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Studies on the Occurrence, Identification and Control of House Dust Mites at Rural Houses of Shebin El-Kom Locality, Egypt

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ABSTRACT
The present study was conducted at Elkom Elakhdar village, Shebin El-Kom, Menoufia Governorate along 2012 year seasons, to calculate and identify the species composition and the occurrence frequency of the extracted dust mites collected from three building ages at rural houses, as well as to determine the toxicity limits of different concentrations of three plant essential oils against two species of the family Pyroglyphidae the main causal of allergy to humans. The obtained results revealed that there were eleven mite species belong to five families (Pyroglyphidae, Chortoglyphidae, Glycyphagidae, Acaridae and Cheyletidae). Of the total collected mites (5276) the highest dominant percentage species was the dust mites: *Dermatophagoides farinae* (66.1%), followed by *D. pteronyssinus* (23.3%), while the percentages of the rest species: *Chortoglyphus arcuatus*, *Lepidoglyphus destructor*, *Glycyphagus domesticus*, *Gohieria fusca*, *Tyrophagus putrescentiae*, *Caloglyphus* sp, *Cheyletus malaccensis*, *Blomia* sp. and *Acarus siro* were ranged between 0.16-2.0%. Regarding to the effect of temperature degrees on mite population, high degrees more than 25°C at summer season, decreased the numbers of *D. farinae* and *D. pteronyssinus*. Toxicological tests of the three plant essential oils against adult stages of *D. farinae* and *D. pteronyssinus* showed that lemon grass oil gave the highest toxicity effect, in comparison with geranium and thyme oils, where mortality percentages were approximately around 100% at 800 ppm concentration on both species. The LC_{50} of lemon grass were 228.992 and 293.615 ppm against the two species, respectively. From the results of the research, it could be recommend that it is preferable to apply control operation during summer season where the mite population density is the least, moreover, the botanical oil extracts effectively controlled the parasitic dust mites, *D. farinae* and *D. pteronyssinus* and can be used in the biological control programs, as well as, it can play effective role in the integrated management programs.

Key words: *D. pteronyssinus*, *D. farinae*, essential oils toxicity, house dust mites

INTRODUCTION

Mites that have been most frequently observed in dust are belonging to the families Pyroglyphidae, Glycyphagidae, Chortoglyphidae, Acaridae and Cheyletidae. The greatest role in causing allergies is played by mites belonging to family Pyroglyphidae, which constitute 60-90% of acari fauna in apartments of temperate climate (Colloff *et al*., 1992; Solarz, 2001a). Among several species of the family Pyroglyphidae, pyroglyphid mites, the *Dermatophagoides farinae* and *D. pteronyssinus* are important due to their cosmopolitan occurrence and abundance in homes, major source of multiple potent allergens and their causal association with sudden infant death syndrome (Heimerdinger *et al*., 2006). Pyroglyphid mites are found in houses in various areas of Egypt (Rezk, 2004; Rezk *et al*., 1996). House dust mites

are more common in dust of mattresses and bedroom floors than in dust from the other areas of the house (Maunsell *et al*., 1968; Van Bronswijk, 1973). The two pyroglyphid mites are important sources of allergens that cause respiratory allergies including asthma worldwide inside homes in humid areas (Hallas, 1991; Arlian *et al*., 1992; Colloff *et al*., 1992; Solarz, 2001a, b; Sharma *et al*., 2011; Pittner *et al*., 2004). The two pyroglyphid mites are also identified as etiologic agent of sensitization and asthma-triggering in children (Lau *et al*., 1989; Arshad and Hide, 1992).

Control of House Dust Mites (HDMs) depends on chemical methods such as fumigation and spraying with acaricidal compounds (Arnau and Guerrero, 1994; Lee, 2007). Although the great effect of the acaricidal compounds, their repeated use has sometimes resulted in the widespread development of resistance has undesirable effects on non-target organisms and has fostered environmental and human health concerns (Pollart *et al*., 1987; Van Bronswijk and Sinha, 1971; Lee *et al*., 2001; Hayes and Laws, 1991). These problems have highlighted the need for the development of new strategies for selective control of dust mites. Plants may be an alternative to the currently-used acaricidal and insecticidal agents to control dust mites and specific pests, because they constitute a rich source of bioactive chemicals (Isman, 2000, 2001; Saad *et al*., 2006). Since these are often active against a limited number of specific target species are bio-degradable to nontoxic products and are potentially suitable for use in integrated management programs, they could lead to the development of new classes of possibly safer pest control agents. Therefore, much effort has been focused on plants or phytochemicals as a potential source of commercial mite-control agents or as bioactive chemical compounds (Kim *et al*., 2001, 2003). Presently, little research has been undertaken to manage house dust mites or their damage by using aromatic plants, in spite of their excellent biological actions.

The purpose of this study was to know the occurrence and the identification of Dermatophagoid mites with different home ages, under rural conditions of Shebin El-Kom locality of Menoufia governorate. In addition to assess the toxic effect of three plant essential oils from aromatic medicinal plants against *D. farinae* and *D. pteronyssinus.*

MATERIALS AND METHODS

Mites collection: Dust samples were collected from nine private houses (all examined houses were consist of one floor) all built from cement and red bricks and overheads with iron and cement and its walls and floors were covered with cement and sand, located in Elkom Elakhdar village, Shebin El-Kom, Menoufia Governorate . The chosen houses were divided into three groups regarding to their building year (2: 10, 11: 20 and 21: 30 years old) each group represented by three houses.

With the aid of portable electric vacuum cleaner (200 watt) one hundred and forty four dust samples along one year, representing the four seasons (January 2012 as winter samples, April as spring, August as summer samples and October as autumn season) were collected from the examined houses. Each house was divided into four parts, each part was consider as a replicate, where four samples were taken from floor, carpets, mattresses, beds and living rooms (Van Bronswijk, 1973). Each part of house was vacuumed for 2-3 min in a disposable bag, the collected dust was placed inside plastic bags and transferred to the laboratory.

Air temperature degrees were monthly measured using a mercury-in-glass thermometer and the grand mean for each season was calculated where it ranged between 13-18°C in winter, 20-23°C in spring, 25-32°C in summer and 19-22°C in autumn, while Relative Humidity (RH%) was measured at the height of half meter using a hygrometer from different rooms it the grand mean percentages were 81% at winter, 64% at spring. The 45% at summer and 72% at autumn.

Mites examination and identification: From each sample, large particles and fibrous materials in the dust were separated by sieving through 300 mess brass sieve of 6 mm diameter, three sub-samples of 1 g dust from each sample was taken for mite examining and counting. Mites were isolated from the dust sub-samples in a glass Petri dish 5 cm under electrical dissecting stereomicroscope 20x with the aid of fine camel brush (000). All examined mites were collected in a small glass tube 10 mL in Ethyl alcohol 70%, then it cleared in lactic acid 50% for 24 h, after that it was cleared with distilled water, then it individually mounted in a drop of Hoyer's solution at the centre of a glass slide. After that the mounted slides were identified with the aid of electrical dissecting stereomicroscope 50x, according to the keys given by Van Bronswijk and Sinha (1971) and with the help of that given by Colloff *et al*. (1992) and AICPA (2000).

Stock culture of house dust mites: Cultures of *Dermatophagoides farinae* and *D. pteronyssinus* were isolated from mattress and floor dust and singly grown in clean dried jars on finely-ground mixture of dust, dried yeast and dried milk (1:1:0.5 W). The stock jars of each species were closed by double layers of muslin and kept in an electrical incubator at 25±2°C and 80±5% RH. After six months, large numbers of different stages were available for toxicological experimentation (Georges-Gridelet, 1987; Andersen, 1988; Rezk and Gadelhak, 2003).

Plant essential oils: Three commercial essential oils were evaluated in the study namely: Geranium (*Pelargonium graveolen*), Lemon grass (*Cymbopogon citrates*) and Thyme (*Thymus vulgaris*) against *Dermatophagoides farinae* and *D. pteronyssinus*. These compounds were obtained from a private drug company as a crude oil, then it was diluted with acetone as required. Five concentrations from each oil (100, 300, 500, 600 and 800 ppm) were applied on adult stages of *D. farinae* and *D. pteronyssinus*.

Essential oil tests: Ten filter paper discs, 1.5 cm diameter, were impregnated with 0.1 mL of the each test concentration (acetone was used as a dilution solution) of each oil (100, 300,

500, 600 and 800 ppm). The filter paper discs were dried for 2 min at room temperature to get rid of acetone. Each treated filter paper was placed in the bottom of a glass micro cell (1.5 cm diameter×2 cm height) containing one female of each mite species, since preliminary observations revealed these as the most resistant mobile stage to the selected materials and covered with a lid. Each concentration was replicated ten times. Control discs were treated with 0.1 mL of acetone of each.

Experiments were done under laboratory conditions of 25±2°C and 80±5% RH. Mortality percentages were determined after 24 and 48 h of oil treatments. Mites were considered as dead if appendages did not move with the aid of the camel brush.

The LC_{50} and their confidence limits were calculated by probit analysis.

Statistical analysis: Mortality percentages were calculated and corrected by Abbott's formula 1925. Slope, LC_{50} at 95% fidicual limits were estimated by probit analysis program (PROBAN), (Jedrychowski, 1991).

RESULTS

Occurrence and species composition of dust mites in different rural houses: Identification of dust mites in the collected samples Table 1 revealed that there are mainly eleven mite species belong to five families, these family are Pyroglyphidae (2 species), Chortoglyphidae (one species), Glycyphagidae (4 species), Acaridae (3 species) and Cheyletidae (one species).

Of the total collected mites (5276) the highest dominant percentage species was *Dermatophagoides farinae*, 66.1%, followed by *D. pteronyssinus* 23.3%, while the percentages of the rest species: *Chortoglyphus arcuatus*, *Lepidoglyphus destructor*, *Glycyphagus domesticus*, *Gohieria fusca*, *Tyrophagus putrescentiae*, *Caloglyphus* sp., *Cheyletus malaccensis*, *Blomia* sp. and *Acarus siro* were ranged between 0.16-2.0%.

The most dominant species was *Dermatophagoides farinae* with occurrence percentage of 33.07% of all collected mites, followed by *D. pteronyssinus* (19.81%) and *Chortoglyphus arcuatus* (9.82%), meanwhile the occurrence percentage of *Lepidoglyphus destructor* was (4.84%), *Glycyphagus domesticus* (5.46%), *Gohieria fusca* (5.62%), *Tyrophagus putrescentiae* 6.40%, *Caloglyphus* sp. (5.15%) and *Cheyletus malaccensis* (6.71%), while both *Blomia* sp. and *Acarus siro* was found as rare numbers, recording 1.09 and 2.03%, respectively.

Seasonal population of *D. farinae* dust mite at different rural houses: Distribution of *D. farinae* was found at different homes which divided to three groups according their age, samples were taken during different seasons of 2012 year, data in Table 2 revealed that the dermatophagoid mite, *D. farinae* numbers was the lowest from samples collected during August (summer), 8.58, 5.20 and 7.33 individuals/g dust at the three home ages, respectively, where mean temperature degrees was ranged between 25-32°C. The numbers of mites collected during January (winter) at mean temperature degrees from 13-18°C were 12.33, 15.03 and 16.58 individuals/g dust mites, at the three home ages, respectively.

Table 1: Identification and occurrence of dust mites inhabiting rural houses at El-Kom Elakhdar village, Shebin El-Kom along 2012 year seasons

Mite taxa	Total No. of mites	Species composition (%)	No. of occurrence	Occurrence (%)
Pyroglyphidae				
Dermatophagoides farinae	3486	66.1	48	33.07
D. pteronyssinus	1228	23.3	29	19.81
Chortoglyphidae				
Chortoglyphus arcuatus	105	2.0	15	9.82
Glycyphagidae				
Lepidoglyphus destructor	66	1.25	7	4.84
Glycyphagus domesticus	76	1.44	8	5.46
Gohieria fusca	79	1.48	8	5.62
Tyrophagus putrescentiae	91	1.72	10	6.40
Acaridae				
Caloglyphus sp	42	0.78	8	5.15
Blomia sp	10	0.18	2	1.09
Acarus siro	9	0.16	3	2.03
Cheyletidae				
Cheyletus malaccensis	84	1.59	10	6.71
Total	5276	100.00	-	100.00

Table 2: Population density of *Dermatophagoides farinae* collected from three rural house ages at 2012 year seasons

		Mean number of *D. farinae*/1 g dust collected from different house ages			
Seasons	Temperature (°C)	2-10 year	11-20 year	21-30 year	Grand mean
Winter (January)	13-18	12.33±4.74	15.03±7.67	16.58±9.26	14.65[c]
Spring (April)	20-23	21.78±12.80	32.45±18.01	28.90±9.88	27.71[a]
Summer (August)	25-32	8.58±3.22	5.20±0.65	7.33±2.13	7.04[d]
Autumn (October)	19-22	24.67±9.77	18.28±7.00	26.67±11.1	23.21[b]
Grand mean		16.84[b]	17.74[b]	19.87[a]	
LSD (5%)		1.76	2.61		

Table 3: Population density of *Dermatophagoides pteronyssinus* collected from three rural house ages at different seasons of 2012 year

		Mean number of *D. pteronyssinus*/g dust collected from different house ages			
Season	Temperature (°C)	2-10 year	11-20 year	21-30 year	Grand mean
Winter (January)	13-18	6.58±3.42	8.97±6.00	5.18±2.24	6.91[b]
Spring (April)	20-23	13.33±1.92	18.24±3.11	20.00±1.48	17.19[a]
Summer (August)	25-32	1.29±1.48	2.10±1.10	5.45±0.82	2.95[c]
Autumn (October)	19-22	16.35±5.75	11.24±3.71	18.24±14.80	15.28[a]
Grand mean		9.39[b]	10.14[b]	12.22[a]	
LSD (5%)		1.82	1.98		

Table 4: Toxicity of five concentrations of three essential oils against *Dermatophagoides farinae* and *D. pteronyssinus*

	Corrected mortality (%)			
	Dermatophagoides farinae		*Dermatophagoides pteronyssinus*	
Plant oils and Concentration (ppm)	24 h	48 h	24 h	48 h
***Cymbopogon citrates* (Lemon grass)**				
100	23.33	27.00	20.00	21.33
300	53.33	58.33	46.67	52.33
500	66.67	72.00	60.00	62.33
600	93.33	95.33	76.67	84.67
800	100.00	100.00	86.67	93.33
***Pelargonium graveolen* (Geranium)**				
100	6.67	18.33	3.33	14.33
300	30.00	32.67	20.00	28.67
500	66.67	74.33	60.00	61.33
600	90.00	98.00	86.67	92.33
800	100.00	100.00	93.33	100.00
***Thymus vulgaris* (Thyme)**				
100	0.00	5.00	0.00	2.67
300	23.33	32.33	20.00	23.33
500	56.67	62.67	43.33	51.67
600	83.33	89.33	66.67	72.33
800	93.33	94.67	76.67	85.67

Samples collected during April (spring) and October (autumn) recorded high numbers of mites, where the mean of temperature degrees were moderate (20-23°C and 19-22°C). At Spring samples *D. farinae* was the lowest in new homes 21.78 individuals/g dust, while it increased to 28.90 and 32.45 individuals/g dust for homes 21-30 and 11-20 years old, respectively. Samples of autumn season recorded the highest numbers specially at the oldest homes, followed by that of new one and 11-20 years old homes, recording 26.67, 24.67 and 18.28 individuals/g dust, respectively.

Statistical analysis of the obtained data (Table 2) proved that there is no significant difference between *D. farinae* numbers collected from 2-10, 11-20 years homes, while grand mean numbers recording 16.84 and 17.74 individuals/g dust, as grand mean collected from old homes (21-30) have high numbers (19.87 individuals/g dust) with significant difference when compare with mite numbers inhabited other home ages. As for temperature, *D. farinae* grand mean numbers was the highest during April 27.71 individuals/g dust when temperature was 20-23°C followed by October (23.21 individuals/g dust). The lowest grand mean number 7.04 individuals/g dust was recorded during August where temperature was 25-32°C. Statistical analysis showed significant differences between samples collected during different seasons, mean that temperature has clear effect on dust mite numbers of *D. farinae*.

Seasonal occurrence of *D. pteronyssinus* dust mite at different rural houses: As for *Dermatophagoides pteronyssinus*, statistical analysis of the data in Table 3 cleared that the highest mean occurrence of mite was recorded at spring and autumn seasons without significant difference, while the least numbers were recorded at summer and winter seasons with significant difference. Regarding to the numbers of the examined mite, the highest numbers were recorded at the oldest houses with significant differences between it and the other home ages, while there were no significant differences in the mite numbers between the houses of 2-10 and 11-20 years.

Toxicological tests: Dermatophagoid mites, especially *D. farinae* and *D. pteronyssinus* which was recorded along this study with high numbers in addition to the fact that they are common cause of asthma and allergic symptoms world wide, therefore, the acaricidal effect of three plant oil extracts (Geranium, Lemon grass and Thyme) at five concentrations was tested against the two mite species.

Data in Table 4 show the mortality percentages of both mites after 24 and 48 h of oil applications. The lemongrass geranium and thyme oil concentrations of 100 and 300 ppm recorded the least toxicity for all tested materials, where the mortality percentages were ranged between 20- 32.67% for the two mite species , except that of lemon grass (300 ppm) which recorded 58.33% mortality of *D. farinae* after 48 h.

Table 5: LC_{50}, slope and fiducial limits of three essential oils after 24 h on Dermatophagoid adults

Plant oils	Slope	LC_{50} (ppm)	Fiducial limits of LC_{50} at 95 (%) Lower (ppm)	Upper (ppm)
Dermatophagoides farinae				
Geranium	0.0211	333.390	45.2033	535.3168
Lemon grass	0.0219	228.992	9.2261	437.2375
Thyme	0.7209	425.260	367.3339	475.9180
Dermatophagoides pteronyssinus				
Geranium	0.3190	396.232	46.6086	614.6837
Lemon grass	0.5679	293.615	212.5984	375.3675
Thyme	0.8190	508.846	437.3259	589.2947

Moreover, the oil concentrations of 600 and 800 ppm recorded the highest mortality reaching 100% at 800 ppm after 24 h for geranium and lemongrass when applied on *D. farinae*, while it was 94.67% after 48 h for thyme oil.

Dermatophagoides farinae appears to be more sensitivity than *D. pteronyssinus* for all plant oil extracts at all examined concentrations, this was cleared from different LC_{50} for tested oils (Table 5). Results in Table 5 show that the LC_{50} of geranium oil was 333.390, 396.232, 228.992 and 293.615 ppm for lemongrass oil, while it raised to 425.260 ppm and 508.846 for thyme oil extract, for *D. farinae* and *D. pteronyssinus*, respectively.

DISCUSSION

From the obtained results it was clear that *D. farinae* numbers were higher than *D. pteronyssinus* in the same samples, also, temperature degrees higher than 25°C decreased the numbers of both *D. farinae* and *D. pteronyssinus*.

The obtained results does not agree with that of previous results in which it was found that the samples of school dust mite from Cairo governorate clear that the numbers of *D. farinae* were less than numbers of *D. pteronyssinus*, also samples taken in January recorded the highest number of both pyroglyphid mites, while this mite family was absent in April, August and October samples. Furthermore, the present results showed that summer season recorded the least mite numbers, while spring and autumn seasons registered the highest mite numbers.

The obtained data is in agreement of that obtained by Warner *et al*. (1999) who found that *D. farinae* numbers collected from three climatic regions in Sweden homes were more that of *D. pteronyssinus*.

The population of mites in the dust samples were found to be vary from place to anther which could be due to the difference in the structure, age of the buildings, status of the individuals, type of furniture and difference in the microclimatic conditions that contributes to the higher accumulation of mites in home dust (Modak *et al*., 1991; Sharma *et al*., 2011). Mites prefer warm, moist surroundings. Mites populations are generally recorded during the rainy, warm seasons but their effect are found maximum during the dry and cooler months of the year (AICPA., 2000).

Finally, from the results of the present study, it could be concluded that the highest Pyroglyphid mite population was recorded at spring season, followed by that of autumn season, while the least numbers were recorded at summer and winter seasons. This will be a great importance in the field of mite control to take the suitable decision of IPM programs.

From the obtained results it could be report that lemongrass oil extract registered the highest toxicity, followed by geranium and the least toxicity results was shown at thyme oil for both mite species under study. These results, confirmed the effectiveness of some essential oils against house dust mite *D. farinae* and *D. pteronyssinus.* Recently, many acaricides have been replaced with newer, safer agents owing to the toxicity, resistance and environmental damage caused by earlier agents Pollart *et al*. (1987) and Hayes and Laws (1991). In the present study, the three plant oil extracts, lemon grass occupied the first rank in the toxicity against Dermatophagoid mites recording complete mortality (100%) at 800 ppm after 24 h comparing with geranium and thyme treatments. The obtained results, are in agreement with those conducted by Saad *et al*. (2006) and Hanifah *et al*. (2011), while it was contrary to those of (Bakr, 2010) who found that thyme oil is the most promising for possible use against *D. farinae* and *D. pteronyssinus*).

CONCLUSION

The botanical oil extracts effectively controlled the parasitic dust mites, *Dermatophagoides farinae* and *D. pteronyssinus* and can be used in the biological control programs, as well as, it can play effective role in the integrated management programs.

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