EVALUATION OF CERTAIN AQUEOUS PLANT EXTRACTS AS ANTIFEEDANTS AGAINST *Spodoptera littoralis* (BOISD.) AND ITS BIOLOGICAL ASPECTS

AMANY S. EL-HEFNY AND SH.S. YACOUB

Plant Protection Research Institute, ARC, Dokki, Giza

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Abstract

Extraction of five plants, leaves of dedonia *Dodonaea viscoza*, (family: Sapindaceae), pulps of sour orange, *Citrus aurantium* v. *amara*, family: Rutaceae), midrib of cabbage leaf, *Brassica oleracea v. capitata*, (family: Cruciferae), turnip root, *Brassica rape. esculenta* (family: Cruciferae) and leaves of Mango-singara, *Mangifera domestica* (family: Anacardiaceae) were tested against the third larval instar of the of the cotton leafworm, *Spodoptera littoralis* (Boisd.) in the laboratory to evaluate their antifeedant activity, relative consumption, growth rates and utilization of ingested and digested food. Also, some biological aspects such as fecundity, hatchability, emergence and adult malformation were recorded. Moreover the obtained results clear that all extracts caused a significant reduction in all cases when compared with the control.

The results also, clearly demonstrated that the best extracts may be arranged in descendingly according to its efficacy as dedonia leaves, pulps of sour orange, midrib of cabbage leaf, turnip root and lastly mango-Singara leaves, respectively.

INTRODUCTION

The Egyptian cotton leaf worm, *Spodoptera littoralis* (Boisduval) (Lep., Noctuidae), is one of the major pests as it causes considerable damage to cotton and other cultivated crops and vegetables (Nasr *et al.*, 1984 and Ahmed, 1988). It infesting more than 87 host plants belonging to 40 plant families (Brown and Dewhurst, 1975).

The extensive and continuous use of synthetic insecticides in the developing countries for pests control have led to many problems such as environmental pollution, adverse effects on non-target organisms and the development of resistance strains (Zidan *et al.*, 1985).

Use of natural products from plant origin is a new trend as certain plant families are rich sources of natural substances that could be utilized in the development of alternative safe methods for pest control. The deleterious effects of plant extracts on insects are manifested in several ways including, growth retardation, feeding inhibition, oviposition deterrence and reduction of fecundity and fertility (Wheeler and Isman, 2001).

The principal aim of the present study was to evaluate activity of five plant extracts activity on some biological aspects, antifeedant activity food consumption and utilization against the Egyptian cotton leafworm, *S. littoralis.*

MATERIALS AND METHODS

I. Preparation of material:

Extractions were prepared as Emara *et al.* (1994) by adding 500 ml boiling water to 50 ground parts of some plant materials and stirring, while pulps of sour orange fruits were squeezed without seeds.

The scientific and English name of the aqueous plant extracts of certain parts used in this study are demonstrated as follows:

	Scientific name	English name	Part used
1	*Dodonaea viscoza*	dedonia	leaf
2	*Citrus aurantium* v. *amara*	sour orange	pulp
3	*Brassica oleracea v. capitata*	cabbage	midrib
4	*Brassica rapa* v. *esculenta*	turnip	root
5	*Mangifera domestica*	Mango-singara	leaf

Collected egg-masses of *S. littoralis* from the field were allowed to hatch and the larvae were fed on fresh leaves of castor oil bean. The rearing was carried out under laboratory conditions 27 °C and 55 – 65% R.H. The 3rd instar larvae were selected on the basis of weight. The chosen larvae were starved for about 4 hours before feeding on leaves of castor bean which were treated by the followed extracts by using dipping method. The remaining living larvae were allowed to fed on castor oil until the pupation period and emergence. The newly emerged adults were mated inside glass jars supplied with a piece of cotton wetted with 10% sugar solution as a feeding source the emerged moths, branches of Tafla (*Nerium oleander* L.) as an oviposition site.

Deposited eggs were kept in plastic jars until hatching in order to calculate the different terms of the biological aspects as follows:

$$\% \text{ Fecundity} = \frac{\text{No. of eggs / treated female}}{\text{No. of eggs / untreated female}} \times 100$$

according to Crystal and Lachance (1963)

$$\% \text{ Hatchability} = \frac{\text{No. hatched eggs / female}}{\text{No. of deposited eggs / female}} \times 100$$

$$\% \text{ Emergence} = \frac{\text{No. of emerged adults in treatment}}{\text{No. of emerged adults in check}} \times 100$$

$$\% \text{ Malformed adults} = \frac{\text{No. of malformed adults in treatment}}{\text{No. of adults}} \times 100$$

III: Food consumption and utilization formula:

One hundred and twenty larvae (3rd instar) of *S. littoralis* were starved for 3 hours and then weighed. Fresh castor bean leaves, *Ricinus communis* were weighed, then leaves were dipped for 10 seconds in the different extracted solutions. The treated leaves were left in shade to be air dried. Twenty larvae for each treatment plus control treatment were divided into 4 replicates each one with 5 larvae each kept in plastic containers with treated leaves. Another 4 replicates of larvae were kept in similar containers with untreated leaves as check. The larvae were daily individually weighed for 3 days. The amount of consumed food was calculated, the antifeedant index (AFI) was calculated from the formula of Sadek (2003)

AFI = $[(C - T) / (C + T)] \times 100$ according to

C : food consumption of control leaves

T : food consumption of treated leaves

Also, the feaces were weighed and consumed food was determined. The nutritional indices of consumption rate (RCR), relative growth rate (RGR), efficacy of conversion of ingested food (ECI) and efficacy of conversion digested food (ECD) were calculated by Woldbauer, (1968) and Farra *et al.,* (1989) as follows:

Relative consumption rate, $RCR = I / Ba\ T$

Relative growth rate, $RGR = \Delta B / Ba\ T$

Efficacy of conversion of ingested food, $ECI = (\Delta B / I) \times 100$

Efficacy of conversion of digested food, $ECD = [\Delta B / (I - F)] \times 100$

where:

I: weight of food consumed

Ba: mean of insect weight during the experiment

T: feeding period in days

Δ B: change in body weight

F: weight of feaces produced during the feeding period

Data were subjected to analysis of variance (ANOVA), (F test) and the least significant differences (LSD) were calculated, (Litchfield and Willcoxon, 1949).

RESULTS AND DISCUSSION

1-Effect of extracts on biological aspects:

1-1- Fecundity:

As shown in Table (1), water extract of dedonia had the highest percentage reduction of fecundity being 90.2%. Also, water extracts of pulp of sour orange and midrib of cabbage leaf achieved 83.5 and 81.3% as percentage reduction than control. While extract of mango-singara leaves caused the least reduction fecundity (45.3%).

1-2- Hatchability:

Data In the same previous table (1), showed that the least percentages of hatchability for the *S. littoralis* larvae were 23.3 and 24.4% by water of dedonia and pulp of sour orange extracts respectively. The remaining treatments could be arranged descendingly as water midrib of cabbage leaf, turnip rootand mango-singara leaves extracts being 44.4, 47.9 and 51.9% egg hatchability, respectively.

1-3- Adult emergence:

The results achieved after the follow up of emerged adults' resulting from treated larvae with different water extracts, indicated that the least percentage of adult emergence caused by pulp of sour orange extract (40%). The remaining treatments could be classified in two groups, the first group had intermediate effect (dedonia, midrib of cabbage leave and mango-singara leaves extracts) achieving 50, 57.1 and 57.1% emergence, respectively. While, the second group represented by water turnip root extract achieved 79.9% emerged adults compared with control treatment (93.3).

1-4- Malformation:

The malformation in adults was remarked as a result of different extract treatments and presented in Table (1). The highest percentage of adult malformation was detected from water pulp of sour orange and dedonia extracts being 52.9 and 43.7%, respectively. While, the least effect on the malformation of adults was achieved from water midrib of cabbage leaf and mango-singara leaves extracts (20%). On the other hand, it is quiet evident from the obtained results that the least percentage of adult malformation among the resultant moths realized from control and it was 10%.

2- Antifeedant properties of *S. littoralis:*

The results illustrated in Fig (1), showed that the antifeedant index (AFI) which was calculated after 24, 48 and 72 hours from the beginning of the experiment depending on the rate of food consumption. In the same time, these values increased with the time after treatment, 40 – 59.9, 61.1 – 83.3 and 70.8 – 95.2%.

After 1. 2 and 3 days, respectively. Sour orange extract caused the highest antifeedant activity being 59.9, 83.3 and 95.2 after these periods respectively. On the other hand, singara and cabbage extracts had the lowest AFI values, 40.7 – 40.2, 59.2 – 61.1 and 74.3 – 70.8 after 1, 2 and 3 days, respectively.

3 – Effect of extracts on food consumption and food utilization.

3-1- Relative consumption rate (RCR):

Data presented in Table (2), clearly showed that the different aqueous extracts reduced relative consumption rate was calculated when 3rd instar larvae *S. littoralis* were fed on food treated by water pulp of sour orange extract being 0.45 gm / gm / day. The remaining treatments caused unsignificant RCR reduction, compared with water sour orange extract. RCR reduction could be arranged descendigly as turnip root, dedonia leaves and midrib of cabbage leaf achieving RCR as 0.64, 0.73 and 0.83 gm / gm / day, respectively. Lastly, water-mango singara extract had a significant reduction (1.83 gm / gm / day) than the former treatments and control treatment (2.0 gm / gm / day).

3.2. Relative growth rate (RGR):

The data in Table (2), showed that water-dedonia extract came on the top of the treatments realizing the lowest relative growth rate being 0.12 gm / gm / day and insignificantly followed by water-pulp of sour orange and turnip root extracts having the same rate 0.13 gm / gm / day. Lastly came the midrib of cabbage leaf extract achieving 0.16 gm / gm / day.

3-3- Efficacy Conversion of ingested food (ECI):

The efficacy of conversion of ingested food was used as a nutritional index differentiates between the extracts against *S. littoralis* larvae. Values of this parameter differed, as previous, according to the extract, 24.5% for dedonia extract increased to reach a maximum 42.4% for mango extract, which recorded 73.8% in the control, Table (2).

These results indicated that, the ability of *S. littoralis* larvae to the food differed with the extract used. The least ability obtained with dedonia while the highest was with mango extract.

3-4- Conversion of digested food (ECD):

Data in the same pervious table pointed to that, the control larvae had the highest ECD (91.5%), followed, significantly, by water mango-singara extract (57.3%) to be considered the least effective extract. On the other hand, water-dedonia extract recorded 30.5% in which it was the most effective extract against the larvae. It was followed insignificantly by water-pulp of sour orange (37.2%), turnip root (39.6%) and midrib of cabbage leaf (43.4%), (Table 2).

Table 1. Effect of the tested plant extrat on rate of fecundity, hatchability, emergence and malformation of *Spodoptera littoralis* (Boisd.)

Treatment	Mean No. of eggs laid / female	%Fecundity Reduction	No. of hatched eggs	% Hatchability	% Reduction in hatchability	%Emergence	% adult malformation
1. Dodonia	36.5	90.2	8.5	23.3	73.7	50	43.7
2. Puplp of sour orange	61.5	83.5	15	24.4	72.5	40	52.9
3. Midrib of cabbage leaf	69.8	81.3	31	44.4	50	57.1	20
4. Turnip rape	177.5	52.4	85	47.9	46	76.9	27.7
5. Mango-singara	203.8	45.3	105.8	51.9	41.5	57.1	20
6. Control	372.8		330.5	88.7		93.3	10

Table 2. Parameters reveal efficacy of five extracts against *Spodoptera littoralis* larvae.

Extracts	AFI (%)				RCR	RGR	ECI	ECD
	1	2	3	Mean	mg/ gm/ d	mg/ gm/ d	%	%
1- Dedonia	51.2	77.6	90.3	73.0	0.73 a	0.12 a	24.5 a	30.6 a
2- Sour orange	59.93	83.3	95.2	79.2	0.45 a	0.13 a	33.1 a	37.2 a
3- Cabbage	40.2	61.1	70.8	57.4	0.83 a	0.16 a	37.9 bc	43.4 ab
4- Turnip	55.1	72.3	87.1	71.5	0.64 a	0.13 a	34.1 c	39.6 ab
5- singara	40.7	59.2	74.3	58.1	1.38 b	0.14 a	42.4 d	57.3 b
6- Control					2.0 c	0.59 b	73.8 d	91.5 c
F value	_	_	_		11.2	22.61	35.49	156.0
L.S.D.	_	_	_		0.53	0.12	8.9	19.0

Means had the same letter (s), within each column are insignificantly different.

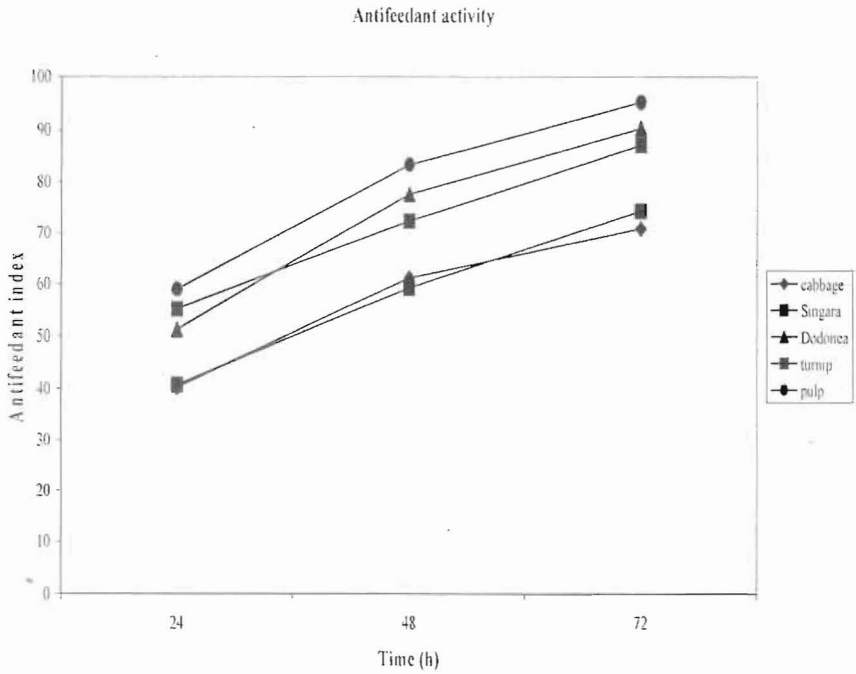

Fig 1. Antifeedant activity of the different crude tested extracts against *Spodoptera littoralis*.

The previous results revealed that the tested extracts could be considered as promising antifeedants from some abundant plants in Egypt for controlling *S. littoralis* unless they are in harmony with those obtained Antonious and Hegazy (1987) evaluated feeding deterrent activities of the potential extract and they proved marked effects as reduction in the produced feacal pellets, larval starvation, pupation and moths malformations. In the same trend, Sadek (2003) stated that antifeedant activity of *Adhatoda vasica* leaves extract exhibited chronic toxicity against *S. littoralis* larvae and reduction on the food consumption.

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تقييم بعض المستخلصات النباتية المائية ضد دودة ورق القطن كمانعات تغذية وتأثيرها على بعض الخصائص البيولوجية

أمـــاني ســـامي الحفنى ، شنـــــوده سيـــــد يعقـــــوب

معهد بحوث وقـــاية النباتات – مركز البحـــوث الزراعيـــة – الدقى

تم اختبار بعض الأجزاء النباتية كمستخلصات مائية وهى أوراق نبات الديدونيا ولب ثمـــار اللارنج والعرق الوسطى لورقة الكرنب ودرنة اللفت واوراق نبات المانجو صنف سنجارة ضد العمر اليرقى الثالث لدودة ورق القطن معمليا، وذلك لتقييم التأثير المانع للتغذية ومعدل اســـتهلاك الغـــذاء ومعدل النمو وكذلك معدل الاستفادة من كل من الغذاء المقدم والمهضوم. ايضا تـــم تقـــدير بعـــض النواحي البيولوجية مثل النسبة المئوية للخصوبة والفقس وخروج الفراشات واخيرا تشوهات الأفـــراد الكاملة. أظهرت النتائج المتحصل عليها أن جميع المعاملات قد سببت خفضا معنويا عن المقارنة.

ويمكن من خلال النتائج ترتيب المستخلصات ترتيبا تنازليا تبعا لكفاءتها كما يلى: مستخلص أوراق الديدونيا، لب ثمار اللارنج، العرق الوسطى لورقة الكرنب، جذور اللفت واخيرا مـــستخلص أوراق المانجو صنف السنجارة، على الترتيب.