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A Facile Synthesis and Characterization of Nano-Λ-Cyhalothrin-New Nanomaterial for Plant Protection

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Abstract

Nano science has wholly chip in to foremost accomplishments in different sectors of agriculture. Insecticides are functional for prevention and control of plant disease. Excessive application of insecticides leads to the unfavourable pesticide consequences on human and plant health and damage environment. In this current study the author reported a facile synthesis of new Nano λ-Cyhalothrin using polycapralactone as an encapsulated agent for insect infection control and its successive characterization of encapsulated complex. Nano λ-Cyhalothrin encapsulated particles were characterized by dynamic light scattering (DLS), Ultraviolet spectroscopy and scanning electron microscopy (SEM). The size distribution was noted at 40 nm-50 nm. The bioactivity study was conducted against various *aspergillusbacillus*. Nano λ-Cyhalothrin showed a better bio-efficacy in comparison with commercial pesticide. The valuable information stated by author leads to potential application of polymeric nanomaterials in protecting plant health with huge potential.

***Keywords:** λ-Cyhalothrin; Nanoencapsulation; Polycaprolactone; Electron microscopy; Antifungal study*

Introduction

Pesticides certainly engage in reaction an imperative role for augment food production. Extensive monitoring of the tangible state and residue levels of pesticides in agricultural products was important at present. Insecticides are painstaking class of pesticides and applied for used for prevention and control of various insect infections.

Lambda-cyhalothrin (C_{23} $H_{19}CLF_3$ $N0_3$) is an insecticide. λ-Cyhalothrin (CY) fit in to a group of pyrethroids. IUPAC name is (S)-α-cyano-3-phenoxylbenzyl (Z)-(1R,3R)-3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2, 2 dimethylcyclopropane carboxylate.

CY products move towards in a range of forms including powders, pellets, liquids, small capsules, and ear tags containing the chemical called Lamda cyhalothrin and are now used to control different types of insects in crops including cereals, cotton, and vegetables [1]. λ-Cyhalothrin is damage the nervous system of insects, CY affects a variety of indoor and outdoor different types of insects. CY has the vigorous constituent with very low solubility in water. Cyhalothrin is inherently highly toxic to many fish and aquatic invertebrate species, binding to soil and sediment reduces exposure and lessens the risk. According to the WHO expert committee, "The concentrations of cyhalothrin and CY that are likely to take place in water from normal agricultural application will be low [2]. Hayam et al. determined the presence of CY residue in Zucchini by gas chromatography [3]. The residual amount estimation of Cyhalothrin and CY insecticides is chiefly reliant on GC methods using different detectors like flame photometric detection, electron capture detection, nitrogen phosphorous detection, gas chromatography–mass spectrometry detection, gas chromatography–tandem mass spectrometry detection or gas chromatography quadrupole mass spectrometry detection etc [4-9]. Nanopesticides proffer a range of benefits including durability, increased efficacy, and a reduction in the amounts of active ingredients that need to be used [10]. A range of formulation types have been suggested including emulsions (e.g., nanoemulsions), nanocapsules (e.g., with polymers), and inorganic ENPs, such as metals, metal oxides, and nanoclays [11-13].

The study of application of nanoparticles for the control of pest is less studied and it is drawing superior attention to researchers. In assured cases pesticide nanoparticles solve the possibility of control of pests effectively [14,15]. In the present work the author reported an ecofriendly and facile synthesis of Nano-λ-Cyhalothrin (NCY) and the characterization of the nanopesticide was studied by using Dynamic light scattering, UV-Vis spectral study and Electron microscopy techniques. Bio assay was conducted against *aspergillusflavus.*

Materials and Methods

Reagents

λ-Cyhalothrin was purchased from S.N. Agro Traders, Andhra Pradesh, India. The capping agent Ploycapralactone was purchased from E. Merck, India. All other chemicals used were of Analytical grade. Double distilled water was used in all attempts.

Preparation of Nano λ-Cyhalothrin

Initially the CY was diaphanously grounded by using mortar and pestle. The ashore pesticide was dissolved in 200 mL acetone and it is mixed with Polycapralactone (1:5) in an ultra sonicate bath for 30 minutes. This will help for the dispersion of λ-Cyhalothrin in polycapralactone. The sonicated solution was kept continuous stirring 5 hours with 1400 rpm and it was subjected to rota vapour for the removal of excess solvent.

Instrumentation

The study was performed by using different instruments for indentify and characterize the formed NCY. The details were given in Table 1.

Table 1. **Instrumentation details**

Instrument	**Make**	**Purpose**
Dynamic light scattering (DLS	Horiba	Particle size distribution
UV-Vis spectrophotometer	Shimadzu UV-1650 PC	Characterization and Identification of organic molecule
Scanning electron microscopy (SEM)	Zeiss Evol8	surface topology

Results and Discussion

Generally the benefits of nanopesticides are less use of chemicals, better efficacy and better control of application. The advantages of nanoparticles are small size, high surface energy and we get more crop yields the delivery of pesticides in agricultural field in the form nano scale could be the unsurpassed substitute for prevention and control pests. Nano-λ-Cyhalothrin (NCY) lowers the toxicity in agricultural fields and it is decidedly active at lower level concentration. The current investigation affords a new facile synthesis of NCY by using Polycaprolactone as capping agent. The polycaprolactone boost the stability and it gradually releases the active NCY constituent to the infected plant. The structure of CY and polycapralactone were given in FIG. 1-3.

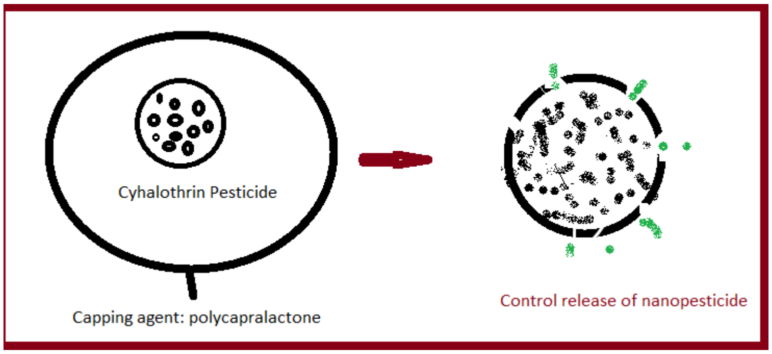


FIG. 1. **Release of nanopesticide**

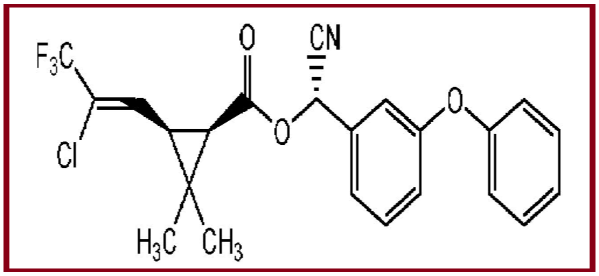


FIG. 2. **Structure of λ-Cyhalothrin**

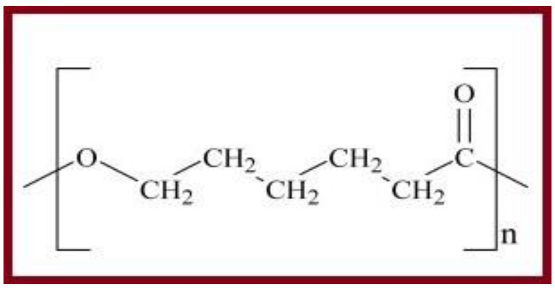


FIG. 3. **Structure of polycapralactone**

DLS analysis

Dynamic light scattering (DLS) measures the scattering intensity based on Rayleigh scattering. pade laplace dispersion factor was considered to report the diameter of the nano-encapsulated CY. DLS primarily based on Rayleigh scattering, oscillations, Brownian movement and fluorescence exponential decay. Generally in DLS a time dependent signal was transformed into the hydro colloidal solution and it results in the exponential decay of the particles. One milli litre of nano-encapsulated CY was suspended in five milli litres of water. The consequential hydro dispersed suspension was analyzed with DLS at 25˚C. The particle size distribution was recorded around 40 nm-50 nm. The signal passed in to hydro colloidal nano suspension, exponential decay of Nano-λ-Cyhalothrin and the particle size distribution were shown in FIG. 4 and 5.

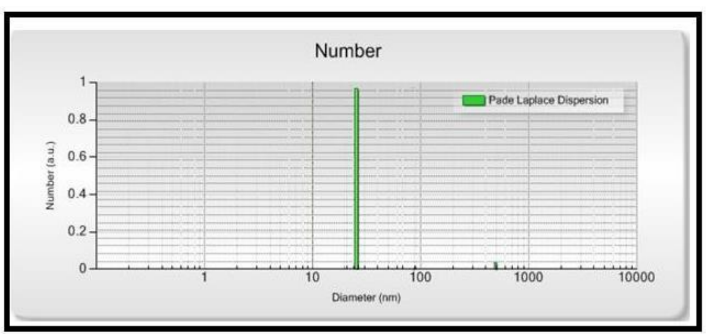


FIG. 4. **Nano-λ-Cyhalothrin size distribution**

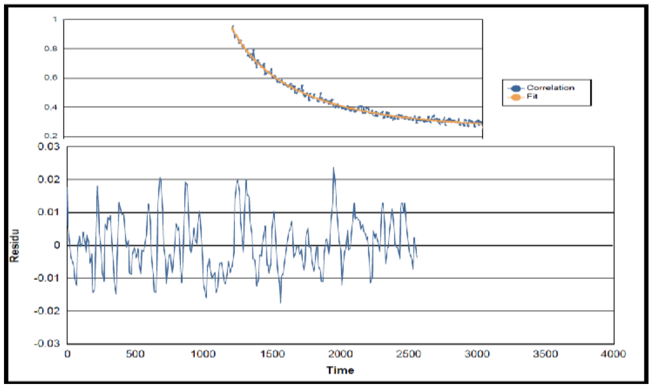
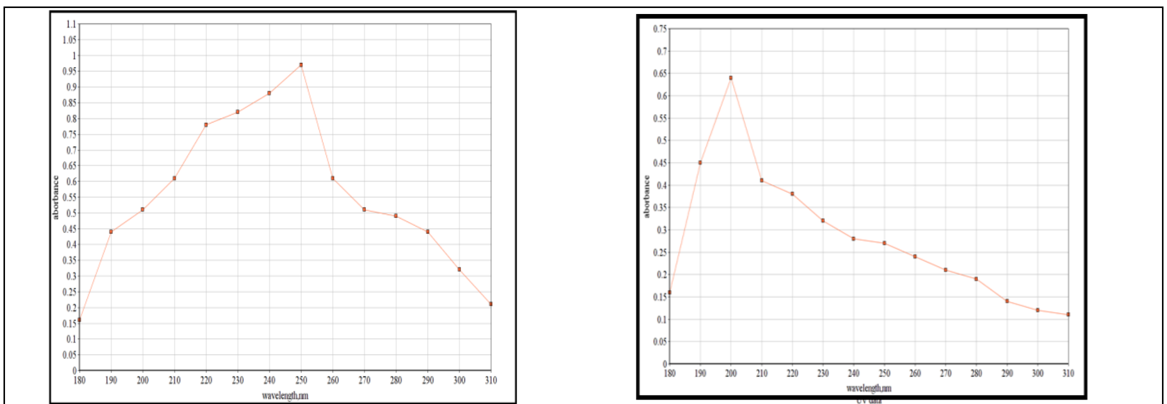


FIG. 5. **Nano-λ-Cyhalothrin pade laplace dispersion**

Ultraviolet-Visible spectral study

In order to make certain the formation and stability of NCY, UV-Vis spectral studies are indispensable. The absorption maximum obtained from the spectra shown in FIG. 6. Formulated was at 250 nm and unformulated at 200 nm.



Formulated **Unformulated**

FIG. 6. **UV-Vis spectra of formulated and unformulated λ-Cyhalothrin**

SEM analysis

From scanning electron microscope (SEM) factors like surface topology, size of NCY etc was studied at 500 × -35 k × magnification. A drop of NCY formed is taken on the stub and it was air dried then subjected to sputtering using sputter coater. The SEM image divulges the homogeneity in shape and it is regular among different scan a regions. The SEM images symbolize the agglomeration of particles and also with narrow particle size distribution. The obtained SEM image described in FIG. 7. and it shows a number of Nano-λ-Cyhalothrin particles in the form of clusters.

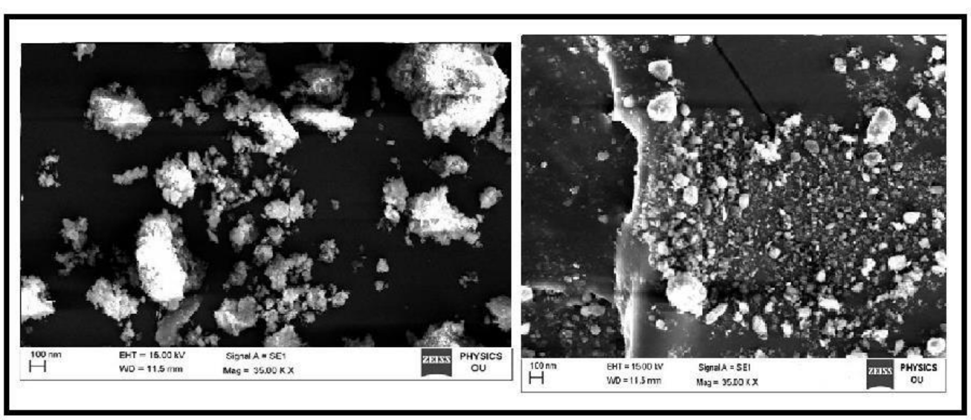


FIG. 7. **SEM images of Nano-λ-Cyhalothrin**

Application of NCY against *aspergillusflavus*

The antifungal activity of NCY was examined against *Aspergillusflavus* in petri dish assay by disc diffusion method [16]. Potato dextrose agar (PDA) medium was selected for the culture of the fungal isolates which induce the conidia production incubated at 37°C temperature for ten days. De-ionized water (sterile) was selected as control. The concentration of NCY was taken 40 ppm and 20 ppm, diluted 100-fold with de-ionized water. On to the PDA mediums filter paper discs dipped in different ppm were inserted and the petri dishes were incubated at 37°C for 2-4 days respectively. The size of the zone was determined by measuring the diameter of the zone in millimeters. NCY showed 2.6 mm for 40 ppm and 0.9 mm for 20 ppm and the commercial CY showed 1.6 mm for 40 ppm and 0.6 mm for 20 ppm. NCY shows better end results with reference to the commercial CY which can be clearly depicted. The various inhibitory zones of NCY samples were shown in FIG. 8. and the effectiveness of CY compared to NCY was given in Table 2.

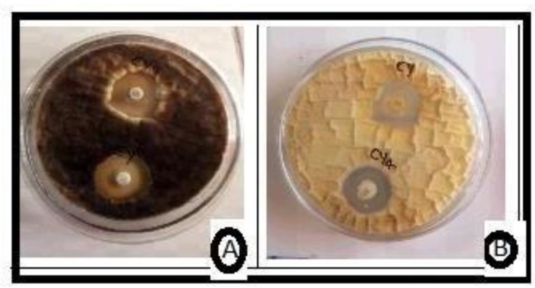


FIG. 8. **The inhibitory zone appearance of and λ-Cyhalothrin Nano-λ-Cyhalothrin (A) Encapsulated λ-Cyhalothrin inhibitory zone against *Aspergillusflavus* (B) Commercial λ-Cyhalothrin inhibitory zone against *Aspergillusflavus***

Table 2: **Effectiveness of CY and NCY against *Aspergillusflavus***

Organism	**Zone of inhibition Commercial CY**		**Zone of inhibition Commercial NCY**	
Aspergillusflavus	*40 ppm*	1.6 mm	*40 ppm*	2.6 mm
	20 ppm	0.6 mm	*20 ppm*	0.9 mm

Conclusion

Nano science has wholly chip in to foremost accomplishments in different sectors of agriculture. In order to minimize the size of CY pesticide molecules polycaprolactone was used as capping agent. The formed NCY is regarded as the better alternative to conventional pesticide. NCY was formulated by using polycapralactone as encapsulating agent. The valuable information stated by author leads to potential application of polymeric nanomaterials in protecting plant health with huge potential.

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Conflict of interests

No conflict of interest was reported by the authors

References

1. Metcalf Robert L, Horowitz. "Insect control, 1. Fundamentals". Ullmann's Encyclopedia of Industrial Chemistry. (2014) Wiley-VCH.

2. Environmental health criteria 99: cyhalothrin (pdf). World health organization, Geneva. 1990. p. 106. ISBN 9241542993.
3. Hayam M Lofty, Abd El-Aziz A, Abd El-Aleem, et al. Determination of insecticides malathion and lambda-cyhalothrin residues in zucchini by gas chromatography. Bulletin of faculty of pharmacy, Cairo university. 2013;51(2):255-260.
4. Stajnbaher D, Zupancic-Kralj L. Multiresidue method for determination of 90 pesticides in fresh fruits and vegetables using solid-phase extraction and gas chromatography-mass spectrometry. J Chromatogr A. 2003;1015:185-198.
5. Islam S, Hossain M S, Nahar N, et al. Application of high performance liquid chromatography to the analysis of pesticide residues in eggplants. J Appl Sci.2009;9(5):973-977.
6. Huang Z, Li Y, Chen B, et al. Simultaneous determination of 102 pesticide residues in Chinese teas by gas chromatography-mass spectrometry. J Chromatogr B. 2007;853 (1–2):154-162
7. Ueno E, Oshima H, Saito I, et al. Multiresidue analysis of organophosphorous pesticides in vegetables and fruits using dual-column GC-FPD, NPD Shokuhin Eiseigaku Zasshi. J Food Hyg Soc Japan. 2001;42(6):385-393.
8. Shuling S, Xiaodonga M, Chongjiu L. Rapid multiresidue determination method for 100 pesticides in vegetables by one injection using gas chromatography/mass spectrometry with selective ion storage technology. Anal Lett.2007;40(1):183-197.
9. Ronald E, Hunter J, Riederer A M, et al. Method for the determination of organophosphorous and pyrethroid pesticides in food via gas chromatography with electron capture and mass spectrometry detection. J Agric Food Chem. 2010;58(3):1396-1402.
10. Shuo Yan, Qian Hu, Jianhao Li, et al. A star polycation acts as a drug nanocarrier to improve the toxicity and persistence of botanical pesticides. ACS Sustainable Chemistry and Engineering. 2019;7(20):17406-17413.
11. Aline Bertolosi Bombo, Anderson Espírito Santo Pereira, Makeli Garibotti Lusa, et al. A mechanistic view of interactions of a nanoherbicide with target organism. J Agri and Food Chem. 2019;67(16):4453-4462.
12. Jhones Luiz de Oliveira, Estefânia Vangelie Ramos Campos, Leonardo Fernandes Fraceto. Recent developments and challenges for nanoscale formulation of botanical pesticides for use in sustainable agriculture. J Agri and Food Chem. 2018;66(34):8898-8913.
13. Wenxun Guan, Wenxiang Zhang, Liming Tang, et al. Fabrication of novel avermectin nanoemulsion using a polyurethane emulsifier with cleavable disulfidebonds. J Agri and Food Chem. 2018;66(26):6569-6577.
14. Karunartene V, Kottegoda N, Alwis A, Nanotechnology in a world out of balance, J. Natl. Sci. Found. 2012;40:3-8
15. Khot L R, Sankaran S, Maja J M, et al. Application of nanoparticles in agricultural production and crop protection. Crop protection.2012;35:64-70.
16. Barry A L, Brown S D. Fluconazole disk diffusion procedure for determining susceptibility of candida species. J Clin Microbio.1996;34:2154-2157.