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ORIGINAL PAPER

The field efficacy of garlic extract against *Dermanyssus gallinae* in layer farms of Babol, Iran

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Abstract *Dermanyssus gallinae* (Acari: Mesostigmata) is the most important hematophagous ectoparasite in layer farms in many countries. The reproduction rate of the parasite is rapid and can be completed in a week under favorable conditions. The parasite has direct and indirect effects on birds. It can also act as a vector for some important pathogens. Many researchers have investigated the effects of essential oils, plant extracts, oriental medicinal plant extracts, and silica against red mite. They can be used as killing agents or repellents. In the present study, the effect of garlic (*Allium sativum*) extract was investigated for controlling red mite infestation in a layer farm in Babol, North of Iran. Our results showed that the extract was effective and we obtained a 96 % success after two successive sprays.

Introduction

Dermanyssus gallinae (Acari: Mesostigmata) is the most important haematophagous ectoparasite in layer farms in many countries (Hoglund et al. 1995; Aldemir 2004; Harrington et al. 2009; Sparagano et al. 2009; Rahbari et al. 2009). The parasite is a nocturnal feeder and considered as a temporary ectoparasite of wild and domestic birds (Evans and Till 1966; Kirkwood 1968; Lancaster and Meisch 1986). In day light, adults and nymphal stages hide in cracks and crevices (Hearle 1938; Kirkwood 1968; Kilpinen 2001). Reproduction rate is rapid, and under favorable conditions, the life cycle can be completed in a week (Maurer and Baumgartner 1992). The parasite infestation has both direct and indirect effects on birds. The blood feeding behavior can cause restlessness, irritation, anemia, and even death in heavy infection (Kirkwood 1968). Furthermore, the mite can act as the vector for some important pathogens such as Salmonella, avian spirochetes, chicken pox virus, Newcastle virus, fowl typhoid, fowl cholera, and *Erysipelothrix* (Zeman et al. 1982; Hungerford and Hart 1937; Chirico et al. 2003). The mite can bite humans and cause dermatitis and nuisance for personnel working in poultry establishments (Chirico et al. 2003).

Prevalence of poultry red mites in laying flocks varies from 20 to 90 %, depending on the country and production system (Sparagano et al. 2009). Studies in Iran revealed mite infestation in layer and breeder farms of seven provinces (Rahbari et al. 2009; Faghihzadeh et al. 2010).

Plant extracts were used to control pests; for example, leaf methanol extracts of *R. communis*, chloroform extracts of *Anisomeles malabarica*, and chloroform extracts of *Gloriosa superba* were used in the control of *Haemaphysalis bispinosa* Neumann and *Hippobosca maculate* (Abduz Zahir et al. 2010), *Annona squamosa*, and *Azadirachta indica* extracts against *Boophilus microplus* Izatnagar isolate (Magadum et al. 2009). The efficacy of *Acorus calamus* extract for the control of cattle tick is discussed (Ghosh et al. 2011). Medicinal plant extracts were used against ticks and fluke (Elango and Abdul Rahuman 2011). Essential oils were also used in the control of arthropods (Martinez-Velazquez et al. 2011).

Many researchers have investigated the effects of essential oils, plant extracts, oriental medicinal plant extracts and silica against red mites (Abdel-Ghaffar et al. 2008; Maurer et al. 2009; George et al. 2009a, b; Magdaş et al. 2010). The effects

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of neem extract have been observed 2 h after spraying on animals and 7 days on soil; (Abdel-Ghaffar et al. 2008). In vitro experiments showed that the oils of sweet basil, coriander, peppermint, and Summer savory were the most effective oils against red mite (Magdaş et al. 2010). Efficacy of neem extract against blowflies, houseflies, and mallophages of chicken were studied (Siriwattanarungsee et al. 2008; Al-Quraishy et al. 2012). A comparison between the efficacy of ByeMite® and Mite-Stop® showed that Mite-Stop® was more effective against all stages of *D. gallinae* (Abdel-Ghaffar et al. 2009). Light microscopic and scanning electron microscopic studies confirmed damages caused by direct contact of neem extract (Mite-Stop®) on *D. gallinae*.

Investigations suggest that the plant extracts can be used instead of chemical pesticides and their effects are acceptable.

The aim of the present study was to test the in vivo effect of garlic (*Allium sativum*) extract for controlling red mite infestation in a layer farm in Babol, North of Iran.

Materials and methods

This research has been carried out in winter 2010 in a 3×16×12 m^3 saloon with 5,000 pullets. The birds were 40 weeks old and the temperature was 18 °C.

All amounts of garlic were wheeled completely and filtered. After filtering, pure extract mixed with water for spraying all surfaces of the saloon.

Before spraying, to calculate the infestation rate, 75 traps comprising folded cardboard papers (20×40 cm) were made and applied. The surfaces of cardboard papers were punched to make a gap of about 1 cm as a suitable space to gather the mites. All traps were put on the floor with a 2-m distance. After 72 h, the samples were collected, frozen at −18 °C, and then counted.

The garlic extract was mixed with purified water (pure water with neutral PH) and sprayed on all the surfaces of the saloon.

Two days after the first spray, the mites were collected and counted again.

To determine the durability of the garlic extract, retrapping was done after a week and the mites were collected again. Eight days after the first spraying, another spraying like the previous one was done, and 2 days after the second spray, the samples were collected from traps, and the efficacy was estimated. To calculate the efficacy of the garlic extract, the following formula was used:

$$E\% = \frac{A-B}{A} \times 100,$$

where A is the number of mites before spray and B is the number of mites after spray.

The effect of garlic extract is estimated by this formula, too:

$$A-B=C;\ E\% = \frac{C}{A}\times 100$$

where A is the number of initial mites in the trap, B is the number of remaining mites in the trap after spraying, C is the number of dead or escaped mites, and $E\%$ is the percentage of dead or escaped mites.

Results

The parasites were collected before and after each spray to calculate the parasite population. Figure 1 showed both untreated and treated mites. The feet and some parts of the body turned dark or black in treated mites (Fig. 1).

After the first spray, the mite population declined significantly to 85 %.

$$E1\% = \frac{1050-157}{1050} \times 100 = 85.0476\%.$$

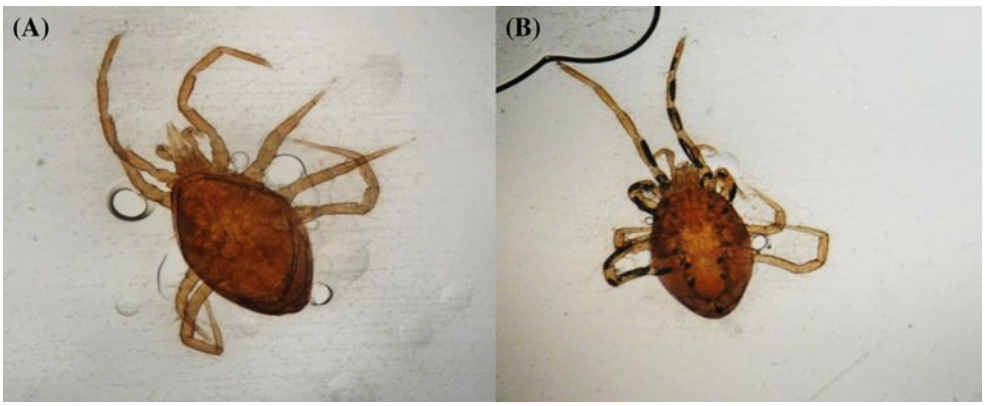

Fig. 1 *Dermanyssus galinae* collected before and after treatment: **a** untreated mite, **b** treated mite

However, after a week, the effect of extract reduced and the efficacy decreased to 75 %. In fact, the mite population in the traps increased from 157 to 263. This increase coincided with the reduction of garlic odor.

$$E = \frac{1050 - 263}{1050} \times 100 = 74.95\%$$

After the second spray, the number of mites was reduced. At this stage, the efficacy became about 86 % so it was more than the first spray.

$$E2\% = \frac{263 - 37}{263} \times 100 = 85.93\%$$

Discussion

The application of plant-derived products is a new alternative method for the control of arthropod infestation, particularly red mites (Kim et al. 2007; George et al. 2008, 2009a, b, 2010). Up till now, more than 50 extracts and oils from different plants like thyme, neem, and garlic and eucalyptus essential oils have been used in vitro from which, garlic had 100 % achievement (Kim et al. 2007; George et al. 2008; George et al. 2009a, b). CO^2 extract of the seeds of the Mediterranean plant *Vitex agnus castus* (monk's pepper) can be used as a spray to keep away especially *Ixodes ricinus* and *Rhipicephalus sanguineus* ticks from animals and humans for at least 6 h (Mehlhorn et al. 2005). *A. squamosa* and *A. indica* extracts were used against *B. microplus* Izatnagar isolate and showed very high level of efficacy (70.8 %) after 24 h of treatment. The effect of treatment on oviposition of the survived ticks was also assessed, and a significant reduction ($P<0.05$) in the reproductive index was noted in comparison to the control (Magadum et al. 2009). These researches and other studies (Abduz Zahir et al. 2010; Ghosh et al. 201; Elango and Abdul Rahuman 2011) emphasized the importance of plant extracts in the control of arthropods.

Red mite infestation is a global problem in all farm types (Aldemir 2004). It was shown in the present study that the administration of garlic extract was efficacious against *D. gallinae* at the selected mite-infested locations. More than 35 compounds have been recommended for red mite control, from which chemical poisons like carbamates, organophosphates, organochlorines, pyrethroids, carbamates, amitraz, and endectocides are useful, but long-term chemical control, may induce the development of heritable resistance in the mites (Chauve 1998). On the other hand, these compounds only are used when the poultry house is empty and may have residue on animals and other problems such as toxicity for human. For these reasons, their application has not been recommended (Keita et al. 2006). Silica powder (Inert dust) can cause dehydration and death in mites, but this material is too expensive and can be used only on horizontal surfaces. In recent years, some recombinant proteins were used for immunization against red mites (Harrington et al. 2009). Mul et al. (2009) used the HACCP method as a control program.

This study demonstrates the in vivo effect of garlic extract to control red mite infestation in poultry. After two sprays, the mite population was reduced from 1050 to 37. It means that we had 96.476 % success in our research.

$$1050 - 37 = 1013$$

$$\frac{1013}{1050} \times 100 = 96.476\%$$

$$E\% = 96.476\%$$

Re-spraying is required to achieve higher efficiency. In the case of neem seed extract (Mite-Stop®), three-time spraying within 8–10 days were recommended to achieve higher efficiency (Abdel-Ghaffar et al. 2008). Abdel-Ghaffar et al. (2008) described that direct contact of *D.gallinae* with neem seed extract (Mite-Stop®) has a high killing rate. In cases when mites do not come into direct contact with the acaricidal

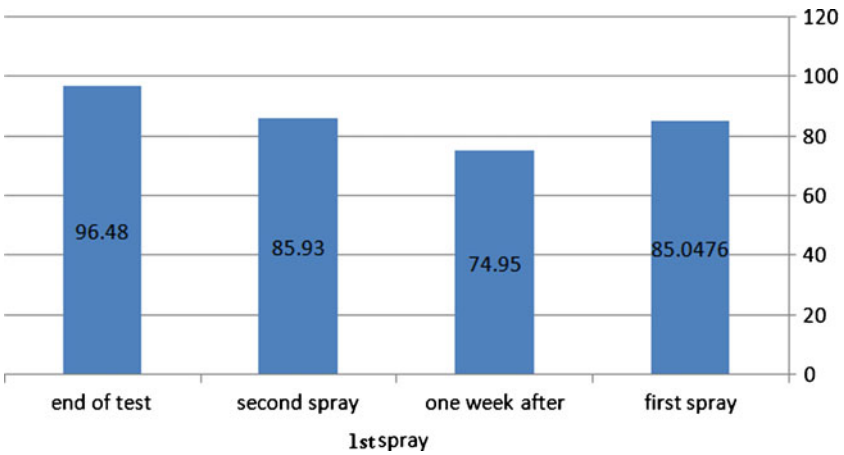

Fig. 2 Efficacy of garlic extracts in every stage (%EFFICACY)

plant compound, some mites may survive. Such cases make it necessary that treatment is repeated at least twice at an interval of 5–7 days (Locher et al. 2010a, b). So by re-spraying, direct contact was increased and a higher efficacy can be achieved.

After the first and the second spraying, the mite populations were reduced to 85.0476 and 74.95 %, respectively (Fig. 2). Abdel-Ghaffar et al. (2008) achieved more than 80 % reduction in the mite population after the first spray, and after the second spray, a dramatic reduction of the mite population increased. Our results were similar to those of Abdel-Ghaffar et al. (2008) and Locher et al. (2010a), b), and emphasized on the importance of the second spray. Locher et al. (2010b) described that the chicken mites turned dark brown or even black after being treated with the neem products. Scanning electron microscopy (SEM) analysis showed damages along the body surface of the mites. Figure 1 shows the color change of feet and some parts of body in treated mites. Treated *Lipeurus caponis* with neem seed extract (Mite-Stop®) stopped leg movements within 3 min and died on their feathers within 1–20 min (Al-Quraishy et al. 2012). It seems that garlic extract has the same effect on red mite and caused color change in the legs of treated mites. However, SEM analysis should be performed to detect the detail of damages caused by garlic extract.

A study on the efficacy of two antimite products (ByeMite®= phoxim, Mite-Stop®=neem seed extract) against all developmental stages of *D. gallinae* in two farms from France and Germany revealed that Mite-Stop® was more effective than the other in both farms. Mite-Stop® is highly efficient even in reduced dosage, which may occur in hiding crevices (Abdel-Ghaffar et al. 2009). Furthermore, the product was reported effective against blowfly, *Chrysomya megacephala* and housefly, *Musca domestica*, ixodid ticks such as *Ixodes ricinus* and *Rhipicephalus sanguineus*, biting louse of horses *Werneckiella*, shaft louse *Menopon gallinae*, elongate feather louse *L. caponis*, and *Columbicola* (Siriwattanarungsee et al. 2008; Schmahl et al. 2010; Al-Quraishy et al. 2011, 2012). Other than the direct killing effect, neem seed extract has an anti-fecundity effect in the subsequent generation of blowfly and housefly. The efficacy of garlic extract against other ectoparasites should be investigated.

The complete success depends on more factors like sanitation and quarantine on the farm. Newly made saloons have fewer crevices so mites cannot lair in fissures. By repairing old saloons, the contamination will be reduced. The mites harbor in feces; so feces should be evacuated in due time. In conclusion, the garlic has not any interference with other methods of preventive treatment and has high efficacy for controlling red mite infestation in chickens.

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