Effects of Cypermethrin Treated Impregnated Curtains on the Mortality of Mosquitoes in Dhaka City

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Abstract: A study investigating the impact of Cypermethrin-treated curtains on mosquito mortality was conducted in two areas of Dhaka city, Motijheel and Shegunbagicha. Experimental flats were equipped with door and window curtains treated with Cypermethrin at a dose of 0.2 g/m² active ingredient (a.i.). Entomological data collected from July to December 2020 revealed that the residual activity of Cypermethrin persisted for approximately six months. During the first three months, the treatment almost completely prevented indoor mosquito resting. A significant increase in mortality rates among mosquitoes entering treated households was observed. Notably, the mortality effects varied between mosquito species, with *Aedes aegypti* exhibiting higher susceptibility to Cypermethrin than *Culex quinquefasciatus*. Immediate mortality accounted for less than half of the overall mortality, while a substantial portion was deferred. Nylon curtains treated with Cypermethrin were found to be more effective than treated cotton-polyester curtains. The study highlighted a marked reduction in *Aedes aegypti* populations, with an 89% decrease compared to control flats–nine times lower than in untreated areas. Additionally, households accustomed to using treated curtains expressed strong support for this method as a preventive strategy against dengue hemorrhagic fever (DHF).

Keywords : Cypermethrin, Impregnated Curtains, Mortality, Indoor Resting Density (IRD), *Aedes aegypti, Culex quinquefasciatus.*

Introduction

Dengue and Dengue Hemorrhagic Fever (DHF) now circulates in Bangladesh especially Dhaka city as an epidemic.The disease is transmitted by *Aedes* mosquitoes. Except that the other diseases of human transmitted by mosquitoes are Malaria, Filariasis, Chikunguniya, Yellow fever and Japanese B-encephalitis[1]. Apart from carrying Dengue, Malaria and other communicable diseases they are almost unrivaled as irritating biting nuisance. Thus, realistic mosquito

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control programs should be taken into consideration.Many working measures have been taken to prevent mosquitoes from feeding on man.The use of bednets, aerosol sprays, repellents, mosquito coils or joss sticks, chemical insecticides for larva and adult control and biological controls have been practiced for a long time.The control of mosquitoes is undoubtedly is the best method of protecting community against diseases. It is of two types: adult control and larval control. Curtis and Lines[2] identified several factors contributing to the frequent failure of mosquito control through the application of residual insecticides. These include (1) the development of physiological resistance to the insecticides, (2) behavioral traits of certain mosquito species or variants that prevent them from resting indoors long enough to absorb a lethal dose, and (3) resistance from residents to allowing access for centrally organized spray teams.Thus interest has been developed for improving personal protection against mosquitoes, other vectors borne disease, and irritant insects. Personal protection can be accomplished either by using a chemical e.g. a repellent agent or by setting a stable physical obstruction between the human and the mosquito. For example, barrier can be achieved by using of curtains or by the use of bednets which are treated by pesticides. Impregnated bednets with repellant has been developed[3] are finest protective measures against mosquitoes while sleeping. However they have some short comings or prevent air circulations which is uncomfortable in tropical countries, and this method can protect human only while one is asleep. Alternatively, to facilitate people remain safe even before going to bed is to use insecticide treated curtains on the windows and doors through which mosquitoes can enter the houses. Impregnated curtains do not hamper the beauty of a house and less works needed to fix the curtain than bednet. After fixing the curtains it does not need to be removing daily. The use of pyrethroids, such as Cypermethrin, which are toxic to insects but not for mammals, for impregnating curtains appear more suitable. Though laboratory tests prove that insecticide impregnated curtains reduced a great number of mosquito population but it was not tested in the field in our country. The present investigation was undertaken to observe the effect of impregnated window and door curtains on house frequenting mosquitoes of Dhaka city.

The term “insect powder” (pyrethrum) denotes the dried and powdered flower heads of *Chrysanthemum cineraria folium* plant. Pyrethroids are the synthetic analogous of the pyrethrums[4]. Elliot et al., (1973)[5] synthesized the first photo stable pyrethroid, permethrin. Although, the permethrin is highly toxic to insects, but has little toxicity on mamals[6]. Following the synthesis of permethrin, a large numbers of pyrethroids have been produced by different

insecticide forms, which are more toxic than permethrin; for instance, Cypermethrin and Deltamethrin. Pyrethroids are the second most extensively used class of pesticides with global sale of about one billion dollars[7]. Pyrethroids have been assessed successfully against mosquito larva by a number of researchers both in the laboratory and in the field[8,9]. Hossain[10] et al. observed two pyrethoid insecticides, Cypermethrin 10E. C and Deltamethrin 2.5 E.C; and tested in the laboratory against the larvae of *Cx. quinquefasciatus* Say in Dhaka city. Deltamethrin was slightly more toxic than Cypermethrin. In Tanzania the study showed that the impregnated window curtains by pyrethroids greatly reduced the mosquito entrance into an investigational shed and also triggered most of those death that entered to exit after feeding[11] . A combination of permethrin impregnated curtains made of cotton on doorways and windows significantly reduced the number of mosquitoes found resting indoors, for about a year at a dose of $1g/m^2$ in Burkina Faso[12]. Nam V.S[13] et al. observed Permethrin treated bamboo curtains for Dengue vector control in Vietnam, Vinhphu province in 537 households of the rural area. The result of the study showed a significant effect on *Aedes aegypti* control. Ansary[14] et al. conducted a field trial in Motibagh, New Delhi a simultaneous control of mosquites and domestic pests by using of Deltamethrin treated curtains. Treated curtains provided 100% killing of *An.stephensi* and *Ae*. *aegypti* for 3-4 months, followed by gradual decline in successive months. Kroeger[15] et al. observed effective control of dengue vectors with curtains and water reservoir covers treated with insecticide in Mexico and Venezuela. Treated curtains and covers can reduce the densities of dengue vectors to low levels and potentially control the transmission of dengue.

Materials and Methods

Sites of Data Collection

Mosquitoes were collected from four fixed catching stations situated in two different areas within Dhaka city, viz, Shegunbagicha and Motijhil. Two flats of the same pattern and measurement were selected in each area. The flats were situated side by side, one was kept as control and the other was as test station.

The experiment was carried out in site A, Motijhil A.G.B. Colony which was situated in Motijhil Area of Dhaka city. The whole area is occupied by a large number of multistoried buildings where Government Employees were used to live. Within the colony there are many trees, bushes and gardens and grassy lawns were present. Rain water accumulated in ditches in the lawn. Two flats F-1 and F-2 were situated on the ground floor of building B-50. Flat F-1 selected as control and Flat F-2 as Test flat. There are 3 rooms of the same size in each flat.The doors and windows were not netted, have two windows (0.91m x 0.91m) and two doors

(1.87m x 1.04 m) in each room, six people lived in each of these flat consisting of four adults and two children in Flat B-50/F2 and five adults and one child in flat B-50/F1.

In site B, two flats in a multistoried Building were selected which was situated in Shegunbagicha area, 24/A, Green Eastern, Shegunbagicha. Flat A-1 was selected as control and A-2 as test flat. It was a residential cum commercial densely populated area on the Northern side of Bangladesh secretariat buildings. Two neighboring flat selected where five rooms in each flat. All the rooms have two large windows (1.35m x 0.37m) each and a door (2.06m x 0.83m). The residents of the flats had pot gardening hobby.

Period of Collection

Experiments were made from July 2020–December 2020. Adult mosquitoes were collected from all the four flats for 3 months before impregnation to get a base line data on the species composition of mosquitoes and their density. After impregnation during the experimental period the Indoor resting mosquitoes were collected weekly. On each collection date mosquitoes were caught thrice in a day. One in the morning (1 hour after sunrise), immediately after sunset and at night (2to 3 hours after sunset). A total of 15 minutes (0.25 hour) was spent in each room during one collection. The collection data were later converted to number of mosquitoes/room/hour. Mosquitoes collected were kept in labeled marked paper cups covered with netting and later were identified by microscope.

During the experiment period, the residents were requested to keep the curtains always hanging down (i.e.not folded up), particularly from sunset to sunrise. Adult resting mosquitoes were collected with the help of an aspirator. The flat contain impregnated curtains and the controlled flats were used to compare. Dead mosquitoes were also collected. The mosquitoes were scored as knocked down or not knockdown. They were kept in a paper cup with a piece of cotton wool soaked with glucose solution for 24 h after which they were counted as dead or alive.

Identification of mosquito species

Stere Brum[16] and UNDP[17] manual were followed for species identification.

Chemical used: Cypermethrin

Chemical name (IUPC Nomenclature);

Rs α-cyano-3phenonylbenzyl R s *cis, trans* 3-(2, 2dichlorovinyl) 2, 2: dimethylcyclopropanecarboxylate.

Empirical formula: $C_{22}H_{19}C_{12}NO_3$

Window and Door Curtain

For site A: A nylon material commonly available in market was selected for the curtains.This was a100% nylon netting with square shaped holes of 1mm^2 area.The curtains were made according to the size of the door and windows. The curtains were filled in such a way that there was no gap between the curtains and the wall or floor. Total 13 meter cloth needed for site A.

For site B: A finely woven cotton polyester sheeting was selected for the curtains. Total cloth needed for curtains were 54 meter.

Impregnation of curtains with Cypermethrin:

The curtains were impregnated with 0.2g/m^{2}a.i. of Cypermethrin formulated as 10% emulsiable concentrate. Impregnation of curtain by dipping in an emulsion of insecticide is an easy method. But impregnation by this method requires much more insecticides, because one has to make at least 4/5 fold more emulsion than in necessary for proper soaking. It was therefore decided to spray the curtains with Hardy –spray can, in the same way as for residual spraying of houses.

Calculation of insecticide needed for experimental flats

Site A: Flat B-50/f-2, Motijheel A.G.B Colony

Total spray able area (11.43x1.03)m^2=11.77m^2

An arbitrary dose of 200mg/m^2 was selected which in widely used for mosquito bed nets (Hossain et al., 1988). So the total amount of insecticide necessary would be = 11.77m^{2}x 200mg = 2.354gm: We know 100gm = 1000ml; so 2.354gm = 23.54 ml

Initial trial showed that spraying at the rate of 200ml/ 100 seconds ensured even distribution. Concentrated 23.54 ml insecticide diluted by adding distill water, and total amount was made 200ml.

Site B: Flat A 2, 24/A, Green Eastern, Shegunbagicha

Total spray able area (52x1.17)m^2 = 60.84m^2 = 61m^2

Total insecticide needed = (61x 200) mg = 12200mg = 12.20gm = 122ml

Concentrated 122ml insecticide diluted by adding distil water and total amount was 200ml.

Total dilution amount made for 18 window and 10 door curtain was (200x18+250x10) = 6100ml

Results

General Mosquito Collection

A total two species of mosquitoes were collected three months from April, 2020 - to June 2020 before impregnation from two experimental sites. One belong to the genus *Culex* Linnaeus and another one to *Aedes* Linnaeus. A total of 304 mosquitoes were collected pre impregnation months, of which *Cx.quinquefasciatus* 70.07% and *Ae. aegypti* 29.93% (Tab. 1; Fig. 1).

Table 1. Total indoor resting mosquito collection from Site A and SiteB before impregnation

Species	Total No	Average density (No/ Room/Hour)	Percentage of total collection
Aedes aegypti Linnaeus	91	6.52	29.93%
Culex quinquefasciatus Say	213	15.43	70.07%
Total	304	21.95	100%

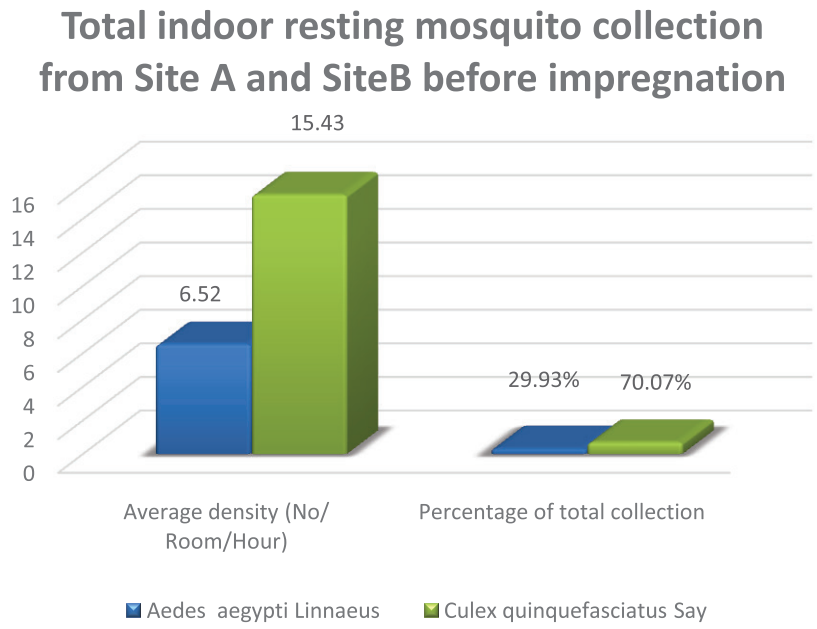

Fig.1. Total indoor resting mosquito collection from Site A and Site B before impregnation

Comparison of Indoor Resting Density (IRD) of Mosquitoes in Control and Test Flats after Impregnation

In Table 2, after curtain impregnation the six months data of the indoor resting density (IRD) of *Cx. quinquefasciatus* and *Ae. aegypti* in (site A, Motijheel A.G.B Colony) test and control flats has been placed . The percentage reduction of mosquitoes in test flat due to impregnated nylon curtains were calculated here. It is markable that after two weeks of impregnation percentage reduction density of *Ae.aegypti* in test flat was 100% which continue next 2 months. In the middle of fourth month it gradually come down to 90% then to 33.33% in the middle of sixth month (Fig.2)

Table 2. Indoor resting density (No/man/hour) of *Ae. aegypti* and *Cx. quinquefasciatus* in Site A (Motijheel); Control and Test flats, after Impregnation with Cypermethrin in Nylon curtains

Date	*Culex* spp Control flat	*Culex* spp Test flat	*Culex* spp % reduction in Test flat	*Aedes* spp Control flat	*Aedes* spp Test flat	*Aedes* spp % reduction inTest flat
15/7/2020	36	1	97.22	05	0	100
15/8/2020	32	1	96.87	10	0	100
15/9/2020	22	1	95.45	11	0	100
15/10/2020	18	3	83.33	10	1	90.00
15/11/2020	26	9	65.38	06	2	66.66
15/12/2020	21	16	23.81	03	2	33.33
Total	155	31	80.00	45	05	88.89

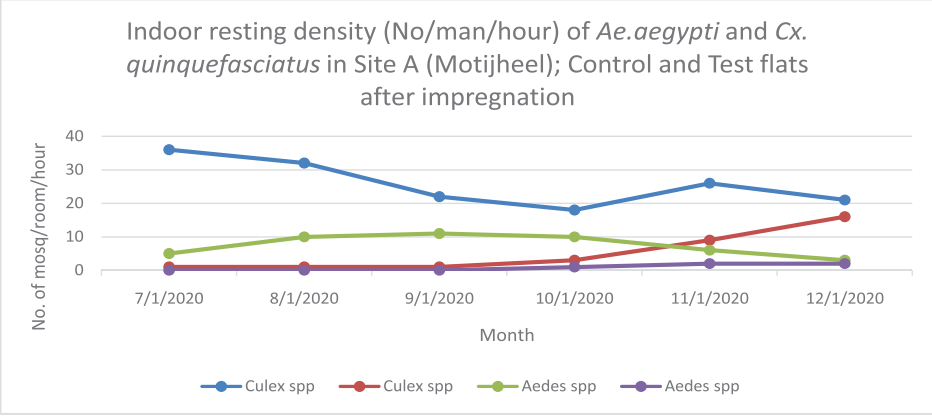

Fig. 2. Indoor resting density of *Ae.aegypti* and *Cx. quinquefasciatus* in Site A ; Control and Test flats , after Impregnation with Cypermethrin in Nylon curtains

In Table 3, the six months indoor resting density (IRD) data of *Cx. quinquefasciatus* and *Ae. aegypti* in (site B, Shegunbagicha) test and control flats has been placed .The percentage reduction of mosquitoes in test flat due to impregnated cotton –polyester curtains were calculated here. It is also markable that after two weeks of impregnation percentage reduction density of *Ae. aegypti* in test flat was 100% which continue next 2 months. In the middle of fourth month it gradually come down to 83.33% then to 20.00% in the middle of sixth month (Fig.3).

Table 3. Indoor resting density (No/man/hour) of *Ae. aegypti* and *Cx. quinquefasciatus* in Site B (Shegunbagicha) ; Control and Test flats, after Impregnation with Cypermethrin in Cotton polyester curtain

Date	*Culex* spp Control flat	*Culex* spp Test flat	*Culex* spp % reduction in Test flat	*Aedes* spp Control flat	*Aedes* spp Test flat	*Aedes* spp % reduction inTest flat
16/7/2020	30	0	100	07	0	100
16/8/2020	28	1	96.42	12	0	100
16/9/2020	15	1	93.33	15	0	100
16/10/2020	11	3	72.72	12	2	83.33
16/11/2020	18	7	61.11	07	3	57.14
16/12/2020	16	13	18.75	05	4	20.00
Total	118	25	78.81	58	09	84.48

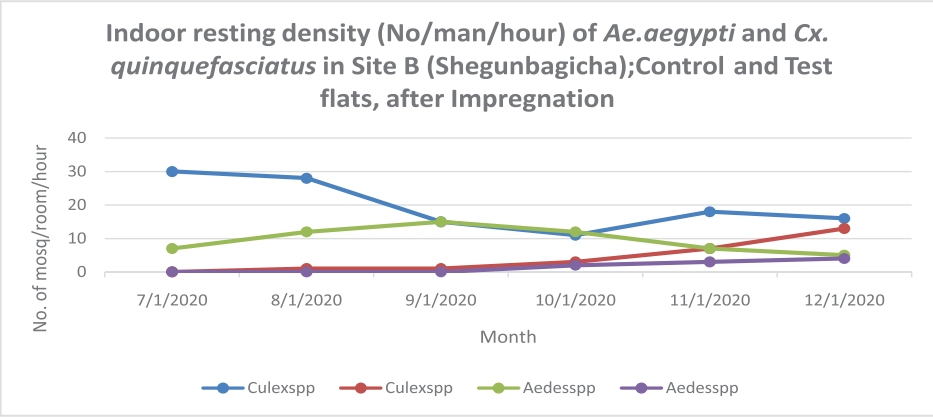

Fig. 3. Indoor resting density of *Ae.aegypti* and *Cx. quinquefasciatus* in Site B ; Control and Test flats, after Impregnation in Cotton polyester curtain

By observing data, graphs and diagrams it can be concluded that Cypermethrin treated curtains significantly reduce the indoor resting density of *Ae. aegypti* and *Cx. quinquefasciatus.* Residual Cypermethrin activity lasts for about six months and first three months showed almost complete prevention of indoor-resting mosquitoes.

For clothing materials of impregnated curtains it shows different percentages of mosquito reduction in two sites. *Ae. aegypti* average % Reduction in test flat Site-A was 88.89% where in Site-B it was 84.48% (comparing Table-2 and 3). On the other hand, *Cx. quinquefasciatus* average % reduction in test flats Site-A was 80%where in Site-B it was 78.81%. Hossain .M.I (1988) stated that LD_{50} value of Permethrin on cotton nets was found to be about three times greater than on Nylon. He also proved that nylon net is more effective than polyester. Our data also shows treated curtain in Site A (Motijheel) made by Nylon material is more effective than treated cotton –polyester curtains in Site B (Shegunbagicha) for both mosquito species.

Mosquitoes Over all Mortality due to Impregnated Curtains

When mosquitoes resting on impregnated curtain in the test flats, were collected and kept in paper cups for 24 hours for observation. Some of them died immediately while the others within 24 hours of holding. Table 4 represents the data of their mortality. Overall mortality was comparable for *Ae.aegypti* and for *Cx.quinquefasciatus.* That is 100% for *Aedes* in both site and 88.5% and 87.5% for *Culex* in Site A and B respectively.Thus it can be said that *Ae aegypti* is most susceptible to Cypermethrin than *Cx. quinquefasciatus.*

Table 4.Overall mortality of Mosquitoes in test and control flat

Sites	Test flat No.ofMosq caught	Test flat No ofMosq dead	Test flat %Mortality	Control No.ofMosq caught	Control No ofMosq dead	Control %Mortality
Site A,*Aedes* Motijheel	12	12	100%	51	1	2
SiteB,*Aedes* Shegunbag	8	8	100%	40	2	4.88
Total *Aedes*	20	20	100%	91	3	3.3
Site A,*Culex* Motijheel	61	54	88.5	120	3	2.5
SiteB*Culex* Shegunbag	33	29	87.5	96	5	5.21
Total*Cuiex*	94	83	88.30	216	8	3.7

Immediate and Deferred mortality of Mosquitoes in Impregnated and Control flats

Immediate and deferred mortality of the Indoor resting Mosquitoes in Site A and Site B flats are shown in Table 5. In the flats with impregnated curtains 47.57% died immediately and 52.43%

died after 24 hours holding. On the other hand in control flat only 89% died immediately and 11% died after 24 hour holding. (Fig.4). In trial flats less than half of the overall mortality is immediate and about half of the mortality is deferred. There was practically very few death after 24 hours among the female mosquitoes caught in the control flats.This information shows that under experimental condition Cypermethrin did not have significant knockdown effect. The mosquitoes are inconvenienced by the irritant effect and has sufficient time to die before receiving a possible lethal dose.

Table 5: Immediate and Deferred Mortality in Impregnated Test and Control Flats

	Impregnated					Control Flats				
Name of species	**No of dead Mosq**	**Immediate mortality**		**Deferred Mortality**		**No of dead Mosq**	**Immediate mortality**		**Deferred mortality**	
		No	%	No	%		No	%	No	%
Ae.aegypti	20	8	37.93	12	62.07	1	1	100%	0	0%
Cx.quinquefasciatus	83	41	48.94	42	57.06	8	7	87.5	1	12.5%
Total	103	49	47.57%	54	52.43%	9	8	89%	1	11%

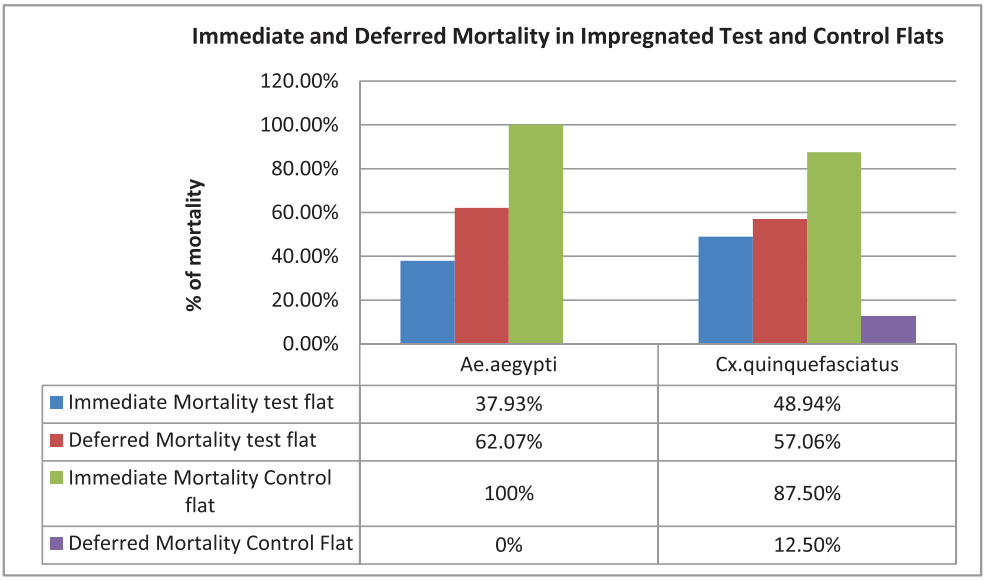

Fig. 4. Immediate and Deferred Mortality of Mosquitoes in Impregnated and Control flats

Discussion

The first objective of this study was to confirm the effectiveness of Cypermethrin impregnated curtains for reduction of indoor resting density of mosquitoes. The second objective was to observe the effectiveness of impregnated curtains on mortality rates of mosquitoes.

In our three month pre impregnation study period we observed *Cx. quinquefasciatus* constituted 70.07% and *Ae. Aegypti* 27.93% of the total population. Ameen[18]et al., (1984) observed the *Cx. quinquefasciatus* formed 57.17% and *Ae. aegypti* 2.87% of the total population. Present investigation showed that the proportion of the *Aedes aegypti* population is ten times higher than the previous population which is very alarming.

The indoor resting density values obtained by experimental period confirmed the effectiveness of Cypermethrin impregnated curtains for reduction of indoor resting mosquitoe[19]. It was noted that after treatment mosquito density showed greater reduction (79%-89%) during the first three months in test flats. It is markable that after two weeks of impregnation percentage reduction density of *Ae.aegypti* in test flat was 100% which continue for next 3 months, then mosquito population gradually increase and at the end of 6th month percentage of mosquito reduction rate was below 30%. Comparing the indoor resting density it was noted that the *Ae. aegypti* population of Site B, Shegunbagicha was higher than Site A, Motijheel. This was happened for huge pot gardening habit of the inhabitants of Shegunbagicha. It was also noted that *Ae. aegypti* is more susceptible to Cypermethrin than *Cx. quinquefasciatus,* and also observed that treated curtain in Site A (Motijheel) made by nylon material is more effective than treated cotton –polyester curtains in Site B (Shegunbagicha) for both mosquito species. Observation also confirmed that less than half of the overall mortality of mosquitoes is immediate and half of the mortality is deferred.

Form our observation in recent dengue epidemic prevention perspective, it can concluded that-

- Wild *Ae. aegypti* mosquitoes are completely susceptible to Cypermethrin.
- Cypermethrin treated curtains have a high effect on dengue vector control.
- Cypermethrin–treated curtains remain effective in killing *Ae. aegypti* even after six months.

The operational benefits of using impregnated curtains, as compared to conventional indoor spraying, are noteworthy. Impregnated curtains require treatment of less than 10% of the surface area covered in full indoor spraying, with the insecticide strategically distributed to maximize mosquito contact and minimize contamination of non-target surfaces. This method

of house treatment is highly reliable, easy to inspect, and less dependent on logistical factors such as specialized equipment or personnel training, which are often necessary for traditional spraying programs. Additionally, the distribution and installation of impregnated curtains are straightforward and efficient.

In our study area, the acceptability of impregnated curtains was outstanding, with a rapid increase as households observed their effectiveness in controlling mosquitoes and other nuisance insects. Furthermore, these curtains provided added protection against pests such as houseflies, cockroaches, bedbugs, and sandflies.

The potential for industrial production of impregnated curtains is significant, as they can be easily stored and transported in plastic packaging. Commercially available Cypermethrin-treated curtains could be particularly valuable in emergency settings and health care facilities, including surgical and pediatric units in field hospitals, where rapid deployment and effective mosquito control are crucial.

References

1. Service, M.W. 1993.Mosquitoes (Culicidae) *Medical Insects and Arachnid spp* 120-240.
2. Lines. J.D and J.D.Lines. 1985. Impregnated fabrics against malaria mosquitoes. *Parasitology today* 5(1), pp.147.
3. Hossain, M. I. 1991.Persistence of Permethrin on Impregnated mosquito netting under various conditions, *Journal of Asiatic Society Bangladesh, Science* 17:1-8.
4. Metcalf, C. L and Flint, W. P. 1967. Destructive and useful insects- their habits and control, pp 328-332.
5. Elliott, M. and Janes , N. F. 1973. Chemistry of the natural pyrethrins. *In* Pyrethrum: the Natural Insecticide (ed.Casida, J.E.). Academic Press, NewYork, pp 55-95.
6. Kadota.T. 1976. Toxicological study of Permethrin, 3-phenoxybenzyl (+_)- cis, trans -2, 2-dimethyi-3-(2, 2-dichlorovinyl)-cyclopropane-1-carboxylate. Research Department, Pesticide Division, Sumitomo Chemical CO., Ltd., Takarazuka, Hyogo, Japan) Received May 20, 1976 *Botyu-Kagaku,* 41,143.1976.pp143-151.
7. Scott, R. C., Ramsey, J. D. 1987. Comparison of the in vivo an in vitro percutaneous absorption of a lipophilic molecule (cypermethrin), a pyrethroid insecticide). *J Invest Dermatol*. Aug 89(2) 142-6.
8. Mulla, M. S. and Darwazeh, H. A. 1978. Biological activity and longevity of new synthetic pyrethhroids against mosquitoes and some non-target insects. *Mosq News* 38:90-96.
9. Darwazeh, H. A and Mulla, M. S. 1981. Pyrethrin tossits against mosquito larvae and their effecs on mosquito fish and selected non target organisms. *Mosquito News.* 41:650-6557.

10. Hossain , M. I., Ameen. M., Ahmed, A. K. M. R. 1995. Efficacy of two Pyrethroid insecticides against *Cx.quinquefasciatus.* Say larvae in Dhaka city. *Bangladesh Journal of Zoology* 23:187-192.
11. Lines, J. D. Curtis, C.F and Njau, R. 1985. Test of repellant or insecticide impregnated curtains, Bed nets and Anklets against malaria vector in Tanzania.WHO. Report not published formally.
12. Majori, G., Sabatineli, G. and Coluzzi, M.1987. Efficacy of Permethrin-impregnated curtains of malaria vector control. *Medical and Veterinary Entomology.* 1.185-192.
13. Nam,V.S., Nguyen, H. T., Tien, T. V., *et al.*1991.Permethrin- treated bamboo curtains for dengue vector control-Field trial, Viet Nam. *DengueNews Letter, Western Pacific Region*. 23-28.
14. Ansary, M. A. and Razdan, R. K. 2001. Concurrent control of mosquitoes and domestic pests by use of Deltamethrin-treated curtains in the New Delhi municipal committee, India. *Journal of the American Mosquito Control Association,*17(2):131-136, 2001.131-136.
15. Kroeger, A., Lenhart, Audrey., Ochoa, M, Villegas, E., Levy, M., Alexander, N. and Mc Call, P. J. Effective control of dengue vectors with curtains and water container covers treated with insecticide in Mexico and Venezuela: cluster randomised trials. *Research BMJ Online* bbmj.com.1-6.
16. Braun, Stereo. 1967. Mosquitospecies review. Scholarly Article.
17. UNDP Project. BGD/89/040. Field Epidemiological Surveillance and disease control. 1992 Manual on entomological surveillance for entomologist and entomological technician.
18. Ameen, M. Hossain, M. I and Khan, M. D. H. 1984. Seasonal prevalence of the common mosquitoes of Dhaka city. *Dhaka University Studies, B*. 32:79-89.
19. Nazneen, S. 1997. Effect of Impregnated Curtains on the Behaviour and Mortality of Mosquitoes in Dhaka City. M. Sc Thesis, Department of Zoology, University of Dhaka, 87-89.