



Persian J. Acarol., 2018, Vol. 7, No. 1, pp. 85–91.
<http://dx.doi.org/10.22073/pja.v7i1.34098>
Journal homepage: <http://www.biotaxa.org/pja>



Article

Acaricidal and repellent properties of some plant extracts against poultry red mite, *Dermanyssus gallinae* (Mesostigmata: Dermanyssidae)

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ABSTRACT

Poultry red mite, *Dermanyssus gallinae* De Geer (Mesostigmata: Dermanyssidae), is an important pest of birds in avicultures and it is an economic, hygienic and epidemiologic problem in the poultry industry. Uses of botanical pesticides are good and safe alternatives instead of chemical compounds. In the present study acaricidal and repellency activities of *Conocarpus erectus*, *Portulaca oleracea* and *Pistacia atlantica* extracts were evaluated against *D. gallinae* by calculation LC_{50} value and repellency index of each herbal extract in laboratory conditions and were compared with abamectin (a conventional chemical acaricide). However, all herbal extracts had less toxicity against the mite than abamectin. Aquatic and ethanolic extracts of *C. erectus* exhibited repellent for *D. gallinae*. The repellency effect was not observed in *P. oleracea* and *P. atlantica* extracts. Therefore, based on this experiment, it could be concluded that the aquatic and ethanolic extracts of *C. erectus* can be used as a safe botanical acaricide and repellent compound for control of *D. gallinae* in avicultures.

KEY WORDS: Birds; botanical acaricide; *Conocarpus erectus*; *Portulaca oleracea*; *Pistacia atlantica*; repellent.

PAPER INFO.: Received: 31 October 2017, Accepted: 25 December 2017, Published: 15 January 2018

INTRODUCTION

Poultry red mite, *Dermanyssus gallinae* De Geer (also called red poultry mite, poultry mite, red mite or chicken mite) is an important pest of birds in avicultures of the world. The mite can cause significant challenges in health and welfare of domestic fowls (Jansson *et al.* 2014). The mites stay hidden in cracks and crevices in the poultry house during the day and come out for feeding on birds at night. Mite infestations, in addition to being a nuisance for human and egg handlers, cause reductions in egg production, feed conversion efficiency, and body weight gains and may affect egg size as well (Nobo *et al.* 2012). The use of chemical pesticides for pest treatment in veterinary is a problematic challenge. Applications of chemicals cause many problems including pest resistance, the ineffectiveness of active ingredients, undesirable residues in the environment and unacceptable risks on non-target organisms. Botanical pesticides are good alternatives for the chemicals (George *et al.* 2014) because phytochemicals reputedly pose a little bad effect on the environment or human health (Isman 2006).

Conocarpus erectus L. (Combretaceae), is a perennial plant which native to Florida's mangrove forest ecosystem in North America. This plant grows up in many tropical and subtropical regions of the world including south of Iran. The tree is suitable for roadsides, parks, and gardens because of attractive green foliage, and tolerance of it to hot and windy conditions (Nelson 1996). *Conocarpus erectus* has high resistant to pest attack. Therefore, it is possible that the plant extracts contain effective pesticide. *Portulaca oleracea* L. (Portulacaceae) and *Pistacia atlantica* Desf. (Anacardiaceae) are two medicinal plants with a pesticidal activity which their efficacy against some arthropod pests was previously documented (Syed *et al.* 2010). Bioactivities of these plant extracts against veterinary pests have not been documented yet. Therefore, the aim of the present study is to investigate acaricidal and repellent activities of *C. erectus*, *P. oleracea*, and *P. atlantica* extracts against *D. gallinae* under laboratory conditions.

MATERIAL AND METHODS

Mite collection

Poultry red mite was collected from egg laying hens (Leghorn, Hy line- W36) of the poultry house, in research aviculture of Ramin Agriculture and Natural Resources University of Khuzestan in the southwest of Iran (31° 35' 50.3" N, 48° 52' 54.5" E) by a fine brush. The mites immediately transferred to the laboratory for experiments.

Plant material and extraction

The leaves of *C. erectus* were collected from green landscape of Ramin Agriculture and Natural Resources University of Khuzestan and *P. atlantica* leaves were collected from southwest mountains of Iran in Khuzestan province. Plants of *P. oleracea* were cultured in the herbal station of the University and harvested during their flowering period. All plant materials were identified botanically in the herbarium of the Department of Plant Protection of the Ramin Agriculture and Natural Resources University of Khuzestan. Plant samples were thoroughly washed with distilled water to remove dust and allowed to dry under shade in the laboratory. The dried leaves were powdered using an electrical blender (Pars Khazar BG330P, Iran).

One hundred grams of each powder plant material was taken to in 1000 ml. bottle and added 1000 ml of a solvent such as water and ethanol (EtOH-H₂O; 80%) separately. The bottles were kept for 72 h at room temperature at a dark place. The solvent from the extracts was removed using a rotary evaporator (N-1000-W-Japan) under reduced pressure until dryness (Movahedian *et al.* 2007). The rotary water bath temperature was 40 °C. Finally, the residues were collected and used for the experiments.

The toxicity effects

The treatments included aquatic and ethanolic extracts of *C. erectus*, ethanolic extract *P. oleracea*, ethanolic extract *P. atlantica* and abamectin (Vertimec® 1.8% EC, Exir Keshavarzi Co.), as a conventional chemical acaricide. To determine the concentration of the stock solution, the solutions were provided according to methods which described by Huerta *et al.* (2010). Five concentrations from the extracts, 0.1, 0.05, 0.01, 0.001 and 0.0001 (g/ml), were prepared. For abamectin treatment, concentrations of 0.01, 0.001, 0.0001, 0.00005 and 0.000001 (g/ml) were used. These concentrations were determined through pilot tests conducted before actual bioassays. All experiments were done simultaneously in a germinator at 25 ± 1 °C, RH 65 ± 5% and photo-period 16: 8 h (light: dark). A circle piece of filter paper, 8.5 cm in diameter, was dipped in each concentration for about 60 seconds. After 10 minutes the filter paper was dry and it was located inside the Plexiglas Petri dish (9 cm in diameter). Ten adults (female) were released in every Petri dish. After 48 h, the insects were checked and mortality percentage of each concentration was separately recorded.

Repellency effect

The concentration of LC₂₅ for each extract was used in the experiments. Experimental unites were consisted a circle filter paper (9.5 cm in diameter) which divided into two equal half. Half of the filter paper was dipped in the extract or abamectin solution (as treated disc) and another half was dipped in methanol or distilled water as a control disc. After 10 minutes, the full disc was then re-made by attaching the discs to transparent tape. The attached paper was placed in a Petri-dish (9 cm in diameter) and 5 adult mites were released in the center of the paper. After 30 minutes, the paper was checked and a number of the mites on treated (G) and control (P) discs were recorded. Index of repellency (IR) was calculated by following formula: $IR = 2 G / G + P$. The repellency index was classified as: values < 1 repellency; 1 neutral; > 1 attractant (Padin *et al.* 2013).

Data analyses

All experiments were conducted according to completely randomized design with five replications. Lethal concentration of 50% (LC₅₀) for each extract was calculated using Probit analysis by SAS 9.2 software. One sample t test by SPSS 16.0 was used for comparisons between IR values and value 1 in repellency experiments.

RESULTS

The toxicity effects

Acute toxicities of different treatments against *D. gallinae* have been presented in Table 1. All herbal extracts had lower toxicity against the mite compared to with abamectin. However, aquatic and ethanolic extracts of *C. erectus* had relatively higher toxicity against the pest. Among the herbal extracts, the highest and the least LC₅₀ values were observed in the ethanolic extract of *C. erectus* (0.00187 mg/kg) and *P. atlantica* extract (0.1068 mg/kg), respectively. There was no significant difference between LC₅₀ values of aquatic and ethanolic extracts of *C. erectus*. LC₅₀ values of *P. oleracea* and *P. atlantica* extracts were not statistically different.

Table 1. LC₅₀ (mg/kg) values of various herbal extracts and abamectin against *D. gallinae*.

Treatment	N	LC ₅₀	Confidence interval		Slope	Chi square	P-value
			Lower	Upper			
<i>C. erectus</i> aquatic extract	250	0.00269	0.00109	0.00552	2.3	40.6	< 0.0001
<i>C. erectus</i> ethanolic extract	250	0.00187	0.00081	0.00367	2.77	46.8	< 0.0001
<i>Portulaca oleracea</i>	250	0.00589	0.00284	0.1039	2.91	39.2	< 0.0001
<i>Pistacia atlantica</i>	250	0.1068	0.00522	0.1923	2.38	32.8	< 0.0001
Abamectin	250	0.000079	0.000049	0.0001283	6.86	28.7	< 0.0001

Table 2. Estimated repellency indices (IR) of various herbal extracts for adults of *D. gallinae*.

Treatment	IR	SE	t (df = 9)	P-value
<i>C. erectus</i> aquatic extract	0.56	0.12	-3.06	0.006
<i>C. erectus</i> ethanolic extract	0.60	0.11	-3.72	0.005
<i>P. oleracea</i>	1.03	0.11	2.25	0.804
<i>P. atlantica</i>	1.08	0.13	0.597	0.565

The repellency effects

Repellency effects of the various herbal extracts on *D. gallinae* according to IR have been shown in Table 2. The data indicated that both *C. erectus* extracts had significant repellency effects on the mites. While there was no significant difference between repellency effects of *P. oleracea* and *P. atlantica* extracts.

DISCUSSION

According to the present investigation, aquatic and ethanolic leaf extracts of *C. erectus* had some toxic effects on *D. gallinae* but not *P. oleracea* and *P. atlantica* extracts. These findings have verified the results of Roy *et al.* (2014), who showed that extract of *Terminalia chebula* Retz., another tree belongs to Combretaceae family, can be used as a botanical acaricide against *Oligonychus coffeae* Nietner (Acari, Tetranychidae). In a similar study, contact and fumigant toxicities of 40 oriental medicinal plant extracts against an ectoparasitic mite, *Dermanyssus gallinae* De Geer (Acari, Dermanyssidae), were evaluated. Many of these plant species had a less toxic effect than chemical acaricides but some of them, such as *Illicium verum* Hook (Magnoliaceae) fruit and *Lysimachia davurica* Ledeb. (Primulaceae) leaf extracts were as toxic as benfuracarb, prothiofos, propoxur and fenthion (Kim *et al.* 2007). The same results were reported about *Lippia origanoides* Kunth (Verbenaceae) and *Gliricidia sepium* Jacq. (Fabaceae) effects on *Tetranychus urticae* Koch (Acari, Tetranychidae) (Sivira *et al.* 2011), *Cleome gynandra* L. (Capparaceae), *Urtica dioica* L. (Urticaceae) and *Capsicum frutescence* L. (Solanaceae) on *T. urticae* on rose flowers leaves under greenhouse condition (Kapsool *et al.* 2015). In addition, the toxicity of methanolic extracts of *Anisosciadium orientale* DC., *Scaligeria meifolia* Boiss., *Trigonella elliptica* Boiss. and *Ptelea viscosa* L., (Ghaderi *et al.* 2013) *Quercus infectoria* L., *Cassia senna* L., *Capsicum annum* L., *Allium sativum* L., and *Thymus vulgaris* L. (Safaa *et al.* 2015) to *T. urticae* were previously reported.

Further, the results showed that aquatic and ethanolic extracts of *C. erectus* are repellent for *D. gallinae*. But there were not any effects on *P. oleracea* and *P. atlantica* extracts. Similarly, the repellent effects of some herbal extracts such as *Myrica gale* L., *Rhododendron tomentosum* Stokes and *Artemisia absinthium* L. on *Ixodes ricinus* L. (Acari, Ixodidae) (Jaenson *et al.* 2005), *Melia azadirachta* L., *Cymbopogon nardus* L., *Spiranthera odoratissima* Hil., *Chenopodium ambrosioides* L., *Ageratum conyzoides* L., *Mentha pulegium* L., *Ruta graveolens* L., and *Memora nodosa* Miers to *Amblyomma cajennense* Fabricius (Ixodida, Ixodidae) (Soares *et al.* 2010) and *Allium cepa* L., *Allium sativum* L., *Syzygium aromaticum* L., *Cinnamomum zeylanicum* L., *Zingiber officinale* L., and *Pandanus amaryllifolious* Roxb. to *Leptotrombidium deliense* Walch (Acari, Trombiculidae) (Hanifah *et al.* 2012) were previously documented.

In conclusion, the aquatic and ethanolic extracts of *C. erectus*, regarding relative toxic and repellency properties, can be used as a botanical and safe acaricide and repellent agent for control of *D. gallinae* in avicultures. Although, more experiments about the efficacy of the botanical acaricide in field condition and evaluation of their side effects were needed for any recommendation.

ACKNOWLEDGEMENTS


The research was supported by Ramin Agriculture and Natural Resources University of Khuzestan which is greatly appreciated.

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ویژگی کنه‌کشی و دورکنندگی برخی عصاره‌های گیاهی برای کنه قرمز طیور، *Dermanyssus gallinae* (Mesostigmata: Dermanyssidae)

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چکیده

کنه قرمز طیور (*Dermanyssus gallinae* DeGeer) (Mesostigmata: Dermanyssidae) یکی از آفات مهم پرندگان در مرغداری‌ها بوده و مشکلی اقتصادی، بهداشتی و همه‌گیر در صنعت مرغداری است. استفاده از آفت‌کش‌های گیاهی جایگزینی مناسب و کم‌خطر برای ترکیبات شیمیایی‌اند. در مطالعه حاضر، اثرات کنه‌کشی و دورکنندگی عصاره‌های *Conocarpus erectus*، *Portulaca oleracea* و *Pistacia atlantica* روی *D. gallinae* با محاسبه مقادیر LC50 و شاخص دورکنندگی هر یک از عصاره‌های گیاهی در شرایط آزمایشگاهی ارزیابی شد و با آبامکتین (کنه‌کش شیمیایی رایج) مقایسه شد. تمامی عصاره‌های گیاهی سمیت کمتری روی این کنه نسبت به آبامکتین داشتند. عصاره های آبی و اتانولی *C. erectus* اثر دورکنندگی برای *D. gallinae* نشان دادند. این اثر دورکنندگی برای عصاره‌های *P. oleracea* و *P. atlantica* دیده نشد. بنابراین و براساس این آزمایش‌ها، می‌توان نتیجه گرفت که عصاره آبی و الکلی *C. erectus* می‌تواند به عنوان یک کنه کش و ترکیب دورکننده گیاهی کم‌خطر برای کنترل *D. gallinae* در مرغداری‌ها مورد استفاده قرار گیرد.

واژگان کلیدی: پرندگان؛ کنه‌کش گیاهی؛ *Conocarpus erectus*؛ خرفه؛ بنه؛ دورکننده.

اطلاعات مقاله: تاریخ دریافت: ۱۳۹۶/۸/۹، تاریخ پذیرش: ۱۳۹۶/۱۰/۴، تاریخ چاپ: ۱۳۹۶/۱۰/۲۵