Nanotechnology in insecticides

The study which focuses of particles with even one dimension in the size range of 10-100 nm is called nanotechnology. As the ratio of surface area to volume increases, the particle size decreases, and their chemical, physical and biological properties of the particles vary in comparison with their bulk counterparts [8]. A fine approach to overcome the drawbacks in normal essential oils is by the incorporation of nanotechnology. Nanoemulsions are useful to improve various aspects of the essential oils like diffusion in water, physical stability and bioavailability, limited toxicity of non-target organisms and less irritation [9]. Application of nanotechnology may increase the taste, texture, and stability characteristics of food [10].

One of the capable oils with insecticidal activity is the castor oil obtained from castor seeds. These are the seeds of the *Ricinus communis* plant. It is a species of perennial plant in the Euphorbiaceae family. The seeds contain between 40%-60% oil that is loaded with triglycerides, primarily ricinolein. Ricin present in the seeds is a water-soluble toxin. It is also present throughout the other parts of the plant in small quantities. This ricin may be held responsible for the insecticidal and larvicidal properties of the oil nanoemulsion.

which the insecticides are affecting the soil microorganisms, ground water and other natural sources of nutrients [19].

Pesticides fate after application to fruits and vegetables

According to OECD guidelines, fate means the outline of circulation of an agent in an system, organism, compartment or sub population of concern as a result of transformation, transport, or degradation. The pesticide may enter the plant through their cuticle and root surfaces. It may thus either enter the plant transport system or remain on the surface. If they remain on the surface, they can undergo one of the three processes-volatilization, photolysis and microbial degradation. Volatilization usually occurs at once after using the pesticide in the farm. The progression depends on the vapour pressure of the specific pesticide. Increased vapour pressure means the pesticide volatiles rapidly whereas low vapour pressure volatiles much slower. The volatilization rate is proportional to the natural factors such as temperature and speed of wind. High wind speed and high temperature causes the pesticide to undergo volatilization much rapidly. Photolysis happens when molecules of the pesticide take up energy directly from the sunlight, thus ending in their break down. Some pesticides are broken down by the third method-microbial metabolism. Microbes can sometimes utilize pesticides for their nutrients. Thus, they can break them into carbon dioxide and other components. As the natural chemicals and synthetic pesticides have a very different chemical structure, microbes cannot usually break them down completely but alter the chemicals at their reactive sites. Those products that are produced may end up being more or less toxic than the starting substance. It is concluded that under ordinary conditions, volatilization is the major process that degrades the pesticides [20].

Alternates for chemical insecticides-plant based insecticides

Melia volkensii

These varieties of plants grow at fair elevations east African nations and other places like Kenya. Initially, a fruit extract obtained from these plants were documented to have insecticidal properties against certain locusts [21]. Later, it was shown to have action against large range of pests and insects [22]. Almost 8 limonoids were isolated from these fruits. When an experiment was conducted to prove the larval growth inhibitor effect and antifeedant effect, it worked against both *Trichoplusia ni*, the cabbage looper and *Pseudaletia unipuncta*, armyworm [23]. Major constituent of these species that showed highly effective insecticidal action was volkensin. This fast-developing species begins to fruit within 5 years and produces fruit almost round the year, making it suitable for daily usage in east Africa [24]. On the other hand, the intricate chemistry involved and shortage of appropriate toxicological data about the plants make it almost implausible to be used in highly developed countries where its approval may require a lot of clear data.

Melia azedarach

It is normally known as the chinaberry tree and is indigenous to eastern Asia. It has been widely cultivated throughout the subtropics and tropics. The fruit extracts obtained from *M. azedarach* have been proved to have insecticidal activities, in par with neem [25]. But, usage of these extracts in crops has been avoided due to the presence of toxins such as limonoids, meliatoxins that may be toxic to mammals. On the other hand, plants grown in Argentina didn't show toxicity while tested with rats, and also contained meliartenin, a limonoid that showed insecticidal and anti feedant effects and thus can be used in crops without any harm [26]. A broad variety of bioactive limonoids such as meliacarpins, volkensin and salannin have been found in the seeds of this tree [27]. The most prominent constituent is toosendanin, which occurs in the bark of this tree at high concentrations such as 0.5%. In China, an extract comprising of Toosendanin, obtained from the bark is refined and used as a bio-

Trichilia Americana

Certain species of *T. Americana* in Costa Rica showed inhibitory effects against a particular species of army worm-*Spodoptera litura* [31]. Methanolic extracts of these species significantly prolonged pupal and larval development. It was later confirmed that it was primarily due to feeding inhibition caused in the insects. Neither injecting it directly nor topically administrating caused any toxicity. When normal diet without the extracts was given, they grew normally [32]. During an experiment, when cabbages were sprayed with 0.5% of methanolic extracts of this plant, it was safe from armyworms for almost 24 hours [33]. But, the active component was not able to be isolated successfully, even when bio assays such as fractionation, or HPLC were done. It was difficult to comprehend as these plants proved to be chemically complex and usually the active constituents were present in very low quantities. In case of future biological studies, and phytochemical investigation, this species have great scope to be used as an alternate as an insecticide.

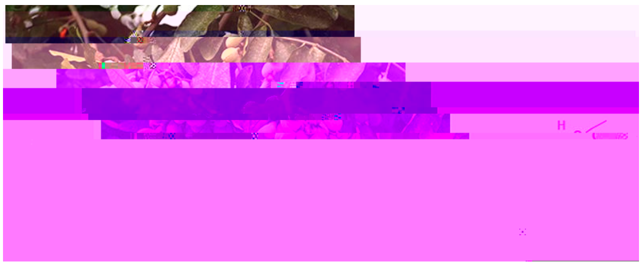

Figure 4: A) Trichilia Americana **B)** Chemical Structure of Methanol.

Role and growth of bio-pesticides in future

Organic production of bio-pesticides is on the rise by 15% per annum in western countries. The significance of bio-insecticides shall be well recognized in growing countries, where farmers are unable to afford synthetic insecticides. Even if they are affordable to farmers via govt loans and subsidies, restricted literacy and absence of proper protective equipment finally results in thousands of unintentional poisonings yearly [34].

Bio-pesticides are getting worldwide importance as a cautious approach to handle pest populations such as weeds, plant pathogens and insects while causing low risk to both people and the nature. Developmental experimentation in production, formulation and delivery may deeply play a role in commercialization of bio-pesticides. Increased research is required towards combining biological agents into normal production systems, and in improving the potential of growing countries to produce and apply bio-pesticides on their own. The commercial investors should be educated on the pros of using bio pesticide, thus encouraging them to conduct programs like public funded donations for improving the bio pesticide usage in the particular region. It is crucial to maintain the value and efficiency of bio-pesticides in the growing countries at a much lower cost than the developed countries. Thus, research on diverse features of bio-pesticides covering the current status, constraints, and prospects towards their efficient consumption for the advantage of human kind are currently in progress [35].With the help of nanotechnology, in future it can be expected that there will be a great improvement in the agricultural field with the involvement of bio-pesticides.

Conclusion

In present world, almost everything is made from chemicals. But it is not healthy to intake anything that has been exposed to too much chemical. Already, chemicals have been incorporated into foods as flavouring agents and preservatives. Moreover, if the crops in the field are also exposed to chemical pesticides, then we cannot even imagine the amount of harmful chemicals that we are consuming daily in the name of food. Even though there is comparatively less possibility to reduce the chemicals after harvesting the crops, the usage of chemical insecticides can be reduced in the previous stage. Worldwide there are numerous problems persistent due to the usage of harmful insecticides. Non target organisms such as fishes, beneficial microorganisms have been affected a lot. To prevent all these side effects, bio-pesticides prepared from natural products should be used. It can either be produced by incorporating the science of nanotechnology and producing insecticides in the form of nanoemulsions or usage of plant derived chemicals for insecticidal purposes. The best plant sources of insecticides include *Azadirachta indica*, *A. excelsa*, *Melia azaderach*, etc. Although the efficiency may be comparatively less than chemical insecticides, need of the hour is to shift to harmless, less toxic natural insecticides keeping in mind the well being of humans and the environment. With further research and improvements, the efficacy of bio-pesticides can be made equal to that of the chemical insecticides.

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