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CONTROLLED RELEASE FORMULATIONS OF LARVICIDES IN MOSQUITO CONTROL PROGRAMMES

Mosquitoes are among the worst of human pests, spreading diseases like malaria, filariasis, yellow fever, dengue and Japanese encephalitis, besides being of immense nuisance value. The management of mosquitoes and mosquito-borne diseases through integrated control strategies will continue to require selective use of insecticides.

Modern pesticides have high intrinsic toxicity and are relatively nonpersistent. During the past three decades, tremendous efforts have been made in order to achieve a substantial increase in selectivity and efficiency of biologically active materials. Conventional application of insecticides needs an initial dose far in excess of what is required for immediate effects, so as to assure the presence of sufficient chemical for a practical period. Such overdosing wastes much of the chemical potential and often cause toxicity to non-target organisms[1].

During the last two decades, interest in controlled release systems has increased in the search for safer, more efficient and selective means of dispensing pest control agents. As a result, the bioavailability of a pesticide, mainly nonpersistent ones, can be maintained at an appropriate level which is slightly above the minimum effective level and well below the tolerance limit for a prolonged period[2,3]. Controlled release formulations were first used in agriculture for low molecular weight fertilizers, pesticides and antifoulants in 1950s. In 1960s this approach was extended to the medical field.

Concepts of Controlled Release Systems

Controlled release is a permeation moderated transport of an active material from a reservoir to a target area to maintain a predetermined concentration for a specified period. When conventional formulations are applied the pesticides dissipate from their application sites due to leaching, evaporation and degradation. In order to prolong the effective duration, exponentially greater quantities of pesticides must be applied. On the other hand when controlled release formulation is considered, a minimum effective level of the pesticide could be maintained by a continuous supply to compensate for the dissipated fraction from the controlled release system[4].

Advantages of Controlled Release Formulations of Larvicides

The major advantages of controlled release formulations of mosquito larvicides are (i) extended duration of activity; (ii) reduction in frequency of application; (iii) protection of the nonpersistent larvicides from environmental degradation; (iv) reduction of larvicide

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contamination in the environment; (v) reduction of toxicity to non-target organisms; (vi) improved economy due to reduced nead of the active agent, less frequent application and no need of spraying equipments; and (vi) convenient for both application and handling.

Classification of Controlled Release Systems

Classification of the controlled release polymeric systems is based on the mechanism controlling the release rate of the incorporated active agent. The rate limiting step of the release process may be pure active agent diffusion (diffusion controlled system), chemical reaction at the interface between the polymer and dissolution medium (chemically controlled system) or countercurrent diffusion of the dissolution medium at a constant velocity into the polymer (swelling controlled system). Externally imposed controls may also be responsible for release as in the magnetically controlled systems. Thus controlled release systems can be classified as (i) diffusion controlled systems: (a) matrices (monolithic devices) and (b) reservoirs (microencapsules), (ii) chemically controlled systems: (a) erodible systems and (b) pendant chain systems, (iii) solvent activated systems: (a) osmotic systems, and (b) swelling controlled systems and (iv) release induced by external forces.

Controlled Release Systems of Mosquito Larvicides

An insecticide formulation which would allow controlled release of larvicide into an aquatic environment at levels sufficient to effectively reduce or eliminate mosquitoe larvae without causing undue environmental effects would be a major contribution to mosquito abatement programmes. The use of controlled release polymeric formulations of larvicides has generated considerable interest and the WHO Expert Committee on Insecticides[5] recommended that such formulations are likely to extend the effectiveness of less persistent larvicides and reduce environmental pollution. The controlled release of various larvicides from a variety of polymer substrates has been investigated by many workers[6-26].

Formulations based on rubber matrices

Toxic rubber compounds were originally developed by the B.F. Goodrich Company, USA as marine antifouling materials. The toxic component, generally compounds of tributyltin, was incorporated in a rubber base and the surface moecule of the toxicant underwent gradual dissolution in water where they were toxic to various aquatic fauna. In the fall of 1964, Cardarelli and Mecier[6], while seeking a rapid bioassay method for determining the toxicity and release rate of organotins from antifouling elastomers by exposing mosquito larvae, observed rapid culicine mosquito mortality.

Chloroprene based materials containing tributyltinoxide (TBTO) and other organotins were effective against many mosquito species. Toxicity of such compounds to mosquito larvae was first shown by Cardarelli and Mecier[6]. Later Cardarelli *et al*[7] tested TBTO impregnated neoprene rubber and found it to give good larval kill for at least 4 months whereas Schultz and Webb[8] in laboratory tests conducted with TBTO impregnated neoprene rubber observed 100 per cent mortality of second instar *Culex pipiens quinquefasciatus* larvae only after 72 hours.

A number of controlled release organotin molluscicides were evaluated against mosquito larvae as a part of a broad environmental impact study. Cardarelli[9] evaluated a number of controlled release organotin molluscicides and their degradation products against mosquito larvae and found them effective at dosages considered to be practical for field application. Waid *et al*[10] synthesized a copolymer with pendant organotin moieties which was reported to be effective for about 24 weeks against *Cx. pipiens quinquefasciatus*.

Formulations based on plastic matrices

The leading programme in the development of plastic based controlled release mosquito larvicides has been conducted at the US Army Environmental Hygiene Agency. Initial work was on the development and evaluation of temephos, chorpyrifos, naled and malathion larvicides impregnated in plastic pellets of polyamide, polyvinylchloride (PVC) and polyurethane. These formulations were found to be highly effective for control of the larvae of *Cx. pipiens quinquefasciatus* over an extended period in the laboratory[11].

Wilkinson *et al*[12] conducted field tests with four formulations of larvicides, temephos, chlorpyrifos, fenthion and naled impregnated in PVC, chlorpyrifos formulated with polyethylene (PE) and charcoal with a polymeric binder. Treatment with chlorpyrifos in PE and chlorpyrifos in charcoal gave effective control for 20-26 weeks.

Fenthion in PVC at 2.5 ppm provided control for 20 weeks whereas other formulations did not exceed eight weeks. The effectiveness of PE and PVC formulations of chlorpyrifos applied to artificial field pools was studied by conducting bioassay against fourth instar larvae of *Cx. pipiens quinquefasciatus*[13]. Single application of the water emulsion was effective for 1-2 weeks whereas single application of each polymer formulation provided effective control for about 24 weeks. Roberts *et al*[14] conducted field trials with chlorpyrifos formulated as a slow release polymer formulation against *Cx. pipiens quinquefasciatus* and observed similar results.

Three formulations of chlorpyrifos based on chlorinated polyethylene were evaluated to determine the residue levels maintained in water under static laboratory conditions during a 16 weeks period[15]. The average weekly residues for all formulations and dosages showed a peak by week 8, which then decreased and began to increase again by week 16. One of the formulations was considered to be suitable for field testing due to its desirable toxicant to carrier ratio.

Dunn and Strong[16] studied the long-term effectiveness of a juvenile hormone (JH) mimic, Zoecon ZR515 formulated with polyurethane foam. They found that a single application of the JH-mimic at the dosage of 1.0 ppm was effective for only 2-3 days, whereas effective control for 60 days was achieved with the single application of the JH-mimic slow release polymer.

Controlled release formulation of chlorpyrifos in pelletized chlorinated PE containing 10.6 per cent active agent was found to be effective for 22 weeks in in-pool bioassay[17]. Keeman[18] evaluated a new formulation, Dursban 10CR, a controlled release formulation of chlorpyrifos. Excellent control was achieved in treated sites at the application rate of 1.5 ppm for 12 to 18 weeks with no recorded effect on non-target organisms.

Laboratory and field studies were conducted to determine the effectiveness and persistence of two formulations of temephos containing 6.3 and 7.2 per cent in PE pellets and a 10 per cent chlorpyrifos in PVC against *Culex* and *Anopoheles* mosquitoes[19]. In ponds, chlorpyrifos at the rate of 1 lb/acre prevented mosquito breeding for 35 days and temephos at 2 lb/acre caused considerable reduction in the population for 21 days.

Saleh *et al*[20] studied the effectiveness of three nonexpanded, expanded and foamed PVC formulations made with both chlorpyrifos and diflubenzuron on *Cx. pipienes quinquefasciatus* and *Ae. aegypti*. The effectiveness period which gave 90-100 per cent larval mortality or emergence inhibition ranged between 3-14 days in the case of chlorpyrifos and 1-12 days with diflubenzuron. In a small scale trial with a slow release formulation of chlorpyrifos against *Cx. quinquefasciatus* larvae breeding in highly polluted drains, a dosage of 1.5 ppm was found to be effective for about four weeks[21].

Das *et al*[22] prepared PE formulations of temephos in the form of floating pellets by air suspension process. The release rate of temephos from 1 per cent formulation applied at 5 ppm was just sufficient to control mosquito larvae during a 24 week test period. Controlled release formulations of fenthion (10%) and temephos (12.5%) in PVC were found to be effective against *Culex* and *Aedes* mosquitoes breeding in cess pits and cement tanks for more than 30 days at the application rate of 10 ppm[23].

Kassem *et al*[24] evaluated three controlled release formulations of fenitrothion based on PVC, formulated as non-expanded, expanded and foamed matrices. The amount of fenitrothion released increased with the increase in exposure time as well as the initial concentration. Saleh *et al*[25] prepared and tested three PVC formulations of fenitrothion against *Ae. aegypti* larvae and reported that the non-expanded formulation was more effective than either the expanded or the foamed formulation. Saleh[26] also prepared three controlled release formulations each of chlorpyrifos and fenitrothion and tested them against the second instar larvae of *Cx. pipiens*. Control (90-100%) was achieved for 85, 77 and 73 days after treatment with the nonexpanded, expanded and foamed formulations respectively, of chlorpyrifos. For fenitrothion formulations the respective periods were 64, 54 and 48 days.

Problems inherent with the controlled release formulations obtained by the incorporation of the mosquito larvicide into non-erodible, non-swellable or non-biodegradable plastics (*viz.* PVC and PE) and elastomers are (i) they do not exhibit constant release rate; (ii) residual insecticide loss within the matrix is observed when the concentration of the active agent in the device falls below its solubility limit in the polymer, thereby discontinuing further release of the toxicant; (iii) such non-biodegradable matrices may accumulate in the

environment and result in environmental pollution; (iv) most of the plastic and elastomeric materials have to be subjected to higher temperatures while processing to incorporate the active agent and their application is limited in the case of thermolabile compounds, and (v) these matrices may have limited usefulness in the case of active agents with low solubility in water as the matrix neither erode nor swell in water.

Formulations based on biodegradable carriers

A few reports of controlled release formulations of larvicides using biodegradable carrier materials are available. Novak *et al*[27] evaluated the release properties of slow release formulations of temephos on corncob and dried coconut husk carriers, against *Ae. aegypti* breeding. Temephos in the radial sections of corncob and coconut husk chips gave control for 27-63 and 61-134 days, respectively.

Nisha *et al*[28] have developed controlled release formulations of fenthion using powdered gummy parts of plant material known as 'jiggieth', cork powder and plaster of paris as carrier materials and evaluated the formulation at the rate of 1 g ai/25 l of water against *Cx. quinquefasciatus*. This formulation was found to be effective for 32, 37 and 27 days in cess pits, soak pits and septic tanks respectively, in controlling mosquito breeding.

Controlled release formulations of mosquito larval control agents, fenthion, temephos and diflubenzuron were developed based on their entrapment in ionotropically cross-linked matrices of carboxymethylcellulose[29-33]. Laboratory evaluation of these formulations was conducted up to 55 weeks with appreciable release of the incorporated active agent. Field evaluation of one of the formulations of fenthion was carried out in husk retting ponds infested with water plants, harbouring the breeding of *Mansonia* mosquitoes. At the application rate of 1 ppm of fenthion in the controlled release formulation, absolute breeding control was noticed up to 17 weeks whereas at 2 ppm, breeding control was observed up to 25 weeks. The maximum level of fenthion present in the habitat was well below the tolerance limit of 0.09 ppm[34].

These formulations are found effective for 17-25 weeks after a single application. Therefore the frequency of application can be restricted to twice or thrice a year, minimizing the cost of control operations by reducing the quantity of the insecticide and man power required. Since the entrapping matrix used for the preparation of the formulation is biodegradable, undue environmental impact due to their application was minimum.

In conclusion, this review clearly shows that controlled release formulations can be the most economic, safe, acceptable and affordable solution for mosquito larval control. The advancements in the development of biodegradable controlled release formulations point towards an ideal means of dispensing larvicides with reduced environmental impact. It is suggested that these formulations could be utilised for national programmes aimed at control of mosquito-borne diseases *viz.* malaria and filariasis, involving larviciding operations.

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ICMR NEWS

An Expert Group meeting on Evaluation of HIV-1 and HIV-2 Kits was held on December 30, 1994 at New Delhi.

Participation of ICMR Scientists in Scientific Events:

Dr. S.L. Hoti, Senior Research Officer, Vector Control Research Centre, Pondicherry, visited the Smith College at Boston in connection with the UNDP/World Bank/TDR project on Application and evaluation of DNA probes in studies on the transmission of *Wuchereria bancrofti* and *Brugia malayi* (November 26 - December 22, 1994).

Dr. B.N. Saxena, Sr. Dy. Director-General, ICMR, delivered the L.S. Ramaswami Memorial Oration at the Department of Zoology, University of Rajasthan, Jaipur (December 3, 1994).

Dr. J.J. Rodrigues, Director-in-Charge, National AIDS Research Institute, Pune, participated in a state-of-the-art invitational meeting on Preventing perinatal HIV transmission in developing countries : Challenges and opportunities at Boston (December 7-10, 1994).

Dr. G.V. Satyavati, Director-General, ICMR, addressed the medical graduates and postgraduates of the Kasturba Medical College, Manipal on the topic "Choice of a career for medical graduates (December 12, 1994). She also delivered the keynote address on "Future of pharmacology as a discipline in medical education/ medical research in India" at the XXVII annual conference of the Indian Pharmacological Society at Bombay (December 21, 1994).

Dr. S.K. Kashyap, Director, National Institute of Occupational Health, Ahmedabad, participated in the WHO Task Group meeting to finalize the Environmental Health Criteria Monographs on Isophorone, Chlorendic Acid and Chlorendic Anhydride at Geneva (December 12-16, 1994).

Dr. Aurobindo Roy, Asstt. Director, National Institute of Virology, Pune, participated in Keystone symposia on Molecular Toxicology at Copper Mountain, Colorado (January 9-15, 1995).

Dr. Satyavati delivered a talk on "Discovery of gum guggul as a hypolipidemic agent" at the Dr. Yellapragada Subba Row Centenary Seminar at New Delhi (January 10, 1995).

Honours/Awards:

Dr. V.M. Katoch, Dy. Director, Central Jalma Institute for Leprosy, Agra was awarded the Dr. S.C. Agarwal Oration Award of the Indian Association of Medical Microbiologists for the year 1994.

Appointments:

Dr. S.K. Bhattacharya took over as Director of the National Institute of Cholera and Enteric Diseases, Calcutta w.e.f. December 30, 1994.

ICMR AWARDS

The Indian Council of Medical Research has awarded the following prizes and awards to various Indian scientists for their outstanding research work in various fields of biomedical sciences.

Dr. B.R. Ambedkar Centenary Award for Excellence in Biomedical Research for the year 1991-92

Dr. G. Padmanabhan
Director
Indian Institute of Science
Bangalore.

Basanti Devi Amir Chand Prize, 1994

Dr. Indira Nath
Professor and Head
Department of Biotechnology
All India Institute of Medical Sciences
New Delhi.

Immunology of leprosy

Amrut Mody Unichem Prize for Research in Maternal and Child Health, 1993

Dr. T. Jacob John
Professor and Head
Department of Microbiology & Virology
Christian Medical College
Vellore.

Vaccinology

Dr. Vidya Sagar Award for Research in Mental Health, 1993

Col. Kripal Singh
Hon. Consultant in Psychiatry
Guru Harkrishan Hospital
New Delhi.

Mental health

Dr. D.N. Prasad Memorial Oration Award for Research in Pharmacology, 1993

Dr. Ranjit Roy Chaudhury
Emeritus Scientist
National Institute of Immunology
New Delhi.

Pharmacology

Dr. Y.S. Narayana Rao Oration Award for Research in Microbiology, 1993

Dr. Brahm S. Srivastava
Deputy Director
Division of Microbial Genetics
Central Drug Research Institute
Lucknow.

Molecular biology of cholera

Dr. Kamala Menon Medical Research Award for Research in Paediatrics, 1993

Dr. R.N. Srivastava
Professor
Department of Paediatrics
All India Institute of Medical Sciences
New Delhi.

Nephrotic syndrome in children

Kshanika Oration Award for Women Scientists, 1993

Dr. Anita Panda
Additional Professor
Dr. Rajendra Prasad Centre for Ophthalmic Sciences
All India Institute of Medical Sciences
New Delhi.

Corneal grafts

and

Dr. Mary Jesudasan
Professor
Department of Microbiology
Christian Medical College
Vellore.

Enteric pathogens and their diagnostic aspects

Dr. J.B. Srivastav Oration Award for Research in Virology, 1993

Dr. Shobha Broor
Additional Professor
Department of Microbiology
All India Institute of Medical Sciences
New Delhi.

Epidemiology and rapid diagnosis of viral infections in India

Smt. Swaran Kanta Dingley Oration Award for Research in Reproductive Biology, 1993

Dr. G.S. Gupta
Professor
Department of Biophysics
Panjab University
Chandigarh.

Male reproductive biology

and

Dr. Kamala Gopalakrishnan
Assistant Director
Institute for Research in Reproduction
Bombay.

Biology of male gametes

Dr. M.O.T. Iyengar Memorial Award for Research in the Fields of Malaria, Filaria, Plague, Medical Entomology, 1993

Dr. B.S. Das
Head
Department of Clinical Biochemistry
Ispat General Hospital
Steel Authority of India Ltd.
Rourkela.

Falciparum malaria

and

Dr. S.K. Kar
Director
Rajendra Memorial Research Institute
for Medical Sciences
Patna.

Lymphatic filariasis

ICMR Prize for Biomedical Research for Scientists Belonging to Under-Privileged Communities, 1993

Dr. R. Jayakumar
Associate Professor
Department of Animal Biotechnology
Madras Veterinary College
Madras.

Rabies

ICMR Prize for Biomedical Research in Underdeveloped Areas, 1993

Dr. S.L. Choubisa
Lecturer
PG Department of Zoology
SBP Government College
Dungarpur.

Haemoglobinopathies

and

Dr. Prafulla Dutta
Research Officer
Regional Medical Research Centre
Dibrugarh.

Malaria in the north-east

Amrut Mody Unichem Prize for Research in Gastroenterology, 1993

Dr. S.L. Broor
Director Professor and Head
Department of Gastroenterology
G.B. Pant Hospital
New Delhi.

Gastroesophageal diseases

Smt. Pushpa Sriramachari Award for Research in Pathophysiology, 1993

Dr. P.P. Gupta
Professor
Department of Veterinary Pathology
Panjab Agricultural University
Ludhiana.

Atherosclerosis and related cardiovascular disorders

Dr. Prem Nath Wahi Award for Research in Cytology and Preventive Oncology, 1993

Dr. Usha Saraiya
Hon. Professor of Obstetrics and Gynaecology
Grant Medical College
Bombay.

Preventive oncology

Prof. B.K. Aikat Oration Award for Research in Tropical Diseases, 1993

Dr. D. Nageswara Rao
Associate Professor
Department of Biochemistry
All India Institute of Medical Sciences
New Delhi.

Macrophage modulation in leprosy

Awards for Scientists Below 40 Years of Age

Dr. T. Ramachandra Rao Award for Research in Medical Entomology, 1993

Dr. V. Vasuki
Research Assistant
Vector Control Research Centre
Pondicherry.

Insect growth regulators

Dr. C.G.S. Iyer Oration Award for Research in Leprosy, 1993

Dr. V.K. Sharma
Associate Professor
Department of Dermatolgy
Postgraduate Institute of Medical
Education and Research
Chandigarh.

Clinical and laboratory monitoring of multidrug therapy in leprosy

Shakuntala Amir Chand Prizes, 1993

Dr. Pratibha Chaturvedi
Senior Research Assistant
Postgraduate Department of Microbiology
K.G. Medical College
Lucknow.

and

Dr. Rinee Mukherjee
Senior Research Assistant
Postgraduate Department of Microbiology
K.G. Medical College
Lucknow.

Regulation of immune response against dengue virus

Dr. S.A. Christine Telles
Assistant Director (Research)
Vivekananda Kendra Yoga Research Foundation
Bangalore.

Physiological effects of yogic practice

Dr. S.J.S. Flora
Scientist 'C'
Defence Research and Development Establishment
Gwalior.

Therapeutic measures for lead poisoning

Dr. Ashok Chauhan
Research Fellow
Department of Hepatology
Postgraduate Institute of Medical
Education and Research
Chandigarh.

Characterization of HEV in north India

ICMR AIDED SYMPOSIA/SEMINARS/WORKSHOPS/COURSES/CONFERENCES

Symposium/Seminar/Workshop/ Course/Conference	Date & Place	Contact Address
VIII North-Eastern Orthopaedic Surgeon's Conference.	January 7-8, 1995; (at New Delhi)	Dr. Sekhar Das, Organising Secretary, NEOSCON 95, Ramakrishna Mission Hospital, Itanagar.
Dr. Yellapragada Subba Row Centenary Seminar.	January 10, 1995; (at New Delhi)	Dr. Indira Nath, Professor and Head, Department of Biotechnology, All India Institute of Medical Sciences, New Delhi.
Symposium on Chromosomal and Molecular Basis of Genetic Analysis.	January 13-15, 1995; (at Varanasi)	Dr. R. Raman, Convener, Chromosomal Symposium, Department of Zoology, Banaras Hindu University, Varanasi.
National Symposium on Modern Trends in Animal Health and Production Research and its Impact on Rural Development.	January 24-25, 1995; (at Hissar)	Dr. S.K. Mahipal, Organising Secretary of the Symposium, Department of Veterinary Public Health and Epidemiology, C.C.S. Haryana Agricultural University, Hissar.
IV National Workshop on Mycoplasmology.	January 1995; (at Madras)	Dr. Usha Anand Rao, Organising Secretary of the Workshop, Department of Microbiology, Dr. A.L.M. Postgraduate Institute of Basic Medical Sciences, Madras.
VIII National Conference of All India Rhinology Society and Functional Endoscopic Sinus Surgery Workshop.	February 7-8, 1995; (at Sevagram)	Dr. V.N. Chaturvedi, Organising Secretary, Department of ENT, Mahatma Gandhi Institute of Medical Sciences, Sevagram, Wardha.
International Seminar on Environment, Sustainable Development and Human Health.	February 11-15, 1995; (at Varanasi)	Prof. Onkar Singh, Convener of the Seminar, Department of Geography, Banaras Hindu University, Varanasi.

COUNCIL'S TRAINING PROGRAMMES FOR 1995-96

Leprosy

At the Central Jalma Institute for Leprosy, Agra:

- Multidrug Therapy Orientation Course in Leprosy for Medical Officers (February 6-18, 1995).

Virology

At the National Institute of Virology, Pune:

- Diploma in Medical Virology (June 1995 - May 1996).

Reproductive Biology

At the Institute for Research in Reproduction, Bombay:

- Training Course on Techniques in Human Semenology (April 17-28), 1995.
- Training Course on Techniques in Immunology, Cell Biology and Molecular Biology (November 2-25, 1995).
- Training Course on Techniques in Neuroendocrine Research (February 6-10, 1996).

Endocrinology

At the National Institute of Nutrition, Hyderabad:

- Annual Training Course on Endocrinological Techniques and their Application (August/September, 1995).

Nutrition

At the National Institute of Nutrition, Hyderabad:

- M.Sc. in Applied Nutrition (June 1, 1995 - February 28, 1996).
- Annual Training Course in Nutrition (December 1, 1995 - February 28, 1996).

Oncology

At the Institute of Cytology and Preventive Oncology, New Delhi:

- Workshop on Molecular Biology of Viruses and Cancer alongwith Oligo DNA Synthesis and Polymerase Chain Reaction (September 18-22, 1995).
- Workshop on Research Methods relating to Oncological Studies with Computer Application (February 12-16, 1996).

Occupational Health

At the National Institute of Occupational Health, Ahmedabad:

- Training Course on Pesticide Residue Analysis (February 6-17, 1995).
- Orientation Course on Occupational Health for Industrial Medical Officers (November 13-24, 1995).
- Training Course on Air Pollution Monitoring and Risk Assessment (December 13-19, 1995).

Medical Entomology

At the Vector Control Research Centre, Pondicherry:

- M.Sc. in Medical Entomology (From August 1995 for 2 years).

Laboratory Animal Technology

At the Laboratory Animal Information Services Centre, National Institute of Nutrition, Hyderabad:

- Training Course for Laboratory Animal Technicians (June - July, 1995).

Clinical Pharmacology

At the Seth G.S. Medical College, Bombay:

- Training Course in Clinical Pharmacology (March 1-25, 1995).

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