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Bioactivity of *Datura stramonium* L. extract against *Tetranychus cucurbitacearum* and the predatory mite, *Phytoseiulus macropilis*

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Abstract
The plant extracts are considered an alternative method for pests control. The effect of acetone and water extracts obtained from *Datura stramonium* plant on *Tetranychus cucurbitacearum* and its predatory mite, *Phytoseiulus macropilis* was evaluated. The impact of the extracts was measured using the sprayed leaf disk technique. The effect of two extracts with five concentrations was examined against the eggs and females of *T. cucurbitacearum* in addition to their side effects on females of predatory mite, *P. macropilis*. The highest unhatchability % of *T. cucurbitacearum* eggs were found at 100% concentration as 61.25, 67.5% and 52.5, 56.25% for one day and three days old eggs for acetone and water extracts, respectively. The acaricidal activity of two extracts of *D. stramonium* was tested against females of mites, *T. cucurbitacearum* and *P. macropilis* by spray bioassay. The acetone extract showed stronger acaricidal activity with LC_{50} value that is 42.82% compared with 55.47% of water extract, for *T. cucurbitacearum.* Regarding the females of *P. macropilis* the LC_{50} values were 93.11 and 98.04% for acetone and water extracts. Both extracts gave poor toxic effect to the predatory mite compared with females of *T. cucurbitacearum*. Furthermore, extracts proved superiority in repellency to spider mite, *T. cucurbitacearum*. Rate of repellency was decreased gradually by time elapsed after treatment. *T. cucurbitacearum* females preferred to settle, deposit eggs and feed on the untreated half of the disc and the majority refused to settle on the treated part especially with the high concentrations. Worthy indicating that both extracts shortened the longevity and decreased fecundity of *T. cucurbitacearum* females. As a consequence, Datura extracts are regarded to be a safe alternative to mite control**.**

Keywords: *Datura stramonium*, *Tetranychus cucurbitacearum*, *Phytoseiulus macropilis*, toxicity, repellency

Introduction

It is interesting to note that *Tetranychus cucurbitacearum*, belonging to the family Tetranychidae, is considered as one from the common serious pests attacking many vegetable crops as well as some other crops of relatively high economic value, i.e., soybean, cotton and bean (El-Duweini *et al*., 2003) [6]. *T. cucurbitacearum* causes severe damage to the infected crops due to leaves wilting as a result of juice absorption and crop loss. Phytoseiids are the most studied because of their importance in the control of phytophagous mites on agricultural crops (Helle and Sabelis, 1985) [9]. There are numerous predaceous mites. Phytoseiid mites are important predators of phytophagous mite populations in IPM programs on outdoor and greenhouse crops that now used as biological control agents in various agricultural ecosystems. Phytoseiulus species have a high potential for population increase, probably the highest in the Phytoseiidae (Zhang, 1995) [20]. For the past several decades, the use of pesticides on a large scale and for an extended period of time, in controlling mites, has led to rapid advancement of resistance in mites, beside their actually predicted serious adverse effects on human, beneficial organisms and the environment. It is memorable that mite control options must be identified and developed that are both safe and eco-friendly, as well as effective, anti-resistance, non-chemical. Therefore, it was found necessary to search for alternative methods in controlling phytophagous mites, avoiding any adverse impact on the naturally occurring predators that may cause environmental imbalance.

Use of natural compounds from plant extracts has been recommended as a possible source of alternative treatments for insect and mite control because many substances of such compounds have novel modes of action, little or minimal toxicity to non-target organisms and mammals, and are less hazardous to the environment (Schmutterer, 1997) [16]. Numerous plant extracts have been described to have different biological activities against insects and mites including repellence, feeding and oviposition deterrence, toxicity, and growth regulatory activity (Singh and Saratchandra, 2005) [17]. Furthermore, plant based insecticides often contain a mixture of active ingredients that might delay or prevent the resistance development (Wang *et al*., 2007) [19]. Therefore, the objective of this study was to determine acaricidal activity of *Datura stramonium* L. (Family: Solanaceae) against *Tetranychus cucurbitacearum* and *Phytoseiulus macropilis* and to identify active components in an effort to gain information-based pesticides for controlling the mite that are effective and safe.

Materials and Methods

Rearing of *Tetranychus cucurbitacearum*

Field samples of Soybean leaves (*Glycine max* L.), infested with the spider mite, *T. cucurbitacearum* were collected and kept in paper bags with necessary data and transferred immediately to the laboratory. The mass culture was initiated by transferring individuals of both sexes of the mite by the aid of a camel's hair brush in trays (30 cm diameter), which were provided with untreated fresh leaves of mulberry, *Morus* sp. To keep the leaves wet and prevent

mites from escaping, they were put on a cotton pads that had been saturated with water. Newly laid eggs were obtained by releasing the adult females of the mite on fresh and clean mulberry leaves, wherever the leaves were necessary changed about 2-4 changes to reach adult stage. All colonies were kept under laboratory conditions, where mites were maintained alive by providing them with fresh host plant.

Rearing of the predatory mite, *Phytoseiulus macropilis*

A stock culture of the predatory mite; *P. macropilis* was collected from soybean, *Glycine max* L**.** at Zagazig district. Mulberry leaves used as a substrate for the predator rearing, were placed on a cotton pads in trays, and each leaf was lined with wet cotton as a barrier. Drops of water were added daily on a cotton pads to maintain suitable moisture for the predator, whenever leaf substrate began to deteriorate, it was replaced with a fresh one. Different stages *T. cucurbitacearum* were offered as preys. The experiments were carried out under laboratory conditions.

Extract of *Datura stramonium* L. (Family: Solanaceae)

Leaves of *D. stramonium* were collected during the vegetative period from production areas of the faculty of agriculture, Zagazig University. Plant materials were dried and powdered by using an electric grinder. The extraction has been carried out according to the procedure outlined by Gokçe *et al*. (2005), where the extract was kept in glass jars (3 liters) at dark room temperature till using, plant extract was prepared from a representative sample of 100g of powdered plant material, was placed in a 2 liters capacity Erlenmeyer flask, 300 ml of acetone solvent was added and the mixture was shaken for 24 h in a horizontal shaker at 120 rpm at room temperature. The plant suspension was sieved through four layers of cheese cloths to separate plant parts. Extract was transferred into a 250 ml evaporating flask and evaporated under a vacuum using a rotary vacuum evaporator at 32 ˚C. The extract solution was kept in a refrigerator at 4 °C until used in the bioassay tests.

Gas chromatography-mass spectrometry analysis (GC/MS)

Volatile compound analysis was performed with a gas chromatography system (Agilent 6890 GC) with an Agilent mass spectrometric detector, with a direct capillary interface and fused silica capillary column PAS-5 MS (30 m × 0.32 mm × 0.25 µm film thickness). Helium was used as the carrier gas at a flow about 1.0 ml/min pulsed splitless. The solvent delay was 3 min and the injection size was 1.0 µl. The mass spectrometric detector was operated in an electron impact ionization mode with an ionizing energy of 70 eV. Scanning from m/z 50 to 500 and the ion source temperature was 230 ˚C. The electron multiplier voltage (EM voltage) was maintained 1250 v above auto tune. The instrument was manually turned using perfluoro tributyl amine (PFTBA). Oven temperature program at 45 ˚C (2 min), 150 ˚C (5 min) at a rate of 2 ˚C min-1, then at 150 ˚C (2 min), 280 ˚C (5 min) at a rate of 8 ˚C min-1; split 30:1 during 1.50 min, carrier gas He: 1 ml min-1, constant flow; sample volume 1 µl. Identifying the parts was based on comparison of their mass spectra with those of Wiley and Nist Tutore Libraries. The gas chromatography-mass spectrometry analysis was done in National Research Center, Giza, Egypt.

Bioassay tests

Ovicidal action of the tested *Datura stramonium* against *Tetranychus cucurbitacearum* eggs

To study the action of *D. stramonium* on eggs of *T. cucurbitacearum*, mated adult females were placed on mulberry leaf discs in Petri- dishes on moist cotton for 24 hrs, then they were removed, 80 newly deposited eggs from one-day old eggs and 80 eggs from three days old eggs were gently dipped separately in different concentrations of *D. stramonium* (100, 75, 50, 25 and 10%) for about 5 seconds according to Ebeling (1960) [5]. In control test, the leaf discs were dipped in tap water only. The treated eggs as well as the control were kept under constant temperatures of 27 ± 3 ºC and relative humidity of 65 ± 5% R.H. In all cases, unhatchability percentages were assessed, incubation period and LC_{50} for one-and three days old eggs were described by Finnay (1952).

Adulticidal action of the *Datura stramonium* against *Tetranychus cucurbitacearum* and its predatory mite, *Phytoseiulus macropilis*

The relative effects of *D. stramonium* on mortality of adult females of *T. cucurbitacearum*, and predatory mite, *P. macropilis* were assessed. All tests had 4 concentrations as mentioned above were carried out with 40 adult females, for each concentration (4 replicates with 10 mites, prey and predator/replicate), control replicates were prepared. Adults of the mite were sprayed with previous concentrations and distilled water for control. LC_{50s} were calculated after 4 days from treatment. The relative efficiency, Toxicity index of the tested pesticides (solvents) was determined according to Sun (1950) [18].

Repellency effect of *Datura stramonium* against *Tetranychus cucurbitacearum* females

To study the repellency effect of the extract against adult females of *T. cucurbitacearum*, different concentrations (100, 50, 25 and 10%) from the extracts were applied according to the technique reported by Meisner *et al*. (1970). Mulberry leaves were cleaned and cutted into two parts of symmetrical portion along the midrib. One leaf portion of the disc was dipped in different concentrations of the extract, while the other portion was dipped in water (control). The treated discs were allowed to dry and put on top of a wetted filter paper placed inside glass Petri–dishes (10 cm in diameter). Fifty adult females, for each concentration (5replicates with 10 mites/replicate). Ten adult females of *T. cucurbitacearum* were placed in middle of Petri–dishes between the two leaf portions. The number of females found on each leaf portion was counted after 1, 2, 3, 4 and 5 days from exposure. The repellency percentages were computed. Deposited eggs were counted on treated and untreated portions

Latent effect of LC_{50} of *Datura stramonium* on the longevity and fecundity of *Tetranychus cucurbitacearum*

The relative effects of *D. stramonium* on some biological aspects of adult females of *T. cucurbitacearum.* Sixty adult females (reared individually), the mulberry leaf discs were sprayed with the concentration which caused 50% mortality and placed upper side down on moist cell cotton in petri-dishes while, the control sprayed with distilled water. The longevity and fecundity of *T. cucurbitacearum* were calculated. Deterrent index % based on the number of eggs on control and tested leaf discs Lundgren (1975) [11].

Latent effect of LC_{50} of *Datura stramonium* on some biological aspects of predatory mite, *Phytoseiulus macropilis*

Adult females of *P. macropilis* were placed on clean leaf discs (40 replicates with one mite/replicate) that provided with *T. cucurbitacearum* stages as source of food. The mulberry leaf discs were sprayed with the concentration which caused 50% mortality and placed upper side down on moist cell cotton in petri- dishes while, the control sprayed with distilled water. The longevity, fecundity and consumption of *P. macropilis* were calculated. Deterrent index% based on the number of eggs on control and tested leaf discs Lundgren (1975) [11].

Statistical analysis

Data were subjected to statistical analysis using one-way analysis of variance,

ANOVA Duncan (1955).

Results

Chemical composition of *Datura stramonium* leaves

The bioactive phytochemicals of *D. stramonium* leaves were analyzed by using hydrodistillation and GC–MS. Data in table (1) and figure (1) revealed that 81 compounds represent about 99.99% of the constituents.

Table 1: Composition and percentages of volatiles from *Datura stramonium* leaves

Peak	Compounds	R.T./min.	Area%
1	Cyclopropene, 1-(2-hydroxypropyl)-2-trimethylsilyl-	5.608	0.2
2	3, 6-Dioxa-2, 7-disilaoctane, 2, 2, 4, 7, 7-pentamethyl-	6.973	0.63
3	2-Hydroxy-N-(4-methylbenzenesulfonyl) propanamide, TMS derivative	7.47	7.16
4	Ethanol, 2-(methylamino)-, N-trifluoroacetyl, O-trimethylsilyl	7.644	1.72
5	2, 3-Butanediol, 2TMS derivative	8.321	7.81
6	Acetamide, 2, 2, 2-trifluoro-N-methyl-N-(trimethylsilyl)-	8.482	0.13
7	Butanoic acid, 4-[(trimethylsilyl)oxy]-, trimethylsilyl ester	8.937	0.39
8	2-[2-(Trimethylsilyloxy) ethoxy] ethanol	9.315	0.55
9	Ethoxy(dimethyl) isopropylsilane	9.375	0.19
10	D-(-)-Ribofuranose, tetrakis (trimethylsilyl) ether (isomer 1)	9.59	0.16
11	Octane, 4, 5-diethyl-	9.878	0.51
12	N-(2-Ethylhexyl) trifluoroacetamide	10.357	1.71
13	l-Gala-l-ido-octonic lactone	10.692	0.15
14	1, 5-Pentanediol, 2TMS derivative	10.758	0.13
15	Silane, 1, 8-octanediylbis [trimethyl-	11.033	0.71
16	tert-Butylpentamethyldisiloxane	11.273	1.1
17	3-Amino-4-carboximidoyl-2-(2-oxopropyl) cyclopent-3-ene-1, 1, 2-tricarbonitrile	12.123	0.12
18	Methyl glycolate, TMS derivative	12.417	10.55
19	Sulfamic acid, 2TMS derivative	12.531	1.48
20	1-Butene, 3, 3-bis [[(tert-butyldimethylsilyl) oxy] methyl]-4-[(2-methoxyethoxy) meth	12.614	0.12
21	α-D-Glucopyranoside, methyl2-(acetylamino)-2-deoxy-3-O-(trimethylsilyl)-, cyclic methylboronate	12.692	0.14
22	2-Methoxyethanol, TBDMS derivative	13.231	4.3
23	Glycerol, 3TMS derivative	14.022	1.33
24	Silanol, trimethyl-, phosphate (3:1)	14.279	5.93
25	Androsta-1,4-dien-3-one, 17-hydroxy-17-methyl-, (17.alpha)-	15.441	0.2
26	Cyclohexene,4-ethenyl-4-methyl-3-(1-methylethenyl)-1-(1-methylethyl)-, (3R-trans)-	15.489	0.17
27	alfa -Copaene	16.537	2.64
28	Cyclohexane, 1-ethenyl-1-methyl-2, 4-bis (1-methylethenyl)-, [1S-(1.alpha, 2.beta, 4.beta)]-	16.866	0.49
29	Caryophyllene	17.765	10.39
30	cis-alpha-Bergamotene	17.914	2.27
31	alpha-Humulene	18.477	1.74
32	gamma -Muurolene	18.909	0.75
33	trans-Caryophyllene	19.07	2.17
34	(-)-alpha-Selinene	19.22	0.44
35	1H-Cycloprop[e] azulene, 1a, 2, 3, 5, 6, 7, 7a, 7b-octahydro-1, 1, 4, 7-tetramethyl-, [1aR-(1a.alpha., 7.alpha., 7a.beta., 7b.alpha.)]-	19.424	0.89
36	beta -Bisabolene	19.615	1.56
37	beta -copaene	19.831	0.47
38	Naphthalene, 1, 2, 3, 5, 6, 8a-hexahydro-4, 7-dimethyl-1-(1-methylethyl)-, (1S-cis)-	19.998	2.3
39	beta -Guaiene	20.31	0.19
40	cis-5,8,11,14,17-Eicosapentaenoic acid	20.741	0.15
41	Caryophyllene oxide	21.544	3.12
42	5, 8, 11-Eicosatrienoic acid, (Z)-, TMS derivative	22.053	0.36
43	13-Retinoic acid, (Z)-, TMS derivative	22.28	0.37
44	10,12-Tricosadiynoic acid, TMS derivative	22.406	0.17
45	[1-(3, 3-Dimethyloxiran-2-ylmethyl)-3, 7-dimethylocta-2, 6-dienyl] trimethylsilane	23.466	0.15
46	(-)-Isolongifolol, TMS derivative	23.711	0.52

R.T.: Retention Time

Table 1: Continued

Peak	Compounds	R.T./min.	Area%
47	Naphthalene, 2-hydroxy-7-[1-(([1-(1,1-dimethylethyl)-1,1-dimethylsilyl] oxy) methyl] ethenyl]-1, 4a-dimethyl-2, 3, 4, 4a, 5, 6, 7, 8-ocahydro-, acetate	24.119	0.13
48	Verrucarol, 2TMS derivative	24.406	0.2
49	D-(-)-Fructofuranose, pentakis(trimethylsilyl) ether (isomer 1)	26.46	0.17
50	D-Psicofuranose, pentakis(trimethylsilyl) ether (isomer 2)	26.628	0.15
51	D-(-)-Fructopyranose, 5TMS derivative (isomer 2)	26.736	0.2
52	1, 2, 3, 4, 6-pentakis-o-(trimethylsilyl) hexopyranose	28.215	0.26
53	beta -D-(+)-Talopyranose, 5TMS derivative	29.922	0.27
54	Hexadecanoic acid, trimethylsilyl ester	30.575	1.25
55	Ethyl iso-allocholate	31.233	0.14
56	Phytol, TMS derivative	32.862	0.24
57	9,12-Octadecadienoic acid (Z, Z)-, TMS derivative	33.455	0.14
58	alpha -Linolenic acid, TMS derivative	33.605	0.48
59	Stearic acid, TMS derivative	34.006	0.64
60	Scopolamine, TMS derivative	36.587	0.17
61	Oleamide, TMS derivative	36.863	0.89
62	2-Methyl-E, E-3, 13-octadecadien-1-ol	38.024	0.21
63	alpha-D-Galactopyranose,1, 2, 3-tris-O-(trimethylsilyl)-,cyclic methylboronate	38.935	0.18
64	1, 5-Anhydrohexitol, 4TMS derivative	39.366	2.75
65	1-Monopalmitin, 2TMS derivative	39.594	0.31
66	D-(+)-Turanose, octakis(trimethylsilyl) ether	40.168	1.9
67	Lactulose, octakis(trimethylsilyl) ether (isomer 1)	40.558	1.59
68	Sucrose, 8TMS derivative	41.043	0.56
69	Uridine, 2', 3', 5'-tris-O-(trimethylsilyl)-	41.342	0.99
70	beta-D-Galactopyranoside, methyl 2, 6-bis-O-(trimethylsilyl)-, cyclic methylboronate	41.905	0.35
71	1-(4-Nitrophenyl)-3, 6-diazahomoadamantan-9-ol	42.181	0.42
72	Octadecanoic acid, 2,3-bis[(trimethylsilyl) oxy] propyl ester	42.348	0.48
73	α-D-Glucopyranosiduronic acid, 3-(5-ethylhexahydro-2, 4, 6-trioxo-5-pyrimidinyl)-1, 1-dimethylpropyl 2, 3, 4-tris-O-(trimethylsilyl)-, methyl ester	42.678	0.19
74	5, 8, 11-Eicosatriynoic acid, tert-butyldimethylsilyl ester	42.821	1.36
75	d-Glucopyranose, 1-C-octyl-2, 3, 4, 6-tetra-O-trimethylsilyl-	43.013	2.35
76	Androst-2-en-4-one, 17-(tetrahydropyran-3-yl) oxy-	43.858	1.21
77	D-Glucose, 6-O-alpha-D-galactopyranosyl-, bis-O-(trimethylsilyl) deriv., cycli	44.732	0.24
78	Acetic acid,17-(4-hydroxy-5-methoxy-1,5-dimethylhexyl)-4, 4, 10, 13, 14-pentamethy l-2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17-tetradecahydrocyclopenta	44.858	0.28
79	Cholesta-5, 7, 9 (11)-trien-3-ol acetate	45.798	0.12
80	Heptacosane	46.295	0.25
81	Cholest-22-ene-21-ol, 3, 5-dehydro-6-methoxy-, pivalate	47.283	0.19

According to the analysis results, eleven compounds represented 39.45% of the total mass of the bioactive parts were identified as main parts. Methyl glycolate, TMS derivative (10.55%) was the most plentiful part of the volatiles in *Datura stramonium* leaves. Other main parts of the volatiles were found to be Caryophyllene (10.39%), 2, 3-Butanediol, 2TMS derivative (7.81%), Caryophyllene oxide 3.12%, 1, 5-Anhydrohexitol, 4TMS derivative (2.75%), N-(2-Ethylhexyl) trifluoroacetamide (1.71%), Hexadecanoic acid, trimethylsilyl ester (1.25%), Oleamide, TMS derivative (0.89%), (-)-Isolongifolol, TMS derivative (0.52%), 1, 2, 3, 4, 6-pentakis-o-(trimethylsilyl) hexopyranose (0.26%), and Cyclopropene, 1-(2-hydroxypropyl) -2- trimethylsilyl (0.2%).

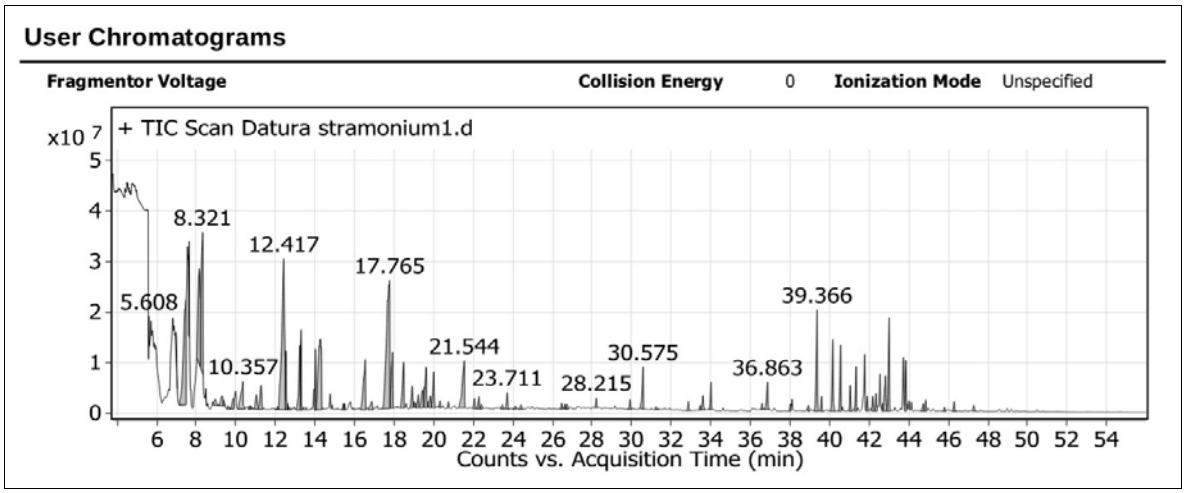

Fig 1: GC–MS volatiles chromatogram of *Datura stramonium* leaves

The present study indicated that using plant extract is of remarkable importance as efficient biocontrol agents against pests or insects. Datura plants, extracted with acetone and water, were used against phytophageous mite, *Tetranychus cucurbitcirum*. Data in table (2) show that the acetone extract was more effective than water extract against eggs of *T. cucurbitcirum*, by using four concentrations. The unhatchability percent ranged between 8.75 and 61.25% at concentration from 10 to 100% acetone extract on one day old eggs. On the other hand, in case of the three days old eggs, the unhatchability percent ranged between 12.5 and 67.5% at the same concentrations. Regarding, the water extract was the least efficiency where, the highest unhatchability percent was 52.5 and 56.25% on one and three old eggs, respectively at 100% concentration while, the unhatchability decreased to 6.25% in both ages at 100% concentration. So, the plant extract from Datura was significantly effective on incubation period of eggs that increased at all concentrations in both solvents compared with control where, incubation period of eggs raged from 3.25 to 5.09 days at 10% concentration from acetone extract while, it ranged from 3.59 to 3.56 days for one and three days old eggs for acetone extract. With respect to water extract, there were simple significant differences compared with the control where the incubation period of eggs were 3.2, 3 days for one and three days old eggs, respectively.

Table 2: Toxicity of *Datura stramonium* on *Tetranychus cucurbitacearum* eggs

Solvents	Conc. %	One day old eggs		Three days old eggs		LC_{50} %	
		Unhatchability %	Incubation period/days	Unhatchability %	Incubation period/days	One day old eggs	Three days old eggs
Acetone	100	61.25±5.04[a]	5.09±0.22	67.50±4.89[a]	3.56±0.13	90.47	80.62
	75	38.75±2.96[b]	4.21±0.18	46.25±2.68[b]	3.19±0.15		
	50	25.00±2.13[d]	3.46±0.07	35.00±2.07[c]	3.26±0.11		
	25	15.00±1.86[e]	3.27±0.09	18.75±1.66[d]	3.18±0.14		
	10	8.75±0.87[f]	3.25±0.06	12.50±1.32[d]	3.12±0.09		
Water	100	52.50±3.83[a]	4.41±0.11	56.25±3.57[a]	3.59±0.16		
	75	32.50±2.61[c]	3.90±0.06	41.25±2.79[b]	3.07±0.20	94.28	98.11
	50	21.25±1.98[d]	3.61±0.10	37.50±2.13[c]	3.00±0.12		
	25	12.50±1.12[e]	3.34±0.14	15.00±1.21[d]	3.04±0.08		
	10	6.25±0.58[f]	3.28±0.13	6.25±0.87[e]	3.10±0.14		
Control		-	3.20±0.15	-	3.00±0.07	-	

Means in columns followed by the same letter are not significantly different at p≤5%
± Standard Error

The data obtained clarify that three days old eggs were more susceptible than one day old eggs, where LC_{50} was 90.47 and 80.62% for one and three-days old eggs at acetone extract, respectively, whereas it was 94.28 and 98.11% for water extract. Data in table (3) evaluate serial concentrations from Datura extract with two solvents against females of *T. cucurbitcirum* where the extraction exhibited high significant mortality effect on *T. cucurbitcirum* but this effect was low on the predatory mite, *Phytoseiulus macropilis* where LC_{50} values for acetone extract against *T. cucurbitcirum* and *Phytoseiulus macropilis* were 42.82 and 93.11%, respectively while, LC_{50} values increased in treatment with water extract were 55.47 and 98.04% against the same mite order, respectively.

Toxicity index showed highly significant differences 100 and 77% between acetone and water extracts against *T. cucurbitcirum* while, the difference reduced 100 and 94.97% against the predator.

Table 3: Toxicity of *Datura stramonium* on *Tetranychus cucurbitacearum* and *Phytoseiulus macropilis* females

Solvents	*T. cucurbitacearum*				*P. macropilis*			
	LC_{50} %	Confidence limits LC_{50} %		Toxicity index %	LC_{50} %	Confidence limits LC_{50} %		Toxicity index %
		Upper	Lower			Upper	Lower	
Acetone	42.82	56.19	42.89	100	93.11	96.23	90.14	100
Water	55.47	60.68	49.65	77.19	98.04	99.26	95.6	94.97

Concerning the repellent effect of Datura extract against *T. cucurbitcirum* females, data in table (4) indicate that repellency percentage decreases over time after the treatment. Where rare in fourth day after treatment in all concentrations but it decreased in water extract treatment compared with acetone extract the highest repellant percent was 79.53% after 24 hrs. from the treatment with acetone extract and decreased to 70.36% at 100% concentration from both solvents. Females of *T. cucurbiticurm* were found preferring to lay eggs in untreated portion, therefore the number of deposited eggs increased in portions with low concentration, where the number of repellent individuals was low.

Table 4: Repellency effect of *Datura stramonium* against *Tetranychus cucurbitacearum* females

Solvents	Conc. %	Repellency%/days after treatment					Total deposited eggs	
		24hr.	48hr.	72hr.	96hr.	120hr.	Treated portion	Untreated portion
Acetone	100	79.53	67.50	40.00	22.16	9.00	1.52±0.11[d]	16.34±1.88[d]
	50	65.61	54.00	30.75	9.23	0.00	1.96±0.21[d]	27.38±2.91[c]
	25	56.21	47.34	40.05	5.00	0.00	2.54±0.36[d]	32.15±3.16[b]

	10	10.09	8.68	5.17	0.00	0.00	3.01±0.42[d]	43.08±4.12[a]
Water	100	70.36	64.37	36.10	19.03	0.00	6.23±0.68c	23.56±2.74[c]
	50	75.71	51.24	27.37	10.50	0.00	7.50±0.89c	30.35±32.98[b]
	25	45.28	40.63	25.23	0.35	0.00	10.00±1.34b	40.24±3.77[a]
	10	13.42	7.48	7.41	0.00	0.00	14.25±1.62[a]	49.41±4.53[a]

Means in columns followed by the same letter are not significantly different at p≤5%
± Standard Error

In connection with the effect of LC_{50} from Datura extract on some biological aspects, related to the females of *T. cucurbitcirum*, data in table (5) indicate that, both solvents extracts diminished the longevity and fecundity of the treated females in comparison with the control. As for acetone extract the longevity was 13.29 days, whereas it reached 15.25 days for water extract and 17.63 days in the control treatment. on the other hand, the number of the deposited eggs attained 51.36 ad 60.22 eggs for the same order while it was 72.84 eggs in the control one. Deterrent index values were 17.29% for acetone and 9.44% for water extract.

Table 5: Effect of LC_{50} for *Datura stramonium* on the longevity and fecundity of *Tetranychus cucurbitacearum*

Solvents	Pre-oviposition Period	Oviposition period	Post-oviposition period	Longevity (days)	Fecundity	Deterrent index%
Acetone	1.83±0.23	9.16±0.81	2.30±0.63	13.29±1.22[b]	51.36±4.21[c]	17.29
Water	1.61±0.21	11.08±0.75	2.56±0.55	15.25±1.31[b]	60.22±5.46[b]	9.44
Control	1.55±0.17	12.76±0.96	3.32±0.67	17.63±1.56[a]	72.84±6.13[a]	-

Means in columns followed by the same letter are not significantly different at p≤5%
± Standard Error

The latent effects of Datura extracts against some biological aspects of *Phytoseiulus macropilis*. Data in table (6) show that there wasn't any significant effect on both of longevity and fecundity of *Phytoseiulus macropilis* females, and consumption was almost the same as the control. By using LC_{50} from Datura extracts, the longevity values were 23.45 and 24.28 days and the fecundity values were 35.24 and 37.80 eggs for both of acetone and water extracts, while those of the control treatment were 26.52 days for longevity and 39.39 eggs for fecundity.

The consumption rates were 91.42, 95.7 and 95.35 individual/ female in acetone, water extracts and the control, respectively. The deterrent index was 5.56 and 2.05% for acetone and water extracts, respectively.

Table 6: Effect of LC_{50} for *Datura stramonium* on the longevity, fecundity and consumption of *Phytoseiulus macropilis*

Solvents	Longevity (days)	Fecundity	Consumption	Deterrent index %
Acetone	23.45±2.03[a]	35.24±2.98[ab]	91.42±6.34[a]	5.56
Water	24.28±2.16[a]	37.80±3.24[a]	95.70±6.77[a]	2.05
Control	26.52±2.32[a]	39.39±3.61[a]	95.35±6.82[a]	-

Means in columns followed by the same letter are not significantly different at p≤5%
± Standard Error

Discussion

The present study demonstrated the leaf extracts of *D. stramonium*, have shown contact toxicity against *T. cucurbitacearum* females, that agreement with Barakat *et al.* (1984) [1] tested some plant extracts against adults and eggs of *Tetranychus urticae* that were less affected than adults, but extracts of *Datura stramonium* showed considerable ovicidal properties, and Kumral, *et al.* (2013) [10] reported that Datura extract was toxic and repellent against the European red mite, *Panonychus ulmi* (Koch). The extract was safer Phyto pesticidal product for the management of *P. ulmi* in both organic and inorganic apple production. The toxicity may be ascribed to the presence of certain alkaloids, such as; scopolamine, hyoscyamine, meteloidine, and apoatropine in addition to terpenoids, and flavonoids. The identified compounds have many biological properties. For instance, lethal, antifeedant and repellent properties. This fact is in agreement with some viewpoints reported by Pavela (2004) and Berkov *et al.* (2006). It is worthy to indicate that previous studies by Philipov and Berkov (2002) [14] showed that certain alkaloids vary in amounts in different parts of *Datura* spp., the fact that explains the reason why leaf extracts were more effective than seed ones. On the other hand, one of the most remarkable findings is that the extracts of the whole plant were found having repellent and antifeedant properties against insect pests, the view point that has been indicated by a number of previous researchers as Devaraj and Srilatha (1993) [3]; Pascual-Villalobos and Robledo (1997) [12] and Prakash and Rao (1997) [15]. In addition, there is a significant effect of *D. stramonium* extract on the nutritional indices and mortality of *T. cucurbitacearum* adults at different concentrations.

Generally, this study suggests that *D. stramonium* extract may be a potential protectant due to its combined contact and antifeedant activity against *T. cucurbitacearum* females. The results of this study highlight the potential benefits of further research into suitable formulations, as well as cheaper and more potent analogs. The lethal and repellent properties were found mainly associated with the presence of high concentrations of 2-tridecanone and trans-caryophyllene.

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