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Laboratory Evaluation of Pesticidal Activities of *Hyptis suaveolens* in Pest Management

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ABSTRACT

The efficacy of use of *Hyptis suaveolens* (L.) Poit in the control of three storage pests was evaluated in a laboratory experiment. The experiment was aimed at determining the potency of *Hyptis suaveolens* as a promising botanical in the control of stored product pests. Thus, fresh, mature and healthy fumigant leaves of *Hyptis suaveolens* were collected in Akungba-Akoko, Ondo State, Nigeria, chopped into very small sizes and weighed to be 100 g. These leaves were soaked consecutively in 1000 mL each of n-hexane, di-ethyl ether and methanol where the essential oil of the plant was then extracted sequentially through solvent extraction methods. Each level of solvent extraction was maintained for 3 days after which the filtrate was exposed to natural air for 24 h. The methanolic extract was further prepared to obtain concentrations of 100, 75, 50, 25, 10, 5, 4, 3, 2 and 1% which were tested for pesticidal activity against cultures of selected stored product pest species in the laboratory under ambient temperature. The laboratory experiment revealed the high insecticidal capability of *H. suaveolens* in the control of the insect pests through contact treatment and 100% mortality of *Sitophilus oryzae*, *Sitophilus zeamais* and *Callosobruchus maculatus* in >15 sec of methanolic extract treatment application.

Key words: Insecticide, bio-pesticide, pest management, Akungba-Akoko, *Hyptis suaveolens*

INTRODUCTION

The use of synthetic insecticides in the control of insect pests has been in use for a very long time. In recent times, the uses of insecticidal plants in the control of insect pest have been adopted. The adoptive use of several plant parts in pest control has also been documented but the use of synthetic insecticides has been mostly exploited in the past decades. Researches now show that field crops or stored commodities treated with synthetic insecticides can be poisonous and hazardous to life because of their toxicity. According to Keita *et al.* (2000), synthetic insecticides are expensive for farmers and they may pose potential risk holding to the lack of adequate technical knowledge relating to their safe use. Overuse and misuse of these insecticides may also cause danger not only to humans that feed on them but to animals.

To avert the attendant problems associated with the use synthetic insects and for convenience, naturally biodegradable plants were considered and adopted. Raja *et al.* (2001) also reported a preference of use of more natural sustainable methods of protecting crops from insects and pest damage. *Hyptis suaveolens* is an ethno-botanically important medicinal plant and distributed throughout the tropic and subtropics. Although, this plant is considered as an obnoxious weed but it has equally been reported that all its parts could be employed in traditional medicine to treat various diseases. The leaves of *H. suaveolens* have been observed to be locally adopted as an effective fumigant treatment against mosquitoes. Thus, this study was aimed at evaluating the efficacy of methanolic extracts of *Hyptis suaveolens* in the biological control of *Sitophilus oryzae*, *S. zeamais* and *Callosobruchus maculatus* which are considered to be serious stored product pests which attack several economically important crops.

MATERIALS AND METHODS

This experiment was carried out in the laboratory of the Department of Plant Science and Biotechnology, Adekunle Ajasin University, Akungba-Akoko (latitude 7°28'N, longitude 5°44'E). Consecutive field studies were conducted on the natural habitation where *Hyptis suaveolens* was predominant for two years. This was aimed at observing the growth and morphological patterns of the plant species and also to determine probable insect infestation during the growth period. Adult *Sitophilus oryzae*, *S. zeamais* and *Callosobruchus maculatus* were collected from damaged rice, maize and cowpea, respectively which were cultured and maintained in the laboratory using fresh similar food crops in the laboratory. Matured fresh leaves of *Hyptis suaveolens* were collected from its natural habitat in Akungba Akoko, Ondo state, Nigeria. The plant species was identified at the International Institute of Tropical Agriculture, IITA, Ibadan, Oyo State, Nigeria while the proximate analysis on the plant species was conducted at the Crop, Soil and Pest Management Departmental Laboratory, The Federal University of Technology, Akure, Ondo State, Nigeria. The rice and maize weevils and cowpea beetles were cultured in No. 1 Kilner jars with meshed lids at room temperature in the laboratory throughout the period of the study. Standard procedure for culturing seed beetles (Ofuya and Credland, 1995) was followed. Susceptible local varieties of rice, maize and cowpea were. Any batch of the crop varieties to be used was first disinfested by deep-freezing for two weeks and acclimatized to the open laboratory conditions for 24 h.

Extraction processes

Extraction using n-hexane: Fresh leaves of *H. suaveolens* were chopped into smaller sizes using a sharp knife out of which 100 g was placed in a beaker and 1000 mL of n-Hexane was added. The content of the beaker was stirred thoroughly using a spatula and was covered with foil paper. The set up was left to extract for 3 days. After 3 days, the content of the beaker was filtered using a filter paper and a funnel. The plant residue was spread on a paper and allowed to dry. The filtrate was exposed to natural air for 24 h and the extract was placed and covered in a McCartney bottle.

Extraction using diethyl ether: The plant residue from the first extraction process was weighed and the weight was recorded to be 93.5 g which was placed in a beaker in which 1000 mL of Di-ethyl ether was added. The content of the beaker was stirred thoroughly using a spatula and was covered with paper foil. The set up was allowed to extract for 3 days which was later filtered using paper and a funnel. The plant residue was also spread on a paper and allowed to dry. The filtrate was exposed to natural air for 24 h. After 24 h, the extract was placed in a McCartney bottle and covered.

Extraction using methanol: The plant residue from the sec extraction process was weighed and recorded to be 87.0 g which was placed in a beaker and 1000 mL of methanol added. The content of the beaker was thoroughly shaken and was covered with paper foil. The set up was also allowed to extract for 3 days which was later filtered using a filter paper and a funnel. The filtrate was exposed to natural air for 24 h in order to allow the evaporation of the solvent used. The residue was weighed and the weight was recorded to be 80.5 g.

Application of spray treatment: Prepared methanolic extracts at 100, 75, 25, 10, 5, 4, 3, 2 and 1% levels of concentrations were placed in spraying bottles' these were applied as spray treatments on the different cultures of insect pests. There was a control experiment with no treatment application.

Data collection and analysis: Data collection was on percentage mortality count. All data were subjected to Analysis of Variance (ANOVA) and means compared for significance differences using Least Significance Difference (LSD) values at the 5% level of probability of Tukey's Honestly significance test. Counts were normalized by square root and arcsin transformations $(x+0.5)^{1/2}$.

RESULTS

From the field survey conducted on *Hyptis suaveolens* for two years, it was observed that the plant species dominates its habitat as an obnoxious weed, distributed throughout the ecosystem. Neither was insect infestation nor morphological distortion observed on the weed throughout the field study.

Proximate analysis: Table 1 shows the values of the proximate analysis. The proximate analysis revealed that the highest percentage was observed in Carbohydrate with 57.58% while the minimum was phenols (0.04%). *H. suaveolens* also contains major mineral elements such as potassium, K (1.40%), Nitrogen, N (1.96%), Calcium (Ca) (0.94%), Magnesium Mg (0.43%), Sodium, Na (0.34%) and Phosphorus, P (0.65%). It also contains flavonoids (7.54%), crude alkaloids (8.21%), crude fibre (5.24%), crude protein {8.09%), ash (3.68%) and crude lipid (3.45%).

Percentage mortality counts were taken between 5 and 15 sec survival levels. It was observed that there was no significant difference ($p>0.05$) at 15 sec as complete insect mortality had taken

Table 1: Proximate analysis of *Hyptis suaveolens*

Mineral content	%
Tannins	0.45
Phenols	0.04
Flavonoids	7.54
Crude alkaloid	8.21
Crude fibre	5.24
Crude protein	8.09
Carbohydrate	57.58
Ash	3.68
Crude lipid	3.45
Potassium	1.40
Nitrogen	1.96
Calcium	0.94
Magnesium	0.43
Sodium	0.34
Phosphorus	0.65

Table 2: Cumulative mortality rate of insect pests at different levels of extract concentration

	S. oryzae		*S. zeamais*		*C. maculatus*	
Concentration (%)	<5 sec	>15 sec	<5 sec	>15 sec	<5 sec	>15 sec
100	90.00±.0.20[a]	100.0±0.0[a]	64.5±2.30[a]	100.0±0.0[a]	86.5±0.3[a]	100.0±0.0[a]
75	70.00±0.30[b]	100.0±0.0[a]	50.2±0.30[b]	100.0±0.0[a]	66.6±0.3[b]	100.0±0.0[a]
50	60.00+0.00[c]	100.0±0.0[a]	47.2±0.40[c]	100.0±0.0[a]	59.3±0.0[c]	100.0±0.0[a]
25	48.70±0.10[d]	100.0±0.0[a]	33.3±0.30[d]	100.0±0.0[a]	46.2±0.5[d]	100.0±0.0[a]
10	30.05±0.20[e]	100.0±0.0[a]	24.5±0.20[e]	100.0±0.0[a]	28.3±0.3[e]	100.0±0.0[a]
5	20.00±0.10[f]	100.0±0.0[a]	22.3±0.30[f]	100.0±0.0[a]	18.6±0.1[f]	100.0±0.0[a]
4	10.05±0.30[g]	100.0±0.0[a]	12.5±0.10[g]	100.0±0.0[a]	8.30±0.1[g]	100.0±0.0[a]
3	3.30±0.30[h]	100.0±0.0[a]	8.3±0.30[h]	100.0±0.0[a]	4.20±0.3[h]	100.0±0.0[a]
2	0.00±0.00[i]	100.0±.00[a]	3.6±0.10[i]	100.0±0.0[a]	0.00±0.0[i]	100.0±0.0[a]
1	0.00±0.00[i]	100.0±0.0[a]	0.0±0.00[j]	100.0±0.0[a]	0.00±0.0[i]	100.0±0.0[a]
Control	0.00±0.00[i]	100.0±0.0[a]	0.0±0.00[j]	100.0±0.0[a]	0.00±0.0[i]	100.0±0.0[a]

Values with different alphabets along columns are significantly different using Tukey's Honestly significant test at $p<0.05$

place before this level of insect treatment as shown in Table 2. The cumulative mortality count at the different treatment levels for the food crops is represented on Table 2.

Table 2 shows that *S. oryzae* had 90% mortality rate at 100% extract concentration, which is the most effective and which is significantly different ($p<0.05$) compared to other treatment levels. Although, there is no significant difference ($p>0.05$) between the control and 1 to 2% concentration levels in all the insect pests at <5 sec treatment application. It could also be observed that in all the treatment applications, 50-100% extract concentration was the effective treatment level for all the insect pests at <5 sec with insect mortality range of 60-90, 47-64.5 and 59.3-86.5% in *S. oryzae*, *S. zeamais* and *C. maculatus*, respectively. Consequently, most insect mortality at the lower extract concentrations occurred >5 and >15 sec where 100% insect mortality had taken place.

DISCUSSION

The result obtained in this study indicated that the mortality rate was significantly different ($p<0.05$) at each treatment application level for the insect pests.

It was also observed that *H. suaveolens* has the ability of repelling insect pests and it is highly effective in the methanolic extract at 100% concentrations beyond 5 sec. Consequently, there are significant differences ($p<0.05$) at each treatment level of *S. oryzae, S. zeamais* and *C. maculatus*. The adoptive use of *H. suaveolens* is gaining more attention as it has been reported effective both in the fumigant and contact treatments. The efficacy of *H. suaveolens* in this finding also corroborates the view of Raja *et al.* (2001) that pulse, when stored in gunny bags and treated with aqueous extract from leaves of *Melia azadirachta, Hyptis suaveolens* and tuber of *Cyperus rotundus*, they effectively protected stored pulses without any infestation for up to six months. Recently, the use of *H. suaveolens* is gaining more attention. Mahesh (2001) reported that it can also be used as antiseptic in burns, wounds and various skin complaints. The fumes of the fresh leaves are also used to repel mosquitoes and control insect pest of stored grains. Although, the plant has been considered as an obnoxious weed, distributed throughout the tropic and subtropics, it has also been reported that all parts of this plant are being used in traditional medicine to treat various diseases. Its leaves have been reported to serve as a stimulant and prevent the formation of gas in the alimentary tract. It is also synthetic and could induce sleep. *H. suaveolens* is devoid of saponins. Tannins (0.520%) and phenols (0.050%) are present. The proximate analysis corroborates other publications that reported *H. suaveolens* to contain flavonoids (12.54%) crude alkaloids (14.32%), crude fibre (9.04%), crude protein (14.22%), ash (5.68%), carbohydrate (66.61%), crude lipid (4.46%) and food energy (363.43 mg cal^{-1}).

The adoptive use of *H. suaveolens* in pest management is coherent with the recent researches that are turning more towards selective bio-rational pesticides, generally perceived to be safer, cheaper and more easily produced than the synthetic insecticides. The findings in this research corroborate other earlier reports on the use of bio-pesticides in the control of field and storage pests of food crops. Corresponding to the mode of application of *H. suaveolens* as fumigant and surface protectant, other plant extracts have also been reported to possess similar protective capabilities. Yalamanchilli and Punukollu (2000) observed that the volatile oil from leaves of *Curcuma domestica* (Indian-Saffron, Red ginger) could effectively protect the seeds against *C. chinensis*, at low concentration. Raja *et al.* (2000) also reported that when jute bags treated with different plant leaves extract including *A. indica* (commonly known as neem and locally referred to as "Dongoyaro") *V. negundo*, *C. collinus* and *J. curcas* (lapalapa) and then used for cowpea seeds storage, the egg laying rates by the *C. maculatus* adults emergence and seed damage were reduced.

Kim *et al.* (2003) showed that potent insecticidal activity of extract from *Cinnamomum cassia* bark and oil, horse radish (*Cocholeria aroracia*) oil and mustard (*Brassica juneca*) oil against *C. chinensis*, within one day after *encalyptus* seed powder treatment cause the death of emerging adult of *C. chinensis*. Consequently, Keita *et al.* (2001) reported that seeds treated with botanical extract oil did not lose their viability and they also established that powder made from essential oil of different basils provided complete protection against *C. maculatus* and did not show significant effect on the seed germination rate while Tapondjou *et al.* (2002) showed that the dry ground leaves of *Chenopodium ambrosiodes* inhibited F1 progeny production and adult emergence of the *C. chinensis* and *C. maculatus*.

Subsequently, the use of *H. suaveolens* forms another basis for a dependable, cheap and readily available means of pest management.

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