IHJPAS. 36(1)2023

Ibn Al-Haitham Journal for Pure and Applied Sciences
Journal homepage: jih.uobaghdad.edu.iq

The Effect of the Crude Terpenoids Compounds of *Melia azedrach* Leaves and Fruits on Some Biological Aspects of Whitefly *Bemisia tabaci*

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Article history: Received 24 Julay 2022, Accepted 9 October 2022, Published in January 2023.

doi.org/10.30526/36.1.2951

Abstract

This study was carried out to determine the effects of crude terpenoid compound extracts of *Melia azedarach* L. leaves and fruits on some biological aspects of whitefly *Bemisia tabaci* (Genn.) under laboratory conditions of 25 ± 2°C and relative humidity of 65-70%. The results indicated a significant effect on eggs and immature stages when treated with 0.5, 1, 1.5, and 2 mg/ml of leaves and fruits. The mortality rate increased with concentration. It reached 98.68, 100, 100, 95.70, 86.30, and 42.68% for eggs, 1st, 2nd, and 3rd nymphal instars, pupa, and adults, respectively, at a concentration of 2 mg/ml for leaves extract. At the same time, it reached 94.86, 100,100, 100, 87.89, and 44.90% for eggs, 1st, 2nd, and 3rd nymphal instars, pupa, and adults, respectively, at a concentration of 2 mg/ml for fruit extract. Also, the proportion of adults who emerged from sprayed eggs reduced to 91.53% and 95.72% when treated with 2 mg/ml of leaves and fruit extracts, respectively. While the developmental period increased to 23.50 and 24.00 days at 2 mg/ml when treated with terpenoid extracts of the leaves and fruits, respectively, compared with 21.00 and 20.83 days at control.

Keywords: *Bemisia tabaci*, Crude Compound, *Melia azedarach*, Terpenoids Extract, Whitefly.

1. Introduction

The whitefly *Bemisia tabaci* is a tiny, soft-bodied insect belonging to the Homoptera order's Aleyrodidae family. It has six life stages, egg, crawler (1st larval instar), two sessile nymphal instars (2nd and 3rd nymphal instars), pupa, and the adult [1, 2, 3]. The adults coat their bodies, especially their wings, with white, waxy powder generated by specific glands, mostly on adults' abdomen, thus the name whiteflies (Figure 1) [1,2,3]. Most whitefly species are arrhenotokous: females are produced from fertilized eggs. Males are haploid and develop from unfertilized eggs [3]. Whiteflies are considered a significant economic pest in both fields. They protect crops and ornamental plants, including guava, cucumber, eggplant, tomato, sweet

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potato, soybean, watermelon, lettuce, cotton, cauliflower, Chinese cabbage, cassava, avocado, okra, hibiscus, verbena, poinsettia, garden mum, *Gerber daisies*, lantana, Mandevilla and rose [4,5]. When the adult and immature whiteflies feed, they excrete honeydew, a sticky excretory waste composed of plant sugars [6]. Over two-hundred plant, viruses are transmitted by whiteflies [5, 6]. More than one hundred were transmitted by *B. tabaci* [3].

Figure 1: Female of *B. tabaci* (40X) "A photo was taken by the author"

B. tabaci has developed a high degree of resistance against different groups of insecticides, including organophosphates, carbamates, pyrethroids, insect growth regulators, and chlorinated hydrocarbons [7-10] explained that the resistance of *B. tabaci* is related to the extensive use of several insecticides, short generation time, high rate of fecundity, and the greater mobility of adults. Also, [11] mentioned that chemical control has been challenging to achieve because of the insect's distribution within the plant's canopy and on the underside of leaves and because of its high reproductive rate. The failure to control whiteflies has also been credited to the ability of immature whiteflies to protect them with a wax secretion that covers their body and is impervious to most insecticides [6]. Botanical insecticides have long been touted, as attractive alternatives to synthetic chemical insecticides for pest management, because botanicals reputedly pose little threat to the environment or human health [12]. Historically, these compounds have been used in agriculture pest control for at least two thousand years in China and the Middle East [13].

Terpenoids are the largest class of plant secondary metabolites. The mevalonate (MVA) pathway in the cytoplasm and the methylerythritol phosphate (MEP) pathway in plastids are synthesized in the plant. At least 40000 compounds of terpenoids have been identified in different parts of plants [14,15]. Chemically, most terpenoids are aromatic compounds, lipid-soluble. The main terpenoids are essential oils responsible for the odor or smell found in many plants [16]. Terpenes are classified according to the number of isoprene units (C_5H_8) [17].

Melia azedarach commonly known as the chinaberry tree, belongs to the Meliaceae family. Many pieces of the literature indicated that the *M. azedarach* tree contains various compounds of terpenoids in roots [18], bark [19]; leaves [20, 21]; seeds [22], and fruits [23].

Previous studies proved that *M. azedarach* extracts act as suitable insecticides against whitefly. [24] indicated a significant reduction in second nymphal instars and egg number of white fly *Bemisia argentifolii* when treated with aqueous extracts of fruit *M. azedarach*. [25] observed that an aqueous extract of *M. azedarach* has a repent effect against first-instar nymphs of whitefly *Trialeurodes vaporariorum*. [26] found that the leaf extract of *M. azedarach* act as an effective insecticide against the adult population of *B. tabaci* at 4 and 6%. Also, [27] showed that the second nymphal stage of *B. tabaci* is susceptible to terpenoid extract of *M. azedarach*.

2. Materials and Methods

Collection and identification of plant samples

Fruits and leaves of *M. azedarach* were collected from gardens at Baghdad University "Jadriyah Campus ."Plants were identified at Baghdad University Herbarium, College of Science. Fruits and leaves of this plant were cleaned from dust, then dried under shade at room temperature for three days. Dried fruits and leaves were ground into powder by an electrical grinder. The powder was kept in a refrigerator at 4°C in a clean container until use [28]. All extraction processes were made in the Botany laboratory at the Biology Department, College of Science, University of Baghdad.

Insect culture

The host plant species used in the study was tomato plants (*Lycopersicon Lycopersicum*) grown from seeds in plastic pots (20 cm diameter) were kept in a large cage with dimensions of (150 x 300 x 200 cm). It was covered with a nylon mesh net until they were severely damaged by whiteflies *B. tabaci*, the new plant added when needed. As well as whiteflies were transferred to potted tomato plants kept inside wooden-framed rearing cages (30 X 30 X 30 cm) covered with white nylon mesh. They were incubated at 25± 2°C, relative humidity 65-70%, and photoperiod was 14:10 (light: dark) hours, provided by fluorescent lamps [29, 30]. Insect identification was confirmed by the Iraqi national history museum of Baghdad University.

For delayed effect, firstly, to obtain newly laid eggs 24 hours old, tomato plants with 30-40 adults (male & female) were kept in wooden-framed rearing cages (30 X 30 X 30 cm) covered with white nylon mesh. They were kept in an incubator at 25 ± 2°C with a relative humidity of 65-70% and photoperiod 14:10 (L:D) hours [29]. 50 eggs 24 hours of age were sprayed with 0.5, 1, 1.5, and 2 mg/ml of plant extracts fruits or leaves (Three replicates of each concentration and control). The eggs were followed up until the adult's emergence. The development period was calculated during the experiment.

Extraction of crude terpenoid compounds

A quantity of 10 gm of plant powder for leaves and fruits was extracted by 200 ml of chloroform in the soxhlet apparatus for 24 hours for extraction. The solvent then evaporated in a rotary evaporator. Crude terpenoid compounds were extracted according to the procedure [28, 31, 32]. The samples were placed in clean dark vials and kept in a refrigerator at 4°C until use.

Detection of terpenoid compounds in M. azedarach.

The crude extract was dissolved in 2 mL of chloroform and evaporated to dryness. 2 ml of concentrated sulfuric acid was added and heated for about 2 min. A grayish color was considered an indication of the presence of terpenoid compounds [33].

Detection of saponins in M. azedarach.

1. Foam test:

Thick foam resulted from shaking 1 ml of extract with 5 ml of distilled water in closed test tube indicated the presence of saponins [34, 35].

2. Mercury chloride reagent:

2 ml of 1% mercuric chloride was added to 5 ml of chloroform extract. The presence of white precipitate indicates the presence of saponins [36].

Preparation of different concentrations

Serial concentrations of terpenoid extract were prepared by dissolving 0.2 mg of terpenoid extraction in 1 ml of dimethyl sulfoxide (DMSO), the volume was completed to 100 ml by using D.W. [37,38].One drop of Citowett added as adhesive agent and surfactant. The control was prepared 1 ml of DMSO and 99 ml D.W. and one drop of Citowett. Different concentrations 0.5, 1, 1.5, and 2 mg/ml of plant extracts were prepared.

Effect of crude extract for terpenoids compounds on immature stages

Leaves of tomato plants with eggs, first, second and third nymphal instars, and pupae (immature stages) of *B. tabaci* on the lower surface placed on wetted cotton in a petri dish [39]. Then sprayed by hand sprayer until runoff, 20 individual (immature stages), four replicates for each concentration as well as control treatment. Then incubated at 25 ±2°C and relative humidity of 65-70%. All mortality rates were corrected according to Abbott formula; for this control deleted from tables [40].

Effect of crude extract for terpenoids compounds on adults

The procedure by [29] was used to evaluate the effects of crud extracts on adult *B. tabaci*. Young tomato plant four to six leaves sprayed with crude compounds until runoff, then 10 adults were introduced to the cylindrical classes by aspirator (covered from the upper with white cloth mesh) then put in incubator for 72 hours at 25±2°C, 65-70% relative humidity and photoperiod 14:10 (L:D) hours. Different concentrations (0.5, 1, 1.5, and 2, mg/ml) of plant extracts were used. Three replicates of each treatment and control. The mortality rate was recorded every 24 hours for three days. All mortality rates were corrected according to Abbott formula; for this control deleted from tables [40].

Statistical analysis

All of experiments designed as factorial experiments with completely randomized design and the least significant difference (L.S.D.) test was used to compare between means [41].

3.Results and Discussion

Table 1 and **2** shows the effect of different concentrations (0.5, 1, 1.5, and 2 mg/ml) of crude extracts of leaves and fruits of *M. azedarach* on different stages of *B. tabaci.* Present study showed that leaves and fruits extracts have an ovicidal effect and suppressed the hatchability of

the eggs even at low concentrations. The mortality rate of eggs was 34.82, 76.83, 84.01 and 98.68% when treated with terpenoids extracts of leaves at concentrations of 0.5, 1, 1.5, and 2 mg/ml, respectively (**Table 1**). When treated with fruits terpenoids the percentage were 31.93, 59.75, 70.09, and 94.86%, respectively (**Table 2**). Also, we observed newly larvae dead after hatching immediately (**Figure 3**). This result might refer to the residual activity of extracts on the emerging crawlers as they were trying to come out of their eggshells. This finding supported by [39] found that treating eggs of whitefly *T. vaporariorum* 5 and 7 days after oviposition with commercial neem extract effect on larval emergence attributed that to contact of emerging larvae with still active residues of the neem treatment. As well, [42] showed that half-emerging of 1st nymphal stadia of *B. tabaci* attributed that to the toxic effect of neem residues. Also, we found that these extracts act as hypertonic solutions making the eggs lose their water and changed their colors (**Figure 4**).

These results are agreeable with those of [43] as they found a reduction in eggs viability of *B. tabaci* when treated with aqueous extract of neem-seed at 0.2 and 2%. Also, [44] concluded that neem oil at a concentration 4 ml/L water was highly effective against eggs of whitefly *Aleuroclava jasmine*. When [45,46] applied pyrrolizidine alkaloids and phenolic compounds from *Ibicella. lutea* leaves on *B. tabaci* eggs, showed inhibition rate reached 64.5 and 67.5%, respectively. Furthermore, [47] found that mortality rate of *B. tabaci* eggs reached 45.02% when treated with crude phenolic compounds of *Nerium oleander* leaves at a concentration 2%.

Additionally, numerous studies have been conducted to evaluate the effect of *M. azedarach* extracts against different insects. [48] found that egg hatching of beetle *Apriona germari* reduced to 87.12% when treated with extracts of *M. azedarach* fruits at 1000 µg/ml. [49] showed that a significant reduction in eggs hatchability of *Anopheles pulcherrimus* when treated with high concentrations of terpenoid compounds of *M. azedarach* fruits. [50] demonstrated the toxic effect of ethanolic extract of *M. azedarach* seeds against *Haemonchus contortus* eggs. Also, [51] found that egg hatching of *Haemonchus contortus* inhibited to 99.4% and 100% when applying aqueous and hydro-alcoholic extracts of *M. azedarach* leaves, respectively at concentration 12.5 mg/ml. [52] showed that the mortality percentages of *Musca domestica* eggs reached 84.18 and 78.57 when treated with crude phenolic compounds of leaves and fruits with concentrations of 0.25-1.5 mg/ml.

Figure (2): shows 1st nymphal instar dead during the hatching (half-emerged dead crawlers) (X40).

Figure (3): shows eggs lost their turgidity (X40).

The mortality rates of first nymphal stadia ranged between 46.87-100% and 48.44-100% at concentrations of 0.5-2 mg/ml when treated with terpenoid extract of leaves and fruits, respectively. Whereas, for second nymphal stadia, the mortality rates ranged between 25.32-100% and 5 2.75-100% at concentrations of 0.5-2 mg/ml when treated with terpenoid extract leaves and fruits, respectively. While, for third nymphal stadia, it ranged between 57.53-95.70% and 44.08-100% at concentrations of 0.5-2 mg/ml when treated with terpenoid extract from leaves and fruits, respectively (**Table1 and 2**)

The present study revealed that nymphal mortality of *B. tabaci* increased as *M. azedarach* extract concentrations increased. [53] showed that the 1st and 2nd nymphal instars were more susceptible than pupae when sprayed with *M. azedarach* extract related to the physiological aspects and increased fat constituent, particularly in pupae or perhaps were associated with the effect of the extract on ecdysis and neuroendocrine hormones. Also, young nymphal were more sensitive than older ones. These findings are supported by [43] found that an aqueous extract of neem-seed act as an antiecdysteroids and inhibition the neuroendocrine functions which control ecdysis in the first larval instar of *B. tabaci*.

Similarly, several local studies proved that *Melia* extracts act as good larvicidal against different insects. [54] found that the mortality rate of Phylloconitis citrella stainton larvae reached 90% when treated with extracts of *M. azedarach* seeds at 25 gm/L. Also, [55] showed that treating *B. tabaci* nymphs with crude oil extract of *M. azedarach* fruits led to increased mortalities with increased concentration. As well as, [56] found that oil extract from *Citrullus colocynthis* seed caused 62.5, 71.2, 89.5 mortality against *B. tabaci* nymphs at concentrations 10, 15, and 20%, respectively. [52] reported that the mortality rate of *Musca domestica* larvae reached 60.92 and 44.98% when treated with crude phenolic compounds of leaves and fruits at concentrations of 1.5 mg/ml.

In global studies, the results are compatible with those of [53] indicated a significant reduction in newly nymphal instars of *B. tabaci* when exposed to fruit extracts from M. azedarach in contrast with eggs and pupae. Nathan & Sehoon [57] showed that the seed extract of *M. azedarach* suppressed the larval activity of teak defoliator *Hyblaea puera* even at a low dose. Also, [58] found that methanolic extracts of leaves and seeds of *M. azedarach* showed intense larvicidal activity for *An. stephensi*. [59] found hydroethanolic extracts of *M. azedarach* leaves effects on the third and fourth-instar larvae of *A. aegypti* after 24 and 48 hours of exposure to the products. [51] found the leaves and seed aqueous and hydro-alcoholic extracts of *M. azedarach* showed 97.8%, 98.4%, and 100% larval development inhibition at 12.5 mg/ml, respectively, of *Haemonchus contortus*. [60] mentioned the aqueous and ethanolic extracts of *M. azedarach* leaves exhibited an antifeedant activity against *S. littoralis* larvae. They caused larvae malformations at the concentration of 2% and made it not able to cross further developmental stages.

Pupae mortality increased by applying the concentrations 0.5, 1, 1.5, and 2 mg/ml of the extracts. It ranged between 40.79 - 86.30% at concentrations of 0.5-2 mg/ml, respectively, when terpenoid extracts of leaves were applied. When fruit extracts were used, the pupal mortality rates ranged between 61.67-87.89% when treated with the same concentrations (**Tables 1 and 2**).

Partially emerged adults were found. Only the head and thorax emerged out of the pupal case. This agrees with Gaur and Kumar's [61] finding that pupa of tobacco cutworm *Spodoptera litura* could not close from the pupal cuticle when treated with root extracts of *Withania somnifera*. Also, [62] observed incomplete adultoid exclusion of peach fruit fly *Bactrocera zonata* from the pupal exuviae after being treated with *Moringa oleifera* leaf extract.

The present study also agreed with [45], showing that Pyrrolizidne alkaloids of *I. lutea* leaves have substantial effects on pupa of *B. tabaci* reached 95.57% at 2% concentration. While it reached 100% when treated with phenolic compounds at the same concentration [46]. [58] found that methanolic extracts of leaves and seeds from *M. azedarach* showed vigorous pupicidal activity on *Anopheles stephensi*. [52] reported that the mortality rate of *M. domestica* pupa reached 67.51 and 51.55% when treated with crude phenolic compounds of leaves and fruits at a concentration of 1.5 mg/ml. Also, [60] reported a significant decrease in the pupa weight of *Spodoptera littoralis* when treated with leaf extracts of *M. azedarach*.

When plant extracts were sprayed on the foliage of tomato plants (**Figure2**). Mortality rates of adults ranged between 8.33-42.68 and 19.90-44.90% at concentrations of 0.5-2 mg/ml when treated with terpenoid extract of leaves and fruits, respectively (**Table 1 and 2**).

Several previous studies reported that *M. azedarach* extracts have insecticidal activity. [63] found that the mortality rate of elm leaf beetle *Xanthogalleruca luteola* increased dramatically when adults fed on treated leaves with an ethanolic extract of *M. azedarach* fruit with 2, 5, and 10%. Similarly, [53] showed that the number of *B. tabaci* adults on tomato plants reduced when treated with fruit and leaf extracts of *M. azedarach*. [64] showed that the mortality rate of An. pulcherrimus adults ranged between 2.35-16.07% and 0.08-6.7% when treated with terpenoid and phenolic compounds of *M. azedarach* fruits at concentrations 500 - 4000 and 500 - 6000 ppm, respectively. At the same time, ethanol extracts of *M. azdarach* drupes showed 61.2% mortality, against rice weevil *Sitophilus oryzae*, at 0.4 ml per 20 g of grains [65]. [66] found that oil fruit extracts of *M. azedarch* caused 100% mortality against *Ocneridia volxemi* at 2% oil and water extracts after 72 hrs. and 144 hrs. of treatment, respectively. [67] reported that the aqueous extracts of fruit and leaves of *M. azedarach* caused an insecticide effect on *D. melanogaster*, reaching 90% mortality.

The present study agrees with many other studies. [54] found that the mortality of *B. tabaci* adults was 40% at concentrations of 20% of crude water extract of *M. azedarach* fruits. In this respect, [45] showed that Pyrrolizidne alkaloids of *I. lutea* leave cause 85% mortality of *B. tabaci* adults at a concentration of 2%. The mortality rate was 68.3% for *B. tabaci* adults when sprayed with a phenolic compound of *I. lutea* leaves at 2%. [68] observed that the mortality rates of whitefly *T. vaporariorum* were 28.3, 25.6, 38.8, 15.6, 84.7, 23.3, 17.5, 22.9, 4.9%, when treated with methanol extracts of each *Nerium Indicum, Fatsia japonica, Dendropanax morbifera, Ficus carica, F.erecta, Pittosparum tobira, Pyracantha angustifolia, and Camellia japonica*, respectively at 10.000 ppm.

Table (1): The effects of crude terpenoids extracts of *M. azedrach* leaves on different stages of *B. tabaci*. Mean (First Line) and Standard Deviation (Second Line).

Extract conc. (%)	Eggs mort. (%)	Nymphal mort. (%)			Pupal mort. (%)	Adults mort. (%)	Delayed Effect (%)
		1st	2nd	3rd			
0.5	34.82 ± 3.48	46.87 ± 3.60	25.32 ± 2.22	57.53 ± 6.70	40.79 ±9.58	8.33 ±4.11	48.14 ± 5.56
1	76.83 ± 3.74	78.27 ± 4.31	58.05 ± 6.07	75.92 ± 10.3	64.21 ±5.00	22.03 ±5.65	57.34 ± 13.23
1.5	84.01 ± 3.28	85.28 ± 6.95	70.72 ± 5.65	89.99 ± 3.60	78.21 ±7.66	36.01 ±12.58	83.93 ± 8.37
2	98.68 ± 1.31	100.00	100.00	95.70 ± 2.60	86.30 ±7.00	42.68 ±15.14	91.53 ± 4.23
LSD	9.578*	13.780*	13.243*	20.137*	23.901 Ns	32.636 ns	27.969*
* (P≤0.05), ns: non-significant.							

Table (2): The effects of crude terpenoids extracts of *M. azedrach* fruits on different stages of *B. tabaci*. Mean (First Line) and Standard Deviation (Second Line).

Extract conc. (%)	Eggs mort. (%)	Nymphal mort. (%)			Pupal mort. (%)	Adults mort. (%)	Delayed Effect (%)
		1st	2nd	3rd			
0.5	31.93 ± 9.35	48.44 ± 14.85	52.75 ± 7.84	44.08 ± 14.58	61.67 ±4.34	19.90 ±3.78	26.35 ± 5.14
1	59.75 ± 4.13	81.05 ± 7.43	82.51 ± 7.45	72.61 ± 2.02	73.34 ±10.88	25.00 ±14.43	60.43 ± 8.51
1.5	70.09 ± 2.53	88.68 ± 6.55	84.12 ± 7.78	94.50 ± 2.15	81.58 ±7.52	43.51 ±6.01	76.35 ± 2.64
2	94.86 ± 3.53	100.00	100.00	100.00	87.89 ±4.37	44.90 ±11.90	95.72 ± 4.27
LSD	17.124*	27.516*	20.532*	22.931*	22.487*	32.636 ns	18.186*
* (P≤0.05), ns: non-significant.							

The results in Tables 1 and 2 show a reduction in the number of adults that emerged from sprayed eggs. It reached 48.14, 57.34, 83.93, and 91.53% when treated with terpenoid leaves at 0.5, 1, 1.5, and 2 mg/ml, respectively, and were 26.35, respectively 60.43, 76.35, and 95.72% for fruit terpenoid extract, respectively at the same concentrations. These results agreed with [39] found that a significant reduction in the number of adults whitefly *T. vaporariorum* emerged from eggs that had been treated with 0.5% Neem Azal-T/S after 5 and 7 days of oviposition.

Furthermore, terpenoid extracts of *M. azedarach* affected the total developmental period of *B. tabaci* (in days) from eggs to adults. At a concentration of 2 mg/ml, the developmental periods were 23.50 days, while it reached 24.00 days at 2 mg/ml when treated with terpenoid extracts of the leaves and fruits, respectively, compared with 21.00 and 20.83 days at control (Table 3). This could be returned to the inhibition of some metabolic enzymes. This finding confirmed by Yousef, and EL-lakwah [69] showed that terpene extract from *M. azedarach* fruits decreased the activity of digestive enzymes, reducing the total contents of proteins and carbohydrates in *Spodoptera littoralis* larvae.

Several previous studies supported our findings and explained the development period of immature stages of *B. tabaci* is prolonged when sprayed with different plant extracts. [43] showed that the lengthening time of *B. tabaci* larvae increased when treated with neem seed extract.

[70] found that aqueous extract and solvent extract of *I. lutea* affected the development period of *B. tabaci*. [71] found that leaves extract of *Lagenaria siceroia* prolongs the developmental period of immature stages of *B. tabaci*. [45] showed that the development period for both *nymph* and pupae of *B. tabaci* increased twice when treated with Pyrrolizidine alkaloids of *I. lutea* leaves at a concentration of 2%. Also, [39] found that the nymph developmental period of *T. vaporariorum* was significantly prolonged when treated with neem products, attributed to the effects of neem ingredients removed gradually.

[46] studied the effects of phenolic compounds of *I. lutea* leaves against *B. tabaci*. They found a prolongation in larval, pupal, and total development periods when treated with a concentration of 0.25%. [47] showed that the development period of immature stages of *B. tabaci* delayed significantly after being treated with extracted phenolic compounds of *N. oleander* leaves and found a direct correlation between the development period and the extract concentration. Similar results also have been reported on immature stages of *B. tabaci* after applying alkaloid extract of *I. lutea* leaves [72]. This finding matches those of [52], indicating that phenolic compounds of *M. azedarach* increased the development period of *M. Domestica* pupae from 5 days in control to 6.4 and 7.2 days after being treated with leaves and fruits extracts, respectively at 1.5 mg/ml.

Table (3): Effect of crude terpenoids extracts of *M. azedarach* on the total developmental period of *B. tabaci* (in days). Mean (First Line) and Standard Deviation (Second Line).

Mean of development periods (days) after treatment eggs with extracts. ± S.D.					
Conc. Extract	**0.0**	**0.5**	**1**	**1.5**	**2**
Leaves	21.00 ±0.00	21.16 ±0.16	22.16 ±0.16	23.00 ±1.12	23.50 ±1.13
Fruits	20.83 ±0.16	21.16 ±0.16	21.83 ±0.16	23.00 ±3.38	24.00 ±2.00
* ($P \leq 0.05$), ns: non-significant					

3.Conclusions

Our results indicate that crude terpenoid compounds of *M. azedarach* leaves and fruits act as a good insecticide against all immature stages of *B. tabaci*, even at low doses under laboratory conditions (25 ± 2°C and relative humidity of 65-70%). A direct correlation was found between extract concentration and the mortality of all developmental stages. Newly nymphal instars are more susceptible than pupae and adults. As well as, the extracts were highly effective against *B. tabaci* after 21 days of spraying the eggs then, consequently causing a reduction in female fecundity. Furthermore, the study suggests using these compounds as an environmentally friendly insecticide to control whitefly.

Acknowledgments

The authors would like to acknowledge Baghdad University herbarium and botany laboratory in the Biology Department College of Sciences/ University of Baghdad for assisting in plant identification and extraction. Acknowledgements are extended to the Iraqi National History Museum for insect identification. We are thankful to the Plant Protection Department - State Board of Agricultural Research /Abu-Graib.

Conflict of Interest Statement

The author declares no conflict of interest.

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