Contents lists available at ThomsonReuters

The American Journal of Science and Medical Research

Journal homepage: http://globalsciencepg.org/ajsmr.html

Research Article

Influence of Andrographolide on the Growth and Development of *Corcyra cephalonica* (Lepidoptera: Pyralidae)

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http://dx.doi.org/10.17812/ajsmr432
Received : 19 August, 2018
Accepted; 23 September, 2018
Available online :29 September, 2018

ISSN: 2377-6196
Published by Global Science Publishing Group. USA

Keywords: Andrographolide, Corcyra cephalonica, Larvae, pupa

ABSTRACT

Andrographolide is the main bioactive component of Andrographis paniculata it is diterpenoid and bitter substance which is extracted from the stem and leaves of the *Andrographis paniculata*. andrographolide exhibits a broad range of biological activity. It is an insect growth regulator, we observed the effect of different concentrations (2, 4, 6, 8 and 10 µg/µl doses) of andrographolide on the growth and development of *Corcyra cephalonica*, in our observations various morphological abnormalities like deformation and degeneration were observed in the larval and pupal stages. The untreated *Corcyra cephalonica* showed normal in the developmental stages with the larval instar stages and henceforth developing into pupa without any deformities. However andrographolide affected larval instars showed disrupted structures of the cuticle like tanning of cuticle and abnormal larvae over-aged larva with either complete or partial damage of pupa. The results demonstrated that andrographolide causes rapid cessation of growth due to disruption of larval structure and inhibition of growth following topical treatment on 4th 5th instar and pupae of *Corcyra cephalonica*.

1. Introduction

The modern insecticide researches started almost 65 years ago with the chlorinated hydrocarbons, organophosphates, methyl carbamates and botanicals, the use of these conventional organic insecticides to control insect pests[9]. In the recent years, the use of synthetic pesticides for pest management has become highly controversial. These pesticides are known to cause extensive environmental hazards as these pesticides accumulated at various concentrations in different levels of ecosystem. Also, the development of pesticide resistance in the pest is another reason of controversy. Even though the insects are exposed to an insecticide for long duration they manifest slowly, the insect not only develops resistance against the specific insecticides to which they are exposed to, but also a group of insecticides develop resistance by way of cross-resistance. To overcome these problems, attempts were made to develop alternate methods of pest control including the use of cultural practices, biological control, use of antifeedants, hormonal insecticides (IGRs) plant extracts. [2,31]

In the search for safer insecticide approaches, interest on plant products acting as an insecticides has grown as more and more pesticides are eliminated from use due to environmental and food safety problems[14] The plant kingdom affords a rich storehouse of chemicals of diverse biological effects on insects. In recent years several plants with insecticidal properties have been identified. Environmentally safer pesticides are selectively toxic, do not bio-accumulate, and exhibit relatively short persistence in the environment. more selective modes of action and reduced risks for non-target organisms and the environment they are most desirable in the modern integrated pest management programs, in the last two decades with the development of natural and synthetic compounds capable of interfering with the processes of growth, development and metamorphosis of the target insects. Plant products (insecticides) appear to be eco-friendly and mixtures of biologically active substances, because they have been found to be selective[24] and pose less negative impacts to ecosystems than conventional insecticides [27].

Use of plant products to insect pest control that adversely affect insect growth and development without causing environmental hazards. These substances were classified as "Insect hormone mimics" or "insect growth regulators" (IGRs). They were considered to have reduced risk as reported by the[29] to being soft to beneficial insects and target specific for juvenile stages. There are three types of insect growth regulators-hormonal, enzymatic and chitin synthesis inhibitors. Both juvenile hormone analogues and ecdysone inhibitors disrupt the ratio of hormones in the young insect. For an insect to be moult in the next stage, the correct ratio of juvenile hormone

and ecdysone must be present. Ecdysone is a primary moulting hormone which is necessary for insects to change from the larval to pupal stage. If the ratio of one hormone to other is not proper, the insect fail to become adult, reducing reproduction and subsequently population increase. With some IGRs, adults even fail to produce viable eggs.

Plants are potential producer of novel chemical compounds which cannot yet be synthesized. Estimations suggest that over 2000 plant species have the potential to identify and develop new chemistries to reduce bacteria, fungal, and insect/arthropod pests[13]. The complexity in chemical compounds in biorational products can also make development of resistance by insect pests is more difficult[21]. These environmental issues have driven agricultural researchers to search for better ecofriendly based pesticides[30].*Corcyra cephalonica* was believed to be of eastern origin but became a cosmopolitan species spreading throughout the world with the transport of food stuffs. Its absence from apparently suitable habitats ex. Flour mills in Iraq, Iran and areas of Pakistan was believed to be due to low moisture contents of stored food in such places.*Corcyra cephalonica* attacked stored products like Sorghum, Bengal grams, groundnut seed and cakes, wheat and wheat bran, rice and rice bran, cotton, maize,cereals, pulses, oil cakes, nuts, dried fruit and various processed foods, redgram, greengram, cowpea, and gingelly cakes in descending order based on the severity of infestation and damage.

Corcyra cephalonica is a pest of stored grain. The quality of the grain will deteriorate unless protected from pests. The larvae of *Corcyra cephalonica* damage the grains of rice and maize by feeding under silken webs. In case, of whole grain Kernels are bound into lumps. When infestation is high the entire stock of grains may be connected into a webbed mass. Ultimately a characteristic bad smell develops and the grain is rendered unfit for human consumption. Larvae are serious economic pests that cause quantative and qualitative losses in tropical and sub-tropical regions. In the present study Andrographolide which was isolated from *Andrographis paniculata.* We investigated the developmental activity effects of Andrographolide on the fourth and fifth instars and pupae of *Corcyra cephalonica,* in laboratory assays

2. Material and Methods

2.1 *Test Insect*

The larvae of *Corcyra cephalonica* caused damage to stored products firstly by feeding and secondly by leaving silken threads wherever they move, thus forming a dense webbing leading to the formation of silken galleries. In case of heavy infestation, food materials become tightly matted together with webbing, larval galleries, cocoons and excreta. Severe pest attack resulted in entire destruction of the stored products and leads to damage of the foodstuffs. Several **insecticides** offer quick and effective control of the pest. Keeping in view their adverse effects on the environment and other non-targeted organisms here an attempt is made to review the historical distribution, biology and biological management methods which are best suited to integrated pest management programme.

2.2 *Collection of Larvae and Maintenance:*

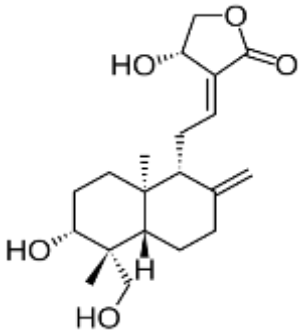
Larvae: The larvae start feeding immediately after hatching. They grow in 25-35 days. There are five instars. The larvae alone cause damage to the grains.Pre-pupal stage: It is the non feeding stage when the larvae make silken cocoons among the grains for pupation. The duration of this stage is 4-5 days. Pupal Stage: This stage spreads over 7-8 days and the insect is in a quiescent state. This arrangement has helped the larvae and adults to evolve in different directions, the larvae specializing in food gathering and the adults developing advanced means of reproduction and dispersal .The adult moths of *Corcyra cephalonica* survive for 8-10 days and are of great economic importance. The adults have a siphoning type of mouth parts, so adults do not feed on the grains. The larva has a well developed chewing type of mouth parts. It is the larva that feeds on the grains and forms infesting stage .The larval stages for the present study were classified on the basis of body weight and head capsule size.IV Instar, chosen for the present study was 45-55mg on an average in weight. The head capsule size was 0.72-0.78 mm .

V Instar larvae weighed 76-85mg and the head capsule size was 103-108mm .The completely grown fourth instar and fifth instar larvae were sorted out and placed in a separate glass dish at room temperature for the experiment For each experiment 3-5 replicates were done and each experiment was repeated at least 5 times.

2.3 Test Product: Andrographolide

Andrographis paniculata is an herb endogenous in Southeast Asia, China and India. It is widely used in traditional remedies and folkloric medicine to cure a variety of human illness. The dried herb is a remedy for a number of ailments related to digestion, vermicidal, analgesic, antibacterial, antityphoid, antibiotic activities, hypoglycemic, besides immune enhancement [25]. Andrographolide the main bioactive component of *Andrographis paniculata* it is diterpenoid and bitter substance it is extracted from the stem and leaves of the *Andrographis paniculata.* Extracts of this plant and andrographolide exhibit pharmacological activities such as those that are immunostimulatory[15], antiviral. As major active constituent, andrographolide exhibits a broad range of biological activities, such as antitumor, antidiabetic, antimalarial, hepatoprotective, anti-inflammatory, antiallergic, antiplatelet aggregation[18], hepatoprotective, and anti-HIV[20]. Many previous studies reported that extracts from *A. paniculata* have morphological deformities properties against insects[8]. Evaluation of Andrographolide for its larvicidal efficacy, Early reports of oral administration of powdered of stem of Andrographis *paniculata* indicated an antifertility effect in male Wistar mice, but no impact on fertility in female mice [26].

Figure-1. Structure of andrographolide
(Chemical formula --$C_{20}H_{30}O_5$)



2.4 Preparation of test solution:

Different concentrations of Andrographolide doses were prepared by dissolving a known amount of Andrographolide in 1 µl of acetone to obtain 2, 4, 6, 8 and 10 µg / µl doses.

Figure-2. Morphological deformities of *Corcyra Cephalonica* treated with Andrographolide

Control Pupa Dorsal side

Overaged larvae

Control- V Instar Larva

Resultant larval-pupal intermediates with exuvia attached

Larval-Pupal intermediate retaining the larval head capsule

Resultant larva with pupal cuticle patch

Control Pupa

The Deformed head of the malformed pupa

Resultant adult with Protruded Ovipositer

2.5 Treatment with Andrographolide:

Thirty Freshly moulted fourth instar, fifth instar larvae and thirty zero-hour pupae were treated topically on the abdominal region with 2, 4, 6, 8 and 10 µg/ µl of Andrographolide with acetone as the carrier solvent with the help of Hamilton micro syringe. Thirty larvae and pupae were treated each time with Andrographolide and the experiments were performed in triplicate. Controls were treated each time with an equivalent volume of carrier solvent acetone. After total absorption of Andrographolide.

The larvae and pupae were transferred into the diet. The treated resultant females were observed for morphological deformities and the results were compared with controls.

3. Results and Discussion

One of the relatively new method to control the *Corcyra cephalonica* is apply a plant product causing physiologic and morphogenetic abnormalities that result in reproductive failure in insects[11]. At this stage, ecdysone is released to initiate the development and differentiation of the reproductive organs, leading to metamorphosis, the morphological abnormality of the internal reproductive organs and histological disruption of

testis and ovaries were similar to the findings reported by other researchers [4,19]. Different concentrations of the plant product Andrographolide applied on fourth instar, fifth instar larvae and pupae. The phytochemical exhibits the ecdysis inhibition the inhibition rate is increasing as per concentration increased. The treated resultants developed abnormalities in larvae, pupae and the adults. The adult survival rate is decreased as per the increase of concentration. The treatment with Andrographolide some of the treated larvae pupated abnormally and henceforth drastically affected.

The presence of Andrographolide has led to the incomplete development of larvae abnormalities such as defective and deteriorated pupae and partial developed adults and overaged larvae. According to the results of this study and other reports, the application of Andrographolide on the *Corcyra cephalonica* not only induces morphological deformities, but also causes the sterility of adults. We found that application of Andrographolide had a direct role on fecundity and fertility of treated insects, therefore it may be concluded that this compound had an effect on the growth of larvae and pupae. Reduction in fecundity similar observations has been reported by[22] on *Aphis glycines* and [4] on *Rhyzopertha dominica.*

4. Conclusions

On the basis of overall findings, it can be concluded that Andrographolide is toxic to *Corcyra cephalonica*, as it mimics the action of JH and maintains the insect in an immature state. Andrographolide caused mortality in larvae and produced abnormal adults and it also affected the sterility of adults. This may be due to the destructive effects of these compounds on reproductive organ development. The plant extract inhibited the growth and development and fecundity of the *Corcyra cephalonica.* Thus Andrographolide may be considered as a leading target compound having the potential to control *Corcyra cephalonica* and can therefore form an important component of various Integrated Pest Management (IPM) programs

Competing Interests

The authors have declared that no competing interests exist.

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