European Journal of Medicinal Plants
4(6): 661-674, 2014

SCIENCEDOMAIN *international*
www.sciencedomain.org

The Efficacy of Hyptis Suaveolens: A Review of Its Nutritional and Medicinal Applications

L. Umedum Ngozi[1*], Nwajagu Ugochukwu[1], P. Udeozo Ifeoma[2], E. Anarado Charity[1] and I. Egwuatu Chinyelu[1]

[1]Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.
[2]Tansian University, Oba, Anambra State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author LUN designed the study, and wrote the first draft of the manuscript. Authors NU, PUI, EAC and EC managed the literature searches. All authors read and approved the final manuscript.

Review Article

Received 19th September 2013
Accepted 3rd February 2014
Published 20th February 2014

ABSTRACT

Aims: To review the phytochemical composition, medicinal uses and pharmacological properties of different parts of the plant, *Hyptis suaveolens*.
Methodology: Detailed data were collected from studies carried out by several researchers on the use of different parts of the plant so as to authenticate the claims by traditional healers in some parts of the world.
Results: *Hyptis suaveolens* has been shown to contain vital nutrients: proteins, carbohydrates, fats, fibre and the phytochemicals: alkaloids, tannins, saponins, flavonoids, and terpenoids which are responsible for its therapeutic use.
Conclusion: There is need to isolate and identify compounds from the plant which would serve as food supplements and also used to improve already existing drugs and formulate new ones.

Keywords: Hyptis suaveolens; phytochemicals; antimicrobial; antidiabetic; anti-inflammatory; insecticide.

**Corresponding author: Email: Umedum.ng@gmail.com;*

1. INTRODUCTION

Plants have always served as food and medicine to man since the beginning of life. Their nutritional and medicinal potentials have been attributed to the phytochemicals and other chemical constituents contained in them. Despite their importance, it has been reported that out of the 250,000 to 500,000 species of existing plants on earth, only about 300 species are utilized in the food, pharmaceutical, cosmetics and perfume industries [1]. Traditionally used medicinal plants produce a variety of compounds of known therapeutic properties. *Hyptis suaveolens* is one of the important traditional medicinal plant belonging to family lamiaceae [2].

Hyptis suaveolens (L.Poit) commonly called bush mint, bush tea, pignut, or *chan* is known as vilayati tulsi in hindi; konda thulasi in Telugu; bhustrena in Sanskrit; daddoya-ta-daji in Hausa; *efiri* in Yoruba; nchuanwu in Ibo; and tanmotswangi-eba in Nupe. *Hyptis suaveolens* is a very common plant found along roadsides and farmsteads in different parts of the world mainly in the tropics and subtropics. It is found in French Guiana, Brazil, Venezuela, Ecuador in Southern America; United States in North America; Bangladesh, China and India in Asia; Benin, Kenya, Nigeria, Sudan, and Cameroon in Africa. Originally native to tropical America, *Hyptis suaveolens* is considered a weed worldwide [3]. The stems of the plant are four-angled, velvety, having long hairs and gland dots. The leaves are opposite and ovate, about 2.5 to 10cm long. Leaves are often purple tinged particularly on the margin. The flowers are auxiliary with long stalk, hairy calyx and about 4mm long. They are often dark purple and glandular. The corolla is two-lipped, mauve with dark purple lines at the base of the broad two-lobed upper lip. The seeds are flat and mucilaginous [3,4]. Different parts of the plant have been used by traditional healers in the treatment of various ailments and disease conditions. In the northern part of Nigeria, a decoction of the leaves is used for treating boils, eczema and diabetes mellitus [4,5]. Crushed leaves are applied on the forehead to treat headaches. Infusion made from the leaves and the inflorescence is used as stimulant, carminative, diuretic and antipyretic [6]. A decoction of the whole plant is also used to alleviate diarrhoea and various kidney ailments.

Hyptis suaveolens has been reported to contain basic food nutrients: protein, carbohydrates, fats and fibre and phytonutrients such as alkaloids, tannins, saponins, flavonoids and terpenoids [7,8]. The plant is also rich in some mineral elements like potassium (K), calcium (Ca), magnesium (Mg), nitrogen (N), sodium (Na) and phosphorus (P).

Due to the presence of these chemical substances, the plant has been reported to possess antioxidant, anti-inflammatory, antimicrobial, anti-diarrhoeal, anthelmintic, anti-diabetic, anti-cancerous, wound-healing and insecticidal properties. So far, there has not been any review from literature on the efficacy of this plant in all dimensions. Its use as food and medicine motivated us to write a comprehensive review on the nutritional and medicinal attributes of this plant that most people may regard as weed.

2. APPLICATIONS

2.1 Nutrition

Studies on the proximate analysis of *Hyptis suaveolens* leaves conducted by many researchers revealed that the plant contains appreciable amount of the basic food nutrients: protein (10.00-14.22)% carbohydrate(66.61-75.05)%, fat(2.00-4.46)%, and fibre (5.15-

9.04)% [8,9,10] as presented in Tables 1 and 2. The high content of carbohydrate show that it is a good source of energy and can help in the oxidation of fats. A diet rich in fibre is desirable because fibre has a physiological effect on the gastrointestinal function. It also has a biochemical effect on the absorption and re-absorption of bile acids and consequently the absorption of dietary fats and cholesterol [8]. Thus it can serve as source of nutritional dietary supplements. Analysis of the protein composition of the seeds showed the presence of globulins (39%), glutelins (36%), albumins (24%) and prolamins (1%). The content of branched amino acids is higher in *Hyptis suaveolens* than in maize and other cereals [9]. Thus, it could provide a good supply of almost all the essential amino acids for different age groups. This medicinal plant therefore, has great potential for benefitting people in countries suffering from poverty and malnutrition. Though there has not been any report on the extensive use of this plant as food, it's use in Asian food recipes as an appetizer due to the presence of its essential oil has been reported [9,11]. It therefore serves as an edible aromatic flavouring for food.

Table 1. Proximate analysis of leaves of *Hyptis suaveolens* from different localities of Chidambaram(C), Nagapattinam(N) and Tanjore(T) [10]

Component Part analysis	%composition(C) Leaves	%composition(N) Leaves	%composition(T) Leaves
Protein	11.25	12.30	10.00
Lipids	4.20	3.00	2.00
Fibre	9.50	7.00	5.15
Carbohydrates	75.05	77.70	72.60
Moisture content	80.75	83.53	82.75
Ash	12.35	18.35	11.40

Table 2. Proximate analysis of leaves of *Hyptis suaveolens* from eastern Nigeria [8]

Analysis	% composition
Crude protein	14.22
Lipid	4.46
Crude fibre	9.04
Carbohydrate	66.61
Ash	5.68

Leaves and seeds of *Hyptis suaveolens* have been shown to contain mineral elements which are very important in human nutrition. These minerals which include calcium, potassium, magnesium, nitrogen, and sodium, are required for repair of worn out cells, strong bones and teeth in humans, building of red blood cells and for body mechanisms. The presence of these minerals shows that the plant can be used as supplement in diet for calcium and potassium [8]. Also, *Hyptis suaveolens* has been shown to contain other metals like zinc, copper and iron. Zinc plays a vital role in growth, aids the catalytic and regulatory action of more than 300 enzymes and helps to maintain a healthy immune system. Copper plays an important role in a wide range of physiological processes in the body which include iron utilization, elimination of free radicals, development of bone, and production of the skin and hair pigment called melanin [12]. Iron is used at the active site of many redox enzymes associated with cellular respiration, oxidation and reduction in plants and animals, and also plays a vital role in forming complexes with molecular oxygen in haemoglobin and myoglobin [13].

The seed oil of *Hyptis suaveolens* is liquid at room temperature and has moisture content and yield of 7.93% and 17.44% respectively. The low moisture content shows that the oil can be stored for a long time. The physicochemical properties of the seed oil shown in Table 3[13] showed acid value of 3.3mgKOH/g which falls within the acid value of 0.6 and 10mgKOH/g for virgin and non-virgin edible oil and fats [14] nearest to other conventional oils that are used for domestic and commercial purposes. The iodine value of 115.8 fell within the iodine value for non-drying liquid oils (80-120). This value is very close to that reported for mustard (108) and cotton seed oil (108) [13]. The saponification value and that of the unsaponifiable matter shows that it has less impurity.

Studies conducted on the fatty acid profile of the seeds, presented in Tables 4 and 5 revealed the presence of palmitic acid (8.09%), stearic acid (2.23%), oleic acid (13.59%), linoleic acid (76.08%), and absence of linolenic, palmitolic, and myristic acids [13]. The polyunsaturated fatty acids (PUFA) found in the oil could help reduce "bad" cholesterol, thereby reducing the risk of atherosclerosis and other heart diseases.

Table 3. Physicochemical properties of extracted oil of *Hyptis suaveolens* [13]

Parameters	***Hyptis suaveolens***
State(at room temperature)	Liquid
Colour	Pale yellow
Odour	Agreeable
Refractive index(at 40^0C)	1.4319
Specific gravity(at 25^0C)	0.8966
Acid value(mgKOH/g)	3.3
Iodine value	115.8
Unsaponifiable matter/w	0.68
Saponification value(mgKOH/g)	195.0

Table 4. Fatty acid profile of *Hyptis suaveolens* seeds [13]

Profile	**% composition**
Palmitic acid (C16:0)	8.09
Stearic acid (C18:0)	2.23
Oleic acid(C18:1)	13.59
Linoleic acid(C18:2)	76.08
Linolenic acid(C18:3)	-
Palmitolic acid(C16:1)	-
Myristic acid (C14:0)	-

Table 5. Total saturates and unsaturates profile of *Hyptis suaveolens* seeds [13]

Profile	**% composition**
Saturated fatty acids	10.32
Monounsaturated fatty acids	13.59
Polyunsaturated fatty acids	76.08
Total saturates	10.32
Total unsaturates	89.67

2.2 Phytochemistry

Extracts of various parts of *Hyptis suaveolens* have been obtained with solvents like petroleum ether, chloroform, methanol, ethanol, n-hexane, and water using soxhlet extraction, cold maceration, and steam distillation methods [1,2,8,10] and subjected to phytochemical screening using standard methods [15,16,17,18]. Results obtained from various studies revealed that the phytochemicals: alkaloids, flavonoids, terpenoids, tannins, were always present in the extracts of all parts of the plant, while saponins were present in some extracts and absent from others. The phytochemical tests of the leaves, stems, and root of *Hyptis suaveolens* carried out by some researchers revealed that saponins were present in the leaves (6.10±0.42%) and stems (10.50±0.79%) of the plant [2,19], but were absent in the root [2]. Leaves had alkaloids(2.80±0.28%), flavonoids(1.90±0.14%),and tannins(5.50±0.074%) while stems had alkaloids(1.60±0.00%), flavonoids(0.30±0.14%), and tannins(0.23±0.07%)[2]. The presence of these phytochemicals has been attributed to the bioactive principles responsible for ethno pharmacological activities of most medicinal plants [20,21].

Essential oils obtained by hydro distillation from *Hyptis suaveolens* have been investigated by GC-MS analysis as reported by [22,23]. The results show that sabinene, limonene, bicyclogermacrene, beta-phellandrene, 1, 8-cineole were the major constituents, others including eugenol, beta-caryophyllene, beta-pinene, terpinolene, and 4-terpinol, were also present as shown in Table 6, [11,23,24,25,26,27,28,29,30].

2.3 Disease Prevention and Treatment

2.3.1 Antioxidant activity

The antioxidant activity of the methanol extract of the leaves of *Hyptis suaveolens* has been evaluated in vitro by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity using gallic acid; a potent free radical scavenger and butylated hydroxyanisole (BHA); a known antioxidant, as reference standards [31]. The antioxidant activity was expressed as IC_{50} value, which is the concentration of sample required to inhibit 50% of the DPPH free radical. The IC_{50} value was calculated using log dose inhibition curve. Lower absorbance of the reaction mixture indicated higher free radical activity. The percent DPPH scavenging effect was calculated using the equation:

$$\text{DPPH scavenging effect (\%)} = 100 \times A_1/A_0$$

Where A_0 was the absorbance of the control reaction and A_1 was the absorbance in presence of the standard sample or the methanol extract of *Hyptis suaveolens* (HSME).

Result obtained from their research Table 7 showed that *Hyptis suaveolens* exhibited strong antioxidant radical scavenging activity with IC_{50} value of 14.04µgmL^{-1}. This value was comparable to those obtained for gallic acid and BHA (0.4 and 1.15µgmL^{-1}), thus proving that HSME is a potent DPPH free radical scavenger. The antioxidant activity of the methanol extract could be attributed to the presence of flavonoids which are known to be potent antioxidants.

Also, the antioxidant activity of *Hyptis suaveolens* oil has been determined by means of the DPPH radical scavenging test and ABTS (2, 2-azinobis-(3-ethylbenzothiazoline-6-sulphonic

acid) free radical decolourization assay [11]. The antioxidant activity of *Hyptis suaveolens* oil determined by the DPPH method expressed as IC_{50} was 3.75mgmL-1 whereas the TEAC value (Trolox equivalent antioxidant capacity as obtained by comparing the absorbance change at 750nm in a reaction mixture containing an oil sample with that containing Trolox) determined by the ABTS assay was 65.02mM/mg. The results indicated that *Hyptis suaveolens* oil possesses antioxidant activity.

Table 6. Composition of *Hyptis suaveolens* oil [6]

Compounds	Percentage	
	Fresh oil	Oil stored at 45^0C
Cyclohexane	0.47	0.32
α-pinene	2.04	1.32
Sabinene	25.40	9.97
2-β-pinene	6.72	4.80
1-Octen-3-ol	2.42	0.66
α-Terpinene	0.97	0.67
Para-Cymene	0.87	1.07
Limonene	5.89	5.04
1,8-Cineole	9.94	7.12
y-Terpinene	1.48	1.08
α-Terpinolene	13.48	8.64
Fenchol	0.78	ND
Terpinen-4-ol	3.86	3.62
β-Elemene	ND	0.60
β-Caryophyllene	11.69	24.03
α-Bergamotene	2.03	2.63
α-Humulene	0.73	1.53
β-Selinene	0.72	1.16
Bicyclogermacrene	4.20	6.02
Spatulenol	0.72	3.44
Caryophylene oxide	ND	2.99
y-Gurjunene	ND	0.62
Bergamotol	0.64	2.76
Naphthalene	4.21	5.30
Phenanthrene	0.72	1.89
Total	99.98	97.28

Table 7. DPPH free radical scavenging activity of methanol extracts of *Hyptis suaveolens* [31]

Extract/ Standard	IC_{50} value(μgmL^{-1}); Mean ± SEM
Gallic acid	0.40±2.68
BHA	1.15±3.56
HSME	14.04±2.08

2.3.2 Antimicrobial activity

Hyptis suaveolens has been reported to possess phytochemicals which were effective against certain fungi such as *Aspergillus niger*, *Candida albicans*, *Rhozophus stolonifera*, *Cryptococcus* and *Fursarium* species [1]. Research findings by [1] explained that the bioactive agents of the plant were more effective in inhibiting growth of isolates than griseofulvin, an antifungal drug. Antibacterial activity of this plant against certain bacterial strains such as *Klebsiella pneumoniae*, *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Enterobacter*, *Proteus mirabilis, Salmonella typhi* A has also been studied [2,32]. Results from these researches Table 8 indicated that whole plant extracts gave the highest antimicrobial activity in comparison with the stems and roots in chloroform and methanol extracts.

2.3.3 Antidiarrhoeal activity

Diarrhoea is one of the main causes of high mortality rate in developing countries where over five million children under the age of five die annually from severe diarrhoeal diseases. Three to five billion cases occur annually [33], and approximately five million deaths are accountable to diarrhoea [34].

It is most prevalent in crowdy living conditions coupled with poor hygiene; a major contributor to malnutrition and cause of rapid dehydration in infants and elderly people. It could therefore result in death if treatment is not given [35]. Studies on the antidiarrhoeal activity of ethanol extract of *Hyptis suaveolens* leaves against an experimental model of castor oil induced diarrhoea in mice has been reported [36] using method described by [37]. Oral administration of the extract (250 and 500) mg/Kg showed significant (P=.010) and dose dependent inhibitory activity against castor oil induced diarrhoea. There was significant delay of onset of diarrhoea on administration of the plant extract. The antidiarrhoeal activity of the plant extract at higher dose (500mg/Kg) was comparable to that of the antimotility drug, loperamide at a dose of 50mg/Kg. Further studies are necessary to isolate and characterize the active principles responsible for the antidiarrhoeal effect and to understand its mechanisms of action.

2.3.4 Anthelmintic activity

An in vitro anthelmintic activity of whole plant extracts of *Hyptis suaveolens* has been investigated [38]. In their research, ethanol and aqueous extracts of the plant were investigated for activity against the Indian adult earthworm; *Pheretima posthuma* and *Ascardia galli* using piperazine citrate as positive and distilled water as negative control. The assay was carried out using the method described by [38], [39]. Different concentrations (25, 50, and 100mg/ml) of each extract were studied in activity, based on time of paralysis and time of death of the worm as presented in Table 9. Time for paralysis was noted when no movement of any sort could be observed except when the worms were shaken vigorously and death was concluded when the worms lost their motility followed with the fading away of their body colours. Extracts of *Hyptis suaveolens* were found to exhibit significant anthelmintic activity at highest concentration of 100mg/ml.

2.3.5 Anthelmintic activity

An in vitro anthelmintic activity of whole plant extracts of *Hyptis suaveolens* has been investigated [38]. In their research, ethanol and aqueous extracts of the plant were

investigated for activity against the Indian adult earthworm; *Pheretima posthuma* and *Ascardia galli* using piperazine citrate as positive and distilled water as negative control. The assay was carried out using the method described by [38], [39]. Different concentrations (25, 50, and 100mg/ml) of each extract were studied in activity, based on time of paralysis and time of death of the worm as presented in Table 9. Time for paralysis was noted when no movement of any sort could be observed except when the worms were shaken vigorously and death was concluded when the worms lost their motility followed with the fading away of their body colours. Extracts of *Hyptis suaveolens* were found to exhibit significant anthelmintic activity at highest concentration of 100mg/ml.

2.3.6 Antidiabetic activity

Studies on the evaluation of antidiabetic activity of the aerial parts of Hyptis suaveolens have been reported [4,40]. Aqueous, methanol and ethanol extracts of the plant have been used to monitor the effect on alloxan-induced diabetic rats. The blood glucose concentration was assayed at time intervals, using chlorpropamide as standard as presented in Table 10. Results showed that there was significant (*P*=.05) reduction in the blood glucose concentration indicating that *Hyptis suaveolens* possesses antidiabetic activity[4], which might be related to the presence of tannins, terpenoids and flavonoids. Acute toxicity studies on the methanol extract of the plant also indicated that it can be considered as relatively safe [4], having obtained an LD_{50} of 2154.1mg/Kg body weight in rats.

2.3.7 Anti-inflammatory activity

The anti-inflammatory activity of two diterpenes, suaveolol and methyl suaveolate isolated from leaves of *Hyptis suaveolens* by column chromatography and repeated preparative thin layer chromatography has been reported [41]. The anti-inflammatory activity of the compounds was tested as inhibition of croton oil-induced dermatitis of mouse ear. Doses ranging from 0.1 to 1µmol/cm^3 were administered in comparison to those of the non-steroidal anti-inflammatory drug indomethacin. The anti-inflammatory activity was expressed as percentage of the oedema reduction in mice treated with the tested substances compared to control mice. ID_{50} (dose giving 50% oedema inhibition) values of the tested compounds were calculated as an index of their anti-inflammatory activity. Results presented in Table 11 showed that suaveolol (ID50=0.17µmol/cm^2) and methyl suaveolate (ID_{50}=0.60µmol/cm^2) were only two to three times less active than indomethacin (ID50=0.26µmol/cm^2). The anti-inflammatory properties of the diterpenes were considered to be contributors to the antiphlogistic activity of extracts of *Hyptis suaveolens*, thus confirming the use of *Hyptis suaveolens* extracts in dermatological diseases [41].

2.3.8 Wound healing activity

The wound healing activity of *Hyptis suaveolens* has been attributed to the presence of flavonoids and triterpenoids [42]. These compounds possess astringent and antimicrobial properties which may be responsible for wound contraction and increased rate of epithelialisation.

Table 8. Antimicrobial activity of chloroform and methanol extracts against selected pathogens [2]

Zone of Inhibition(mm)								
		Chloroform extracts			Methanol extracts			
Bacterial strains	**Con(µg)**	**Stem**	**Root**	**Whole plant**	**Stem**	**Root**	**Whole plant**	**Anti-biotic**
Bacillus subtilus	10	-	-	2.2±0.25	6.5±0.45	4.1±0.41	13.2±0.2	10
	50	3.2±0.11	7.3±0.57	8.5±0.3	15.5±0.45	12.9±0.60	22.8±0.75	
	100	9.6±0.15	8.0±0.20	17.2±0.25	24.1±0.95	18.4±0.89	27.2±0.87	
E. coli	10	-	4.0±0.26	-	7.6±0.55	11.0±0.35	17.2±0.25	16
	50	4.6±0.15	6.4±0.15	7.6±0.20	11.0±0.20	16.0±0.12	17.0±0.15	
	100	8.2±0.1	5.0±0.25	15.1±0.20	17.0±0.20	27.1±0.32	29.3±0.9	
Klebsiella pneumonia	10	-	-	-	10.0±0.15	6.3±0.30	12.2±0.25	17
	50	4.5±0.15	3.4±0.10	6.1±0.15	3.4±0.45	4.1±0.15	18.0±0.25	
	100	6.0±0.3	7.7±0.20	13.0±0.11	0.3±0.30	23.2±0.26	24.7±0.32	
Pseudomonas aeruginosa	10	-	-	-	3.1±0.15	2.1±0.23	4.8±0.20	10
	50	3.3±0.1	3.0±0.19	9.6±0.15	8.3±0.32	5.9±0.25	10.2±0.25	
	100	6.2±0.20	5.1±0.20	19.1±0.32	11.2±0.20	12.1±0.11	14.3±0.30	
Candida albicans	10	-	-	-	8.6±0.51	11.0±0.35	15.2±0.25	15
	50	3.6±0.11	4.4±0.15	6±0.20	10.0±0.22	15.0±0.10	17.0±0.10	
	100	7.0±0.1	5.0±0.25	10.1±0.2	15.0±0.20	17.1±0.32	20.3±0.9	
Rhizophus stoloniphera	10	-	-	2.2±0.25	6.5±0.45	4.1±0.41	13.2±0.2	10
	50	3.2±0.11	7.3±0.57	8.5±0.3	15.5±0.45	12.9±0.60	22.8±0.75	
	100	9.6±0.15	8.0±0.20	17.2±0.25	24.1±0.95	18.4±0.89	27.2±0.87	
Aspergillus niger	10	-	-	-	8.6±0.51	11.0±0.35	15.2±0.25	20
	50	3.6±0.11	4.4±0.15	6±0.20	10.0±0.22	15.0±0.10	17.0±0.10	
	100	7.0±0.1	5.0±0.25	10.1±0.2	15.0±0.20	17.1±0.32	20.3±0.9	

Table 9. Anthelmintic activity of extracts of *Hyptis suaveolens* [38]

Extracts	Concentration in mg/ml	*Pheretima* P	*Postuma* D	*Ascardia* P	*Galli* D
Aqueous	25	89.03±0.4	118.21±0.6	53.15±0.76	70.5±0.34
	50	72.00±0.3	101.98±0.1	46.02±0.21	60.2±0.11
	100	64.73±0.8	85.63±0.1	27.5±0.18	42.5±0.48
Alcoholic	25	65.00±0.14	72.00±0.44	64.04±0.9	79.5±0.23
	50	43.00±0.21	66.00±0.11	49.7±0.1	68.2±0.1
	100	23.00±0.9	33.00±0.45	34.2±0.6	45.75±0.2
Piperazine	25	1.5±0.7	54.5±0.4	41.23±0.14	3
citrate	50	0.9±0.12	30.2±0.1	29.75±0.5	54.5±0.4
	100	0.5±0.17	18.5±0.8	20.05±0.9	30.2±0.1
					23.5±0.58
Control	---	---	---	---	---

P=time taken for paralysis (min); D=time taken for death of worms (min).

Table 10. Effect of methanol extract of *Hyptis suaveolens* leaves on blood glucose level of alloxan-induced diabetic rats [4]

Group(n=6)	Mean blood glucose level mg/dL±SEM					
	0 Hour	1 Hour	2 Hour	4 Hour	6 Hour	24 Hour
I (750mg/Kg extract)	178.33± 9.13	176.67± 8.16	141.67± 13.29	120.00± 4.48*	138.33± 7.49*	171.67± 7.53
II(Chlorpropamide, 250mg/Kg)	165.00± 20.74	148.33± 21.37	136.67± 16.33	110.00± 2.58	93.33± 3.33*	131.67± 14.72
III(Normal saline)	148.33± 29.27	143.33± 28.05	146.67± 26.58	155.00± 8.85*	161.67± 7.92	166.67± 15.06

**P=.05 is significant; ± SEM: Standard Error of Mean; n=6(number of animals per group).*

Table 11. Anti-inflammatory activity of suaveolol and methyl suaveolate isolated from *Hyptis suaveolens* [41]

Substance	Dose µmol/cm^3	Oedema Mean±SE	Inhibition	ID_{50} µmol/cm^2
Control	-	7.0±0.3	-	-
Suaveolol	0.1	5.9±0.2*	16	0.71
	0.3	4.7±0.2*	33	
	1.0	3.0±0.2*	57	
Methyl suaveolate	0.1	5.8±0.2*	17	0.60
	0.3	4.5±0.2*	36	
	1.0	2.8±0.3*	60	
Indomethacin	0.1	5.8±0.3*	17	0.26
	0.3	4.5±0.4*	36	
	1.0	2.9±0.3*	59	

P=.05 at the analysis of variance as compared with controls.

2.3.9 Insecticidal activity

Botanical insecticides have long been touted as alternatives to synthetic chemical insecticides for pest management because they pose little threat to the environment and human health [43]. *Hyptis suaveolens* has been reported to be effective against infestation by the pink stalk borer, *Sesamia calamistis* on maize; it has been used for control of *Trogoderma granarium* (Coleoptera: Dermestidae) in stored groundnut [43,44]. Other reports have shown that methanolic extracts of the plant were effective in the biological control of *Sitophilus oryzae*(rice weevil), *Sitophilus zeamais*(maize weevil), and *Callosobruchus maculatus* which are serious stored product pests that attack various economically important crops. The essential oil has also been reported to be effective against the adult granary weevil *Sitophilus granaries* [30]. A protease inhibitor isolated from the seeds of *Hyptis suaveolens* has been reported to have a high activity against the intestinal trypsin-like proteases from different insect pests, particularly against the insect *Prostephanus truncatus*, a most important insect pest of maize. Research conducted on its use for protection against mosquito bites has shown that it is as effective as DEET (N, N-dimethyl-3-methyl benzamide), one of the well-known arthropod repellents [45,46]. The ability of *Hyptis suaveolens* to act as an effective insecticide or pesticide has been attributed to its essential oils. However, it is advised that in cases where it has been employed by method of mixed cropping, caution should be applied since *Hyptis suaveolens* is a fairly prolific plant and may compete with crops for space, water and nutrients.

3. CONCLUSION

Though numerous studies have been conducted on different parts of *Hyptis suaveolens*, there is still need to isolate and identify new compounds responsible for its pharmacological properties. Studies should also be extended to the edibility of the plant since research has shown that it is rich in vital nutrients that are needed for growth and proper functioning of the human body.

CONSENT

Not applicable.

ETHICAL APPROVAL

Not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mbatchou VC, Abdullatif S, Glover R. Phytochemical screening of solvent extracts from *Hyptis suaveolens* LAM for fungal growth inhibition. Pakistan Journal of Nutrition. 2010;9(4):358-61.
2. Prasanna SR, Koppula SB. Antimicrobial and preliminary phytochemical analysis of solvent extracts of *Hyptis suaveolens* from banks of River Krishna. International Journal of Bio-Pharma Research. 2012;1(1):11-5.

3. Chukwujekwu JC, Smith P, Combes PH, Mulholland DA, Vanstanden J. Antiplasmodial diterpenoids from the leaves of *Hyptis suaveolens*. Journal of Ethnopharmacology. 2005;102(2):295-97.
4. Danmalam UH, Abdullahi LM, Agunu A, Musa KY. Acute toxicity studies and hypoglycemic activity of the methanol extract of the leaves of *Hyptis suaveolens* Poit. (Lamiaceae). Nigerian Journal of Pharmaceutical Sciences. 2009;8(2):87-92.
5. Abdullahi M, Muhammed G, Abdulkadir NU. Medicinal and economic plants of Nupeland. Jube: Evans; 2003.
6. Arnason JT. Bioactive products from Mexican plants, phytochemistry of medicinal plants. Springer; 1995.
7. Raizada P. Ecological and vegetative characteristics of a potent invader, *Hyptis suaveolens* Poit from India. Journal of Ecology and Application. 2006;11(2):115-20.
8. Edeoga HO, Omosun G, Uche LC. Chemical composition of *Hyptis suaveolens* and *Ocimum gratissimum* hybrids from Nigeria. African Journal of Biotechnology. 2006;5(10):892-5.
9. Aguirre C, Torres I, Mendoza-Hernandez G, Garcia-Gasea T, Blanco-Labra A. Analysis of protein fractions and some minerals in chan (*Hyptis suaveolens L*.) Seeds. Journal of Food Science. 2012;77(1).
10. Sulta H, Ali J, Annamalai K. Comparative phytochemical and nutritional studies of leaves of three different localities of *Hyptis suaveolens L*). Poit, Lamiaceae members. International Journal of Current Molecular Research. 2013;1(1):16-7.
11. Witayapan N, Sombat C, Okonogi S. Antioxidant and antimicrobial activities of *Hyptis suaveolens* essential oil. Scientia Pharmaceutica. 2007;75:35-46.
12. Umedum NL, Udeozo IP, Muoneme O, Okoye N, Iloamaeke I. Proximate analysis and mineral content of three commonly used seasonings in Nigeria. IOSR Journal of Environmental Science, Toxicology and Food Technology. 2013;5(1):11-4.
13. Rai I, Bachheti RK, A Joshi, Pandey DP. Physicochemical properties and elemental analysis of some non cultivated seed oils collected from Garhwal region, Uttarkland (India). International Journal of Chem Tech Research. 2013;5(1):232-6.
14. Dawodu FA. Physicochemical studies on oil extraction processes from some Nigerian grown plant seeds. Electronic Journal of Environmental Agriculture and Food Chemistry. 2009;8(2):102-110.
15. Harbourne JB. Phytochemical methods: A guide to modern technique of plant analysis. New York: Chapman and Hall; 1973.
16. Hang W, Lantzh. Comparative methods for the rapid determination of phtatesien cercal products. J. Sci. Food and Agric.1983;34:1423-6.
17. Harbourne JB. Phytochemical methods: A guide to modern technique of plant analysis. New York: Chapman and Hall; 1984.
18. A.O.A.C. Official methods of analysis. Association of Official Analytical Chemists. 1990;1213.
19. Ijeh II, Edeoga HO, Jimoh MA, Ejeke C. Preliminary phytochemical, nutritional and toxicological studies of leaves and stems of *Hyptis suaveolens*. Research Journal of Pharmacology. 2007;1:34-6.
20. Edeoga HO, Okwu DE, Mbaebie BO. Phytochemical constituents of some Nigerian medicinal plants. African Journal of Biotechnology. 2005;4(7):685-8.
21. Omoyeni OA, Aterigbade E, Akinyeye RO, Olowu RA. Phytochemical screening, nutritional/ antinutritional and amino acid compositions of Nigeria *Melanthera scandens*. Scientific Reviews and Chemical Communications. 2012;2(1):20-30
22. Asekun OT, Ekundayo O. Essential oil constituents of *Hyptis suaveolens* L.) Poit (Bush Tea) leaves from Nigeria. Journal of Essential Oil Research. 2000;12:227-230.

23. Azevedo NR, Campos IF, Ferreira HD, Portes TA, Santos SC, Seraphin JC et al. Chemical variability in the essential oil of *Hyptis suaveolens*. Phytochemistry. 2001;57:733-6.
24. Sidibe L, Chalchat JC, Garri RP, Harama M. Aromatic plants of Mali (III): Chemical composition of essential oils of two *Hyptis* species: *H. suaveolens* L.) Poit. And H. *spicigera* Lam. Journal of Essential Oil Research. 2001;13:55-7.
25. Kossouoh C, Mondachirou M, Adjakidje V, Chalchat JC, Figueredo G. A comparative study of the chemical composition of the leaves and fruits deriving the essential oil of *Hyptis suaveolens* L.) Poit from Benin. Journal of Essential Oil Research. 2010;22:507-9.
26. Kodakandla V, Guvvala V, Sabbu S, Bhukya B. Variations in volatile oil compositions of different wild collections of *Hyptis suaveolens*(L.) Poit from Western Ghats of India. Journal of Pharmacognosy. 2012;3(2):131-5.
27. Uzama D, Ikoko PP, Fagbohun A, Rabiu LD. GC-MS analysis of *Hyptis suaveolens* essential oil. International Journal of Natural Product Science. 2013;3(3):21-4.
28. Fun CE, Svendsen AB. The essential oil of *Hyptis suaveolens* grown in Aruba. Flavour and Fragrance Journal.1990;5(3):161-3.
29. McNeil M, Facey P, Porter R. Essential oil from the *Hyptis* genus-A review. Nat Prod Commun. 2011;6:1775-96.
30. Benelli G, Flamini G, Canale A, Molfetta I, Cioni PL, Conti B. Repellence of *Hyptis suaveolens* whole essential oil and major constituents against adult granary weevil *Sitophilus granarius*. Bulletin of Insectology. 2012;65(2):177-183.
31. Gavani U, Paarakh PM. Antioxidant activity of *Hyptis suaveolens* Poit. International Journal of Pharmacology. 2008;4(3):227-9.
32. Samrot AV, Mattew AA, Largus S, HN, KA. Evaluation of bioactivity of various Indian medicinal plants-An in vitro study. Internet Journal of Internal Medicine. 2010;8(2): DOI: 10.5580/de.
33. World Health Organization (WHO). Resistance to antimicrobial agents. Bull. Scientific working group, World Health Organization.1996;71:335-6.
34. Heinrich M, Heneka B, Ankli A, Rimpler H, Sticher O, Kostiza T. Spasmolytic and antidiarrhoeal properties of the Yucatec Mayan medicinal plant *Casimoroa tetramesia*. J. Pharm. Pharmacol. 2005;57:1081-5.
35. World Health Organization (WHO). Manual for treatment of diarrhoeal diseases WHO/CDR: Geneva. 1995;3.
36. Zeshan, Shaikat H, Hossain T, Azam G. Phytochemical screening and antidiarrhoeal activity of *Hyptis suaveolens*. Internet Journal of Applied Research in Natural Products. 2012;5(2):1-4.
37. Shoba FG, Thomas M. Study of antidiarrhoel activity of four medicinal plants in castor-oil induced diarrhoea. J. Ethnopharmacol. 2001;76:73-6.
38. Nayak, Nayak PS, Kar DM, Das P. In vitro anthelmintic activity of whole plant extracts of *Hyptis suaveolens* Poit (short communication). International Journal of Current Pharmaceutical Research. 2010;2(2):50-1.
39. Ajaiyeoba EO, Onocha PA, Olarenwaju OT. In vitro anthelmintic properties of *Buchholzia coriaceae* and *Gynandropsis gynandra* extract. Pharm. Biol. 2001;39:217-220.
40. Nayak PS, Kar DM, Nayak S. Evaluation of antidiabetic and antioxidant activity of aerial parts of *Hyptis suaveolens* Poit. African Journal of Pharmacy and Pharmacology. 2013;7(1):1-7.
41. Grassi P, Urias Reyes TS, Sosa S, Tubaro A, Hofer O, Zitterl-Eglseer K. Anti-inflammatory activity of two diterpenes of *Hyptis suaveolens* from El Salvador. Z. Naturforsch. 2006;61:165-170.

42. Shenoy C, Patil MB, Kumar R. Wound healing activity of *Hyptis suaveolens* L.) Poit. International Journal of PharmTech Research. 2009;1(3):737-744.
43. Adda C, Atachi P, Hell K, Tamo M. Potential use of the bush mint *Hyptis suaveolens* for the control of infestation by the pink stalk borer, *Sesamia calamistis* on maize in southern Benin, West Africa. Journal of Insect Science. 2011;11(33).
44. Musa AK, Dike MC, Onu I. 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 Journal of Agronomy. 2009;2(3):176-9.
45. Aguirre C, Castro-Guillen JL, Contreras L, Mendiola-Olaya E, Gonzalez de la Vera L. Partial characterization of chrymotrypsin-like protease in the larger grain borer(*Prostephanus truncates* (Horn)) in relation to activity of *Hyptis suaveolens* L.) trypsin inhibitor. Journal of Stored Products Research. 2009;45:133-8.
46. Abgali AZ, Alavo TB. Essential oil from bush mint, *Hyptis suaveolens*, is as effective as DEET for personal protection against mosquito bites. The Open Entomology Journal. 2011;5:45-8.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=433&id=13&aid=3771