Chemical Structures of Neem for Pest Management

Dr. Menka Sisodia
Department of Zoology
Kolhan University, Chaibasa, Jharkhand- 833201 (INDIA)

ABSTRACT

Different parts of the Neem Tree can effect more than 200 intect Species and some nematodes, Fungi, bacteria and Viruses of pests with a multitude of pesticidal ingredients. Its main Chemiacal broadside is a mixture of 3 or 4 related compounds and it backs these up with 20 or more to other which are minor but sometheless active in one way or another. In respect to main these compounds belong to a general closs of natural products called triterpenes and especially the Limonoids. Of the namerout pesticidal agerb is lated so far from neem kernels, Azadirachtin is the amost active against insects. Thiscompounds is found with the sad of the neem tree. It affects hereby 90% on most of the best.

1. INTRODUCTION

The complexity of these compounds demonstrates that nature is still the greatest chemist. Of the numerous pesticidal agents isolated so far from neem kernals, azadirachtin is the most active against insect. In addition to inhibiting their growth, it interface with their powers of taste. Many leaf-eating insect are repelled by plants to, which even small amounts azadiracchtin have been applied.

2. MATERIALS & METHODS

Azadirachtin A is a chemical compound belonging to the limonoids. it is a secondary metabolite present in the Neem tree seeds. the molecular formula is C35H44O16. Azadirachtin A is a highly oxidised which boasts a plethora of oxygen functionality, comprising hemiacetal, and tetra-substituted oxirane as well as well as a variety of carboxee among the plant secondary metabolites.

Additionally, both tertiary hydroxyl groups andf tetrahydrofuran ether are present. inspection of the niciccular structure reveals 16 stereogenic centres, 7 of which are quatemary. These characteristics explain the great difficulty encountered when trying to produce it by a synthetic approach. It was initially found to be active as a feeding inhibitor towards the desert locust (Schistocerca gregaria), it is now known to affect over 200 species of insect, by acting mainly as an antifeedant and growth disruptor. It fulfills many of the criteria needed for a natural insecticide if it is to replace synthetic compounds. Azadirachtin A is biodegradable and shows very low toxicity to mammals, thus being environmentally sound.

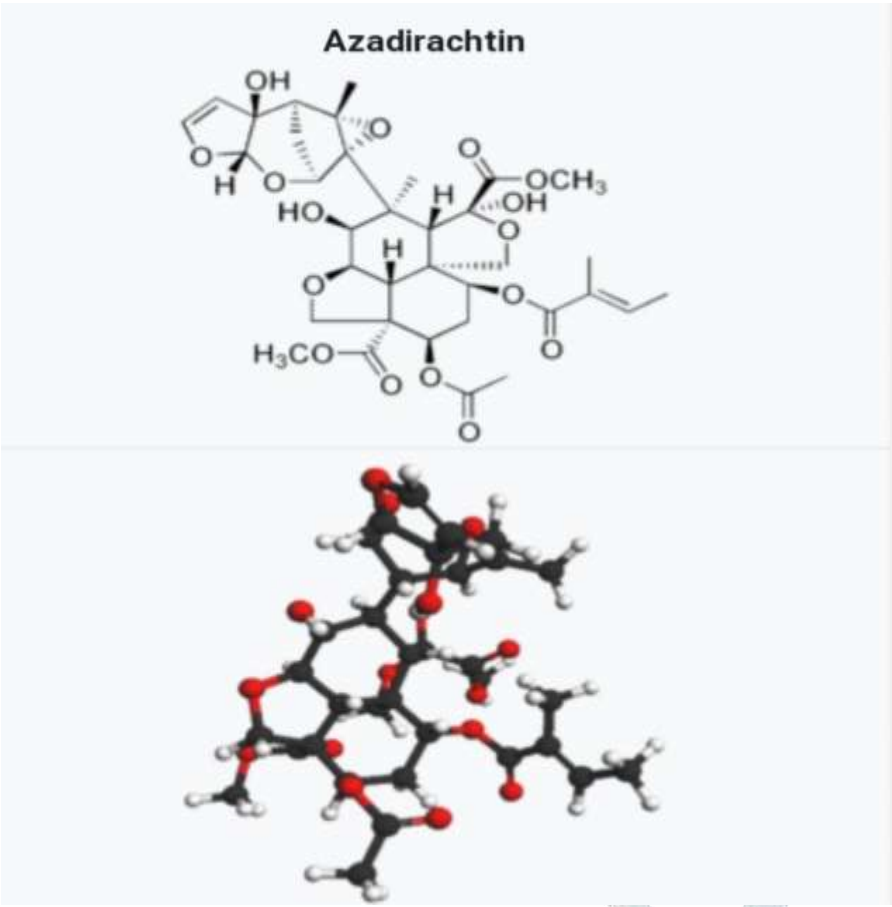

Fig : Chemical Structure of Azadiractin

This compound is found within the seeds of the Neem tree (0.2 to 0.8 per cent by weight). Azadirachtin is structurally similar to insect hormones called ecdysones, which control the process of metamorphosis as the insects pass from larva to pupa to adult. It affects the corpus cardiacum, an organ similar to the human pituitary, which controls the secretion of hormones. Metamorphosis requires the careful synchrony of many hormones and other physiological changes to be successful, and azadirachtin seems to be an ecdysone blocker. It blocks the insect's production and release of these vital hormones. Insects then will not molt. This of course breaks their life cycle. On average, neem kemels contain between 2 and 4 mg of

azadirachtin per gram of kernel. The highest figure so far reported-9 mg per g-was measured in samples from Senegal.

It appears to cause some 90 per cent of the effect on most pest. It does not kill insects-at least not immediately. Instead it both repels and disrupts their growth and reproduction. Research over the past 20 years has shown that it is one of the most potent growth regulators and feeding deterrents ever assayed. It will repel or reduce the feeding of many species of pest insects as well as some nematodes. In fact, it is so potent that a mere trace of its presence prevents some insects from ever touching plants.

2.1. Meliantriol

Another feeding inhibitor, meliantriol, is abie, in extremely low concentrations, to cause insecied cease eating. The demonstratin of its ability to prevent locusts chewing oil crops was the first scientific proof for neem's traditional use for insect control on India's crops.

2.2. Salannin

Yet a third triterpenoid isolated from neem is salannin. Studies indicate indicate that this composed also powerfully inhibits feeding, but also not influence insect molts. The migratory locust, California red scale, striped cucumber beetle, houseflies, and the Japanese beetle have been strongly deterred in both laboratory and field tests.

2.3.Nimbin and Nimbidin

Two more neem components, nimbin and nimbidin, have been found to have antiviral activity. They affect potato virus X, vaccinia virus, and fowl pox virus. They could perhaps open a way to control these and other viral diseases of crops and livestock.

Nimbidin is the primary component of the bitter principles obtained when neem seeds are extracted with alcohol. It occurs in sizable quantities-about 2 per cent of the kernel.

2.4.Others

Certain minor ingredients also work as anti-hormones. Research has shown that some of these minor neem chemical even paralyze the swallowing mechanism and so prevent insects from eating. Examples of these newly found limuloids from neem include deacetylazadirachtinol. This ingredient, isolated from fresh fruits, appears to be as effective as azadirachtin in assays against the tobacco budworm, but it has not yet been widely tested in field practice.

2.5.MODE OF ACTION

The fact that the extracs can be taken up by plants (and thereby confer protection from within) is one of neem's most interesting and potentially useful features. As has bebn noted, however,

the level of this systemic in activity differs from plant to plant and formulation to formulation. Extracts without oil, with a little oil, and with much oil exhibit different levels of systemic action

The systemic activity differs with the insect as well. It is not effective on some aphids, for instance. They fed in phloem tissues, where (for reasons yet unknown) the concentration of azadirachtin is very low. Phloem is the plat's outermost layer of conductive tissues and insects such as these, whose mouthparts cannot penetrate past it, are little affected by neemtreatments. On the other hand, leafhoppers and plant-hoppers, that feed at least half the time on the deeper layer of conductive tissues (called the xylem), get knocked down.

The growing accumulation of experience demonstrates that neem product work by intervening at several stages of an insect's life. The ingredients from this tree approximate the shape and structure of hormones vital to the lives of insects (not to mention some other invertebrate and even some some microbes). The bodies of these insect absorb the neem compounds as if they were the real hormones, but this only blocks their endocrine systems. the resulting deep-seated behaviral and physiological aberration leave the insects so confused in brain and body that they cannot reproduce and their population plummet.

Increasingly, approaches of this kind are seen as desirable methods of pest control: pests don't have to be killed instantly if their populations can be incapacitated in ways that are harmless to people and the planet as a whole. In the 1990s this is particularly important: many synthetic pesticides are being withdraw, few replacements are being registered, and rising number of insects are developing resistance to the shrinking number of remaining chemical controls.

But, for all the uncertaintly over details, various neem extracts are known to act on various insect on the following ways:

1. Distrupting or inhibiting the development of eggs, larvae, or pupae;

2. Blocking the molting of larvae or nymphs;

3. Disrupting mating and sexual communication;

4. Repelling larvae and adults;

5. Deterring females from laying agg;

6. Sterilizing adults;

7. Poisoning larvae and adults;

8. Deterring feeding;

9. Blocking the ability to "(that is, reducing the motility of the gut.)

10. Sending matamorphosis awry at various stages; and

11. Inhibility the formation of chitin.

As noted earlier, neem extract have proved as potent as many commercially available synthetic pesticides. they are effective against dozens of species of insects at concentration in the parts-per-million range. At present, it can be said that repellency is probaby the weakest effects, except in some locust and grassopper species. Antifeedant activity (although interesting and potentially extremely valuable) is probably of limited significance; its effects are short- lived, and highly variable. Blocking the larvae from molting is likely to be neem's most important quality. Evantually, this larvicidal activity will be used to kill off many pest species.

2.6.Effectiveness

Neem is most useful against pest that feed on plants. Neem extract control some insects well and others not so well, and are better at controlling pest on some crope than other crops.

Cold present neem oil and seed cake can both the used for pest control. the leaves can also be used to control pests. but there is less useful chemicals than in the seed.

2.7.Good Control

Neem extract is usually most effective against beetle larvae, butterfly and moth caterpillars Examples of these are Mexican bean beetle, Colorado potato and diamondback moth.

Neem is very effective against grasshoppers, leaf miners and leaf hoppers, for example variegated grasshopper, green rice leafhopper and cotton jassis.

When neem is taken up by the plant, it will usually leaf hoppers and hoppers as, they feed from the part of the plant, which carries the azadieacchtin around inside the plant Grasshopper wuill stop eating almost immediately after neem extract is applied but catepillars may not stop eating for 2 or 3 days.

2.8.Moderate Control

Neem is fairly good at controlling adult, beetles, aphids and white flies. White fly are less likely to settle and lay their eggs for some time after spraying. Beetles that feed on plant material as adults, e.g. brown leaf beetle, may sometimes avoid plants treated with neem extracts. Aphids avoid plants, which are sprayed regularly. When neem extracts are taken up by the plant it will not control aphids as they feed on the outer laver of the plant, which contains very little of the neem extract.

2.9.Poor Control

Neem gives only poor control of mealybugs and scale insects, adult, bugs, fruits maggots and spider miles.

2.10.Nontarget Species

As has been mentioned, neem extracts proved to be soft on unintended targets. Further examples are as follows:

2.11.Earthworms

In greenhouse studies, when neem leaves and seed kemels were incorporated into potting soil containing earthworms (Eiseniafoetida), the number of young worms produced increased 25 per cent. In field trials, there were no differences in the number of worms, but the average weight of each worm was highest in neem-treated plots. Thus, it seems possible that neem products can favor earthworms, at least under certain conditions.

2.12.Beneficial Insects

Neem seems remarkable benign to spiders, butterflies, and insects such as bees that pollinate crops and trees, ladybugs that consume aphids, and wasps that act parasites on various crop pests. In the main, this is because neem products must be ingested to be effective. Thus, insects that feed on plant tissues succumb, while those that feed on neclar or other insects rarely contact significant concentrations of neem products.

All this is coming clearer from recent research. For example, only after repeated spraying of highly concentrated neem products onto plants in flower were worker bees at all affected Under these extreme conditions, the workers carried contaminated pollen or neclar to the hives and fed it to the brood. Small hives then showed insect growth-regulating effects; however, medium-sized and large bee populations were unaffected.

Under laboratory conditions, the larvae of ladybugs and lacewings have shown some insect growth regulating effects from neem picked up from the bodies of to the insects. However in greenhouse trials in Florida, neem products proved essentially nontoxic to predators and parasitoids of the cotton aphid and the sweet potato which Neither the amount of predation nor of parasitism was notably reduced.

A census of natural aphid enemies collected from seven different field trials indicated that neem has no detrimental effects on either predators (Coccineldschrysopids, syrphids) or parasitoids (ichneumonids, braconids). The aphids in the neemacaied plots were actually

carrying more parasites then were those in either the control plots or the plots trealed with the insecticide pyrethrum.

2.13.Toxicity

In toxicological studies carried out in the USA and Germany, different neem product were neither mutagenous nor cancerogenic, and they did not produce any skin irritations or organic alterations to mice and rates even at high concentrations. In another Canadian study, Neem was found to be harmless to Aquatic invertebrates and other non-target species.

DISCUSSION

The simplest technology (and the most widly employed today) is to crush or grind the kernels and extract them with water. They may, for example be steeped overnight in a cloth bag suspended ina barred of water. for reasons not yet understood, this process is less effective than pouring the water into the bag and collecting the extract as it emerges. The resulting crude suspension can be used in the field without further modification. It can also be filtered and employed as a spray-able emulsion.

Water extracts of ground neem leaves are also very useful. Because neem is an evergreen, they are obtainable throughout the year.

3.1. Benefits

Neem Biopesticide (Emulsifiable Concentrate) is well suited for an integrated Pest Management (IPM) Program because of the following salient features:

1. Neem Pesticide is a natural product, absolutety non-toxic, 100% biodegradable and environmentally friendly.
2. It is suited for mixing with other synthetic pesticides and in fact enhances their action.
3. None or lesser quantity of synthrtic pesticides need to be used, thcrcby reducing the environmental load.
4. Several synthetic pesticides being single chemical compounds cause easy development of resistant species of pests. Neem consists of several compounds hence development of resistance is impossible.
5. Neem does not destroy natural predators and parasites of pests thereby allowing these natural enemies to keep a check on the pest population.
6. Neem also has a systemic action and seedlings can absorb and accumulate the neem compounds to make the whole plant pest resistant.
7. Neem has a broad spectrum of action active on more than 200 species of pests.

8. Neem is harmless to non-target and beneficial organisms like pollinators, honey bees, mammals and other vertebrates.

3.2. Preparations for Pest Control

Azadirachtin, salannin, and nimbin all have the same basic limonoid structure. This different from, but is not unlike, that of the stocks to, which the insect hormones (ecdysones) belong. An insect ingesting traces of these compounds is deeply affected becouse these hormones mimics block the parts of the brain that products the hormones necessary to growth and development. In many cases, for instance, the insect's body may be ready to change while the hormones to complete the molt are not available. these deep-seated hormonal effects are the reason for neem's subtle, powerful and yet insect-specific influences. Two compounds related to salannin, 3-deacetylsalannin and salanol, recently isolated from neem, also act as antifeedants.

3.3. Method of Application

Neem extract can be applied in many ways, including some of the most sophisticated. forexanple, they may be employed as sprays, powder drenches, or dilluents in irrigation water-even through trickle-or subsurface-irrigation system. In addition, they can be applied to plants through injection or applications, either as dusts or spray. Moreover, They can be added to baits that attract insect (a process used, for instance, with cockroaches) they are even burned. For example, neem leaves and seeds and dry neem cake are ingredients in some mosquito coils.

No new or unusual technology is required for any of the processing. It can be done using aither simple Village-Scale technology or high-technology methods and industrialized facilities. The most common procedures are summarized below.

3.4 : Water Extraction

The simplest technology (and the most widly employed today) is to crush or grind the kernels and extract them with water. They may, for example be steeped overnight in a cloth bag suspended ina barred of water. for reasons not yet understood, this process is less

effective than pouring the water into the bag and collecting the extract as it emerges. The resulting crude suspension can be used in the field without further modification. It can also be filtered and employed as a spray-able emulsion.

Water extracts of ground neem leaves are also very useful. Because neem is an evergreen, they are obtainable throughout the year.

4. RESULT

4.1. Uses of Neem Extract

There are many different ways to apply neem extracts. Some of the most common methods are described in this section.

Preparing Crushed Neem Seed.

4.2. Preparing crushed Neem Seed

1. The ripe fruit pulp should be removed from the seed as soon possible after harvest, otherwise the seeds may become covered in mould. In some areas birds or fruits bats eat the pulp leaving the seed on the ground.
2. The seeds should then be laid out in a thin layer in the sun to dry out for a few days. The dried seeds should be stored in containers with plenty of air to stop mould growing.
3. The shells have to be removed using stones or a big morlar. The shells can then be removed by winnowing in the same way as with cereals.
4. The kemels are then ground in a mill or in a morlar.

4.3. Neem to Control Stem Borers on Young Plants

1. A small amount of crushed neem seed powder should be mixed with the same amount of dry amount of dry clay or sawdust.
2. The mixture is placed in the funnel of young maize of sorghum plants.
3. Rain will gradually dissolve the active chemicals in the neem seed.
4. This treatment may need to be repeated every 8 to days until the plants flower.

4.4. Extracting Neem Oil

To press neem oil by hand the kemels of the neem seed should be crushed as described in the previous section

- Add a small amount of water until the mixture forms a firm paste that can be kneaded
- Knead the paste until oil drops form on the surface.
- Press firmly to extract the oil.

- The kneading and pressing should be continued in turn until the maximum amount of oil is removed. (The oil content of the seed kemcl is about 45%)

In some areas there are traditional ways of removing oil from other seeds such as sesame or groundnut. It is a good idea to try these methods with neem.

If the oil is heated in the process, its ability to control insects will not be affected.

4.5. Controlling BruchidBeeties in Stored Beans

Neem oil is used to control Bruchid beetles, which are small beetles whose larvae eat into stored beans and other legumes.

- Mix a small quantity of neem seed oil with beans or seeds before storing.
- The oil has a bitter taste but is not reported to change the taste of stored beans for humans to eat.

4.6.Control of Soil-borne Pests

The neem cake, which is left after the oil is extracted from the seed, is also useful for controlling several pests, which live in the soil, particularly nematodes.

4.7. Neem Water Extract for Plant Protection

- Prepare 500g of crushed neem seed kemels as described previously. Mix crushed neem seed with 10 litres of water. It is necessary to use a lot of water because the active ingredients do not dissolve easily. Stir the mixture well and leave to stand for at least hours.
- Spray the neem water directly on vegetables using a sprayer or straw brush.
- The effect lasts for 3 to 6 days. If kept in the dark neem water will be effective for 3 to 6 days.
    - It has been estimated that 20-30 kg neem seed (an average yield from 2 trees). Can normally treal one heclare.
    - If crops have to be watered, water should go directly on the soil because water running over the leaves of sprayed plants may wash off the extract.
    - If alcohol is available, 50 time more azadirachtin can be dissolved and extracted.

4.8. Water based Neem Spray to Control Cutworms

Water based neem spray is most effective against pests such as Cutworms. During the day the aterpillars stay on the ground and fed on plant roots. At night they eat young stems.

Plants most affected include many vegetables and other affected plants include maize Tobacco and coffee.

ACKNOWLEDGEMENT

The author is thankful to Dr. KanakLata, Ex-Principal, The Graduate School College for Women, Jamshedpur, and Dr. Rabinder Kumar Singh Dean Science Faculty, Kolhan University, Chaibasa for their help and encouragement during the research work completion. I am also thankful to my family members especially to my daughter Arusha and on Achyut for maintaining and cooperating throughout the completion and compilation of work also thankful to my elder sister Abha Singh for the proper guidance.

REFERENCES

1) Benizri, E., Baudoin, E., and Guckert, A. (2001)., Root colonization by inoculated plant growth, promoting rhizobacteria. Biocontrol Sci. Technol. 11:557-574.

2) Klopper, J.W. (1993). Plant growth-promoting rhizobacteria as biological control agents. Pages 255-274 in: Soil Microbial Ecology: Applications in Agricultural and Environmental Management. F.B. Metting, Jr., ed. Marcel Dekker Inc., New York, USA.

3) Razdan A., Pettersson, D.(1994). "Effect of chitin and chitosan on nutrient digestibility and plasma lipid concentrations in broiler chickens". British Journal of Nutrition 74:277-288.

4) Sawada H, Kuykendall LD, Young JM (2003). "Changing concepts in the systematics of bacterial nitrogen-fixing legume symbionts".J.Gen. Appl.Microbiol. 49 (3):155-79

5) Yuan, Zhuangdong (2007). "Study on the synthesis and catalyst oxidation properties of chitosan bound nickel(II) complexes." (PDF). Journal of Agricultural and Fool Chemistry (HuagongShikanZazhishe 21 (5):22-24.