Veterinary Parasitology 169 (2010) 222–225

Contents lists available at ScienceDirect

Veterinary Parasitology

journal homepage: www.elsevier.com/locate/vetpar

Short communication

Effect of plant essential oils as acaricides against the poultry red mite, *Dermanyssus gallinae*, with special focus on exposure time

D.R. George [a,*], G. Olatunji [b], J.H. Guy [a], O.A.E. Sparagano [a]

[a] School of Agriculture, Food and Rural Development, Newcastle University, Newcastle upon Tyne, NE1 7RU, England, UK
[b] School of Medical Sciences, Newcastle University, Newcastle upon Tyne, NE1 7RU, England, UK

ARTICLE INFO

Article history:
Received 27 October 2009
Received in revised form 15 December 2009
Accepted 21 December 2009

Keywords:
Dermanyssus gallinae
Essential oil
Toxicity
Knock-down

ABSTRACT

Essential oils from thyme and cade have been shown to be effective acaricides against the poultry red mite, *Dermanyssus gallinae* (De Geer) when tested over a 24 h period. Data on the actual rate of knock-down achieved with these products is lacking and potentially important as essential oils are likely to display only short-term toxicity.

When tested over periods of less than 24 h, thyme essential oil killed *D. gallinae* relatively quickly and so may make for an effective acaricide even if the residual toxicity of this product is low. However, cade essential oil did not display such a high level of mite knock-down, suggesting it may hold less promise in *D. gallinae* management.

Comparison of the results with those obtained elsewhere using alternative *D. gallinae* products further confirms the possibility that thyme essential may be useful in control of this pest. This might be especially true if thyme essential oil were employed as part of an integrated pest management approach.

1. Introduction

Pest management by conventional means (the use of synthetic pesticides) has become increasingly hampered by issues including stricter legislation, pest resistance and an increase in consumer demand for foodstuffs produced in an environmentally responsible or even organic manner. As a result, increased interest is being shown in developing alternative methods of pest control to reduce or eliminate reliance on synthetic pesticides. One such method involves the use of plant-derived-products, such as plant essential oils, as pesticides (Isman, 2000).

The poultry red mite, *Dermanyssus gallinae* (De Geer), is a serious ectoparasite of laying hens in the UK and Europe (Chauve, 1998; Sparagano, 2009). In taking a blood-meal from its host, *D. gallinae* can cause stress and even anaemia in the birds it feeds from, and may serve as a vector for numerous poultry pathogens (Kim et al., 2004). Several plant extracts and essential oils have already been identified as being toxic to *D. gallinae* (Kim et al., 2004; George et al., in press, 2009a,b; Maurer et al., 2009).

Research suggests that plant essential oils exert their toxic effect against *D. gallinae* by fumigant action (Kim et al., 2004; George et al., 2009b). As might be expected, the volatile/aromatic compounds (primarily terpenes) responsible for exerting this toxic effect often display low residual toxicities. For example, mortality of adult *D. gallinae* exposed to a range of lavender essential oils was greatly reduced after the oils had been exposed to the environment for a period of just 24 h (George et al., 2008). Such a lack of residual toxicity could be viewed as beneficial, where environmental persistence of any bioactive compounds will be low (Isman, 2000). Nevertheless, if a product with a low residual toxicity is to be efficacious against *D. gallinae* at the same time, a rapid knock-down of the target pest is required. To date, work

* Corresponding author. Tel.: +44 0 1912228893; fax: +44 0 1912226720.
E-mail address: D.R.George@ncl.ac.uk (D.R. George).

0304-4017/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.vetpar.2009.12.038

with essential oils and *D. gallinae* has only considered mite mortality following product exposure over 24 h (e.g. Kim et al., 2004; George et al., in press). With the possibility that essential oils may not remain efficacious for more than 24 h, high *D. gallinae* knock-down in a shorter period may be required for these products to work effectively as acaricides.

The aim of this experiment was to test the toxicity of two plant essential oils found in previous work to be effective as acaricides for *D. gallinae* over a 24 h period, over shorter periods. A general comparison of this data with similar figures for other alternative *D. gallinae* control products was also made.

2. Methods

The essential oils of thyme (*Thymus vulgaris* L.) and cade (*Juniperus oxycedrus* L.) were selected for study on the basis that both oils had been found to kill 100% of *D. gallinae* at 0.21 mg/cm^2 over 24 h in previous work (George et al., in press). Essential oils were sourced from New Directions (Southampton, UK) and applied to Whatman No. 2 filter papers (4.25 cm diameter) at this same concentration by spot treatment. The experiment described was conducted at Newcastle University (UK).

Treated (or untreated control filter papers) were placed into Petri-dishes with approximately 23 adult female *D. gallinae* collected from a free-range laying hen farm in Northumberland (UK) no more than 6 days prior to use. Dishes were then sealed using a layer of Clingfilm and Parafilm and placed in a growth room at 22 °C (16:8 L:D cycle). Mite mortality in dishes was assessed after varying exposure periods (EP) of 0 (mites placed into dishes as above then removed immediately), 2, 4, 8, 12 and 24 h. Mortality was assessed under magnification where a mite was deemed dead if it exhibited no movement following repeated agitation with an entomological pin.

Sixteen replicates were undertaken over 16 runs of the experiment, with two runs completed per week. Each run tested one replicate of both essential oils against all EP treatments. For each EP treatment, a control (spot treatment with distilled water only) was used. Fresh essential oils were used each week.

Mortality in dishes treated with essential oil was corrected to take account of control mortality using Abbott's correction. The data was then subjected to a two-way analysis of variance (ANOVA) with oil and EP as the main factors. *Post hoc* testing was done using Tukey Tests. Prior to analysis it was necessary to arcsin square-root transform the data and remove three data points as outliers (>3 SD from the mean) to fit the residuals from the ANOVA to a normal distribution. Probit analysis was also conducted to allow general comparison of Lethal Time (LT) values with those previously published for other alternative *D. gallinae* products.

3. Results

Overall, significantly higher *D. gallinae* mortality was achieved with thyme essential oil than with cade essential oil ($F_{(1,177)} = 384.49$, $P < 0.001$). The effect of EP was also significant overall ($F_{(5,177)} = 88.19$, $P < 0.001$), where higher mortality ($P < 0.05$) was achieved after a longer EP except when comparing data collected after a 4 h EP to that collected after either a 2 h or 8 h EP. There was also a significant interaction between oil and EP ($F_{(5,177)} = 9.27$, $P < 0.001$). As can be seen in Fig. 1, where differences between means as identified by Tukey's Tests are displayed, thyme essential oil was both more toxic to mites, and faster in exerting this toxicity than cade essential oil. After only a 2 h EP to thyme essential oil significant *D. gallinae* mortality, as compared to the 0 h EP treatment, was achieved. The same was not seen with cade until mites had been exposed for four times as long.

LT values confirmed that thyme was the more acaricidal essential oil where, at the concentration used, 50% *D. gallinae* mortality could be expected after less than 5 h of exposure. This figure compares favourably with work conducted elsewhere on alternative *D. gallinae* control products (Table 1).

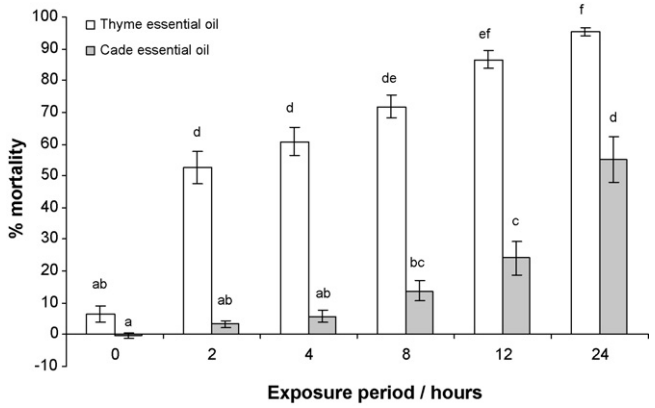

Fig. 1. Mean mortality of *Dermanyssus gallinae* subjected to thyme and cade essential oils for varying exposure periods (EP). Means not sharing a common letter are significantly different ($P < 0.05$). $n = 16$ for all means except 'Thyme-2 h EP' where $n = 15$ and 'Cade-24 h EP' where $n = 14$ (data points removed as outliers; see methodology).