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Comparative biopotentials of bitter guard, *Momordica charantia* Linn. Winter cherry, *Withania somnifera* Dun. and Black nightshade, *Solanum nigrum* Linn. agaist Bihar hairy caterpillar, *Spilarctia obliqua* Linn. (Lepidoptera: Arctiidae)

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Abstract

Various plant parts like unripe fruits of *Momordica charantia* Linn. (Cucurbitaceae), rhizomes of *Zingiber officinalis* Linn. (Zingiberaceae), leaves of *Withania somnifera* Dun and *Solanum nigrum* Linn. (Solanaceae), were taken for preparation of powder and extractions under laboratory condition. From obtained extract different concentrations (0.5, 1.0 and 2.0 percent) were prepared for experimentation against Bihar hairy caterpillar, *Spilarctia obliqua* Linn. (Lepidoptera: Arctiidae) and one untreated control was also done. The result from observations on mean mortality of three treatment and each treatments with three repelications were calculated. The highest mortality was recorded in *Momordica charantia* Linn. (72.83%) followed by *Withania somnifera* Dun. (64.82%) and *Solanum nigrum* Linn. (64.82V) whereas *Z. officinalis* Linn. (59.64%), and control (12.26%), respectively.

Keywords: Botanical insecticide, dosage, mortality, seed quality, storage pest

1. Introduction

A large number of insect-pests as, Bihar hairy caterpillar, *Spilarctia obliqua* Walker, cabbage butterfly, *Pieris brassicae* Linn., cotton leafwarm, *Spodoptera littoralis* Baised, cabbage borer, *Hellula undalis* Fabr., mustard sawfly, *Athalia proxima* Klug., cabbage semi-looper, *Trichoplusia ni* Hub and cabbage leaf webber, *Crocidolomia binotalis* Zell. and stored insect pest like Maize weevil *Sitophilus zeamais* and *Sitotroga cerealella* are limiting factors of crops, vegetables and stored grain insect-pest.(Antonius and Hagazy 1987, Weaver *et al.* 1991, Krishnarajah, *et al.* 1985, Ahmed and Eapen 1986, Mehta. and Sandhu 1992, Mwangi *et al*. 1992) [1-6]

Among them, larvae of, Bihar hairy caterpillar, *Spilarctia obliqua* Walker are the most damaging to the vegetable and crops. (Turowski 1963) [7]. Among above mentioned insect pests, Bihar hairy caterpillar, *Spilarctia obliqua* Walker (Lepidoptera: Arcitiidae) is a sporadic in nature has been in regular occurrence in northern Indo- Gangatic reigion, causing considerable damage to cruciferous crop, vegetables, pulses, cereals, oil seeds, fiber crops and other plants of economic importance in our country (Deshpande and Tipnis 1977, Golob and Webley 1980, Meisner *et al*. 1981) [8-10].

The larvae feed and causing enormous destruction by making holes in the leaves

In nature, there are so many plant species, which are not even touched by the insets to feed. It means, such plants must have some to deterring chemicals, which exhibit their feeding. Such plants are being utilized for insect pest management (Bekele, *et al.*1996, Abe and Matsuda 2000, Chandel *et al.* 2004, Dubey *et al.* 2004) [11-14]. Therefore, the need for the alternative pest control has been device,which have insecticidal properties to combat the hairy caterpillar, *Spilarctia oblique* destructions.

Recently, application of synthetic pesticide has been considered as the most effective management strategy of storage pests. Most of farmers depend on this method to control the pest infestations, though it takes high cost ([xxxxxx]. This long-term application also rose the public awareness related to the adverse impacts towards the human health and environment (Srivastava and Awasthi 1958, Paul *et al.* 1965) [15, 16].

Therefore, the development of eco-friendly strategy to control the storage pests has been widely investigated through the utilization of bioactive compounds extracted from plants (Sahoo and Senapathi, 2000) [17]. These botanical sources offer more affordable control strategy since the raw materials are easily found from the local flora and its bioactivity properties could be generated without having fully purified (Chandel *et al.* 2001, Chalapathi Rao, *et al*. 2002) [18, 19].
Considering its availability, the utilization of botanical insecticide should be adjusted based on the local flora found in each location. One of plants showing potential bioactivity properties found in the vicinity of Kanpur Uttar Pradesh, India. Previous studies emphasized that certain naturally occurring botanicals contained diverse array of medicinal and insecticidal properties against a number of insect pest [20]. However, the use of this plant to manage the Bihar hairy caterpillar, *Spilarctia obliqua* Linn was poorly studied.
Therefore, this present study was aimed to evaluate the insecticidal activity of bitter guard extract against the number of insect-pest [21] and investigate the effect of this botanical compound towards the quality of seed during storage. The results of this study would enrich the choice of potential botanical insecticides for the management of storage pest, thus might reduce the use of synthetic pesticides.

2. Materials and Methods

2.1 Procurement of raw plant materials

The regular experiments of selected four botanical soxhlet extractives regarding insecticidal efficacy were conducted under laboratory conditions. The plants parts used for extracts were collected mainly from wasteland and wild areas and some plants were collected from cultivated fields of the farmers. The investigations on the screening of various available indigenous naturally occurring plant extracts on *viz.* unripe fruits of Bitter guard *Momordica charantia Linn.* (Cucurbitaceae), leaves of Black nightshade, *Solanum nigrum* Linn. (Solanaceae), Winter cherry, *Withania somnifera* Dun. (Solanaceae) and rhizomes of *Zngiber officinalis* Linn. (Zingiberaceae) were screened for their bioefficacy insecticidal against third instars caterpillars of Bihar hairy caterpillar, *Spilarctia obliqua* Linn. laboratory.

Table 1: List of selected plant extract, their vernacular name, part used and natural order

Scientific Name	Vernacular Name	Part Used	Family
Momordica charantia Linn.	Bitter guard	Unripe fruits	Cucurbitaceae
Solanum nigrum Linn.	Black nightshade	Leaves	Solanaceae
Withania somnifera Dun.	Winter cherry	Leaves	Solanaceae
Zingiber officinalis Linn.	Ginger	Rhizome	Zingiberaceae

2.4 Apparatus used for experiment

Small plastic jars (capacity 50 ml) were used for the experiment; there was one set of two jars joined by clear plastic pipe of 1cm diameter at an angle of 180 degree for each replication. One jar of each set was provided with 5cm of leave given the name 'A' while the other jar was kept empty and given the name 'B'. In jar 'A', the grains treated with extracts were placed, while the jar B remained empty. The jars used for experiment were disinfected with alcohol.

2.5 Preparation of Stock Solution

For stock solution, 50ml. extract in each case was taken into reagent bottles and 50ml. benzene was added in it to dissolve the constituents of the materials. The mouth of the bottles were stopper with airtight corks after which, these bottles containing the solutions were kept in refrigerator.

2.6 The Insecticidal Formulations

Five concentrations (0.5, 1.0, 2.0 percent) were used for experiments on insecticidal tests in the laboratory conditions. However, only three concentrations (0.5, 1.0 and 2.0 percent) were used for insecticidal test in the laboratory experiment. The different concentrations of the herbal extracts were prepared from the stock solution using benzene as solvent and Triton X-100 as emulsifier. The level of solvent and emulsifier were kept constant.

Table 2: Preparation of different formulations of the selected plant materials

Concentration (%)	Amount of Stock Solution (ml)	Amount of Benzene (ml)	Amount of Emulsifiable Water (ml)	Total Amount of water (ml)
0.50	5.00	20.00	475.00	500.00
1.00	10.00	15.00	475.00	500.00
2.00	20.00	5.00	475.00	500.00

3. Experimental Protocol

For testing the insecticidal bio-efficacy, mustard 'varuna' leaves as food were taken in a plastic container (300 ml) were used as food sprayed with different concentrations (0.5, 1.0 and 2.0 percent) of each extract and then air dried for 30 minutes to farm a dry film on treated leaves. Five pairs of newly emerged one day old adult beetles were released in each plastic container and the mouth was closed with its lid. Each treatment was replicated thrice including control. All treated containers were kept at ambient room temperature (27-30 °C) in the laboratory for mortality. After 6, 12 and 24 hours, dead and alive beetles were counted and removed from each container. The efficacies of plant materials as insecticides against third instar caterpillars of Bihar hairy caterpillar, *S. obliqua* Linn was assessed considering mortality percentage. Thus data was collected on the number of Bihar hairy caterpillar, *Spilarctia obliqua* Linn. were died on treated food and mortality over control was recorded. The data were arranged in tabulated form and graph formats. The mortality (%) was corrected by Abbots's formula (Abbott, W.S. 1925) [23].

Table 3: Mean mortality% of *S. obliqua* against diferrent concentrations and extracts

Treatment	Con.	Lab.	Mean	Mortality	%	After	
		6	Hrs.	12	Hrs.	24	Hrs.
(Plant extracts)	(%)	T_1	T.B.V.$_1$	T_2	T.B.V.$_2$	T_3	T.B.V.$_3$
M. charantia Linn.	0.5	48.93	56.8	61.22	76.8	68.85	87.0
M. charantia Linn.	1.0	68.85	87.0	68.85	87.0	83.85	98.9
M. charantia Linn.	2.0	75.00	93.3	90.00	100.0	90.00	100.0
S. nigrum Linn.	0.5	39.23	40.0	45.00	50.0	59.01	73.5
S. nigrum Linn.	1.0	54.78	66.7	63.44	80.0	77.71	95.5
S. nigrum Linn.	2.0	61.22	76.8	75.00	93.3	83.85	98.9
W. somnifera Dun.	0.5	43.08	46.6	46.92	53.4	56.79	70.0
W. somnifera Dun.	1.0	54.78	66.7	56.79	70.0	61.22	76.8
W. somnifera Dun.	2.0	83.85	90.0	90.00	100.0	90.00	100.0
Z. officinalis Linn.	0.5	41.15	43.3	45.00	50.0	48.85	56.7
Z. officinalis Linn.	1.0	50.77	60.0	52.78	63.4	59.01	73.5
Z. officinalis Linn.	2.0	71.56	90.0	83.85	98.4	83.85	98.9
Control (Benzene+ H_2O)	-	0.00	0.00	18.44	10.00	18.44	10.00

Figures within TBV represent mean percentage transformed back values.)
C.D. for the treatment combination means = 0.139

The analysis of variance in table 4 shows that the main effect of insecticides, concentration, period as well as first order and second order interaction are highly significant "insecticide x concentration", which is non-significant. The effect of "Control x Treatment"

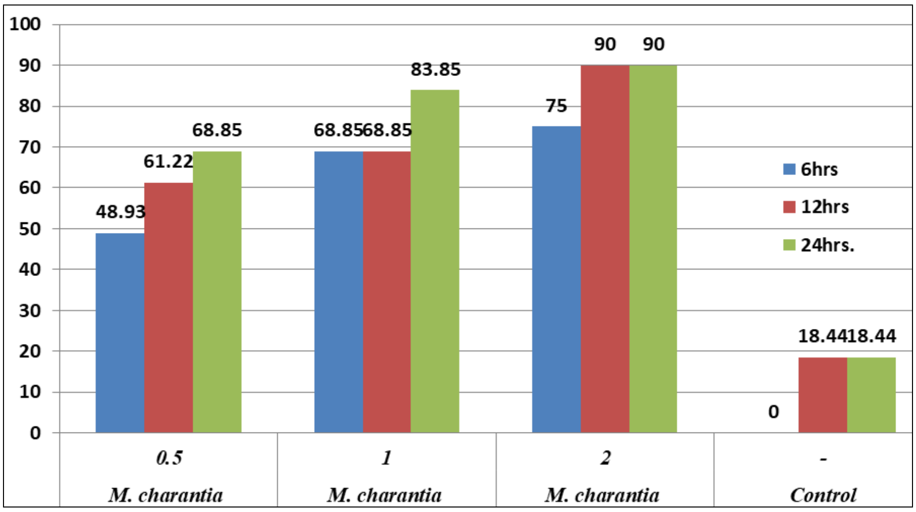

Fig 1: Mean larval mortality of *Spilarctia obliqua* against different conc. and *M. charantia*

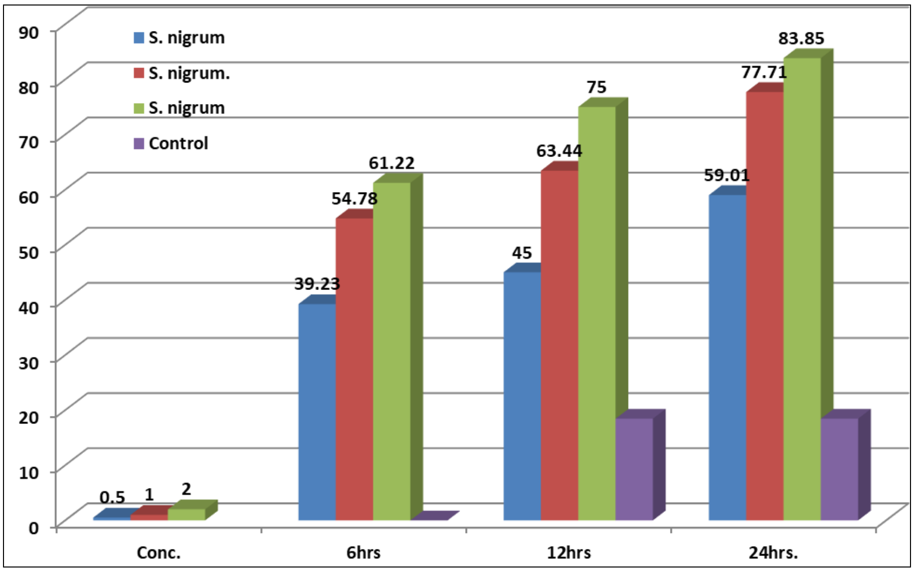

Fig 2: Mean larval mortality of *Spilarctia obliqua* against different conc. and *S. nigrum*

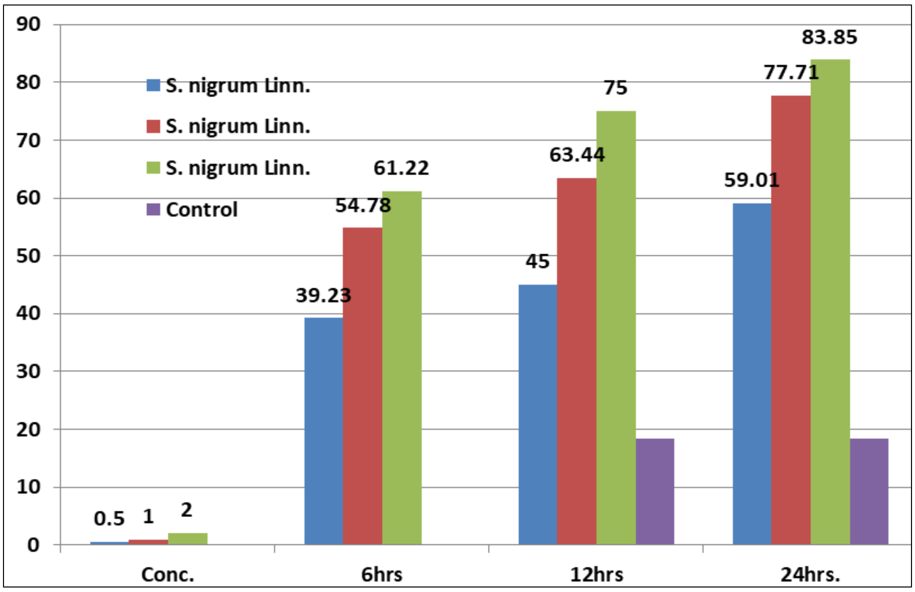

Fig 3: Mean larval mortality of *Spilarctia obliqua* against different conc. and *W. Somnifera*

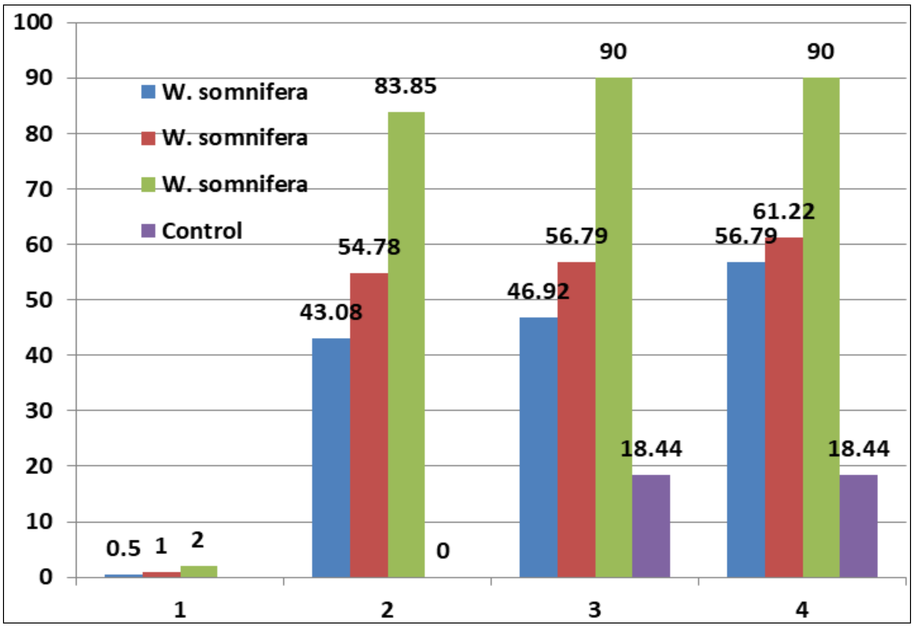

Fig 4: Mean larval mortality of *Spilarctia obliqua* against different conc. and *Z. officinale*

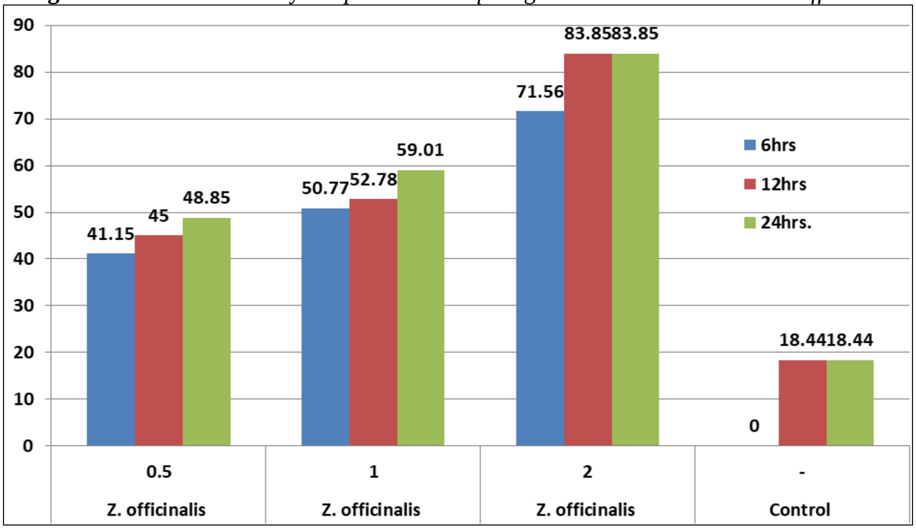

Fig 5: Mean larval mortality of *Spilarctia obliqua* against different extracts

Table 4: Mean mortality% of *S. obliqua* in exposure periods irrespective of concentration

Treatment	Lab.	Mean	Mortality	%	After		Mean	%
	6	Hrs.	12	Hrs.	24	Hrs.	Mortality	
(Plant extracts)	T_1	TBV_1	T_2	TBV_2	T_3	TBV_3	G.T.	TBV
M. charantia	64.26	81.1	73.35	91.8	80.90	97.5	72.83	91.3
S. nigrum	51.74	61.6	61.14	76.7	73.52	91.9	62.13	78.2
W. somnifera	60.57	76.7	64.57	81.6	69.33	87.5	64.82	81.9
Z. officinalis	54.49	66.3	60.54	75.7	63.90	80.7	59.64	74.5
Control	0.00	0.00	18.44	10.00	18.44	10.00	12.26	4.25

The highest mortality was recorded in *Momordica charantia* Linn. (72.83%) followed by *Withania somnifera* Dun. (64.82%) and *Solanum nigrum* Linn.(64.82V) whereas *Z. officinalis* Linn.((59.64%), and control (12.26%), respectively.

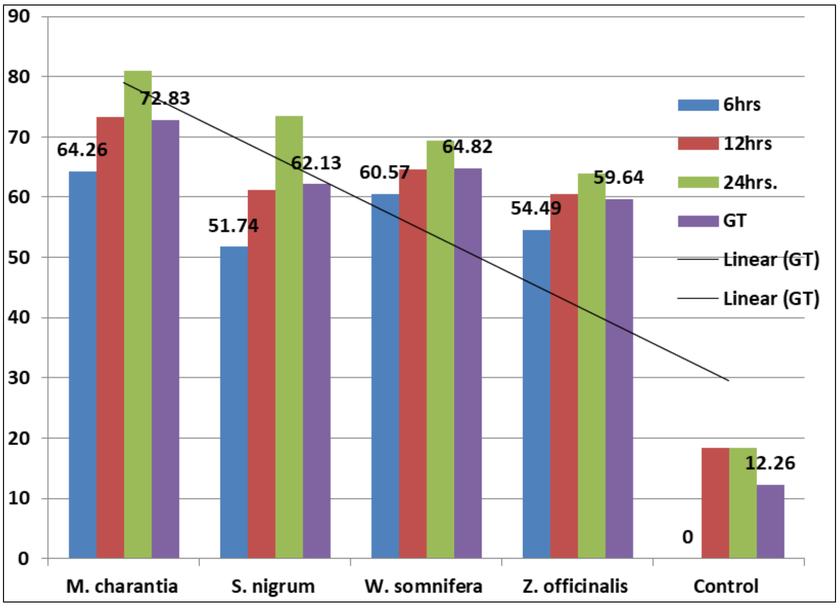

Fig 6: Mean larval mortality of *Spilarctia obliqua* against different extracts in different exposure periods

Table 5: Mean mortality percentage of *Spilarctia obliqua* in different concentration irrespective of treatments.

Concen-trations		Lab.	Mean	Mortality	%	After	Mean	%
	6	Hrs.	12	Hrs.	24	Hrs.		
	T_1	**TBV_1**	**T_2**	**TBV_2**	**T_3**	**TBV_3**	**G.T.**	**TBV**
0.5	45.19	50.4	49.74	58.2	57.09	70.5	50.67	59.8
1.0	56.96	70.3	62.23	78.3	68.38	87.0	62.50	78.7
2.0	75.25	93.5	83.32	98.7	80.06	97.1	81.54	97.9

(Figure within parenthesis represent mean percentage transformed back value)
C.D. for treatment x period means = 0.080
C.D. for treatment means (plant extract) = 0.045
C.D. for treatment means (control) = 0.139

Table 5 indicates that all the three concentration differed significantly to one another. The concentration 2.0% is superior to concentration 1.0 and 0.5%. 2.0% concentration killed grubs of *S. obliqua* (81.54%).

It is also observed that the difference in the percentage kill of grubs in concentration 2.0% and 1.0% is greater than the difference in concentration to kill the grubs in 1.0% and 0.5% in all the three periods.

Table 6: Mean mortality percentage larvae of *S. obliqua* in different exposure periods irrespective of treatments under *In vitro*.

Treatments	Lab.	mean	mortality	%	after		Mean	Mor-
	6	Hrs.	12	hrs.	24	hrs.	tality	(%)
	T_1	**TBV_1**	**T_2**	**TBV_2**	**T_3**	**TBV_3**	**G.T.**	**TBV**
Plant Extracts	59.13	73.7	65.09	82.3	70.49	88.9	64.91	82.0
Control	00.00	0.00	18.44	10.00	18.44	10.00	12.26	4.25
Mean values	29.56	24.4	74.31	92.7	79.71	96.9	71.04	89.5

Similarly the difference in percentage mortality of the grubs in 24 hours and 12 hours is greater than the difference in percentage mortality in the period of 12 hours and 6 hours.

4. Result and Discussions

The data depicted in table 3 and figure 1to 5 and 6 indicated that the plant extract of *Momordica charantia* Linn. Gave the maximum and highest larval mortality. It killed 72.83%% larvae of *S. obliqua* followed by *Withania somnifera* Dun. (64.82%) and *Solanum nigrum* Linn. (64.82% TBV) whereas *Z. officinalis* Linn. (59.64%), and control (12.26%), respectively. The plant extract of *Momordica charantia* differed significantly from remaining once except *Withania somnifera* from which it does not differs significantly to one another.

The table 4 and Figure 6 reveals that the transformed back values of plant extract of *Momordica charantia* Linn. Showed 91.3% larvae mortality (TBV) of larvae of *S. Obliqua* followed by *Withania somnifera* Dun. (81.9%TBV) and *Solanum nigrum* Linn. (78.2 TBV) and *Z. officinalis* Linn.((5974.5% TBV), whereas control (4.25%), respectively. The plant extract of *Momordica charantia* differed significantly from remaining once except *Withania somnifera* and *Z. officinalis*, from which it does not differs significantly to one another.

Table 5 indicates that all the three concentration differed significantly to one another. The concentration 2.0% is superior to concentration 1.0 and 0.5%. It is observe that the difference in the percentage larvae of *S. obliqua* kill in concentration 2.0% and 1.0% is greater than the difference in concentration to kill the grubs in 1.0% and 0.5% in all the three periods.

The Table 6 indicates that the maximum percentage of larvae of *S. obliqua* mean mortality after 24 hrs. (79.71%) and minimum after 6 hrs (29.56%). The period of 24 hrs. is significantly superior to period of 12 hrs. (74.31%)%) and 12 hrs. (29.56%) in both control and treated.

The overall effect of all the treatments in killing the larvae is greater than that of control in all the three periods. Finally, it can be concluded on the basis of Table 28 that all the ten plant extracts are toxic to Bihar hairy caterpillar, *S. obliqua* Linn. larvae. Among all the four plant extracts, of *Momordica charantia* Linn. Is most toxic and placed at the top and *Z. officinalis* is least toxic and placed at the bottom of merit of selected bio-insecticide.

The present findings to the inconformity with those workers who has done works on use of eco-friendly naturally occurring indigenous plant origin insecticides against various insect pest of crop and vegetable.

Gautam and Chauhan (2003) [21] tested insecticidal properties of 24 asteraceous plants against *S. obliqua* Walk. and observed that 1000 ugml-1 abstract of S. lappa was most effective (65.3% mortality) followed by *Cichorium intybus* (54.6%) and *Vernonia cinerea* (38.6%) as compared to extracts of other species.

Singh and Kanaujia, (2003) [22] evaluated certain biopesticides against third instar larvae of *Spilosoma obliqua* Walk. on castor. Out of which NSKE (5.0%) exhibited 1.44% residual toxicity and have third position of relative toxicity i.e. 158.84 Pt values.

Abe and Matsuda (2000) [23] tested *Momordica charantia* leaves ethnol extract at 120- ug/fifth instar caused 51.8% S. litura larval mortality. Gautam and Chauhan (2003) [21] tested insecticidal properties of 24 asteraceous plants against S. obliqua Walk. and observed that 1000 ugml-1 abstract of S. lappa was most effective (65.3% mortality) followed by *Cichorium intybus* (54.6%) and Vernonia cinerea (38.6%) as compared to extracts of other species [ ].

Tested the efficacy of new insecticides against citrus leaf miner, *Phyllocnistis citrella* Stainton and compared with commonly used insecticides along with neem- based formulations. Among different insecticides evaluated neem formulations *viz*., neem seed kernel, azadirachtin were found in causing high mortality of leaf minor larvae.

5. Conclusion

Overall it can be concluded that application of botanical insecticide exhibited strong insecticidal activities especially in unripe fruit extract of *Momordica charantia* and leaves ectract of *Withania somnifera* Dun. Both plant extract also showed no negative effect on the seed. Therefore, these results emphasized the promising potential of botanicals to be developed as the botanical insecticide for the management of Bihar hairy caterpillar, *Spilarctia obliqua* Linn. (Lepidoptera: Arctiidae) under laboratory trials.

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