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— SHORT COMMUNICATION —

Leaf essential oil composition and tick repellency activity of *Commiphora swynnertonii* Burtt

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The essential oil of the leaves of *Commiphora swynnertonii* Burtt was found to repel adults of *Rhipicephalus appendiculatus* Newmann at doses of 0.1 and 10% (v/v) in tick climbing repellency bioassays. Ten sesquiterpenoids were identified in the oil by gas chromatography-mass spectrometry (GC-MS). Two of these compounds, α-copaene and isocaryophyllene, exhibited repellency against adults at different doses. A 0.1% (v/v) solution of α-copaene caused 83% repellency and a 1% solution of this compound was found to be as effective as the commercial arthropod repellent N,N-diethyl-toluamide (DEET). Isocaryophyllene was moderately active, exhibiting 55% repellency in a 10% (v/v) solution. These results suggest that the oil may have a potential in tick control and in integrated tick management.

Key words: *Commiphora swynnertonii*, Burseraceae, *Rhipicephalus appendiculatus*, repellents.

INTRODUCTION

The livestock Brown Ear Tick, *Rhipicephalus appendiculatus* Newmann is a pest of major economic importance in Eastern, Central and Southern Africa (Hoogstraal, 1956). It is a vector of the haemoprotozoan *Theileria parva* which causes East Coast Fever (ECF).

Currently, ticks are controlled by synthetic acaricides which pose various problems, such as environmental pollution, contamination of meat and development of resistant tick strains (Dipeolu & Ndungu, 1991; Kaaya *et al*., 1996).

The use of anti-tick plants which repel, immobilize or kill ticks has been previously investigated (Sutherst *et al*., 1982). Studies carried out on tick repellent and acaricidal properties of *Gynandropsis gynandra* Briq. were encouraging (Dipeolu *et al*., 1992; Malonza *et al*., 1992). This paper presents results of gas chromatography - mass spectrometry (GC-MS) on the hydrodistilled oil of *Commiphora swynnertonii* Burtt and repellency activity findings based on the climbing method as previously described by Ndungu *et al*. (1995).

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MATERIALS AND METHODS

Plant material

The leaves of *C. swynnertonii* Burtt were collected from central Tanzania. The identity of this plant was confirmed by the late Mr S. Kibuwa and a voucher specimen No 2888 is deposited at the Tanzania National Herbarium, Arusha.

Plant extraction

Fresh leaves (0.6 kg) of *C. swynnertonii* Burtt were hydrodistilled using a Clevenger apparatus to yield about 2.1 g (0.35%) of oil.

Ticks

Ticks were reared at the Tropical Pesticides Research Institute (TPRI), Arusha, Tanzania. They were maintained by feeding them on the ears of rabbits according to the method described by Bailey (1960).

Synthetic chemicals

Compound α-copaene was obtained from Chemical-Biochemical, Fluka Chemicals, Switzerland, and isocaryophyllene from Merck, Germany.

Analysis of oil

GC-MS of the oil was carried out using a low resolution mass spectrometer VG Quattro (Fissons, Manchester, UK) coupled to a gas chromatograph 5890 series 11 (Hewlett Packard, Böblingen, Germany), equipped with a methyl silicone column DB-5 MS (J & W Scientific Inc.) (30 m, ID = 0.25, FD = 0.25 um).

Tick climbing repellency bioassays

A climbing bioassay as previously described by Ndungu *et al*. (1995) was used to test for adult *R. appendiculatus* Newmann repellency of the essential oil and the synthetic compounds. This method (climbing bioassay) exploited the behavior of *R. appendiculatus* Newmann ticks to climb up grass stems and settle at the tip so as to wait for a passing host.

The climbing system (Fig. 1) consisted of two 26 cm long metal rods covered with glass tubes, 7 cm apart, attached to a metal base placed in a tray of water. A 1 cm wide filter paper ring placed 10 cm up each rod served as a carrier for the test material and the control. Stock solutions were prepared by dissolving 100 μl of each test material in 100 μl of dichloromethane. Serial dilutions were carried out so as to prepare 0.001% (v/v) to 10% solutions.

Tests were performed on isocaryophyllene, α-copaene and N,N-diethyl-toluamide. The latter was prepared following procedures described previously (Hassanali *et al*., 1990). About 80 adult ticks were released on the top of the aluminum base of the climbing assembly. Each assay lasted for 1 hr. Five replicates were carried out for each dose. Percentage repellency was calculated using the formula:

$$PR = [(Nc\text{-}Nt)/(Nc+Nt)] \times 100$$

where, Nc and Nt represent the number of ticks above the filter paper strip on the control and treated glass tubes, respectively.

RESULTS

The composition of the essential oil from the leaves of *C. swynnertonii* Burtt is shown in Table 1. Five sesquiterpenoids and four sesquiterpenoid derivatives were identified. The presence of α-copaene and isocaryophyllene was confirmed by GC-co-injection with the authentic samples. The structures of the other

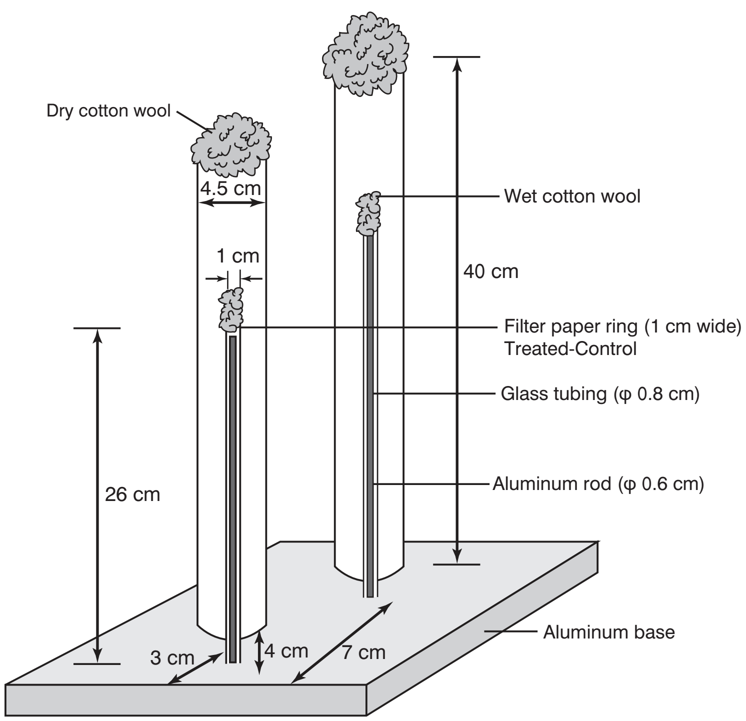

FIG. 1. Climbing bioassay assembly.

TABLE 1. Composition of the essential oil from the leaves of *C. swynnertonii*

Peak	Component	Method of analysis	RT	% composition
1	α-copaene	GC-MS, RT	10.69	2.91
2	1-ethyl-1-methyldiisopropyl-2,4-cyclohexane	HRMS	10.83	0.97
3	isocaryophyllene	GC-MS, RT	11.30	1.51
4	1,1,4,8-tetramethyl-4,7,10-cycloundecatriene	HRMS,PBM	11.80	3.62
5	4-methyl-1,5-dimethyl-4-hexenylbenzene	HRMS,PBM	12.02	0.27
6	furan-3-(4,8-dimethyl-3,7-nonadienyl)	HRMS,PBM	13.17	3.36
7	unidentified	HRMS,PBM	13.58	1.33
8	unidentified	HRMS,PBM	13.60	1.78
9	unidentified	HRMS,PBM	13.80	1.33
10	unidentified	HRMS,PBM	14.37	9.62
11	unidentified	HRMS,PBM	14.52	6.37
12	9-(3-furanyl)-2,6-dimethyl-2,5-nonadien-4-one	HRMS,PBM	15.20	13.84
13	enolate ion isomer of 9-(3-furanyl)-2,6-dimethyl-3,5-nonadien-4-ol	HRMS,PBM	15.50	52.23
14	enolate ion isomer of 9-(3-furanyl)-2,6-dimethyl-2,4-nonadien-4-ol	HRMS,PBM	16.22	0.85

HRMS: high resolution mass spectrometry; PBM: probability based matching system; RT: retention time

TABLE 2. Mean percentage repellencies (± S.E.) of the oil obtained from the leaves of *C. swynnertonii*, two of its identified components and DEET to *R. appendiculatus*

Dose % (v/v)	Test material			
	Oil	Isocaryophyllene	α-copaene	DEET
10	87.3 ± 2.7 [b]	55.7 ± 0.7 [c]	100.0 ± 0.0 [a]	100.0 ± 0.0 [a]
1	71.0 ± 3.5 [b]	43.8 ± 1.8 [c]	100.0 ± 0.0 [a]	100.0 ± 0.0 [a]
0.1	48.3 ± 8.0 [c]	33.2 ± 0.8 [a]	83.8 ± 3.1 [b]	100.0 ± 0.0 [a]
0.01	NT	NT	66.8 ± 1.1 [c]	94.9 ± 0.9 [a]
0.001	NT	NT	50.8 ± 1.8 [c]	86.0 ± 1.0 [b]

Mean values with the same letters within the same dose are not significantly different at the 5% level; NT = not tested

components were deduced from two techniques, namely the probability based matching system and the examination of the MS data.

Table 2 summarizes repellency activities of the oil obtained by hydrodistillation of the leaves of *C. swynnertonii* Burtt, and two identified components of the oil, α-copaene and isocaryophyllene. α-copaene and isocaryophyllene exhibited repellency activity against *R. appendiculatus* Newmann at concentrations of 0.001 and 10% (v/v), respectively.

The repellency activity of α-copaene at 1% (v/v) solution was comparable to the commercial insect repellent DEET.

DISCUSSION

The hydrodistilled oil of the leaves of *C. swynnertonii* Burtt was found to repel the adults of *R. appendiculatus* Newmann and is therefore a promising anti-tick natural product. In the climbing bioassay, the repellency activity exhibited by α-copaene at 1% (v/v) was 100% which compared well with the activity induced by the commercial repellent DEET. Isocaryophyllene had the lowest activity (43.8%) at 1% (v/v).

The repellency activity of the oil of *C. swynnertonii* Burtt is caused by the additive effect of most of the compositionally significant components at different levels of repellency. The general pattern of repellency of the tested components suggests that the structural requirement for repellent activity is different in *R. appendiculatus* Newmann.

The possibility of using the oil in the field is currently being explored. Studies carried out by Maradufu (1982) on the hexane extract of the gum of *C. myrrh* (Neels) Engler showed repellency activity on the adults of *R. appendiculatus* Newmann and the house flies *Musca domestica*.

The hexane extract of the gum of *C. erythraea* Engler has also been reported to possess larvicidal and repellent activities against larvae of *Amblyomma americanum* Linnaeus, *Dermacentor variabilis* Say and repellency against adults of *Ixodes dammini*, *D. variabilis* Say and *A. americanum* Linnaeus (Carroll *et al.*, 1989).

Three different types of plant defenses have been suggested as possibly being relevant to tick control. The first of these is the hooked trichome that was found on the silver leaf of *Desmodium uncinatum* (Jacq.) DC. and the green leaf of *D. intortum* Miller. Although the main function of the hooked trichomes seems to be to attach the creepers to the substrate plants, they retard the ascent of tick larvae and sometimes trap insects. The second type of defense is the glandular trichome such as that found in some *Stylosanthes* and *Aeschynomene* cultivars which secrete viscous fluids in which tick larvae become trapped and immobilized. The third type is the plant chemicals that are toxic or repellent to ticks such as those found in *Stylosanthes* and *C. swynnertonii* Burtt.

In the case of *Stylosanthes*, chemical analyses of the secretions from *S. viscose* (L.) Sw. and *S. scabra* Vogel and bioassays strongly suggested that α- and β-pinene were the major toxic constituents (Sutherst & Wilson, 1986).

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