krishnamurthy YL, Shashikala J. 2006. Inhibition of aflatoxin B production of *Aspergillus flavus* isolated from soybean seeds by certain natural plant products *Let Appl Microbiol* **43**: 469-474.

28. Kumar RB, Suryanarayana B. 2008. Ethnomedicinal Recipes for Respiratory and Bronchial diseases from tribals of Sriharikota island. *Ethnobot leaflets* **1**: 896-911.

29. Malele RS, Mutayabarwa C K, Mwangi JW, Thoithi GN. 2003. Essential oil of *Hyptis suaveolens* (L.) Poit. from Tanzania: Composition and antifungal activity. *J Ess Oil Res* **8**: 438-440.

30. Mandal SM, Mondal KC, Dey S, Pati BR. 2007. Antimicrobial activity of the leaf extracts of *Hyptis suaveolens* (L.) poit. *Ind J Pharma Sci* **4:** 568-569.

31. Mbatchaou VC, Abdullatif S, Glover R. 2010. Phytochemical screening of solvent extract from *Hyptis suaveolens* LAM for fungal growth inhibition, *Pak J Nut* **9**: 358-361.

32. Moreira ACP, Lima EDO, Wanderley PA, Carmo ES, De Souza EL. 2010. Chemical composition and antifungal activity of *Hyptis suaveolens* (L.) but leaves essential oil against species *Aspergillus. Brazilian J Microbiol* **41**: 28-33.

33. Musa AK, Dike MC, Onu I. 2009. Evaluation of Nitta (*Hyptis suaveolens* Poit.) seed and leaf extracts and seed powder for the control of *Trogoderma granarium* Everts (Coleoptera: Dermestidae) in stored groundnut. *American-Eurasian J Agro* **2**: 176-179.

34. Nantitanon W, Chowannapoonphon S, Okonogi S. 2007. Antioxidant and anti-microbial activity of *Hyptis suaveolens* essential oil. *Sci Pharm* **75**: 35-36.

35. National Herbarium of New South Wales, Plants of Papua New Guinea,: http://www.pngplants.org/proj_details.html

36. Northern Territory Government, Australian Database (2013) http://www.nt.gov.au/nreta/natres/weeds/find/hyptis.html

37. Okigbo RN, Okeke, JJ, Madu NC. 2010. Larvicidal effects of *Azadirachta indica, Ocimum gratissimum* and *Hyptis suaveolens* against mosquito larvae. *J Agric Tech* **6**: 703-719.

38. Pålsson K, Jaenson TG. 1999. Plant products used as mosquito repellents in Guinea Bissau, West Africa., Sweden. *Acta Trop* **72**: 39-52.

39. Pålsson K, Jaenson TG. 1999. Comparison of plant products and pyrethroid-treated bed nets for protection against mosquitoes (Diptera: Culicidae) in Guinea Bissau, West Africa. *J Med Entomol* **36**: 144-148.

40. Pandey G, Srivastava JK. 2012. Shelf life evaluation of an effective ant repellent from *Hyptis suaveolens.* In: *Recent Advances in Plant Sciences*, Excellent Publishing House, New Delhi, India, Pp 163-166.

41. Pandey G, Srivastava JK. 2010. Evaluation of insect repellent properties of an exotic weed: *Hyptis suaveolens*. Fourth International Conference on Plants and Environmental Pollution, Lucknow, **4**: 200-201.

42. Philippine Medicinal Plants. 2011. SuobKabayo: *Hyptis suaveolens*. Website: http://www. Stuartexchange.org/index.html.

43. Qureshi S, Rai MK, Agrawal SC. 1997. *In-vitro* evaluation of inhibitory nature of extracts of 18-plant species of Chhindwara against 3-keratinophilic fungi. *Hindustan Antibiot Bull* **39**: 56-60.

44. Rajput R, Bose U, Barma M, Udupa LA, Bhat V, Rao N. 2010. Evaluation of *Hyptis suaveolens* for anti-oxidant property and reversal of dexamethanose suppression in dead space wound model. *Int J Pharm Sci Bio* **1**:141-144.

45. Rojas A, Hernandez L, Pereda-Miranda R, Mata, R. 1992. Screening for antimicrobial activity of crude drug extracts and pure natural products from Mexican medicinal plants. *J. Ethnopharmacol* **35** : 275-283.

46. Santos TC, Marques MS, Menezes lA, Dias KS, Silva AB, Mello IC, Carvalho AC, Cavalcanti SC, Antoniolli AR, Marçal RM. 2007. Antinociceptive effect and acute toxicity of the *Hyptis suaveolens* leaves aqueous extract on mice. *Fitoterapia* **78**: 333-336.

47. Seyoum A, Pålsson K, Kung'a S, Kabiru EW, Lwande W, Killeen GF, Hassanali A, Knols BG. 2002. Traditional use of mosquito-repellent plants in western Kenya and their evolution in semi-field experimental huts against Anopheles gambiae: ethnobotanical studies and application by thermal expulsion and direct burning, *Trans R Soc Trop Med Hyg* **96**: 225-231.

48. Sharma GP, Raghubanshi AS. 2009. Plastic responses to different habitat type contribute to *Hyptis suaveolens* Poit. invasiveness in the dry deciduous forest of India. *Ambio* **38**: 342-344.

49. Sharma N, Verma UK, Tripathi A. 2004. Bioactivity of essential oil from *Hyptis suaveolens* against storage microflora, *Proc. Int. conf. Controlled Atmosphere and Fumigation in stored Products*, 99-116.

50. Sharma PP, Roy RK, Anurag, Gupta D. 2010. Pentacyclic triterpinoids from *Betul autilis* and *Hyptis suaveolens. Int J Pharmatech Res* **2**: 1558-1562.

51. Sharma PV. 2004. Classical Uses of Medicinal Plants, ChaukhmbhaVisvabharti, Varanasi, India.

52. Shirwaikar A, Shenoy R, Udupa AL, Udupa SL, Shetty S. 2003. Wound healing property of ethanolic extract of leaves of *Hyptis suaveolens* with supportive role of antioxidant enzymes. *Indian J Exp Biol* **41**: 238-241.

53. Soares SF, Borges LM, de Sousa Braga R, Ferreira LL, Louly CC, Tresvenzol LM, de Paula JR, Ferri PH. 2010. Repellent activity of plant-derived compounds against *Amblyomma cajennense* (Acari: Ixodidae) nymphs. *Vet Parasitol* **167**: 67-73.

54. SysTax, Herbarium, University of Ulm, http://www.biologie.uni-ulm.de/systax/infgard/index.html

55. SysTax: A Database System for Systematics and Taxonomy, http://www.biologie.uni-ulm.de/systax/

56. Tonzibo ZF, Florence AB, Bedi G, Chalchat JC. 2009. Biological, chemical composition of essential oil of *Hyptis suaveolensis* (L) Poit. *European Newspaper of Sci Res* **38**: 565-571.

57. United States Department of Agriculture, USDA. 2011. Plant profile for *Hyptis suaveolens*, Natural Resources Conservation Service, http://plants.usda.gov/java/profile?symbol=HYSU3.

58. USDA PLANTS, USDA PLANTS Database, http://plants.usda.gov/java/

59. Ziegler HL, Jensen TH, Christensen J, Staerk D, Hägerstrand H, Sittie AA, Olsen CE, Staalsø T, Ekpe P, Jaroszewski JW. 2002. Possible artifacts in the *in-vitro* determination of antimalarial activity of natural products that incorporate into lipid bilayer: apparent antiplasmodial activity of dehydroabietinol, a constituent of *Hyptis suaveolens. Planta Med* **68**: 547-549.