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Application of nanotechnology in control of cattle tick

A thesis presented by

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(M.V.SC., Fac. Vet. Med. Beni-Suef Univ., 2018)

**For fulfillment of the degree of Philosophy Doctorate
(PhD) on Veterinary Medical Science
(Parasitology)**

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(2022)

Contents

Subjects	Pages
I. Introduction.....	1
II. Review of literature.....	5
2.1. <i>Rhipicephalus (Boophilus) annulatus</i> , Biology and Veterinary importance	5
2.2. Ticks control (Chemical control)	7
2.2.1. Using of nanoparticles in ticks control	8
2.2.2. Using of Essential oils and nanoemulsions in ticks control	11
III. Material and methods.....	16
3.1. Ethical approval	16
3.2. Collection, identification and preparation of eggs and larvae of ticks	16
3.3. Used materials	16
3.3.1. Nanoparticles preparation and characterization	16
3.3.2. Preparation of nanoparticles Zn-Fe LDH and Zn-Al-GA LDH nanoparticles.	17
3.3.3. Synthesis of iron oxide nanoparticles from clove bud extract	18
3.3.4. Loading of deltamethrin on nanomaterials	18
3.3.5. Characterization of nanoparticles	19
3.3.6. Essential Oils and their nanoemulsions preparation and characterization	20
3.3.7. Gas Chromatography-Mass Spectrometry of oils	20
3.3.8. Nanoemulsion preparation of essential oils	22
3.3.9. Characterization of Nanoemulsion	23

3.3.10. Combinations of essential oils with each other and with food oils	23
3.4. Acaricide activity of the prepared materials	23
3.4.1. Adult immersion test	23
3.4.2. Ovicidal activity	24
3.4.3. Larval packet test	24
3.5. Field Trial using two forms of geranium	25
a. Animal preparation for field application	25
b. Experiment application for geranium nanoemulsion and geranium/sesame oil combination	25
3.6. Statistical analysis	26
IV. Results	27
4.1. Collection and identification of <i>R. annulatus</i> ticks	27
4.2. The Efficacy evaluation of deltamethrin loaded nanocomposites	27
4.2.1. Characterization of the prepared nanoparticles	27
a. FE-SEM and HR-TEM	27
b. X-ray diffraction and Fourier transform infrared spectroscopy (FT-IR)	30
4.2.2. Acaricidal bioassay of loaded deltamethrin nanocomposites	33
4.2.2.1. Adulticidal effect	33
4.2.2.2. Larval mortality	34
4.3. The Efficacy evaluation of essential oils against <i>R. annulatus</i>	36
4.3.1. Gas Chromatography-Mass Spectrometry of oils	36

a. GC-Mas analysis of geranium	36
b. GC-Mas analysis of citrus limon	36
c. GC-Mas analysis of tea tree	36
4.3.2. Characterization of oils nanoemulsion	36
4.3.3. Acaricidal activity of oils against <i>R. annulatus</i> tick	37
4.3.3.1. Adulticidal activity of EOs formulations	37
4.3.3.2. Ovicidal activity of EOs formulations	43
4.3.3.3. Larvicidal activity of EOs formulations	44
4.4. Field trial of geranium nanoemulsion and geranium/sesame oils combination	47
V. Discussion.....	53
VI. Conclusions.....	62
VII. English summary.....	63
VIII. References.....	65
Arabic summary.....	1

List of tables

Table Number	Table Title	Pages
1	Chemicals and physical characteristics of deltamethrin	17
2	GC-Mas of <i>Pelargonium graveolens</i> essential oil (granium)	20
3	GC-Mas of Citrus limon (CL)	21
4	GC-Mas of Tea Tree (TT)	22
5	FE-SEM and HR-TEM of nanoparticles materials	28
6	XRD patterns and FT-IR spectra of nanoparticles	30
7	Effect of deltamethrin and its freshly loaded nanocomposites against the resistant <i>Rhipicephalus annulatus</i> adult tick	34
8	Larval packet test by the freshly synthesized/loaded deltamethrin nanocomposites	35
9	LC ₅₀ and LC ₉₀ of deltamethrin and its freshly loaded Nanocomposites <i>Rhipicephalus annulatus</i> larvae.	36
10	Essential oils characterizations	37
11	Adulticidal activity of tested EOs on <i>R. annulatus</i> (the ratio between oils binary mixture 1:1)	38
12	Egg production index (EPI) of EOs treated adult <i>R. (B.) annulatus</i> (the ratio between oils binary mixture 1:1)	39
13	Adulticidal activity of PGSO in different ratios	39
14	LC ₅₀ , LC ₉₀ and Synergistic factor of adulticidal activity of PG against <i>R. (B.) annulatus</i> (the ratio between oils in the binary mixture 1:1)	40
15	Adulticidal activity of tested TT on <i>R. annulatus</i> (the ratio between oils binary mixture 1:1)	41
16	Adulticidal activity of tested CL on <i>R. annulatus</i> (the ratio between oils binary mixture 1:1)	42
17	LC ₅₀ , LC ₉₀ and Synergistic factor of adulticidal activity of TT and CL against <i>R. (B.) annulatus</i> (the ratio between oils in the binary mixture 1:1)	42

18	Ovicidal effect of EOs (the ratio between oils in the binary mixture 1:1)	43
19	Larvicidal effect of PG (the ratio between oils in the binary mixture 1:1)	44
20	LC ₅₀ , LC ₉₀ and Synergistic factor of larvicidal activity of PG (the ratio between oils in the binary mixture 1:1)	45
21	Larvicidal effect of TT & CL (the ratio between oils in the binary mixture 1:1)	46
22	LC ₅₀ , LC ₉₀ and Synergistic factor of larvicidal activity of TT & CL (the ratio between oils in the binary mixture 1:1)	47
23	Percent reduction of ticks by PGSO and PGN formulations in relation to deltamethrin in the control <i>R. annulatus</i> on naturally infested cattle	48

List of figures

Figure Number	Figure Title	Pages
1	Cattle naturally infested by <i>R. annulatus</i> ticks (a,b,c), Adult ticks deposit eggs (d), Larvae (e) and adult ticks (g)	27
2	FESEM images of the prepared Zn-Al LDH/GA (a), Zn-Fe LDH (b) and Iron oxide (c) nanoparticles showing sheets and tiny layers. HRTEM images for Zn-Al LDH/GA (d), Zn-Fe LDH (e) and Iron oxide (f) showing layers, sheets and spherical like.	29
3	XRD pattern of the as-synthesized nanomaterials compared to their pattern before and after adsorption of deltamethrin. (a) Zn-Fe/LDH/delta, (b) Zn-Al-GA/LDH/delta, (c) Fe-oxide/delta	31
4	FTIR spectra of the as-synthesized nanomaterials compared with their spectra before and after adsorption of deltamethrin. (a) Zn-Fe/LDH/delta, (b) Zn-Al-GA/LDH/delta, (c) Fe-oxide/delta	32
5	Naturally infested cattle by <i>R. annulatus</i> ticks at different parts of the body (neck, withers, preneal region) before treatment by geranium oil nanoemulsion (PGN)	49
6	Naturally infested cattle by <i>R. annulatus</i> ticks after 7 days post treatment by PGN showing reduction in ticks number at different parts of the body.	50
7	Naturally infested cattle by <i>R. annulatus</i> ticks on the neck and shoulder region before treatment by geranium/sesame oil mixture (PGSO)	51
8	Naturally infested cattle by <i>R. annulatus</i> ticks after 7 days post treatment by PGSO showing reduction in ticks number	51
9. A.	A. Ticks were collected from treated animals by deltamethrin showing normal egg deposition	52
9. B.	B. Ticks were collected from treated animals by PGSO showing low egg deposition from only 3-4 live ticks	52
9. C.	C. Ticks were collected from treated animals by PGN showing no egg deposition and dead ticks	52

Table of Abbreviations

Abbreviations	Meanings
AIT	Adult immersion test
BOD	Bio-oxygen demand incubator
CL	<i>Citrus limon</i>
CLN	<i>Citrus limon</i> nanoemulsion
Delta (D)	Deltamethrin
DF	Number of deaths of adult female
EO	Essential oil
EPI	Egg production index
Fe-oxide (Fe-O)	Iron oxide
Fe-oxide/LDH	Iron oxide conjugated with layered double hydroxide
FE-SEM	field emission high resolution Scanning Electron Microscope
FT-IR	Fourier Transform Infrared Spectroscopy
GC-MS	Gas Chromatograph- mass spectrometry
HR-TEM	High resolution transmission electron microscope
LC ₅₀	The lethal concentration of 50% of population
LC ₉₀	The lethal concentration of 90% of population

LDH	Layered double hydroxide
LPT	Larval packet test
LS	<i>Linseed</i> oil
NCs	Nanocompositions
NPs	Nanoparticles
PDI	polydispersity index
PG	<i>Pelargonium graveolens</i> essential oil
PGN	<i>Pelargonium graveolens</i> nanoemulsion
<i>R.(B.) annulatus</i>	<i>Rhipicephalus (Boophilus) annulatus</i>
SF	The synergistic factor
SO	<i>Sesame seed</i> oil
TC post	The mean number of live ticks on cattle after the treatment
TC pre	The mean number of live ticks on cattle before the treatment
TT	<i>Melaleuca alternifolia</i> (Tea tree oil)
TTN	<i>Melaleuca alternifolia</i> (Tea tree oil) nanoemulsion
UV	UV-visible spectrophotometer
XRD	X-ray diffraction
Zn-Al-GA	Zinc- aluminum- Gallite

Abbreviations

Zn-Al-GA/LDH	Zinc- aluminum- Gallite conjugated with layered double hydroxide
Zn-Fe	Zinc- iron
Zn-Fe/LDH	Zinc- iron conjugated with layered double hydroxide

VII. Summary

Layered double hydroxide (LDH) compounds are now used as drug delivery systems. Deltamethrin (Butox®) was loaded on Zn-Fe LDH, Zn-Al-GA Layered double hydroxide (LDH) and Fe –oxide nanoparticles NPs. Then its acaricidal efficacy was evaluated. The nano-composites (NCs) were prepared by the co-precipitation method and characterized before and after deltamethrin loading. The deltamethrin-loaded NCs were applied against the phenotypically resistant *Rhipicephalus annulatus* ticks (adult and larvae). The adult ticks treated by Butox® alone or Butox®loaded nanocomposites at different concentrations showed no mortality. A significant ($P \leq 0.05$) reduction in egg production index was observed at the recommended dose (x) (1 µl/ml distilled water) and its bi-folds (2x, 3x and 4x) in ticks treated with deltamethrin/Zn-Fe LDH nanocomposites compared to deltamethrin alone. Moreover, no significant difference ($P > 0.05$) was recorded in larval mortality between the treatments with deltamethrin alone and its loaded nanocomposites. The acaricidal activity of deltamethrin was not improved after loading it with these nanocomposites.

The aim of the present study was to evaluate in vitro and in vivo the acaricidal activity of two forms of *Pelargonium graveolens* (geranium). One form was *P. graveolens* essential oil (PG): nanoemulsion (PGN) and synergism of PG with sesame oil (SO), (PGSO). *Sesame seed* oil (SO), *Melaleuca alternifolia* (Tea

tree oil) (TT), *Citrus limon* (CL) and *Linseed* oil (LS) were evaluated alone, in the nanoemulsion form and in the synergistic combination forms. Oils nanoemulsion was prepared and characterized by UV-Vis spectrophotometer and zeta droplet size measurement. The results revealed that LC₅₀ values for adult ticks decreased to 1.91% and 5.60% for PGSO and PGN respectively while it was 7.53% for PG. Moreover, LC₅₀ of PGN and PGSO were 1.688 and 0.944% respectively, while for PG was 3.435% for larvae. TT and CL have significant adult mortality while TTN and CLN have not any acaricidal efficacy. Also, there are antagonistic effect between TT and CL with PG, SO and LS. However, the PGN showed non-significant results with PG while PGSO showed significant ovicidal effect even at the low concentration (2.5%). The PGSO and PGN formulations were applied in a field trial control on tick-infested cattle. PGSO and PGN succeed to decrease the tick burden by 74.83% and 87.97%, respectively at three-week post-application and performed better than deltamethrin-treated cattle (29.88%).