Discerning the Problems of Mosquitoes and Contriving an Eco friendly Mosquito Repellent

By

Shanmathi. S.J

(20PIR011)

Thesis Submitted to
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043.

In partial fulfilment of the requirement for the Degree of

Master of Science in Interior Design and Resource Management

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INTRODUCTION

India is one of the emerging and developing country (EDC) found in southern Asia. It is the world's largest democracy, and one of the world's fastest growing economies. In 2013 India was the seventh richest country in the world. Estimates suggest that it had grown to become the fifth largest economy in 2020 and is projected to be the third largest world economy after China and the USA by 2025. India is an example of a country that has become richer along with the growing population.

The population of India in 2016 was approximately 1.3 billion people, and a recent United Nations report predicts that India will overtake China as the most populous country in 2022. India has around 50 millionaire cities (with a population of over a million people), and is home to three of the world's megacities (over 10 million people) - Delhi, Mumbai and Kolkata.

However, despite its rapid growth, poverty in India is widespread. The Human Development Index (HDI) places India 136th out of 187 countries, with 25% of the nation's population still living on less than $1.25 (US dollar) a day. (www.bbc.co.uk)

Generation of waste is inevitable in every habitation howsoever big or small. Since the dawn of civilization humanity has gradually deviated from nature and today there has been a drastic change in the lifestyle of human society. Direct reflection of this change is found in the nature and quantity of garbage that a community generates. We can dispose the waste or reuse the waste and can earn money through proper management. Indian cities which are fast competing with global economies in their drive for fast economic development have so far failed to effectively manage the huge quantity of waste generated. There are about 593 districts and approximately 5,000 towns in India. About 27.8 percent of India’s total population of more than 1 billion (as per Census 2001) lives in urban areas. The projected urban population percentage is 33.4 percent by the year 2026. The quantum of waste generated in Indian towns and cities is increasing day by-day on account of its increasing population and increased GDP. The annual quantity of solid waste generated in Indian cities has increased from six million tons in 1947 to 48 million tons in 1997 with an annual growth rate of 4.25 percent, and it is expected to increase to 300 million tons by 2,047 (CPCB, 1998).

Population explosion, coupled with improved life style of people, results in increased generation of solid wastes in urban as well as rural areas of the country. In

India like all other sectors there is a marked distinction between the solid waste from urban and rural areas. However, due to ever increasing urbanization, fast adoption of 'use and throw concept 'and equally fast communication between urban and rural areas the gap between the two is diminishing. The solid waste from rural areas is more of a biodegradable nature and the same from urban areas contains more non-biodegradable components like plastics and packaging also. The repugnant attitude towards solid waste and its management is however, common in both the sectors. Universally 'making garbage out of sight' is the commonly followed practice.

Dumping of solid wastes not only gives an ugly look and foul smell, but also causes serious health hazards. Sometimes, the outbreak of epidemics takes place due to the accumulation of wastes, particularly near water bodies, especially like stagnant water, unused pools etc.

Wastewater effluents are also major contributors to a variety of water pollution problems. Most cities of developing countries generate on the average 30–70 mm3 of wastewater per person per year. Owing to lack of or improper wastewater treatment facilities, wastewater and its effluents are often discharged into surface water sources, which are receptacles for domestic and industrial wastes, resulting to pollution. The poor quality of wastewater effluents is responsible for the degradation of the receiving surface water body. Various diseases spread on an epidemic scale due to waste accumulation on land and water bodies. Vectors like flies, mosquitoes, rodents and pet animals transmit these diseases. (https://www.toppr.com/ask/content/concept/impact-of-waste-accumulation-205950/). Mosquitoes are often attracted to water, especially standing water. Therefore, water bodies like lakes, stagnant creeks, bogs, marshes, and swamps or open gutter can serve as a breeding ground for mosquitoes. Hence there is a dire need to manage the solid and water waste to manage efficiently for the sake of public health.

In India, the urban local bodies, popularly known as the municipal corporations/councils, are responsible for management of activities related to public health. However, with increasing public and political awareness as well as new possibilities opened by economic growth, solid waste management is starting to receive due attention. The various initiatives taken by government, NGOs, private companies, and local public drastically increased in the past few decades.

Nonetheless, land filling is still the dominant solid waste management option for many other countries like India around the world (Rajshree, 2015).

In absence of suitable management, porcelain (including glass) and plastic wastes sustain pathogens and parasites of medical importance (Hamer. 2003), The organic residues and entrapped water in porcelain (including glass) and plastic wastes create suitable biotope for breeding of vector mosquitoes, particularly *Aedes* spp. (Pramanik, 2007).

Important vector-borne disease for India, include **malaria, dengue, Japanese encephalitis, kala-azar, lymphatic filariasis and chikungunya**. They are being addressed by the National Vector Borne Disease Control Programme, Directorate of Health Services, Ministry of Health and Family Welfare, Government of India. WHO (2006) also reiterates that Dengue and Chikungunya are examples of mosquito borne viral diseases posing concern for public health worldwide, in the tropics and subtropics .

Mosquito related diseases infect over 500 million people resulting in 1 million deaths approximately. In India, annually around 40 million people contract mosquito borne diseases (*https://www.mortein.co.in ›)*. Even today, the mosquito is responsible for over 1 million deaths each year (www.rti.org).The overall prevalence rate of the disease in India is 0.57 per 10,000 population (09-Mar-2021 actly.in). Use of bed net, repellents such as coils, vaporizers, mats and creams can be used to reduce the risk of malaria and other infectious diseases.

Mosquito are one of the most prevalent and troublesome menaces that come with rains in India. This is a particularly rampant problem in places like Coimbatore, Tiruppur and Chennai in Tamilnadu and areas towards the North East as these environment are favorable for mosquito breeding. Yet, other areas too, witness issues like stagnant water and poor drainage, which also cause mosquitoes to multiply.

The mosquito can also breed inside the home, right under nose. There are several odd places where mosquitoes can, unfortunately, thrive and create health problems for everyone living under that roof. Some of the most common places in and around home where mosquitoes can breed are shallow, stagnant water, marshes**,** ponds, lakes, children's pools, the interiors of tyres, birdbaths, and other shallow-

water containers .Mosquitoes will breed in areas where water is held for several days. As a result, humans are plagued by mosquito bites. (timesofindia.indiatimes.com)

In addition to posing a risk to one's health, mosquito bites are a nuisance that cut into productivity. People still have the impression that being bitten by mosquitoes prevents them from doing their jobs to their fullest potential. It is possible that the working pattern will be altered, the working efficiency will decrease, outside activities will be limited, and there will always be a concern of being sick owing to illnesses carried by vectors**.** When the worker takes absence due to the mosquito bite, his or her pay will be reduced. The family will be affected as a result. For some workers, mosquitoes are an on-the-job hazard. The best way to prevent the spread of mosquito-borne diseases is to stay indoors where air conditioning is available or where all windows and doors have screens, or away from high-risk areas. However, that's not always possible, especially for those who need to perform work outside of buildings. These individuals should understand precautions to take to stay safe from disease-carrying mosquitoes... The installation of mosquito netting on doors and windows is one mosquito prevention measure that is being considered by an increasing number of homeowners as well as building owners of commercial structures today.

In order to protect from mosquito bites number of alternative are there like use of bed nets, mosquito repellents, coils , mats, creams and lotions, mosquito traps, mosquito rackets etc. are available, The bed net is an invention that dates to antiquity, with various mentions across geographical regions. It is rumored that Cleopatra, the last pharaoh of Egypt, slept under a mosquito net. However, it wasn't until the invention and testing of the insecticide-treated net (ITN) in the late 1980's—which combined the physical barrier of nets with the repellent and mosquito-killing effects of insecticides—that bed nets became a viable preventive tool against malaria and other mosquito-borne diseases. Worldwide, treated bed nets were responsible for two-thirds of the seven million lives saved from malaria between 2000 and 2015, and are seen as a cornerstone of malaria prevention and control efforts (www.rti.org/insights/mosquito-facts).

Insecticides are used to kill insects while mosquito repellents are not. DEET (**N,N-diethyl-meta-toluamide)** is a reliable and highly effective insect repellent. The chemical has been in public use since 1957. The repellent is sold under numerous

brand names and comes in lotion, spray and many other forms. (Jackson.2015). Concentrations of DEET range from about 5% all the way up to 100%. Products with 10% to 35% DEET will provide adequate protection under most circumstances. DEET should be used with proper precautions, especially in children, who can experience irritation or other reactions after swallowing or prolonged skin application. However, if DEET products in moderate concentrations are used according to directions, they are considered safe.

IR-3535 is used as an insect repellent against mosquitoes, deer ticks, and biting flies. It can be expected to provide long-lasting protection for those seeking a non-DEET product. Picaridin, also known as KBR 3023, is an effective alternative to DEET products which provides long-lasting protection against mosquito bites, comparable to about a 10% concentration of DEET. This repellent has been used worldwide since 1998. Compared to DEET, Picaridin is nearly odourless, does not cause skin irritation, and has no adverse effect on plastics (Jackson.2015). People have reported skin and eye irritation from products with Picaridin (HSD 2016). Vomiting has also been reported. People who have inhaled DEET repellents have reported coughing and respiratory irritation. If eaten, they can cause stomach and digestive irritation. Although rare and largely due to accidents or overexposures, neurological effects have been reported. The EPA found inconclusive evidence linking seizures in children to DEET exposure (DEET 2014).

Oil of lemon eucalyptus can cause significant eye damage. Washing eyes after an exposure can reduce the risks of long-term harm. It has been linked to skin irritation in animal studies. (BRED 2000). IR3535 is an eye irritant. Human and animal studies show if it is undiluted, it can cause skin irritation. In studies with diluted IR3535, skin irritation was not reported (HSD 2016).

A mosquito repellent is a chemical that keeps mosquitoes away from humans, stopping them from biting and sucking on their blood. It usually comprises an active chemical that repels mosquitoes as well as secondary substances that, among other things, dilute the active ingredient to a desired concentration and aid in its release when needed. Mosquito repellents come in creams, lotions, oils that are applied to the skin directly and sticks and liquidators used to evaporate the product to drive mosquitoes.

Insect repellant is an important item of safety gear that protects workers on the job as well as members of the household are also protected. It is on par with safety helmets, glasses, and gloves in terms of its importance. It is more cost-effective, rather than invest in costly illness treatments or the cost of a life. (https://facilityexecutive.com/2018/04/put-mosquitoes-out-of-work-not-your-staff/)

When people use chemical repellents, it might cause health problems in their families, such as skin blisters, seizures, memory loss, migraines, stiffness in the joints, shortness of breath, skin irritation, and breathing problems. Chemical products are dangerous as they get absorbed into the skin or inhaled more easily than natural products. For instance, 15 per cent of whatever quantity of DEET used gets absorbed in skin, In this regard there is a growing demand for organic repellents but the number of good companies catering to this demand is very less. Though the demand for herbal repellents has increased only recently, they are certainly not new entrants to the market. Though herbal products are 5-10 per cent costlier than synthetic repellent, they are more effective and provide immediate results Watwani (2016). https://www.downtoearth.org.in/news/environment/naturally-repelling-52668.

Though natural repellents have started to make a mark in the market, the demand for synthetic products is still much more. “Nearly 70 per cent of the population is not bothered about what repellents they use,”. Licensing of organic products is also a concern. “Many companies claim their products are 100 per cent natural but they use chemicals along with essential oils,” (Watwani 2016) https://www.downtoearth.org.in/news/environment/naturally-repelling-52668.

People looking for alternatives to synthetic mosquito repellents may find that some natural repellents are effective in protecting them from bites. These products are also likely to be less toxic to humans and the environment. Natural mosquito repellents can be an effective way to repel mosquitoes and prevent bites. Some essential oils may be as effective as a synthetic repellent, such as DEET, but they often have a shorter protection time because they evaporate from the skin more quickly. Citronella, Lemon ,eucalyptus, Clove, Peppermint, Lemongrass, Basil , Neem , Catnip and Thyme are some of the natural products used to prepare natural mosquito repellents (2019 https://www.medicalnewstoday.com/articles/325337). With this concept the investigator had taken an effort to formulate an eco friendly mosquito repellent for the benefit of the consumers.

The study on "**Discerning the Problems of Mosquitoes and Contriving an Eco friendly Mosquito Repellent**" was under taken with the following objectives

To:

1. Collect data on the mosquito-related issues encountered by residential and commercial users.
2. Learn more about the products that are currently available on the market to protect from mosquitoes
3. Contrive an eco-friendly mosquito repellant and get feedback from a sample of users about its effectiveness.

This is only the beginning of the research for the investigator. She has high expectations that future researchers will be able to use this study as a springboard for additional in-depth research on the topic and improve the usability of this repellant for customers. It is possible that in addition to protecting users against mosquitoes, it will also protect them from the potentially damaging effects of the chemicals that are used in synthetic repellents.

"A Journey of thousand miles start from a single step".

II REVIEW OF LITERATURE

The Literature pertaining to the study on **"A Comparative Analysis of Commercial and Environmental Mosquito Repellents on Creating and Ergonomic Personal Space in Interiors"** is reviewed under the following headings.

A. Environmental Issues

B. Types of Mosquitoes

C. Health Hazardous

D. Ergonomically Affected

E. Preventive Measures

- **Use Appropriate Pesticides**
- **Use Structural Barriers**
- **Community Mosquito control**
- **Using insecticides**

F. Mosquito repellent

- **Chemical repellent**
  - **Synthetic repellents**
- **Non – Chemical repellents**

G. Mechanical Methods

- **Electrical mosquito zipper**
- **Mosquito magnet**
- **Mosquito net**
  - **Medicated net**
  - **Non – medicated net**
- **Mosquito traps**

H. Different types of mosquito nets

A. Environmental Issues

Land use patterns have been associated with vector populations and vector borne disease dynamics. Changes to the physical environment can result in altered interactions among vectors, reservoirs, pathogens, and human hosts (Institute of Medicine, 2003).

The emergence and re-emergence of mosquito-borne diseases can often be linked to human land use changes such as deforestation, agriculture and urbanization (Morse 1995, Gubler 1998, Patz2000). These land use changes may influence disease prevalence and distribution by increasing breeding habitats, food resources, and changing vector-host relationships (Tuno, NOBUKO 2005, Bayoh 2003). These characteristics may increase the survival and growth rates of mosquito larvae (Ye-Ebiyo, Vemane, Richard2003, Bond, 2005). Newly available habitats for mosquitoes, such as irrigation systems, dams and other water-holding bodies, have also enabled mosquitoes to spread into previously uninhabitable areas (Amerasinghe,1990 and Harb,1993).

A principal risk factor in the emergence of zoonotic diseases (diseases that transfer from other animals to humans) is the alteration of the vector-host relationship due to land use modification (Schrak.,1995, Daszak.,2001). This change in relationship occurs when a vector is introduced to a new habitat or exposed to a new host.

India

Dengue, malaria and chikungunya struck over 1.13 million people in the country last year. Of these, 766 succumbed. India bears a huge burden of mosquito-borne diseases, contributing 34 per cent of global dengue and 11 per cent of global malaria cases. Despite this, the country has made no headway in tackling the mosquito menace. One reason for this is presence of only a handful of entomologists (www.downtoearth.org.in).

Malaria is still a major public health problem in India. The epidemiology of malaria constitutes man as host, four species of protozoan parasite, plasmodia (Plasmodium vivax, Plasmodium falciparum, Plasmodium malariae and Plasmodium ovale) and anopheline mosquitoes as vectors. Environmental conditions play an important role in the transmission dynamics of malaria, as the parasite has to pass its

developmental cycle in the mosquito. The three main climatic factors that affect malaria transmission and distribution are temperature, precipitation and relative humidity. Climate predicts, to a large degree, the natural distribution of malaria.

Climate change is a new emerging threat to health, particularly in the context of vector borne diseases. The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) 3 has highlighted that by 2100 the global temperature would increase by 1.8 C–4 C. The Fourth Assessment Report of IPCC (2007) has clearly highlighted the possible increase in vector-borne diseases spatially and temporally. The Government of India has also taken initiatives for studying the vulnerability assessment and adaptation measures to address the threat of climate change in the field of vector-borne diseases. The logic behind the possible increase/decrease in malaria transmission in view of climate

Tamil Nadu

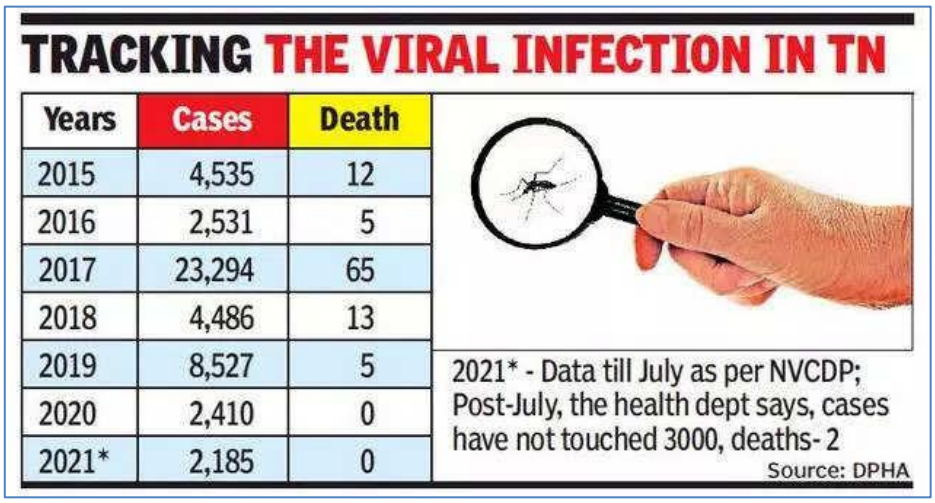

Figure1: Tracking the Viral Infection in Tamil Nadu

In 2020, Tamil Nadu reported fewer cases of the viral infection – the state had 2,410 cases of dengue according to the data uploaded by the

National Vector Borne Diseases Control. Since then, case have continued to increase. "This year we tested more than 89,000 samples with an aim to initiate early measures to prevent outbreaks. Tests done this year is nearly three times more than the tests done in 2020," he said (www.google.com/m.timesofindia.com/city/chennai).

- 40 people died due to mosquito-borne disease in Tamil Nadu.
- Maximum cases reported in Madurai i.e upto 1268, 129 being treated for Dengue.
- Dengue shock syndrome affects children under 10 years old with weak immunity.

Arundhati's teachers and friends said she was one of the smartest kids in school.

But tragedy struck on Monday, when the 12-year-old died from dengue in Coimbatore's Dharapuram. The sight of the young girl's parents crying over her dead body has shaken the state of Tamil Nadu, where as many as 40 people have been killed by the mosquito-borne disease this year. 80 have died due to co-morbidity.

And those are just the official figures. Opposition parties claim that up to 400 people have died.

Now, the state's health secretary has asked the public to join the battle against the disease (www.indiatoday.in)

Coimbatore

Coimbatore: With 74 people getting diagnosed and hospitalized with dengue in the first five weeks of this year in the district, residents are worried about the growing mosquito menace, because of which they are forced to keep the windows and doors closed after 5pm. What’s worrying them the most is the day mosquitoes.

As per the data available with the health department, 56 people were hospitalized with dengue in January and another 18, 10 of them children below 12 years, in the first seven days of February (https://m.timesofindia.com/city/coimbatore/growing-mosquito-menace-worries-residents-as-dengue-cases-goup/amp_articleshow/80776269.cms).

The Coimbatore City Corporation has levied Rs.50,000 fine for allowing breeding of dengue spreading mosquitoes on residential premises.

A large-scale mosquito breeding was found in the Murugan Nagar near Thudiyalur, where a large number of construction workers are staying

(https://m.timesofindia.com/city/coimbatore/growing-mosquito-menace-worries-residents-as-dengue-cases-go-up/amp_articleshow/80776269.cms)

B. Types of Mosquitoes

1. Yellow fever mosquito

Yellow fever is a viral infection spread by a particular type of mosquito. The infection is most common in areas of Africa and South America, affecting travelers to and residents of those areas.

In mild cases, yellow fever causes a fever, headache, nausea and vomiting. But yellow fever can become more serious, causing heart, liver and kidney problems along with bleeding. Up to 50% of people with the more-severe form of yellow fever die of the disease.(https://www.mayoclinic.org/diseases-conditions/yellow-fever/symptoms-causes/syc-20353045)

2. Asian tiger mosquito

The Asian tiger mosquito (*Aedes albopictus*) is a small black and white mosquito, about 1/4-inch long. The name *"tiger mosquito"* comes from its white and black color pattern. It has a white stripe running down the center of its head and back with white bands on the legs (www.idph.state.il.us/envhealth/pctigermosquito.htm)

3. Anopheles mosquito

Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected female Anopheles mosquitoes. (WHO 2022)

4. Southern house mosquito

The mosquito is brown with the proboscis, thorax, wings, and tarsi darker than the rest of the body. The head is light brown with the lightest portion in the center. The antennae and the proboscis are about the same length, but in some cases the antennae are slightly shorter than the proboscis (https://entnemdept.ufl.edu/creatures/aquatic/southern_house_mosquito.htm).

5. Pitcher plant mosquito

Wyeomyia smithii, the **pitcher plant mosquito**, is an inquiline mosquito that completes its pre-adult life cycle in the phytotelma of—that is, the water contained by—the purple pitcherplant, Sarraceniapurpurea. In this microcommunity of

bacteria, rotifers, protozoa, and midges, *W.* smithii is the top-level predator; its presence determines the bacterial species diversity within the pitcher.(Celeste 2008)

6. Eastern salt marshes mosquito

Aedes sollicitans, the **eastern saltmarsh mosquito** (also known as *Ochlerotatus sollicitans*), is a species of mosquito native to the eastern seaboard of the United States and Canada as well as the entire Gulf coast and is also present in the Bahamas and Greater Antilles. While primarily found in coastal areas within a few miles of the coast, it is occasionally found inland in areas with saline pools, the species was reported as far west as Arizona. The species is a prime vector for Eastern equine encephalitis, Venezuelan equine encephalitis and dog heartworm (https://en.m.wikipedia.org/wiki/Aedes_sollicitans).

7. Mosquito prevalence in India

The possible reasons for low level of Zika prevalence in India have been discussed, by extracting some probable explanations from previous experience of chikungunya virus-vector model/studies (Sumit Bhardway, 2017).

Lymphatic filariasis is is prevalent but its distribution is confined to a few districts and disease transmission is steadily declining. Dengue has recently invaded the state, with a large concentration of cases in Guwahati city that are spreading to suburban areas. Control of these diseases requires robust disease surveillance and integrated vector management on a sustained basis, ensuring universal coverage of evidence-based key interventions based on sound epidemiological data. This paper aims to present a comprehensive review of the status of vector borne diseases in Assam and to address the key challenges (Sharma, Dev, 2015).

Different types of water attract different types of mosquitoes.

- **Permanent water mosquitoes:** These mosquitoes tend to lay their eggs in permanent-to-semi-permanent bodies of water.
    - Some mosquitoes prefer clean water, while others like nutrient-rich waters.
    - Some mosquitoes lay eggs near the edges of lakes and ponds, or among plants in swamps and marshes, or in containers that hold water.

- **Floodwater mosquitoes:** These mosquitoes lay their eggs in moist soil or in containers above the water line. The eggs dry out, then hatch when rain floods the soil or container. Floodwater habitats include:
    - Temporary pools and ponds created by melting snow or rain
    - Floodplains along stream and river banks
    - Irrigated fields and meadows
    - Containers that hold water and fill up after a rain shower
    - Tree holes that collect rainwater

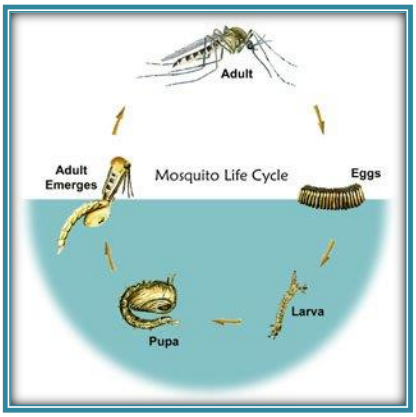

Figure 2: Mosquito Life Cycle

A system for the classification of mosquito life cycle types is presented for mosquito species found in the northeastern United States. Primary subdivisions include Univoltine Aedine, Multivoltine Aedine, Multivoltine Culex/Anopheles, and Unique Life Cycle Types. A montotypic subdivision groups life cycle types restricted to single species. The classification system recognizes 11 shared life cycle types and three that are limited to single species.

Criteria for assignments include:

- where the eggs are laid,
- typical larval habitat,
- number of generations per year, and
- stage of the life cycle that overwinters.

The 14 types in the northeast have been named for common model species. A list of species for each life cycle type is provided to serve as a teaching aid for students of mosquito biology (Journal of Vector Ecology, 2004).

C. Health Hazardous

Constructed wetlands and mosquitoes

Constructed wetlands are increasingly being installed to 'polish' urban drainage and storm water by reducing contaminants before disposal into river systems. Unfortunately, they also provide habitat for mosquitoes that can be nuisance pests and transmit pathogens such as arboviruses and malaria.

Disease transmission depends on mosquito species and abundance, and extent of contact with humans; the characteristics and siting of wetlands determine hazards, and indicate risks for nuisance or disease (Russell 1999).

The North-eastern region of India consists of the eight states namely, Assam, Manipur, Mizoram, Meghalaya, Arunachal Pradesh, Nagaland, Tripura and Sikkim; which expends over the area of about 262,179 square kilometres(Northwest Hydraulics Consultants 2006).

The sickness caused by waterborne diseases arises when pathogens arrive into the supply of water in lack of detection and are then ingested, either via drinking water or through contaminated food, by uncircumcised persons (Mansour 2013). In the region of South Asia, It is evaluated that around 23 percent of population (about 400 millions of person) surviving in high level risk conditions in relation to waterborne diseases (Mogasale, 2014 and Kaljee, 2018). Across to the world, the mosquito borne diseases causes to the great figures in terms of worldwide mortality and morbidity, particularly influencing to the youth adults and children on assessing the regional areas of malaria (Nanjesh, 2017).

Malaria is in the category of mosquito borne infectious disease due to parasitic protozoa of genus plasmodium which spread by female Anopheles mosquitoes (Kone, 2018).

Malaria and Dengue

Malaria and dengue, the most important mosquito-borne global threats, are expanding their spatial range, gradually emerging in previously unaffected areas, and re-emerging in areas where they had subsided for decades (LenDale 2016 and Watts, 2019).

Malaria

Malaria is a life-threatening disease caused by protozoans of the genus Plasmodium. Five species cause disease in humans, but two of them, Plasmodium falciparum and Plasmodium vivax, pose the biggest threat, with P falciparum being responsible for about 97% of all global cases (~230 million). About 93% of all cases occur in sub-Saharan Africa, where malaria is disproportionately linked to inequality and poverty.(WHO 2019) Malaria is transmitted between humans by female Anopheles mosquitoes, which are mainly found in tropical and subtropical areas, although some species could be found at higher latitudes. The main African vector Anopheles gambiae is highly anthropophilic, can feed and rest indoors and outdoors, and likes to feed at night (Sinka 2010). Anopheles mosquitoes are more ubiquitous in rural areas, although there are growing concerns about urban and peri-urban malaria because of the establishment of Anopheles stephensi in eastern Africa (Mathanga 2016 and Taken, 2019).

Dengue

Dengue is the fastest-growing mosquito-borne viral disease in the world, and has substantially expanded its spatial range in the past 60 years (Bhatt 2013).

Dengue is transmitted between humans by female Aedes mosquitoes. The two main dengue vectors are Aedes aegypti and Aedes albopictus. Both species are highly anthropophilic and often compete for the same habitats. (Juliano 2004) Aedes mosquitoes are typically found in urban and peri-urban regions, although Ae albopictus are also found in rural environments. (Kraemer 2015) Ae albopictus has a cooler thermal optimum (26·4°C) than Ae aegypti (29·1°C), and has the ability to diapause over winters. (Mordecai 2019) Consequently, Ae albopictus is frequently found in temperate zones. Both species prefer to lay eggs in human-made containers and feed during daytime, particularly at dawn and dusk.

D. Ergonomically Affected

1. Human attractiveness

Mosquitoes (Diptera: Culicidae) cause huge social and medical damage to humans since these insects are major contributors to the burden of vector-borne infections worldwide. Mosquitoes of different species are vectors of diseases such as dengue, malaria, congenital Zika syndrome, lymphatic filariasis, yellow fever, West

Nile fever, chikungunya, among many others. Plasmodium alone causes 212 million human malaria cases annually, mainly in tropical countries (Franklinos et al., 2019). In addition to the damage caused by diseases transmitted by mosquitoes, these insects are responsible for a series of non-lethal impacts to the daily lives of individuals living in mosquito-infested areas due to the bites that cause pain, allergic reactions, besides other physical and psychological discomforts, which disrupt people's work activities and sleep quality.

Although the problems mentioned above are common to different populations worldwide, not all individuals suffer from the problems caused by mosquitoes to the same degree, not only due to different geographical distribution of mosquitoes, but also because humans are not equally attractive to these insects. For instance, in a given environment, while some individuals suffer from a large number of bites, others are little bothered by mosquitoes (Enserink, 2002). Indeed, multiple experimental approaches have shown that human attractiveness to mosquitoes is variable between different individuals (Schreck et al., 1990; Lindsay et al., 1993; Knols et al., 1995; Qiu et al., 2006; Verhulst et al., 2011; Omolo et al., 2013).

Heat and volatile organic compounds released into the air by humans are signals used by female mosquitoes to locate humans and then to obtain a blood meal. However, these signals are not homogeneously released by humans. There is great variability in the release of mosquito attractants between individuals. This variability explains, at least in part, why some individuals are preferred by mosquitoes (Enserink, 2002; Smallegange et al., 2011).

An often-neglected factor, not mentioned in many studies addressing human-mosquito interactions, differences in individual attractiveness to mosquitoes modify the risk of infectious diseases transmitted by these insects (Lindsay et al., 1993).

Ultimately, identifying mosquito-attracting molecules can help the development of better mosquito traps and repellents, as well as novel tools for mosquito capture and control (Enserink, 2002). For example, the identification of highly efficient mosquito attractants could be applied in better "mosquito magnet" devices for home use and in a new generation of traps to be used in scientific research. Moreover, individuals with high susceptibility to mosquito bites (potentially identified through genetic or chemical testing) could be advised to take additional

precautionary measures against mosquitoes (use of repellents, long clothing, bednets) when visiting endemic areas for mosquito-borne diseases. Moreover, the study and manipulation of skin microorganisms and associated mosquito attractants to create microbial-based repellants, thus reducing the human attractiveness to mosquitoes, is on the frontier of vector control strategies (Lucas-Barbosa et al., 2021).

2. Basic aspects of human-mosquito interactions and mosquito attractants

The attractiveness of humans to mosquitoes can be understood as based on two basic steps. The first step is the attraction of the mosquito from long distances to the proximity of an individual. The second step is the mosquito bite per se. It is interesting to note that a greater attractiveness does not necessarily result in more bites, which may depend on factors such as the defensive action of the individual in relation to the presence of mosquitoes (Lindsay et al., 1993).

Mosquitoes use humidity, heat, and visual and olfactory stimuli to guide the flight, landing, and to find a food source (Meniman et al., 2014; Ray, 2015; Raji and DeGennaro, 2017). Carbon dioxide (CO2), lactic acid, acetone, and ammonia are some of the most well-known volatile human-derived signals used by mosquitoes to locate humans (Smallegange et al., 2011; Takken and Verhulst, 2013; Raji and DeGennaro, 2017; Dormont et al., 2021). Anthropophilic mosquitoes differentiate humans from other animals (e.g., cows) by detecting volatile organic compounds emitted characteristically by humans, although some mosquito species cannot significantly differentiate human odors from non-human primate odors (Smallegange et al., 2011; Takken and Verhulst, 2013; Raji and DeGennaro, 2017; Verhulst et al., 2018b). These human-derived signals are called “kairomones”, which are substances, or chemical signals, that mediate the interaction between different species, benefiting only the species that receives the chemical signal (Sbarbati and Osculati, 2006), in the present case, mosquitoes. In this article, the terms “kairomones” and “mosquito attractants” will be used interchangeably.

Kairomones are interpreted by mosquitoes in combination as compound blends. In this sense, the attraction of Anopheles gambiae (sensu stricto) and Aedes aegypti mosquitoes to a human host is mediated by the synergic effect of CO2, lactic acid, and other volatile components. Conversely, a kairomone alone, such as lactic acid or CO2, may have a reduced effect as a mosquito attractant compared to a

combination of human-derived kairomones (Geier and Boeckh, 1999; Dekker et al., 2002).

Kairomones are detected by mosquitoes through sensory (olfactory) receptors found in the antennae, labellum and maxillary palps. These receptors include odorant, gustatory, and ionotropic receptors (Takken and Verhulst, 2013; Ray, 2015; Raji and DeGennaro, 2017). Mosquitoes detect CO2 through the gustatory receptors, composed of Gr1, Gr2 and Gr3 sub-units found in maxillary palps, with a predominant role played by the sub-units Gr1 and Gr3 (Erdelyan et al., 2012; McMeniman et al., 2014). CO2 induces flight takeoff and also sustains the flight, being the main molecule used by mosquitoes to find a blood source over long distance (Ray, 2015; Raji and DeGennaro, 2017). There is evidence showing that in female Ae. aegypti the synergic detection of CO2, heath and other human-derived kairomones is mediated especially by the Gr3 sub-unit (McMeniman et al., 2014). Despite the specificities of distinct mosquito sensory receptors, the detection system of volatile kairomones is likely robust and redundant (Raji and DeGennaro, 2017).

In summary, the information presented above indicates that both the intensity and the combination of human-derived mosquito attractants released by a given individual influence the susceptibility to mosquitoes. The next section of this review will detail the factors that influence these aspects.

3. Physical and Emotional Stress of Mosquito Bites

When a mosquito bites, the saliva of this insect causes redness, swelling, and itching to the human. However, that's not it. It will be transmitted to the next person if the mosquito bites an infected person before that. Mosquitoes are the cause of hundreds of diseases. The most common mosquito diseases in India include Malaria, Dengue, Chikungunya, Japanese Encephalitis and a few other. They have far – reaching effects and can also turn out to be fatal in extreme cases. The reported number of deaths due to mosquito diseases in India is slowly on the rise (Siddhesh Dumbre, 2020).

Health effects of pesticides can cause both acute and chronic problems. Acute health effects appear shortly after exposure to these pesticides and can include: skin and eye irritations, headaches, dizziness and nausea, weakness, difficulty breathing, mental confusion and disorientation, seizures, coma, and death. Chronic health effects

may not be apparent until months or years after exposure. Such health aliments include nervous, reproductive, and immune system disorders, and cancer (Jaime 2016).

4. The role of human and mosquito behaviour in the efficacy of a house-based intervention

Housing improvement such as blocking eaves and screening windows can help in reducing exposure to indoor biting mosquitoes. The impacts of physical barriers could potentially be boosted by the addition of a mechanism that kills mosquitoes as they attempt to enter the house.

Contemporary control of malaria mosquitoes relies heavily on the core technologies of long-lasting insecticidal nets (LLIN) and indoor residual spraying (IRS) of insecticides (WHO 2015).

One recent variation on the theme of house modification is what the WHO Vector Control Advisory Group (VCAG) (https://apps.who.int/iris/bitstream /handle/10665/274451/WHO-CDS-VCAG-2018.03-eng.pdf) have called a 'Lethal House Lure'. This approach aims to modify the house in some way so that rather than simply blocking entry with a physical barrier, the house becomes a 'lure and kill' device that targets malaria mosquitoes as they host search and attempt to feed indoors at night. One version of a Lethal House Lure combines general house improvement (e.g., blocking eaves, patching holes in walls, fitting screening to windows) with In2Care EaveTubes (Knols, Bart, 2016). The EaveTubes are pieces of 16.5 cm diameter PVC (polyvinyl chloride) pipe fitted into the closed eaves of a house, with typically 8–10 tubes per house. The tubes act something like chimneys to channel human odour cues out of the house. When mosquitoes follow these odour plumes, they enter the tubes and contact an insecticide-treated screen able to kill even insecticide-resistant mosquitoes (Oumbouke and Welbeck, 2018; Andriessen, 2015).

5. Air Pollution due to the mosquito repellents

Despite its potential benefit as a mosquito repellent, the mosquito coil may generate undesirable emissions, which constitute a potential source of indoor air pollution. The base material of the mosquito coil is mainly organic in nature, consisting of organic fillers, binders, dyes, and other additives capable of burning slowly to gradually release the insecticide with smoke. Mosquito coil smoke

emissions may contain pollutants such as carbon monoxide, particulate matter, polycyclic aromatic hydrocarbons (PAHs), aldehydes, ketones and a suite of volatile organic compounds (VOCs) (Liu 203)

E. Preventive Measures

- Eliminate standing water in rain gutters, old tires, buckets, plastic covers, toys, or any other container where mosquitoes can breed.
- Empty and change the water in bird baths, fountains, wading pools, rain barrels, and potted plant trays at least once a week to destroy potential mosquito habitats.
- Drain or fill temporary pools of water with dirt.
- Keep swimming pool water treated and circulating.

➢ **Use Appropriate Pesticides**

- Control mosquito larvae using the appropriate methods for the habitat
- Control adult mosquitoes using insecticides.

➢ **Use Structural Barriers**

- Cover all gaps in walls, doors, and windows to prevent mosquitoes from entering.
- Make sure window and door screens are in good working order.
- Completely cover baby carriers and beds with netting.

(https://www.epa.gov/insect-repellents/tips-prevent-mosquito-bites)

➢ **Community Mosquito Control**

Mosquitoes lay eggs in standing water. It takes about 7 days for mosquito eggs to hatch. By getting rid of standing water once a week, or by making water move and flow, mosquito breeding is interrupted and they do not live to spread diseases. To prevent mosquitoes from breeding, get rid of places where water collects (standing water) such as old car tires, flower pots, oil drums, ditches, uncovered water storage containers, and any standing water inside the house. Manage the land in ways that prevent water from collecting so the water will instead soak into the ground. The watersheds should be protected so that water will keep flowing. Breeding fish that eat

mosquitoes shall be grown. (A Community Guide to Environmental Health 2012) Some of the Breeding fish that eat mosquitoes are the Central American mosquito fish, South American guppies, African tilapia, carp, etc. These fish have different common names in different places, but are often called "mosquito fish. "They can be used to control mosquitoes. Make sure water flows and fields drain byrestoring natural water ways, making drainage channels to let water move, and filling in unused irrigation trenches and ponds. Drain rice paddies once a week for 2 or 3 days to kill young mosquitoes with out harming rice production.

Plant trees to provide homes for birds, bats, and othe rnatural helpers in mosquito control. Neem trees from Africa and India keeps mosquitoes away and the leaves can be used as medicine.

F. Mosquito Repellents

Anything that is used to apply to clothing, skin or other surfaces that repel the mosquito from attracting and biting on that surface is known as mosquito repellent (Walker 2011). Some mosquito's repellent that are based on the ultrasound having high frequency sounds are also available in market (Sukumar, 1991). Older methods of mosquito repellents include the rubbing of mana, vinegar and plant oils on the body (Singh, 2012). Ancient people also used to burn the bay, black cumin, oregano and galbanum to restrict the mosquitoes. Burning of plant or plant materials produce the smoke that is oldest method to control mosquito (Uniyal, 2015).

One method for the controlling of the mosquito is fogging that is temporary method for controlling pests but is mostly essential in the situation of health dangers from severe bug inhabitants and for an outside movement where these pests are undesirable (Ramar, 2014). Mostly thermal fogging is used whereas each gallon contains the 5.0% piperonal Butoxide and 0.5% pyrethrin's (Patel.,2012). Another technology is transdermal technology where mosquito repellents are injected into the blood stream to protect itself from the mosquito bite (Kongkaew, 2011). This type of repellent contains the thiamine or Vitamin B1 and it is known as most effective repellent known to date. Female mosquito remains repulsive to the fragrance of Thiamine that is major mechanism for the control of mosquito (Uniyal, 2015).

❖ **Chemical repellents**

Different types of mosquito repellents such as synthetic compounds, aromatic oils and herbs are used against mosquitoes. Chemical mosquito repellents have an extraordinary protection profile but they are noxious against the nervous system and skin as eye irritation, swelling, low blood problem, rashes and worse problem (Patel 2012).

1. Synthetic repellents

Most effective synthetic repellent is DEET that is poison and has ability to make the carbon monoxide and natural odour as human body produces (Impoinvil, 2007).

Longer lasting and most effective repellent is IR3535 (3-[NButyl-N-acetyl]-amino propionic acid as compare to the DEET for defense against mosquitoes. Effective relief can also get from the plant-based repellents. The time of action of essential oils is short lived and it evaporates easily (Kayedi 2014).

There examples are as follow:

- DEET (*N, N-diethyl-m-toluamide*)
- Icaridin known as Bayrepel, KBR 3023 and Picaridin
- Bog Myrtle
- Permethrin (Petel *et al*., 2012)

Among all the repellents the N, N-diethyl-3-methyl toluamide (DEET) is best synthetic mosquito repellent that can be available easily but it has harmful effects. It is considered that the use of DEET has maximum biting inhibition rate that is 88.7-92.5%. The use of DEET has many side effects such as muscle twisting, seizures, slurred speech, nausea, rashes; affect motor capacity, sensory disturbance, loss of learning abilities and memory damage (Yoon 2015). DEET does not deliver long lasting defense from the bite of all species of mosquito such as *Anopheles* that cause malaria. The use of the DEET is not suggested for the children, lactating and pregnant women (Wang 2008). Hydroxyethyl Isobutyl piperidine Carboxylate is commonly known as Icaridin. It is colourless and odourless and used against the insects (Katrizky, 2008). It has same wrought principle as DEET because it can also block the olfactory receptors of the insects or it shades the insect's sense of smell and it is

difficult for them to find the human. It is considered as best as compare to the DEET because it requires in less amount for action (Pal M, Kumar 2011). It is non-toxic for the skin and eyes; and slightly toxic for the oral route. It can be safe to use but cannot use on the broken skin. Icaridin is moderate chemical which do not accumulate and fade away easily. To make it less toxic it's better to use it with other compounds (Ramar, 2014) Permethrin is only useable on camping gear, bed nets, shoes and clothing and cannot use on the skin (Gaddaguti, 2016). It is very effective and has the ability to kill the ticks and mosquitoes. Cloths on which Permethrin is applied remain safe for humans but these products should not put on the skin. It should use in the form of spray on the cloth (Khoobdel, 2005) Its effectiveness remains for six hours. Permethrin is obtained from the pyrethrum that is naturally occurring pesticide (Katrizky, 2008). It gives more protection when mixed with the DEET. When Permethrin is applied on the uniform that is light weight it gives 97.7% protection from mosquitoes. When Permethrin is applied it causes somewhat skin irritation whereas it has no serious effect. It is non-toxic for humans and birds while highly toxic for insects (Ditzen , 2008).

- **Non-Chemical repellents**

1. Physical method

It is essential to change the water in the bird baths, pools, fountains and rain barrels once a week. During the dawn and dusk it is necessary to use the full sleeved clothing. Screening of doors and windows is also very important to protect itself from the mosquito attack (Yang , 2008).

G. Mechanical Methods

Mechanical method contains the devices such as mosquito magnets and electro mosquito zapper.

a. Electric mosquito zipper

For trapping the mosquito this device works by using the ultraviolet light and then killing of mosquito occurs when mosquito interact with the lethal charge of electric charge (Onyett, 2014).

b. Mosquito Magnet

Its principle based on copying of mammal's properties such as giving off heat, moisture and carbon dioxide. When mosquito comes close to the device it drew in and suddenly dies. This magnet also combined with the octenol and can be used for the sand flies, black flies, midges and mosquitoes (Onyett, 2014).

c. Mosquito Net

- Mosquito netting can be made from cotton, polyethylene, polyester, polypropylene or nylon (HWH 2012). A mesh size of 1.2 millimetres (0.047 in) stops mosquitoes, and smaller, such as 0.6 millimetres (0.024 in), stops other biting insects such as biting midges/no-see-ums.(Mosquito Nerting Criteria 2009).
- A mosquito bar is an alternate form of a mosquito net. It is constructed of a fine see-through mesh fabric mounted on and draped over a box-shaped frame. It is designed to fit over an area or item such as a sleeping bag to provide protection from insects. A mosquito bar could be used to protect oneself from mosquitoes and other insects while sleeping in jungle areas (Tawrell 2006). The mesh is woven tightly enough to stop insects from entering but loosely enough to not interfere with ventilation. The frame is usually self-supporting or freestanding although it can be designed to be attached from the top to an alternative support such as tree limbs.

- Medicated Net

Mosquito nets can be made medicated by K-O tablets that contain the 25% deltamethrin. In one litre of water one tablet is mixed, net is soaked in it for ten minutes and then dried it in chilled area (Peterson 2011) This net remains effective for six months and mosquito will remain away. World Health Organization approves the medicated nets and these nets are more effective than the liquidators or coils (Atieli, 2010).

- Non-medicated Net

Different sizes and shapes of mosquito netting is available that can be made of various materials such as polyester, polyamide and cotton. Style of net is important to protect itself from the mosquito bite (Gaddaguti 2016). It is important to buy a net that

contain the mesh size large enough to pass the air and small enough to protect from the mosquito bite. Mosquito nets are an operative way to naturally prevent from mosquitoes (Zhu and Berkeley, 2012).

d. Mosquito traps

Mosquito traps are used to capture and lure the female mosquitoes. These traps copy the various mosquito attractants such as body heat and exhaled carbon dioxide. Most of the traps are powered by the propane or electricity so their use is safe (Kawlekar, 2015). Traps contain impeller fan when mosquito is attracted toward the trap it will attach on the sticky surface on the trap and will electrocuted (Sumithra, 2014).

e. Natural repellents

Mosquitoes are responsible for the transmission of certain diseases, like dengue, malaria and chikungunya that might take a massive toll on the health because of the increase in the number of mosquito breeding. Hence, it is important for reduce mosquito populations around and inside the home and other living areas.

The market is filled with tools and mosquito repellent products to kill or get rid of mosquitoes. But most of the insecticides which are available on the market are believed to contain high chemical agents which can cause allergies and skin infections. Now, in case, if don't want to use the high chemical agents to get rid of mosquitoes can use the natural mosquito repellents.

1. Garlic Water

Garlic water is considered one of the best ways to get rid of mosquitoes. Just need to crush a few cloves of garlic and then boil them in water. After that pour the solution in a spray bottle and spray it around room, near all your outdoor light bulbs, garage, etc. This solution will kill mosquitoes instantly. Garlic is made up of several properties-so when you spray garlic water in home it helps to keep mosquitoes at bay.

2. Lemongrass

Lemongrass leaves are the most commonly found plants found in India. The lemongrass oil helps to get rid of mosquitoes. We can use lemongrass oil or can crush the leaves and then applying the oily mixture directly to the skin. The protections

from lemongrass oil can last several hours. So, one might feel the need to use lemongrass oil repeatedly since it is less concentrated.

3. Vinegar

Vinegar is one of the most easily available ingredients. Whether it is an apple cider vinegar or normal vinegar both can help to get rid of mosquitoes. Take 3 cups of water and 1 cup of vinegar in a spray bottle and spray it on skin. The spray can be sprinkled around the dining table and screen of the house also.

4. Lemon and cloves

Half lemon and a hand full of clove work as a wonder ingredient to keep mosquitoes away. Take a lemon slice, insert some cloves in it and place it in a room. This magic ingredient will help to keep mosquitoes away.

5. Lavender oil

Mosquitoes can't stand the scent of lavender oil! So can use the Lavender oil to keep mosquitoes away. Can spray it around home and surrounding areas. Can even put some on your body to avoid getting bit!

6. Basil

Basil or Tulsi is believed to be great for making tea but mosquitoes detest it. Can use basil as a multi-use mosquito repellent--can place a plant on windowsill to keep mosquitoes at bay, or even use it as a topical oil and apply it to your skin. It releases an odor that repels these pesky insects.

7. Camphor

Camphor is a versatile repellent-it's strong odor drives mosquitoes away. Take two tablets of camphor in about a quarter cup of water and spray it around room or outdoor. For more effect, can burn some camphor in the room and close all doors and windows and leave it burning for about 20 minutes. Stay outside the room; will see the instant results.

8. Peppermint

Peppermint is another natural way to combat mosquitoes. To use Peppermint just need to combine a few drops of peppermint essential oil with one cup of water in

a spray bottle, shake well, and spray on skin. This instant peppermint spray will not only help to repel the blood-sucking beasts, but also smell minty fresh!

9. Coconut oil and neem oil

A combination of coconut oil and neem oil works as a natural repellent. Just need to mixed coconut oil and neem oil together well with water and spray it on skin. This will help to repel mosquitoes for up to half a day.

10. Coffee grounds

Coffee grounds can help keep mosquitos at bay. It not only an eco-friendly alternative, but it's a great way to reuse coffee grounds! can simply burn some coffee grounds in a coffee tray or egg carton, and trust the smoke to repel these pests (India today. 2020).

11. Nochi leaf

"Distribution of nochi plants for mosquito control," the Mayor said, catapulting the rurally well-known plant to urban stardom. Not that it is a total stranger to the city. "Anyone who has come from the village will be familiar with its properties".

"Growing nochi is an excellent idea," said Sheela Rani Chunkath IAS, who writes on Indian traditional medicine. "It is a handy plant for several common ailments." Boil a bunch of leaves and carefully add a heated brick to keep it bubbling. Inhale the vapour with a bed-sheet covering your head — a soothing remedy for respiratory infection and headaches. And it get rid of mosquito (The Hindu, 2013).

H. Different Types of Mosquito Nets

Mosquito nets differ in chemical composition, weight, structure, thickness, pore size, and mechanical properties (Clarke, 2009; Wilhelm, 2007, Freuclenberg, 2006). Processing mosquito nets using steam sterilization at 134 °C, which is commonly performed in Western countries, alters the nets' appearance: the nets shrink and become hard and stiff, with sharp, brittle edges (Stephenson, 2011).

The most commonly used mesh implants are made of polymers such as polypropylene or polyester and differ in structure, fiber type, filament weave, pore size, weight, thickness, tensile strength, and tear force (Sanders 2012).

Mosquito nets differ in construction from surgical mesh implants and are typically made of cotton, polyethylene, nylon, or polyester(Fox 2008). In recent years, papers have reported the use of locally sourced mosquito nets for hernia repair surgery in developing countries (Clarke, 2009; Wilhelm 2007; Kingsnorth 2007).

Polyethylene has the disadvantage of having a relatively low melting point (approximately 122°C), which makes it impossible to use pressure steam sterilizers to processing polyethylene nets, because the temperature required for steam sterilization is 134°C. However, most of the sterilizing facilities available in developing countries are vertical autoclaves, where the temperature does not exceed 121 °C. Although a higher steam sterilization temperature is more effective (minimum 3 min at 134 °C), at least 15 min at 121 °C is also thought to be a safe method for sterilizing medical devices (Stephenson, 2011).

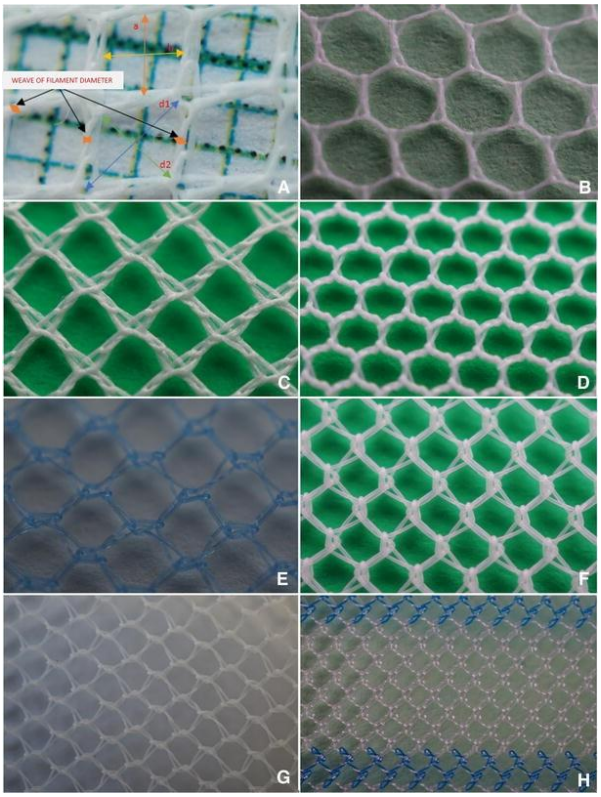

Figure 3: Mosquito Nets

Synthetic materials used for analysis: mosquito nets from Tanzania (A), Nigeria (B), Zambia (C), Poland (D), Ethiopia (E), India (F), Ghana (G), and commercial hernia mesh Optilene (H).

1. Sliding mosquito nets

It is a simple, economic and long-lasting system which allows to replace the fabrics at a low cost. The great variety of special profiles and brushes provide installation solution in difficult spaces.

2. Pleated mosquito nets

Figure 4: Pleated Mosquito Nets

Pleated mosquito nets are the best option for doors in exit to terraces and balconies and for areas with a lot of transit, because they are easy to open and can be left in any position.

They are very quick and easy to install, with no building work, with small anchoring plates.

3. Fixed mosquito nets

Figure 5: Fixed Mosquito Nets

This is the best economic and simple solution for windows or sliding doors, being assembled and activated from the inside.

It remains fully integrated into the woodwork, adapting to the space and covering it all.

The use of magnets (optional) allows an easy installation, avoiding the presence of screws.

4. Hinged mosquito nets

Figure 6: Hinged Mosquito Nets

Recommended for outside doors that open from inside. The best solution in the way out to balconies, terraces and entrance and exit areas.

With its system of hinges with a recovery spring, this mosquito net becomes the best solution for places with transit of people with reduced mobility, elderly people or children.

5. Mosquito nets zip

The mosquito nets zip, a new motorised rolling mosquito net with a box which allows a maximum protection against insects.

This system allows to cover large opening spaces without let the fabrics leave the guides, thanks to the lateral zips.

Moreover, the new phifer glass® fabrics provides higher benefits and a maximum protection.

6. Rolling mosquito nets

Figure 7: Rolling Mosquito Nets

A convenient, practical and long-lasting system. The fabrics can be replaced when it becomes aged. Recommended for all types of windows.

Easy to install, use and maintain. The fabrics is hidden when you do not need it, to keep it in good condition and protect it from dirt.

7. Magnetic mesh

Figure 8: Magnetic Mesh

Magnetic Insect Screen provides a solution to your mosquitoes and insects problem at home or at work. It's suitable to be installed on your existing windows, sliding or push-out type, to keeps mosquito and other insects out but allow air to flow through thus improve ventilation. Excellent dengue prevention, also can be used as pet / cat screen.

Ideas to keep window mosquito nets clean:

Mosquito mesh for windows is fairly simple to clean and do not require much effort. Scheduling to clean all the window meshes once every month is a good start. Here are four trouble-free DIY ideas to keep your mosquito net for windows clean (www.google.com).

III METHODOLOGY

Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. Typically, it encompasses concepts such as paradigm, theoretical model, phases and quantitative or qualitative techniques (Kara and Helen. 2015).

Research Methodology is science of studying how research is done scientifically. A way to systematically solve the research problem by logically adopting various steps. Methodology helps to understand not only the products of scientific inquiry but the process itself. Research Methodology aims to describe and analyze methods, throw light on their limitations and resources, clarify their limitations and resources, explain their presuppositions and consequences, relating their potentialities to the twilight zone at the frontiers of knowledge. (www.researchgate.net).

The methodology involved in the conduct of study on **"Discerning the Problems of Mosquitoes and Contriving an Eco friendly Mosquito Repellent"** is as follows:-

Phase 1: Baseline Survey about Problems of Mosquitoes and Repellent used in Residential and Commercial Buildings

Phase 2: Market Survey to find out the Types of Repellent Available in Shops

Phase 3: Formulation of Eco-friendly Mosquito Repellent

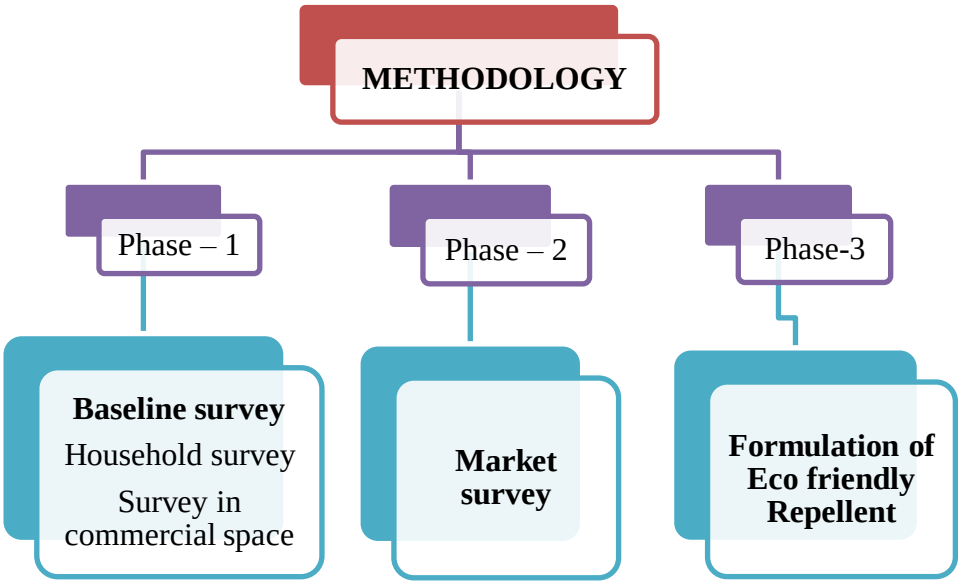

Figure 9: Research Design

Phase 1: Baseline Survey about Problems of Mosquitoes and Repellent used in Residential and Commercial Buildings

A baseline survey is a study that is done at the beginning of a project to collect information on the status of a subject before any type of intervention can affect it. It was considered essential by the investigator to know about the prevalence of mosquitoes in the houses and shops of the surveyed samples (Dash,.2008).

This phase includes the survey among people living in selected residential and commercial building. Survey is a data collection tool used for gathering information from a group of individuals, representing the sample. This group represents a larger population from which the sample is drawn (Asif., 2022). The steps involved to carry out the survey in residential and commercial buildings are given below:

A. Selection of Area
B. Selection of Sample
C. Selection of Tool
D. Formulation of Tool and Collection of Data
E. Consolidation and Analysis of Data

A. Selection of Area

Coimbatore is a district in Tamil Nadu State of India. It has a total of 5 taluks with a total area of 4,732 sq. km. There are 69 towns and 237 villages in this district.

Population of Coimbatore District is 3,654,026 according to the assessment during the year 2022. As per 2011 census of India, Coimbatore District had a population of 3,458,045 in 2011 out of which 1,729,297 were male and 1,728,748 were female. Coimbatore is a city of widely diversified population of various cultural and economic backgrounds. The survey was done in selected areas of Coimbatore City such as, Gandhipuram, Hopes College, Saibaba colony and R.S.Puram which are the residential and commercial neighbourhood located at the heart of the city. These highly populated areas were selected for the survey.

B. Selection of Sample

Sampling means the process of selecting a part of the population. (Martinez – Mesa., 2014). Sample is defined as a finite part or subset of participants drawn from the target population. In turn, the target population corresponds to the entire set of subjects whose characteristics are of interest to the research team (Rohrig and Bernd, 2010). The sample should be representing the population to ensure that can find from the research sample to the population as a whole. Sample design is determined before data are collected. It refers to the technique or the procedure the researcher would adopt in selecting items of the sample (Kothari, 2014).The number of samples selected for the household survey was 100 and for commercial survey it was 50. They were selected by purposive sampling method. Purposive sampling (also known as judgment, selective or subjective sampling) is a sampling technique in which researcher relies on his or her own judgment when choosing members of population to participate in the study.

Purposive sampling is a non-probability sampling method and it occurs when "elements selected for the sample are chosen by the judgment of the researcher. Researchers often believe that they can obtain a representative sample by using a sound judgment, which will result in saving time and money"(Black 2010)

C. Selection of Tool

Interview schedule was the tool used for gathering relevant information required for the study. Interview schedule is found to be more comfortable to elicit the requirements and information from the subjects since it involves interaction between the respondent and there is a face-to-face contact (Melrile, 2007). Two interview schedules were framed individually to collect the required information from

households and people from commercial spaces. Different types of commercial spaces such as, offices, road side shops, supermarket and store that are located in different areas of Coimbatore were selected and relevant information was gathered.

D. Formulation of Tool and Collection of Data

In order to gather the required information from the households and commercial space an interview schedule was formulated. The interview schedule was prepared to obtain details from the households on background information of the respondents, the actions taken to protect themselves from mosquitoes, awareness on natural mosquito repellent and health issues faced due to mosquito bites. Similarly the interview schedule was framed to gather information from owners of commercial space on method followed to protect from mosquitoes and problems faced due to mosquitoes. The interview schedule was pre tested among ten homemakers and five shop owners. Pre testing refers to testing of the schedule on a small sample of respondents to identify and eliminate potential problems. Even the best schedule can be improved by pretesting, (Malhotra 2008).Based on the response from the preliminary survey the schedules were modified and the finalized interview schedules are presented in Appendix I and II

The details were collected from the members in the households and commercial space owners or workers at their showrooms through friendly conversation. The objectives of the study were clearly explained to the respondents and the necessary data were collected with an emphasis on understanding the importance of the type of repellents they use in the premises.

E. Consolidation and Analysis of Data

The necessary information collected were consolidated and presented in suitable Tables, as tabulation is the process of summarizing raw data and displaying the same in a compact form for further analysis (Kumar 2009). The tabulated data is presented and discussed under Chapter IV - Results and Discussion.

The consolidation of data includes the process of encoding the data and categorizing it. Coding involves the desegregation of textual data into segments, investigating the data resemblances and dissimilarities, and assembling conceptually alike data in the particular nodes (Wickham, 2005). The data collected are generally in an unintelligible form and need to be classified and tabulated before they are

analyzed (Bhattacharya, 2010). The tools used for the analysis of data are percentage analysis. The frequency distribution is the most common method that has to be organized for emerging out the data well. Percentage analysis is applied to generate a contingency table from the frequency data for a better understanding percentage.

Thus, the data were collected, coded, and presented in tabulation and diagram which is a procedure of summing up the unprocessed data and exhibiting it, in a compact form for further study. (Leech 2006) indicates that tabulation is one of the simplest method and most revealing device for summarizing data and presenting the information. The consolidation of data was tabulated and discussed under Results and Discussion.

Phase 2: Market Survey to find out the Types of Repellent Available in Shops

Market research is the investigation of the structure and development of a market for the purpose of formulating efficient policies for purchasing, production and sales (Madan 2010). Market research is quite different from marketing research. It is the framework in which the buyers act in process of transferring the ownership of a particular product (Khanzode,2007). Marketing research is a important part of overall business research, and a systematic collection and analysis of data. Market research is an early step in the marketing process and includes an analysis of market demand for a new product, or for existing products, as well as appropriate methods of distributing. This phase of the study consisted of following steps.

A. Selection of Locale
B. Identifying the Samples
C. Selection of Tool
D. Conduct of the survey
E. Consolidation and Analysis of Data

A. Selection of Locale

Coimbatore is the third largest city of the state. It is one of the most industrialized cities in Tamil Nadu, known as the Manchester of the South. The city is situated on the banks of the river Noyyal. For the study the investigator selected the shops which sell mosquito repellent situated in R.S.Puram , Mettupalayam Road, Gandhipuram Crosscut road, and NSR road Saibaba colony .

These places were very popular and large number of the consumers was visiting the shops everyday to buy consumer products. These areas were selected for the study as these areas were easily accessible for the investigator. Co-operation extended by the respondents was also a reason for the selection of the shops.

B. Identifying the Samples

"Sampling maybe defined as the selection of some part of an aggregate or totality on the basic of which a judgment or inference about the aggregate or totality is made" (Gupta 2005).

Purposive sampling is similar to judgment sampling except that the sample is chosen so that a particular research purpose or objective is served and is adequate for the sample that is typical rather than representative (Krishnaswamy, 2008).

The primary sources of data in research are where the respondents may be selected according to the scale of study; they can be smaller in number or very large in number also. All the units who are related to the topic of the study are known as the universe of the study. If it appears that universe is very large and it would be feasible as a small part of the whole universe. Under sampling, it is not necessary to go for the whole universe, only representative sample can be drawn and conclusions are drawn (Singh, 2015). Among the selected four areas, Saibabacolony, R.S.Puram, Gandhipuram and Saibaba Colony, the investigator collected 25 samples from these area. The information on types of repellent available and demanded by the consumers was collected from Supermarket, Departmental store and , medical shops etc. which sell mosquito repellent located in the above said places in Coimbatore.

C. Selection of Tool

According to (Martin, 2018) survey has a variety of purposes and can be carried out depending on the methodology chosen and the objectives to be achieved. The data is usually obtained through the use of standardised procedures whose purpose is to ensure that each respondent is able to answer the questions to avoid biased opinions that could influence the outcome of the research or study. The data are those which are collected as fresh and thus happened to be original in character. An interview schedule was designed to gather information on mosquito repellent used, products sold, and its cost.

D. Conduct of the Survey

According to Kothari (2004) observation implies the collection of information by way of investigators own observation, without interviewing the respondents .In case the interview apprehends that the informant is not getting accurate information, may cross existent and thereby try to obtain the information. (Sharma. 2005). The survey was conducted using the pre tested schedule. In order to fulfil the main objectives of the study it was essential to formulate an interview schedule containing a series of questions related to the demand and sale of mosquito repellents. The investigator approached the shop owners at their convenient time, explained the purpose of study and put forth the questions one by one and recorded the answers instantly in the schedule. A copy of the interview schedule is presented in Appendix III.

Figure 10: Market Survey

E. Consolidation and Analysis of Data

Interpretation of collected data is not only necessary but unavoidable in research. The data collected are generally in an unintelligible form and need to be classified and tabulated before they are analysed (Ranjith-kumar, 2009). The necessary information collected are consolidated and presented in suitable table as, tabulation is the process of summarizing raw data and displaying the same in compact form for further analysis. The results are discussed suitably and presented under Results and Discussion Chapter IV.

Phase 3: Formulation of Eco-friendly Repellent

The repellent that is now available in the market cause serious health and mental effects. In order to avoid this, people must move on to eco-friendly repellents. Therefore, this research focuses on preparing an eco-friendly repellent.

A. Selection of Materials for Preparing Eco-friendly Mosquito Repellent

B. Preparation of Repellent

C. Conduct of Efficacy test

A. Selection of Materials for Preparing Eco-friendly Mosquito Repellent

The investigator referred various books, journals and magazines to gather information on eco-friendly materials which can kill or drive mosquitoes. The summary of various eco-friendly mosquito repellents and its medicinal value are given in the following Table1.

Table 1: Eco friendly Mosquito Repellents and its Medicinal Value

Eco friendly materials	Botanical name	Common name	Medicinal value
Castor oil 	*Ricinus communis*	Ricinus communi	The castor oil plant, which is used to make laxatives, now possibly holds the key to controlling the mosquito menace in a 'green' way. Castor oil can be used **to kill mosquito larvae**.
Neem oil 	*Azadirachta indica Juss*	Margosa oil	Neem oil acts as a great **indoor mosquito-repellent** owing to its smell that wards off mosquitoes.
Lemon grass oil 	*Fresh lemongrass*	Cymbopogon citrates	**Lemongrass oil (Cymbopogon citratus) is an effective repellent against mosquitoes** (Diptera: Culicidae) and house flies.
Garlic 	*Allium sativum*	Allium sativum	Garlic makes a powerful natural insect repellent. Garlic can be used **to repel a variety of crawling and flying insects, including mosquitoes**," according to Patrick Parker, SavATree Plant Health Care Program Director.
Marigold petals 	*Tagetes*	Marigolds	Due to its strong smell, antioxidant content and volatile oils, these ***flowers*** can be ***used*** to naturally drive off ***mosquitoes***, pests and other.

Common salt 	_	Common salt	Treat a mosquito bite by soaking it for a few minutes in saltwater, then applying an ointment made of salt and lard.
Cinnamon bark 	*Cinnamomum burmannii*	Ceylon cinnamon	Early research suggests that applying cassia ***cinnamon*** oil cream to the skin can protect against ***mosquito*** bites.
Carom seeds 	*Ajwain*	Omam	Mix mustard oil with ground carom seeds. Dip cardboard pieces in this mixture and tie in the corners of the room. This will help get rid of the mosquitoes from the room.
Nochi leaf 	*Chinese chastetree*	Chaste tree	The smoke from the leaves is used as a mosquito repellent and by mixing in oil also is a good repellent.
Camphor 	_	Camphor	Early research shows that applying camphor along with menthol and eucalyptus oil might help **reduce the size of mosquito bites**.
Guava leaf 	*Psidium guajava*	**Guava leaf**	The saponins are known to be anti-microbial and to inhibit moulds and protect plants from insect attacks.

B. Stepwise Procedure for Preparation of Eco friendly Repellent

Step 1: Select a clean and dry pan for preparing the mosquito repellent.

Step 2: Add 200 ml of castor oil, 50 ml 0f neem oil, and 10 ml of lemon grass to the pan.

Step 3: Allow to boil for one minute.

Step 4: To the above preparation 5 gram of garlic, 5 gram of Marigold flower petals, 1 pinch of common salt, 5 gram, of cinnamon bark, 2 gram of carom seeds, 5 gram of Nochi leaf and 2 gram of camphor was added to the oil and heated in a low flame for five minutes

Step 5: After 5 minutes, the investigator removed the oil from the flame and kept aside until it reaches the room temperature

Step 6: The investigator filtered the oil and stored in a bottle for further use.

Figure 11: Preparation of Eco friendly Repellent

C. Conduct of Efficacy Test

The investigator distributed the prepared mosquito repellent to 22 households who expressed their willingness to try the prepared oil in place of a normal repellent. The samples were selected and instruction was given to light a lamp using the oil for three consecutive days, A check list was given to record their views on prepared list. The results were consolidated, tabulated and presented in Chapter IV Results and Discussion .

Figure 12: Eco-friendly Repellent made by the Investigator

Figure 13: Efficacy Test

IV RESULTS AND DISCUSSION

The findings of the study on "**Discerning the Problems of Mosquitoes and Contriving an Eco friendly Mosquito Repellent**" are written briefly under the following topics:

Phase 1: Baseline Survey about Problems of Mosquitoes and Repellent used in Residential and Commercial Buildings

Phase 2: Market Survey to find out the Types of Repellent Available in Shops

Phase 3: Contriving an Eco-friendly Repellent and Collecting the Feedback from the Selected Users

Phase 1: Baseline survey about mosquitoes and repellent used in commercial building

The results of the baseline line survey were dealt under the following two headings:-

A. Survey about Problems of Mosquitoes and Details of Repellent Used in Residential Buildings

B. Survey about Problems of Mosquitoes and Details of Repellent Used in Commercial Buildings

A. Survey about Problems of Mosquitoes and Details of Repellent Used in Residential Buildings

For the research study,100 residential buildings and 50 commercial buildings were selected from Coimbatore. The samples were interviewed to gather the information about the study.

The finding of the survey consisted of the following sub-headings

1. General Information about Surveyed Households

2. General Details about Houses

3. Prevalence's of Mosquito

4. Information on the Mosquito Entry Points in Selected Households

5 Measures Taken to Overcome the Problem due to Mosquitoes

6. Common Health Issues Faced due to Mosquitoes

1. General Information about Surveyed Households

Table 2 gives information on gender, age group of the respondents and the income group of the families of the respondents.

Table 2: General Information about Surveyed Households

Particulars	**Background**	**No of samples N = 100**
Gender	Male	54
	Female	46
Age of the Sample	20-35	25
	36-50	55
	51-65	20
Income of the family	Less than 50,000	20
	50,000- 1 lakh	35
	1 lakh-2 lakhs	25
	Beyond 2 lakhs	20

According to the results of the study, 54 per cent of the respondents were male, while the remaining 56 per cent were female respondents. This demonstrates that both the male and female members of the household share responsibility for the activities that takes place in their home and is aware of such actions. At most 55 per cent of the respondents belonged to the age bracket of 20-35 years, 25 per cent of the respondents belonged to the age group of 20-35 years, and 20 per cent of the respondents belonged to the age group of 51-65 years. A maximum of 35 per cent of the selected households belonged to the middle income group, earning between Rs.50,000 and Rs1 lakh; 25 per cent of the selected households belonged to income group between Rs.1 and Rs.2 lakhs; 20 percent earned less than Rs.50,000 and another 20 per cent earned more than 2 lakhs. This reveals that the survey had included the entire income group.

2. General **Information about Surveyed Households**

The information presented under this part of the study includes location and type of the house, type of building, number of doors and windows present, number of bedrooms provided and reasons for closing the doors and windows.

Details of the location of the selected households and the type of ownership of households are presented in Table 3 below.

Table 3: General Information about Surveyed Households

Details of Residence	Percentage of Respondents (N = 100)
Location of Residence	
Urban	51
Rural	34
Semi urban	15
Type of House	
Own house	55
Rented house	35
Lease house	10
Type of building	77
Terraced	23
Tiled	

The highest percentage of surveyed households,(51 per cent), was found to be located in urban areas, 34 per cent of the households were found to be located in rural areas, and the remaining houses were found to be located in semi-urban areas. A survey was conducted with a diverse group of individuals to investigate the difficulties experienced by the families as a result of the mosquitoes.

With regard to the ownership specifics of the sampled households, the vast majority (55%) was living in their own houses, 35 per cent were living in rented houses, and the other 10 per cent were living in houses that were under lease.

When the type of roof that the respondents' residences had was analyzed, it was determined that 77 per cent of the respondents were living in terraced buildings, and the remaining respondents were living in tiled houses. People who reside in houses that are constructed out of tiles are more likely to encounter a higher overall number of issues that are related to mosquitoes.

Based on the results of the survey, the investigator learned that just 27 per cent of respondents had a main door that was separate from doors that led to other rooms

in the house. The remaining ones each featured a front door as well as a back door. It's possible that the mosquitoes are getting in through these doors if left open in the evening.

Table 4: Details on Number of Doors Present in the Selected Households

Details	Number of doors	Percentage N=100	Time of keeping the doors open					
			Never		Morning		Night	
			No:36	%	No:40	%	No: 24	%
Number of Doors	3-5	64	16	45	-	-	20	83
	5-7	24	12	33	32	80	4	17
	1-3	12	8	22	8	20	-	-

Sixty four percent of the residences that were surveyed were found to have three or more doors in their structures. Among these people, 36 per cent never left their doors open unless it was absolutely essential, 40 per cent of households kept the doors open during the day, and the remaining 24 per cent closed their doors at night to avoid being bitten by mosquitoes. Twenty-four percent of the homes that were studied had between five and seven doors, whereas at least twelve percent of the homes only had between one and three doors. Mosquitoes typically enter a building through the open doors. It's possible that the people whose homes were examined will come up with a solution to the problem of troublesome mosquitoes.

Windows are also a major point of entry for mosquitoes. An attempt to find out the number of windows in the houses of selected households is presented in Table 5.

Table 5: Number of Windows Present and Period of its Closure

Details	Number of Windows	Percentage No:100	Period of closure					
			Always		Morning		Night	
			N=52	%	No:36	%	No: 12	%
Number of Windows	2-5	48	12	23	4	12	4	33
	6– 9	52	40	77	32	88	8	67

Ventilation is one of the major principles involved in planning a house. In the houses that were studied, a maximum of 52 percent had between six and nine windows, while the other 48 percent had between two and five windows. Because

they were concerned about their privacy, the vast majority of homes (88 per cent) shut at least some of their windows even in the morning. In order to maintain their privacy, the majority of people (77 per cent) always kept the windows of their bed rooms closed. At least one-third of people on the whole did not leave their windows open throughout the night for a variety of reasons, including to maintain their privacy, avoid being bitten by mosquitoes, and for safety considerations.

5. Number of Bedrooms Present in the Residences of Surveyed Households

In today's society, the number of bedrooms a home possesses has evolved into a metric that can be used to evaluate a family's socioeconomic status. Table 6 provides further information regarding the number of bedrooms that are available in each of the homes.

Table 6: Number of Bedrooms Provided

Number of Bedrooms	Percentage N=100
1 BHK	12
2BHK	52
3or more BHK	36

Among the homes that were surveyed, the largest number of households with two bedrooms was 52 per cent, followed by the maximum number of families with three or more bedrooms, which was 36 per cent, and the remaining 12 per cent were living only in single-bedroom homes. The house owners have a greater obligation to ensure that all of the occupants have a mosquito-free space in which they can have a restful night's sleep as the number of bedrooms in the home grows.

6. Reasons for Closing the Doors and Windows

Table 7 below gives information on major reasons stated by the households surveyed for closing the doors and windows of their houses as informed by the respondents.

Table 7: Reasons for Closing the Doors and Windows

Details	Doors		Windows	
	(No: 25)	%	(No:25)	%
Safety	25	100	15	60
Protect from Mosquitoes	13	52	12	48
Privacy	10	40	11	44
Any other Specify	2	8	5	20

Among the surveyed houses all the households closed their doors for safety reasons while 60 per cent of the households informed that they closed the windows for the same purpose. Majority 52 per cent and 48 per cent of the surveyed households closed their doors and windows respectively in order to protect from mosquitoes. Privacy was referred as the major reason for closing their doors by 40 per cent of the households while 44 per cent of the surveyed households pointed out as a reason for closing their windows. They also said that it was to shield the vision from an unattractive look and to provide protection from the dirt and dust that would otherwise be caused by the strong breeze.

3. Prevalence's of Mosquito

Mosquitoes carry serious diseases such as malaria, dengue, and yellow fever. These diseases spread quickly from one person to the next. Mosquitoes breed in stagnant water. To prevent diseases spread by mosquitoes: we have to reduce the risk of being bitten, use bed nets, install netlon screens, use safe insect repellents, mosquito coils, and clothes that cover as much of the body as possible,

All the respondents faced the problem of mosquito bite throughout the year but at varying intensity in different period. Figure 14 provides information on the active seasons for mosquitoes as expressed by the respondents.

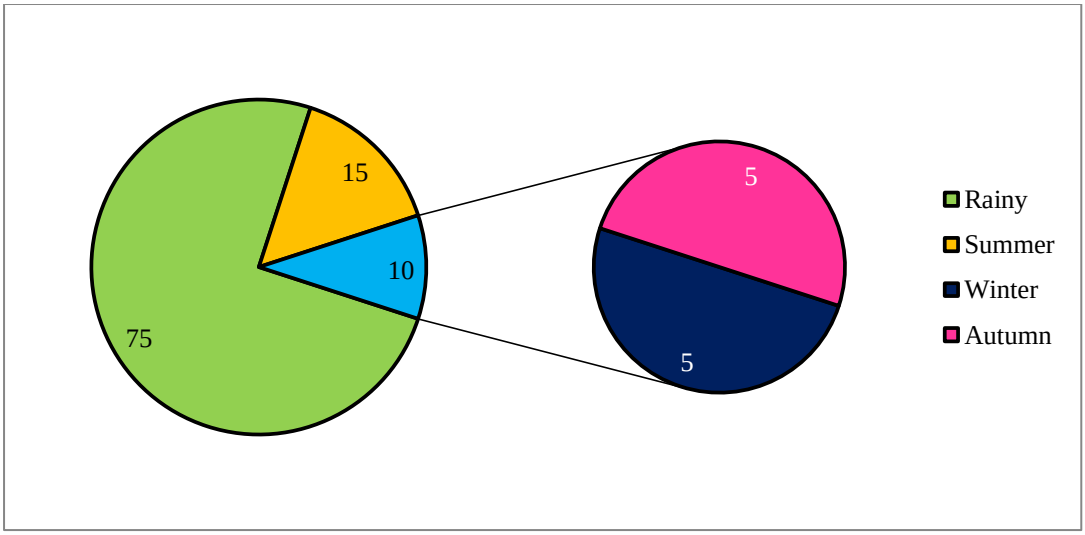

Figure 14: Active Seasons for Mosquitoes

From the figure above it could be understood that a majority of 75 per cent of the houses surveyed revealed that the problem of mosquito bite is at the maximum during rainy period. Even during summer (15 per cent), winter (5 per cent), and autumn (5 per cent) they also faced problem due to mosquitoes.

When it comes to the health and cleanliness of a home, the environment plays a very significant part in ensuring its upkeep. In addition to this, it plays an important part in the hatching of mosquitoes, which may be a major hindrance to the occupants' ability to carry out their daily duties. Figure 3 is where the information on the environmental conditions of the houses that were surveyed is shown graphically in Figure 15.

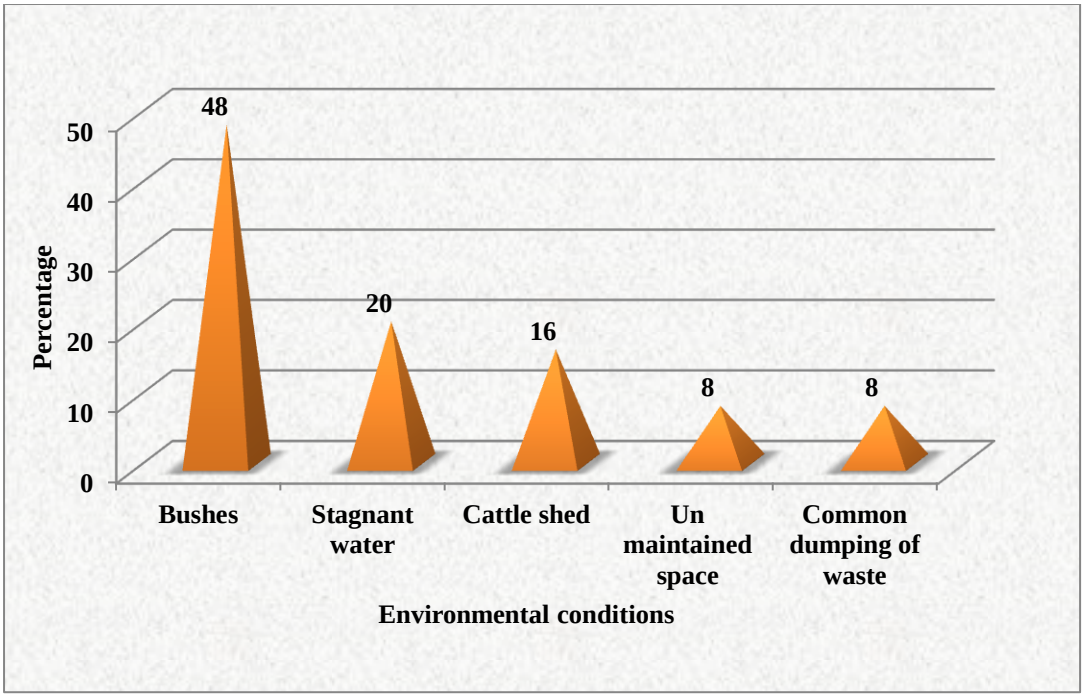

Figure 15: Information on the Environmental Conditions of the Surveyed Households

The majority of respondents (48%) stated that the shrubs that surrounded their homes were the primary reason that they kept their doors and windows shut, as they were concerned that opening them could attract unwanted insects into their homes. The houses that were surveyed provided the following explanations for the existing predominance of unclean environmental conditions: the existence of cow sheds nearby (16 percent), stagnation of sullage water (20 percent), unmaintained space (8 percent), and dumping of waste near their house (8 percent) which served as a breeding ground for mosquitoes.

4. Information on the Mosquito Entry Points in Selected Households

The following Figure 16 gives information on common entry point of mosquito.

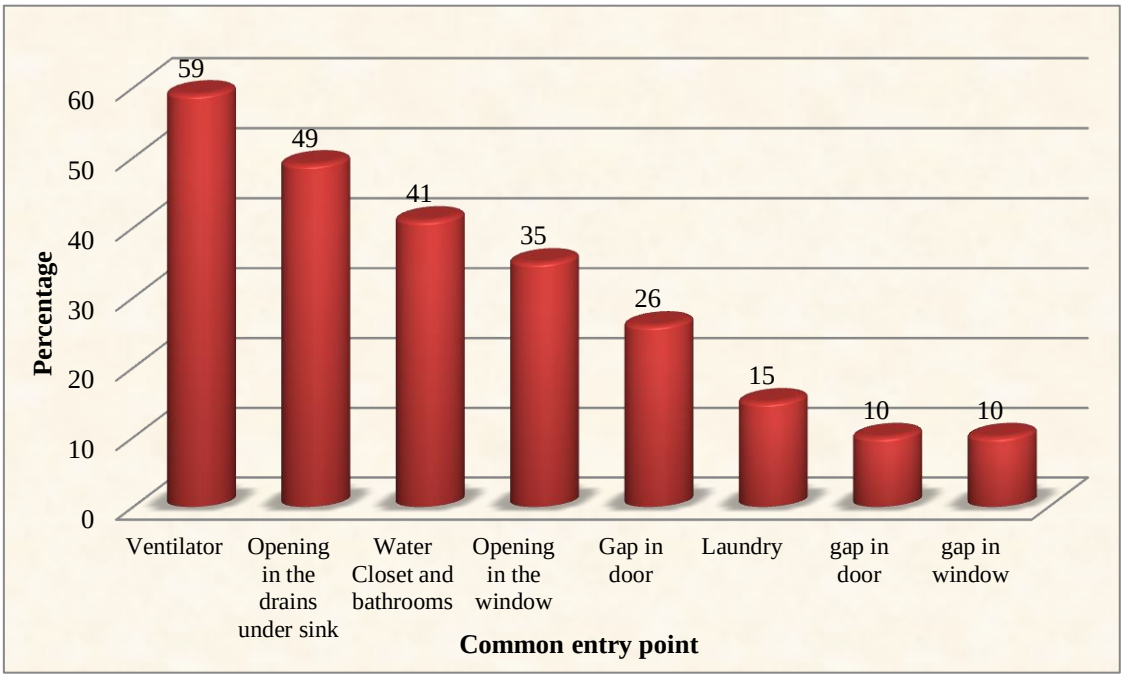

Figure 16: Common Entry Points of Mosquitoes

The ventilator was the entry point for mosquitoes in a maximum of 59 percent of the houses which were surveyed; the opening in the drains under the sink was the entry point for mosquitoes in 49 per cent of the houses; the water closet was the entry point for mosquitoes in 41 percent of the houses; the gap in the doors and windows were the entry point for mosquitoes in 26 percent of the houses; the laundry area was the entry point for mosquitoes in 15 percent of the houses; and the gap in the roof was the entry point in 10 per cent of the households. (not represented in the figure) Ask me for doubt

Generally all the surveyed households take measures to protect themselves from mosquito bites like avoiding exposing themselves outdoors in the evening, closing the doors and windows during sunset hours when mosquitoes are more, and creating smoke with neem leaves out doors if possible. Other measures taken by the households to overcome the problem of mosquitoes is given below.

5. Measures Taken to Overcome the Problem of Mosquitoes

Though the surveyed homemakers were aware of eco friendly measures to drive away the mosquitoes they were sticking on other chemical repellents as they are widely available. Figure 17 displays the measures taken by the respondents to overcome the problem of mosquitoes.

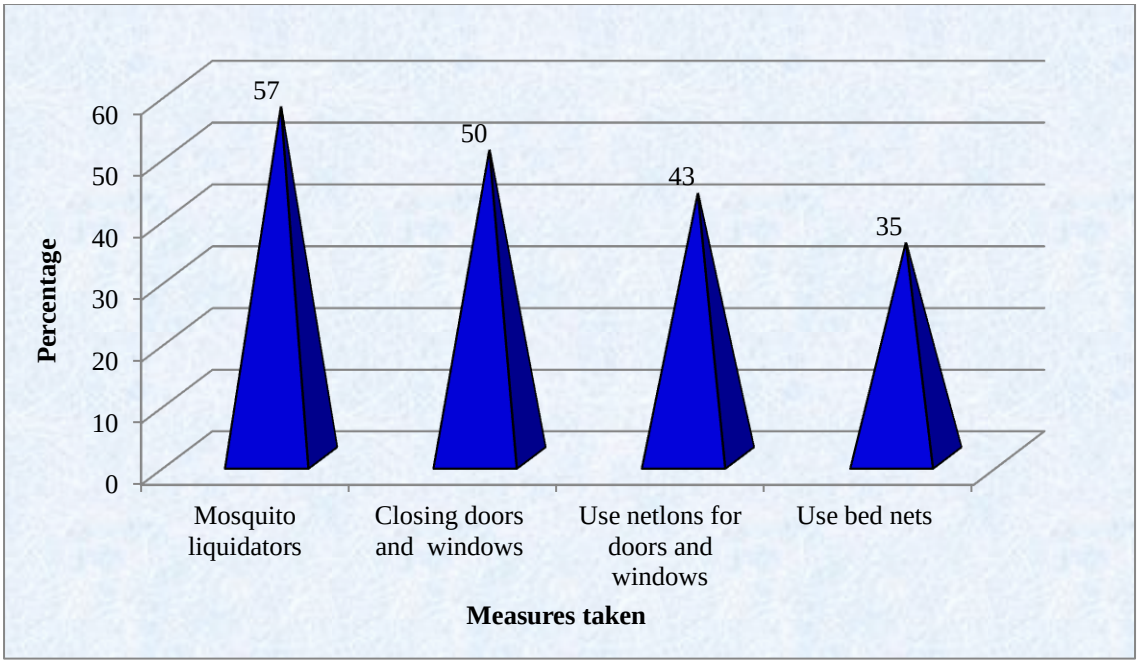

Figure 17: Measures Taken to Overcome the Problem of Mosquito

In order to protect themselves and their families from being bitten by mosquitoes, the majority of the households (57%) that were interviewed said that they use mosquito repellents in their homes. Seventy-six percent of them reported using it for ten to fifteen hours every day. They expressed that they switch it on in the late evening till morning is represented in Figure 18.

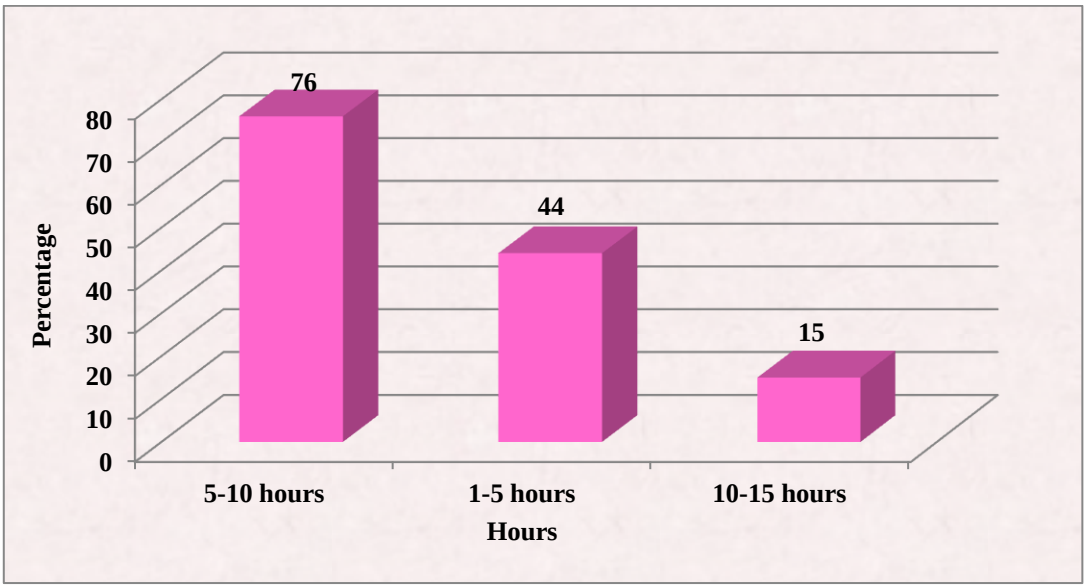

Figure 18: Hours of use of the Repellent Per Day

The frequency of changing the mosquito repellent given in Figure 19.

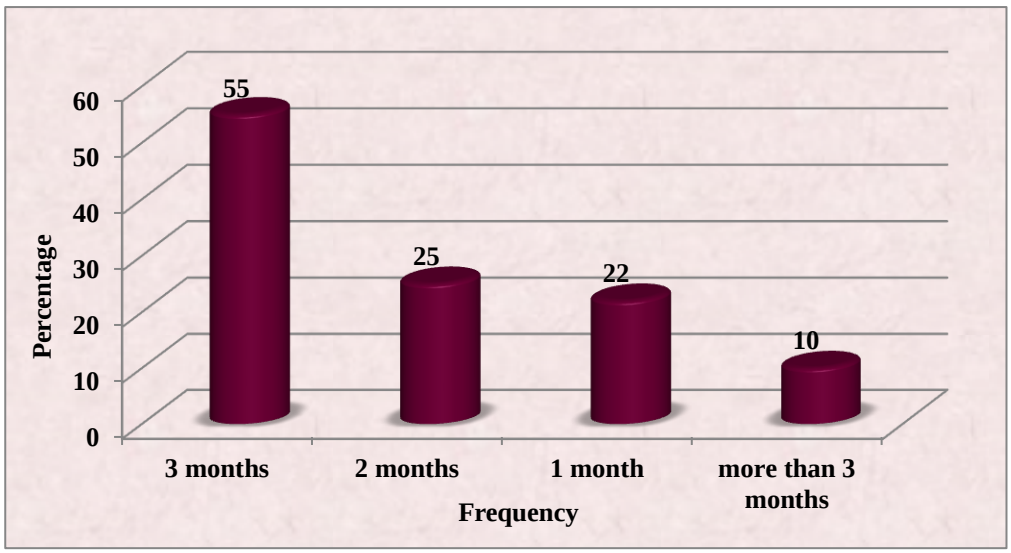

Figure 19: Frequency of Changing of Mosquito Repellent

The frequency of refilling the mosquito repellents varied with the number of hours it works. Once in 3 months the repellent was changed as informed by 55 per cent of those who used repellents. Twenty five per cent replaced the repellents every 2 months. Twenty two per cent informed that used for 1 month. Ten per cent informed that they used to refill after every three months.

The common repellents used in the households are shown below in Figure 20.

Figure 20: Common Mosquito Repellents Used by Surveyed Households

During the study, 55 percent of respondents reported having health problems as a result of mosquito bites. Table 10 shows the health difficulties that their families are facing as well as the side effects of utilising mosquito repellents.

6. Common Health Issues Faced due to Mosquitoes

The health issues faced in the households are presented in Table 8.

Table 8: Health Issues Faced by the Surveyed Families due to Mosquitoes

Category	Number of Respondents (N=55)
Malaria	46
Chikungunya	41
Dengue virus	20

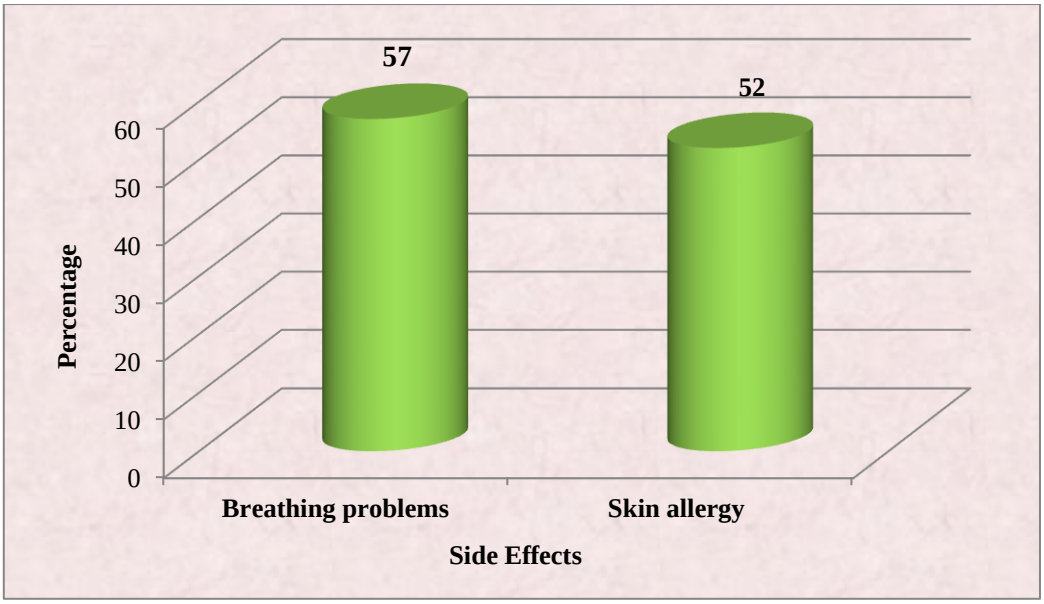

Figure 21: Side Effects of Using Mosquito Repellent

Mosquito bites are the cause of a wide variety of diseases. The largest number of malaria-affected families was 46 percent, Chikungunya-affected families was 41 per cent, and dengue fever-infected families made up 20 per cent of the families who experienced health difficulties.

The use of mosquito repellents has been associated with a variety of adverse side effects, as reported by the respondents. This also represented in Figure 8.The problems that they encountered included a maximum of 57 per cent of the samples

being affected by breathing problems owing to mosquito repellents and additionally, a maximum of 57 per cent of the samples were afflicted by skin allergy. As a result, it is necessary for us to locate an alternate abiotic repellant that has the potential to not cause any adverse effects.

B. Survey about Problems of Mosquitoes and Details of Repellent Used in Commercial Building

The results of the survey under this topic was discussed under the following topics

1. General Information about the Commercial Areas that were Surveyed
2. The Standard Amenities that are offered in the Office.
3. The Various Mosquito Repellent Treatments.
4. The Factors Influencing the Choice of Insect Repellent
5. Measures made to Reduce the Risk of Mosquito bites
6. Problems faced owing to mosquito

Table 9 gives information on gender and age of the respondents.

Table 9: General Information about Surveyed Commercial Areas

Personal information	Details	Number of Respondents N=50	%
Gender	Male	29	58
	Female	21	42
Age Group	20-35	19	38
	36-50	19	38
	51-65	12	24

According to the results of the survey, there were a total of 58 percent male and the remaining respondents were female. This demonstrates that both the male and female members of the household share responsibility for the activities that takes place in the commercial area and is aware of such actions. There were a maximum of 38 percent of respondents who fell into the age range of 20 to 35 years old, and there were 24 percent of respondents who fell into the age range of 51 to 65 years old.

2. The Standard Amenities that are provided in the office.

Details of the available in the office are given in the below Table 10.

Table 10: General Standard Amenities (Available in the Office)

Details	Number of Respondent N=50	%
Windows in the office		
10-15	22	44
5-10	19	38
Above 15	9	18
Doors in the office		
4	21	42
2	18	36
More than 4	11	22

The most common ways to enter a structure are through the doors and windows. According to the results of the survey, a maximum of 44 per cent of the commercial buildings that were studied had between 5 and 10 windows, 38 per cent had between 5 and 10 windows, and 18 per cent had more than 15 windows. The greatest number of commercial buildings, 42 per cent, had provided four doors, while 36 per cent of those buildings had only two doors and 22 per cent of those buildings had more than four doors. All the surveyed respondents expressed they have problem of mosquitoes in the late evening. None of them grow plants which serve as mosquito repellant or used netlons to protect from mosquitoes. Since these people do not stay till night they said they did not bother to fix netlons. Since they had problem of mosquitoes in the late evening they used mosquito coils or mosquito repellents to drive the mosquitoes.

3. Mosquito Repellent Used

The costs that were expended to defend against mosquitoes ranged anywhere from one hundred to one thousand rupees The amount of money spent varied according on the size of the office, the number of working hours that were required, and the level of difficulty presented by the mosquito problem. The Table 13 that

follows provides information on various approaches that can be used to repel mosquitoes.

Table 11: Mosquito Repellent Used

Details	Number of Respondent (N=50)	%
Mosquito repellent are using in office		
Liquidators	30	60
Coils	20	40
Place of using mosquito repellent		
Throughout the office	28	56
Only in the lobby	22	44

It was possible to deduce from the results of the survey that a maximum of 60 percent of offices utilized liquid repellents to drive mosquito , while forty per cent used coils whenever it was necessary. Very few of those who responded to the survey (10%), however, said they had tried to sprinkle natural liquid insect repellents in and around the area where they were working.

4. Factors Influenced the Selection of Mosquito Repellent

Table 12 gives information on factors influencing selection of mosquito repellent by the respondents is given below.

Table 12: Factors Influenced the Selection of Mosquito Repellent

Factors Influenced	Number of Respondent (N=50)	%
Safety	16	32
Price	15	30
Advertisement	13	26
Friends and relatives	11	22
Popularity of Brand	10	20

It is heartening to see that maximum 32 per cent of commercial respondents identified safety as a crucial concern in their choosing of a mosquito repellent, according to the study that was conducted on variables that impacted selection of a mosquito repellent. The following most important factor that was considered by 30 per cent of the respondents was the price of the product. Other aspects that played a role in the respondents' choice of mosquito repellent were advertising (cited by 26%), recommendations from friends and family (22%), and the popularity of the brand (20%).

5. Measures taken to reduce the risk of mosquito bites

The following Table 13 gives information on steps taken to prevent mosquitoes

Table 13: Steps Taken to Prevent Mosquitoes

Details	Number of Respondent N=50	%
Sources of mosquito are reduced in yard		
Eliminate standing water	26	52
Closing up holes in structures	24	48
Regular cleaning of storage tanks		
2 months	26	52
4 months	19	38
More than 4 months	5	10
Cleaning of drainage system		
2 years	29	58
More than 2 years	15	30
1 year	6	12

According to the findings of the survey, a maximum of 52 per cent of the people who responded were successful in avoiding the sources by preventing the accumulation of water in the front and rear yards of the commercial space by consistent cleaning. The problem was decreased by 48 per cent as a result of the closure of gaps in the structures. One cleaning of the water storage tank was performed on a maximum of 52 per cent of samples every two months, 38 per cent of

samples once in every four months, and 10 per cent of samples once in every more than four months.

Based on the results of the survey, it is possible to deduce that a maximum of 58 per cent of respondents clean the drainage pipes once in every 2 years in order to prevent mosquito breeding.

6. Problems Faced due to Mosquitoes

Due to the fear of common vector borne diseases like Malaria, **Chikungunya** and Dengue fever had made a maximum of 36 per cent of the respondents to suffer due to infection for 5-10 days Hence 48 per cent of them stopped doing work after 5.30pm in the outdoors

The following Table 14 gives information on problems faced due to mosquito

Table 14: Problems faced due to mosquito

Details	Number of Respondent N=50	%
Days to recover from Disease		
5-10 days	18	36
More than 10 days	17	34
1-5 days	15	30
Give up outdoor activities because of the mosquito bites		
Do work regularly	26	52
Stop doing work after 5.30 pm	24	48

Fear of common vector-borne diseases such as Malaria, Chikungunya fever, and Dengue fever, which caused an infection, in a maximum of 36 per cent of the respondents that lasted between 5 and 10 days. This also had caused 48 per cent of them to stop working outside after 5:30 p.m. due to the risk of contracting the disease and causing themselves to suffer for weeks. However 52 per cent also accepted that they do the work regularly.

Phase 2: Market Survey to find out the Types of Repellent Available in Shops

Market survey includes the types of mosquito repellent available around the city of Coimbatore. The findings of the survey of the research consisted of the following sub headings.

1. General Information Regarding the Market Survey
2. Mosquito Repellents Available in the Shops and Preferred by Customers
3. Types of Mosquito Nets Available and the Materials that are used
4. Details about the Mosquito Repellents
5. The Price of Mosquito repellents

1. General Information Regarding the Market Survey

The issues were brought up, and questions were posed, in accordance with their particular sphere of production. The information that gathered were the year the shop was started, the types of sales involved, and the type of seller who run it can be found in Table 15.

Table 15: General Information about Market Survey

Details	Category	Number of Respondent (N=25)	%
Year of starting the firm	Before 2000	2	8
	2001-2005	4	16
	2005-2010	5	20
	2010-2015	7	28
	2015-2020	5	20
	After 2020	2	8
Type of Sales	Wholesale and retail	16	64
	Retail	9	36
Type of Seller	Manufacturer	10	40
	Wholesaler	9	36
	Retailer	6	24

As per the results of the study, a maximum of 28 per cent of the stores that were surveyed were inaugurated between the years 2010 and 2015, followed by 20 percent of shops that were established between the years 2015 and 2020, and another 20 percent of shops that were founded between 2005 and 2010.

Based on the results of the survey, it was possible to deduce that 64 per cent of respondents were involved in both retail and wholesale trade. The remaining ones were involved in retail trade only,

Based on the results of the survey, it was possible to infer that a maximum of 40 per cent of the manufacturers were also involved in wholesale sales, followed by 36 per cent of businesses that focused solely on wholesale transactions, and the remaining 24 per cent were only retailers.

2. Mosquito Repellents Available in the Shops and Preferred by Customers

The following Table 16 gives information on products available in the shops and customer preferred mosquito repellent are given below

Table 16: Products Available and Customer Preference Regarding Mosquito Repellents

Details	Number of Respondent (N=25)	%
Mosquito repellent available in the market		
Electric repellent	15	60
Cream and lotion	10	40
Spray	8	32
Coil	7	28
Fabric roll on	6	24
Preference of mosquito repellent by customers		
Electrical repellent	11	44
Cream and lotion	9	36
Fabric roll on	5	20
Spray	4	10
Coil	1	4

A maximum of 60 per cent of the stores that were investigated sold electric insect repellents. This was followed by sales of mosquito creams and lotions (40 percent), sales of mosquito spray (32 percent), mosquito coil (28 percent) and fabric roll on (24 per cent). On the other hand, when the preferences of consumers regarding mosquito repellent were surveyed, the majority of respondents (44%) claimed that electric repellent was their top choice, 36 per cent of respondents indicated that creams and lotions were their product of choice, while 20 per cent of respondents stated that their customers went for mosquito spray.

3**. Types of Mosquito Nets Available and the Materials that are used**

Cotton, polyethylene, polyester, polypropylene, or nylon is some of the materials that can be used to make mosquito netting. Mosquito netting is primarily utilized for the purpose of providing protection against mosquitoes. It is possible to construct mosquito netting into tents, hang it over beds from the ceiling or a frame, install it in windows and doors, or do any combination of these things.

Only 48 per cent of the shops that were checked out carried mosquito nets in their inventory. The following Table (Table 17) provides information on the various kinds of mosquito nets that may be purchased as well as the materials used to make them.

Table 17: Material used for Mosquito Netting and Types of Mosquito Nets Sold

Details	Materials available	Number of Respondents (N=25)	%
Material used for mosquito netting	Cotton	6	50
	Polyethylene	9	75
	Polyester	12	100
	Polypropylene	6	50
	Nylon	12	100
Types of mosquito nets	Door type	3	25
	Window type	12	100
	Magnetic type	12	100
	Pleated type	6	50
	Special door type	12	100
	Roller type	6	50

Cotton mosquito nets are more expensive, despite the fact that they are more comfortable. Therefore, it was available for purchase in 50 per cent of the stores. On the other hand, polyester and nylon mosquito nets could be discovered in all the shops that specialized in selling mosquito nets. All of the stores that sell mosquito nets have a variety of mosquito nets, including window-type nets, magnetic-type nets, and special door-type nets. Window-type nets, magnetic-type nets, and special door-type nets are particularly common as they were available in all the stores. The roller type, the pleated type, and the door type were the three other varieties of nets that could be purchased from the stores.

4. Information on Special Mosquito Killers Available in the Surveyed Shops

There are number of ways through which we can get rid of mosquitoes such as repellents, creams, coils and so on. However various mosquito killers and traps are available recently in the market. Some of the killers available in the shops surveyed are given in Table 18.

Table 18: Information on Special Mosquito Killers Available

Details	Category	Number of Respondent (N=25)	%
Best electric method used to kill mosquito	Racket killer	20	80
	Lamp killer	12	48
	Philips insect killer	6	24
	Blastoise electronic led	3	12
	Clean UV lamp	3	12
	Aapkiekartkillr	2	8
Herbal mosquito repellent	Santa	9	36
	Campuses	6	24
	Herbal hunter	5	20
	Tulsi	5	20
Main ingredient in mosquito repellent	DEET-Chemical name N,N – diethl- meta – toluamide	19	76
	Lemon eucalyptus oil	12	48
Effective mosquito repellent	Nathaniel wipes	13	52
	Coleman lemon encalyptus insect repellent	12	48

According to the findings of the survey, the investigator was able to ascertain that numerous insect repellents are sold in the market. In 80 per cent of the stores that were surveyed, the racket killer was available. The lamp killer, was found in 48 per cent of the shops. It appeared to be the next most popular mosquito killer. Other mosquito killers that were seen in the shops included those made by Philips, Blastoise electronic led, Clea UV lamp, and Aapkiekartkillr.

These shops were also selling a limited selection of herbal insect repellents, one of which was a Santa product, which was found in 36 per cent of the shops that were surveyed. Other natural mosquito repellents that were accessible included Tulsi, Campuses, and Herbal Hunter. Each of these natural mosquito repellents was available in 20 per cent, 24 per cent and 20 per cent of the shops respectively. In addition, these stores sold N,N-diethl-meta-toluamide at a rate of 76 per cent, lemon eucalyptus oil at a rate of 48 per cent, Coleman lemon encalyptus insect repellent at a rate of 48 per cent, and Nathaniel wipes at a rate of 52 per cent. All of these products are used as the primary ingredient in mosquito repellent.

5. The Price of Mosquito Repellents

In spite of the fact that numerous insect repellents are sold in stores, people are not familiar with these products because they are fairly expensive and, most likely, do not have a great deal of success in repelling mosquitoes. Table 19 below gives information on cost of mosquito repellent.

Table 19: Price of Mosquito Repellents

Product name	<Rs. 50	N=25 %	Rs. 51-100	N=25 %	Rs. 101-150	N=25 %	Rs. 151-1000	N=25 %	>Rs. 2000	N=25 %
Coil	9	36	2	8	-	-	-	-	-	-
Cream	10	40	18	72	-	-	-	-	-	-
Mosquito net	-	-	-	-	-	-	16	64	20	80
Electrical repellent	-	-	20	80	-	-	9	36	5	20
Biotic pest	16	64	15	60	-	-	-	-	-	-
Sprays	-	-	-	-	18	72	-	-	-	-
Fabric roll-on	-	-	12	48	-	-	-	-	-	-

According to the shops that were surveyed, the price of cotton mosquito nets was very high and ranged over two thousand rupees as given by 80 per cent of the

shops. The costs of mosquito repellents appear to be within a reasonable range (Rs 101-150). It includes the machine and the liquidator.The prices of various products, including coil, cream, biotic pest control, and fabric roll-on, ranged from less than Rs 50 to more than Rs.100 each.

Phase 3: Contriving an Eco-friendly Repellent and Collecting the Feedback from the Selected Users

Based on the information gathered she formulated an eco friendly mosquito repellent. In order to evaluate the effectiveness of the prepared eco-friendly repellent, a total of 22 homemakers used the repellent that had been developed. Instructing the homemakers to light a lamp with the prepared repellant, which was oil based, was one of the directions given to them. The effectiveness was judged according to the effect it had to drive the mosquitoes. The information that can be found in Table 22 pertains to the process that was used to apply the repellant, and Table 23 details the level of contentment that was reported by the homemakers.

A. Technique of using mosquito repellent by the housewives

Table 20: Technique of using Mosquito Repellent by the Housewives

Technique used	(N=22)	%
Lighted lamp	21	4.6
Used Electric liquidator	1	0.2

Even though it was specified to ignite the lamp with the prepared oil, a resourceful housewife made an effort to utilize the oil by pouring it into an empty liquadator bottle and testing out its efficacy. In accordance with the instruction, other people ignited the lights in the evening, when they saw mosquitoes. The homemaker seems to use the repellent for more than a month similar to that of the branded liquidator. Hence the homemakers can make maximum use of the repellent by using an empty liquidator bottle in future if possible. Further research can be done to design a bottle for the repellent developed.

B. Characteristics of Mosquito Repellent oil

Table 21: Characteristics of Mosquito Repellent Oil

Criteria for assessment	Highly Satisfied		Satisfied		Neutral		Not Satisfied		Highly Not Satisfied	
	N=22	%	N=22	%	N=22	%	N=22	%	N=22	%
Colour	9	41	6	27	5	22	2	9	-	-
Viscosity	-	-	5	22	1	5	6	27	10	45
Aroma	-	-	-	-	22	100	-	-	-	-
Duration	10	45	7	32	5	22	-	-	-	-
Elimination of mosquito	19	86	3	14	-	-	-	-	-	-

It is heartening to see that 86 per cent of housewives are quite satisfied with the performance of the mosquito repellent, since this figure shows a positive trend. Regarding the aroma of the repellant, all the homemakers surveyed reported feeling neither content nor unhappy with the aroma. The size of the lamp determined how long it would take for the light to burn completely. 45 per cent of respondents indicated a high level of unhappiness with the mosquito repellent due to the fact that it was manufactured using oil it was sticky. In subsequent research, the investigator could test the sample with a different fragrance or another base in an effort to lessen the product's viscosity.

C. The cost incurred in preparing the biotic mosquito repellent

An effort taken by the investigator to prepare a biotic repellent included the following natural products. The costs of the products are presented in Table 22.

Table 22: Ingredients used for Preparing Mosquito Repellent

No.	Ingredients Used	Quantity	Cost (Rs)
1.	Castor oil	400 ml	450
2.	Neem oil	100 ml	48
3.	Lemon grass oil	20 ml	28
4.	Cinnamon bark	10 gram	1
5.	Nochi leaf	10 gram	-
6.	Guava leaf	10 gram	-
7.	Garlic	10 piece	4
8.	Marigold flower	10 gram	-
9.	Carom seeds	4 gram	1
10.	Common salt	2 pinch	-
11.	Camphor	1 piece	-
	Total		**532**

The prices of the components that were used to make the mosquito repellent are listed in the Table that can be seen above. Castor oil costs took up the majority of the cost. There is a possibility that the price will be reduced if a bigger quantity of it is bought. Additional substances such as neem oil and lemon grass seem to have a cost that is comparable to the others. The remaining components may be obtained without incurring any expense or for very little money. Because of this, it is possible for individual homes to prepare this and profit from it. It's possible the investigator may go into business with it in future. It is possible that in the coming days, a new scent may be added to, so that when the lamp is lit, it will release a perfume into the air that the residents will find pleasant. However the price of the repellent was not satisfactory since the price of around 550 ml of the repellent was calculated to be Rs.532.

V SUMMARY AND CONCLUSION

Population growth and better lifestyles create solid waste in urban and rural locations. Epidemics may break out owing to waste collection around water sources like stagnant water, abandoned pools, etc. Waste build-up on land and water spreads illnesses epidemically. Insects, rodents, and pets spread these illnesses. Stagnant water and mounting of solid wastes attracts mosquitoes. 40 million Indians experience mosquito-borne ailments and India has 0.57 cases per 10,000 people every year. Mosquitoes are one of India's most annoying rain time vectors. Mosquitoes may breed both in open stagnant water as well inside, under the nose. As a result people suffer from mosquito bites leading to life threats due to vector borne diseases.

Mosquito bites are a health danger and a productivity-killer. People still believe getting bitten by mosquitoes hinders their work. Working patterns may change, efficiency may drop, outdoor activities may be curtailed, and vector-borne diseases will always be a worry. Bed nets, insect repellents, coils, mats, creams and lotions, mosquito traps, mosquito rackets, etc. may protect against mosquito bites. Use of chemical repellents may induce blisters, seizures, memory loss, headaches, joint stiffness, shortness of breath, skin irritation, and respiratory issues. Natural repellents are gaining popularity, although chemical treatments are still more popular. Natural insect repellents may be good alternatives to commercial ones. These items are less hazardous to people and the environment. With this idea, the researcher contrived an eco-friendly mosquito repellent for users. The study on "**Discerning the Problems of Mosquitoes and Contriving an Eco friendly Mosquito Repellent**" was under taken with the following objectives

To

- Collect data on the mosquito-related issues encountered by residential and commercial users.
- Learn more about the products that are currently available on the market to protect from mosquitoes
- Contrive an eco-friendly mosquito repellant and get feedback from a sample of users about its effectiveness.

The methodology involved in the conduct of study is as follows:-

Phase 1: Baseline Survey

Phase 2: Market Survey

Phase 3: Formulation of Eco-friendly Mosquito Repellent and Assessing its Efficiency

Phase 1: Baseline Survey about Problems of Mosquitoes and Repellent used in Residential and Commercial Buildings

The survey was done in selected areas of Coimbatore city such as, Gandhipuram, Hopes College, Saibaba colony and R.S.Puram which are the residential and commercial neighbourhood located at the heart of the city. The number of samples selected for the household survey was 100 and for commercial survey it was 50. They were selected by purposive sampling method. Two interview schedules were framed individually to collect the required information from households and people from commercial spaces. The details were collected from the members in the households and commercial space owners or workers at their showrooms through friendly conversation

Phase 2: Market Survey to find out the Types of Repellent Available in Shops

For the study the investigator selected the shops which sell mosquito repellent situated in R.S Puram , Mettupalayam Road, Gandhipuram Crosscut road, and NSR road - Saibaba colony . The investigator collected 25 samples from these area. The information on types of repellent available and demanded by the consumers was collected from supermarket, departmental store and , medical shops etc which sell mosquito repellent located in the above said places. . An interview schedule was designed to gather information on mosquito repellent sold, and its cost. The investigator approached the shop owners at their convenient time, explained the purpose of study and recorded the answers instantly in the schedule.

Phase 3: Contriving an Eco-friendly Repellent and Collecting the Feedback from the Selected Users

. The investigator referred various books, journals and magazines to gather information on eco-friendly materials which can kill or drive mosquitoes. Based on the information gathered she formulated an eco friendly mosquito repellent. She

prepared the repellent and distributed to 22 households who expressed their willingness to try the prepared oil in place of a normal repellent.

The findings of the study are as follows:-

Phase 1: Baseline Survey about Problems of Mosquitoes and Repellent used in Residential and Commercial Buildings

The results of the baseline line survey were dealt under the following two headings:-

A. Survey about Problems of Mosquitoes and Details of Repellent Used in Residential Buildings

B. Survey about Problems of Mosquitoes and Details of Repellent Used in Commercial Buildings

A. Survey about Problems of Mosquitoes and Details of Repellent Used in Residential Buildings

- According to the results of the study, 54 per cent of the respondents were male. At most 55 per cent of the respondents belonged to the age bracket of 20-35 years. . A maximum of 35 per cent of the selected households belonged to the middle income group. The highest percentage of surveyed households,(51 per cent), was found to be located in urban areas. With regard to the ownership specifics of the sampled households, the vast majority (55%) was living in their own houses. When the type of roof that the respondents' residences had was analyzed, it was determined that 77 per cent of the respondents were living in terraced buildings.
- Based on the results of the survey, the investigator learned that just 27 per cent of respondents had a main door while the rest had a main door and a back door. Windows and doors were the main entry point for the mosquitoes. Among the homes that were surveyed, the largest number of 52 per cent of households were with two bedrooms. Majority 52 per cent and 48 per cent of the surveyed households closed their doors and windows respectively in order to protect from mosquitoes. All the respondents faced the problem of mosquito bite throughout the year but at varying intensity in different period. A majority of 75 per cent of the houses surveyed revealed that the problem of mosquito bite is at the maximum during rainy period. The majority of respondents

(48%) stated that the shrubs that surrounded their homes were the primary reason that they kept their doors and windows shut, as they were concerned that opening them could attract unwanted insects into their homes.

- Though the surveyed homemakers were aware of eco friendly measures to drive away the mosquitoes they were sticking on other chemical repellents as they are widely available. In order to protect themselves and their families from being bitten by mosquitoes, the majority of the households (57%) that were interviewed said that they use mosquito repellents in their homes. The frequency of refilling the mosquito repellents varied with the number of hours it works. Once in 3 months the repellent was changed as informed by 55 per cent of those who used repellents.
- During the study, 55 per cent of respondents reported having health problems as a result of mosquito bites. . The largest number of malaria-affected families was 46 percent, Chikungunya-affected families was 41 per cent, and dengue fever-infected families made up 20 per cent of the families. A maximum of 57 per cent of the samples were affected by breathing problems owing to mosquito repellents

C. Survey about Problems of Mosquitoes and Details of Repellent Used in Commercial Building

- According to the results of the survey, a maximum of 44 per cent of the commercial buildings that were studied had between 5 and 10 windows. All the surveyed respondents expressed they have problem of mosquitoes in the late evening. Since they had problem of mosquitoes in the late evening they used mosquito coils or mosquito repellents to drive the mosquitoes. From the results of the survey it is understood that a maximum of 60 percent of offices utilized liquid repellents to drive mosquito. According to the findings of the survey, a maximum of 52 per cent of the people who responded were successful in avoiding the sources by preventing the accumulation of water in the front and rear yards of the commercial space by consistent cleaning as a measure to prevent mosquitoes. Due to vector borne diseases caused infection, maximum of 36 per cent of the respondents suffered for 5 to 10 days.

Phase 2: Market Survey to find out the Types of Repellent Available in Shops

As per the results of the study, a maximum of 28 per cent of the stores that were surveyed were inaugurated between the years 2010 and 2015. Maximum 64 per cent of respondents were involved in both retail and wholesale trade. A maximum of 60 per cent of the stores that were investigated sold electric insect repellents. According to the findings of the survey, the investigator was able to ascertain that numerous insect repellents are sold in the market. In 80 percent of the stores that were surveyed, the racket killer was available. These shops were also selling a limited selection of herbal insect repellents. The costs of mosquito repellents appear to be within a reasonable range (Rs.101-150).

Phase 3: Contriving an Eco-friendly Repellent and Collecting the Feedback from the Selected Users

It is heartening to see that 86 per cent of housewives are quite satisfied with the performance of the mosquito repellent. However the price of the repellent was calculated as Rs.536 for 550 ml. Efforts should be taken to reduce the price.

Suggestions for Follow up Study

It is possible to do a follow-up research on the following elements.

1. The insect repellent may be made with a variety of fragrances, and test the most preferred aroma by consumers.
2. It may be stored in bottles and vaporized using a vaporizer.
3. The impact of the repellent may be investigated using scientific methods.

In conclusion, tropical nations like India face a significant challenge in the form of an infestation of mosquitoes. Even if there are a variety of chemicals and repellents on the market, it is vital for us to investigate the primary factor that leads to the reproduction of mosquitoes and to maintain the environment clean. The government needs to push researchers to develop a repellant that is affordable and safe, as well as environmentally beneficial. Consumers should also be able to recognize a harmless repellant and use it in order to maintain a healthy lifestyle.

*"**He who has health has hope and he who has hope has everything**."*

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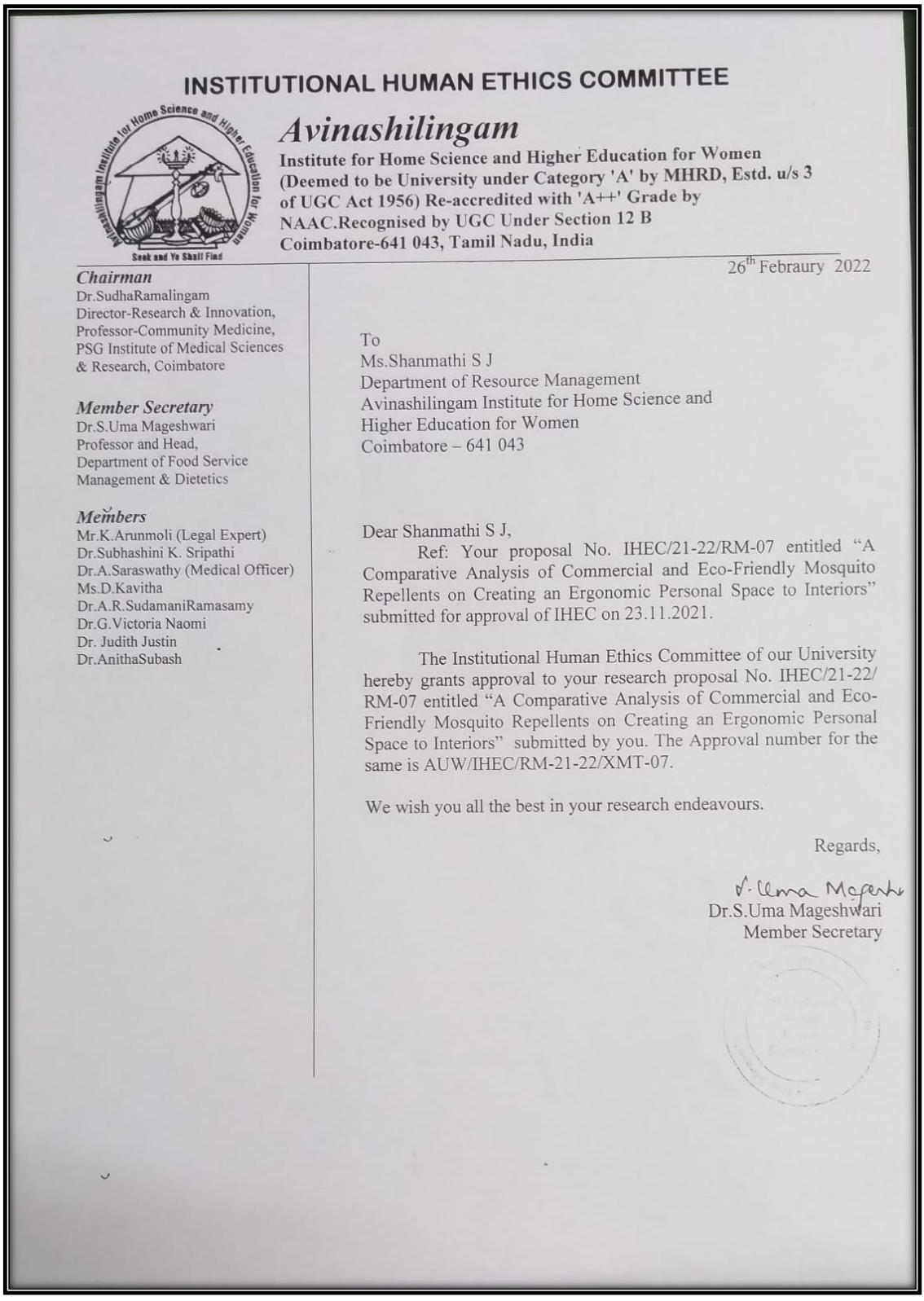
APPENDIX I

Institutional Human Ethics Committee



INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam

Institute for Home Science and Higher Education for Women
(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956) Re-accredited with 'A++' Grade by NAAC.Recognised by UGC Under Section 12 B
Coimbatore-641 043, Tamil Nadu, India

Seek and Ye Shall Find

Chairman
Dr.SudhaRamalingam
Director-Research & Innovation,
Professor-Community Medicine,
PSG Institute of Medical Sciences & Research, Coimbatore

Member Secretary
Dr.S.Uma Mageshwari
Professor and Head,
Department of Food Service Management & Dietetics

Members
Mr.K.Arunmoli (Legal Expert)
Dr.Subhashini K. Sripathi
Dr.A.Saraswathy (Medical Officer)
Ms.D.Kavitha
Dr.A.R.SudamaniRamasamy
Dr.G.Victoria Naomi
Dr. Judith Justin
Dr.AnithaSubash

26th Febraury 2022

To
Ms.Shanmathi S J
Department of Resource Management
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Shanmathi S J,

Ref: Your proposal No. IHEC/21-22/RM-07 entitled "A Comparative Analysis of Commercial and Eco-Friendly Mosquito Repellents on Creating an Ergonomic Personal Space to Interiors" submitted for approval of IHEC on 23.11.2021.

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/21-22/RM-07 entitled "A Comparative Analysis of Commercial and Eco-Friendly Mosquito Repellents on Creating an Ergonomic Personal Space to Interiors" submitted by you. The Approval number for the same is AUW/IHEC/RM-21-22/XMT-07.

We wish you all the best in your research endeavours.

Regards,

S. Uma Mageshwari
Dr.S.Uma Mageshwari
Member Secretary

APPENDIX II

Prevalence and Prevention of Mosquitoes in Residential Area

Background Information

1. Name of the interviewer:
2. Address:
3. Contact no:
4. Sex: □ Male □ Female
5. Age: a) 20 –35 b) 36 – 50 c) 51 – 65 d) 66 – 80
6. Annual Income:

   □ Less than 50,000 □ 50,000 –1 lakh

   □ 1 lakh – 2 lakhs□ Beyond 2 lakhs
7. Type of House resided in

   □ Own house □ Rented house □ Lease house
8. Area of Residence

   □ Semi urban □ Urban □ Rural

I. Prevalence of Mosquito

Resident's behaviour

1. Do you keep your doors and windows open?

   □ Yes □ No

   a) If yes, When? _____
   - Morning
   - Afternoon
   - Evening
   - Night
   - Full day

   b) How many hours do you keep windows and doors open
   - 1 – 2 hours
   - 2 – 3 hours
   - 3 – 4 hours
   - More than 5 hours
2. When do you think the mosquito funsies is more?

   a) Day b) Evening c) Night
3. In which season, the mosquito will be more active?

   a) Summer b) Winter c) Autumn d) Rainy
4. Number of Bedrooms Present in the Households

   a)1 BHK b) 2BHK c) 3or more BHK

5. Reasons for Closing the Doors and Windows
   a) Safety b) Protect from Mosquitoes c) Privacy d) Any other Specify
6. Information on the Environmental Conditions of the Households
   a) Stagnant water
   b) Bushes
   c) Un maintained space
   d) Common dumping of waste
   e) Cattle shed

Assessment of House quality

1. Which is the common entry points of mosquitoes

Holes	
Opening in the window	
Opening the screens	
Dark areas	
Under the sink	
Closet	
Laundry	
Gap in door	
Window	
Ventilator	

2. Measures Taken to Overcome the Problem of Mosquito

   a) Use bed nets

   b) Use netlons for windows and doors

   c) Closing doors and windows

   d) Mosquito liquidators

Insecticide treatment

1. Which mosquito repellent do you use?
   a) Coil b) Electric mosquito repellent c) Sprays b) Cream
2. How oftenyou will change the mosquito repellent liquid?
   a) 1-month b) 2 months c) 3 months d) more than 4
3. Use of the repellent per day?
   a) 1-5-hour b) 5-10-hour c) 10-15-hour d) more than 15 hour

4. What type of mosquito repellent are you using?

Coil	
Mosquito repellent cream	
Mosquito Net	
Electrical mosquito repellent	
Mosquito repellent patch	
Mosquito repellentbracelet	
Sprays	
Mobile case for mosquito repellents	
Fabric Roll-on	
Patch	

5. Are you aware of natural pest control?

□ Yes □ No

If yes, which of the following is used by you

a) How you were aware of natural pest control
b) For how long you had been using it
c) Did you have any health issues because of mosquito products?
d) Do you think it is Cost effective?

II Health issues faced

1. Do you have any health issues faced due to mosquito bites

Malaria	
Dengue virus	
Zika virus	
Wesk Nile virus	

2. What are the side effects of using mosquito repellent?

a) skin allergy

b) Breathing problems

c) other

Contriving an Eco-friendly Repellent and Collecting the Feedback from the Selected Users

1. Technique of using mosquito repellent by the housewives

a) Technique used b) Lighted lamp c) Used Electric liquidator

2. Characteristics of Mosquito Repellent oil

Criteria for assessment	**Highly Satisfied**		**Satisfied**		**Neutral**		**Not Satisfied**		**Highly Not Satisfied**	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Colour										
Viscosity										
Aroma										
Duration										
Elimination of mosquito										

APPENDIX III

Interview Schedule on Prevalence and Prevention of Mosquitoes in Commercial Area

Details of shop

1. Name of the shop
2. Location of the shop
3. How, many years of Enterprise
    a) Before 2000
    b) 2001-2005
    c) 2005-2010
    d) 2010-2015
    e) 2015-2020
    f) After 2020
4. What kind of selling
5. What type of sealer
    - Manufacturing
    - Retailer
6. Contact Number
7. E – mail ID

Products and service provided

1. Types of mosquito repellents available in the shop
    a) Coil
    b) Mosquito repellent cream
    c) Cream
    d) Fabric roll on
    e) Bracelet
    f) Electrical mosquito repellent
    g) Spray
    h) Patch
2. Most preferred mosquito repellent by the customer
    a) Coil
    b) Mosquito repellent cream
    c) Mosquito Net
    d) Electrical mosquito
    e) Biotic pest control
    f) Others (Specify) _____
3. What is the material available for mosquito netting?
    a) Cotton
    b) Polyethylene
    c) Polyester
    d) Polypropylene
    e) Nylon

4. Different type of mosquito nets
    a) Door type mosquito net
    b) Window type mosquito net
    c) Magnetic type of mosquito net
    d) Velcro type mosquito net
    e) Pleated type mosquito net
    f) Special door type net
    g) Roller type mosquito net

Information on Mosquito Repellent Methods

1. What are the best electric method used to kill mosquitoes?
    a) Mosquito lamp killer
    b) Blastoise Electronoc led
    c) Mosquito killer Racket
    d) Clea UV lamp
    e) Philips insect killer machine
    f) Aapkiekart mosquito killer
2. What is the herbal mosquito repellent liquid vaporizer?
    a) Campuses
    b) Herbal hunter
    c) Santa
    d) Tulsi
    e) Voice
3. What is the main ingredient in mosquito repellent?
    a) DEET –Chemical name N, N – diethl –meta – toluamide
    b) Lemon eucalyptus oil
    c) Other (specify) _____
4. What is the most effective mosquito repellent repellent
    a) Coleman Lemon eucalyptus insect repellent
    b) Nathaniel wipes
    c) Other (specify) _____

Cost of the Mosquito Repellent

1. What is the cost of the product

Product name	**Less than Rs.50**	**Rs.51-100**	**Rs.101-150**	**Rs. 151-1000**	**More than Rs.2000**
Coil					
Cream					
Mosquito Net					
Electrical mosquito repellent					
Biotic pest control					
Bracelet					
Sprays					
Night lamp					
Patch					

Mobile case for mosquito repellents					
Fabric Roll – On					
Others (Specify)					

2. Do you provided any warranty/ survey
   □ Yes □ No
   If yes, How many years
   a) Less than 1 years
   b) 2 years
   c) More than 3 years

3. What is the Installation cost for electrical mosquito repellent
   a) Less than 1000 Rs
   b) More than 2000 Rs

4. Do you provide after sales service
   □ Yes □ No
   If yes, Service Cost _____

APPENDIX IV

Commercial Space

Background Information

1. Name of the interviewer:
2. Name of the office :
3. Address :
4. Contact no :
5. Age: a) 20 – 35 b) 36 – 50 c) 51 – 65 d) 66 – 80
6. E-mail ID

General facilities available in your office

1. How many windows are there in your office?
   a. 5 – 10 windows b) 10 – 15 windows c) above 15 windows
2. How many doors are there in your office?
   a. 2 doors b) 4 doors c) more than 4 doors
3. Do you have indoor gardening in your office?

   □ Yes □ No

   If yes, because of the plants, do you face any problems of mosquitoes
   a) Present of mosquito is more
   b) No, because we are used grow the mosquito repellent plants
   c) Other

Mosquito repellent Methods followed in your premises

1. What type of mosquito repellent are you using in office

   a) Natural mosquito repellents b) Electrical mosquito repellent

2. If you are using the natural mosquito repellent, what are you using?

   a) Plants b) Spraying natural liquid around the working area.

3. Are you using the electrical mosquito repellent?

   □ Yes □ No

   If yes, which place you place the electrical mosquito repellent

   a) All area in the office
   b) Only in lobby
   c) Other

4. How much your money spent for evacuation of mosquitoes?
   a) Rs.5000 – 10000 b) Rs.10000-15000 c) more than 15000 rs

5. How many mosquito repellent products are used on an average, during summer?
   a) 1-2 bottle
   b) 2-3 bottle
   c) 3-4bottle (boxes)
   d) More than 5 bottle (boxes)

6. Factors affecting the selection of insect repellent products
    a) Brand
    b) Friends recommend
    c) Price and package
    d) Safety
    e) Other (specify) _____

Steps taken to prevent mosquitoes

1. Currently, how the sources of mosquitoes are reduced in the yard?

    a) Eliminate standing water
    b) Closing up holes in structures
    c) Other (specify) _____

2. Are the water storage tanks regularly cleaned in the office?

    □ Yes □ No

    If no, how long period take to clean it

    a) 2 months b) 4 months c) more than 4 months

3. Are you cleaning the drainage system of your office regularly.

    □ Yes □ No

    If no, how long it takes to clean it

    a) 1 year b) 2 year c) more than 2 years

4. Wich one is best Biotic Method to control the mosquito bite

    d) Cinnamon oil
    e) Lemon grass oil
    f) Tea tree oil
    g) Mixing of neem oil and garlic as smoke

Problems faced due to Mosquito

1. Do you get affected by a mosquito bite? If yes, how much days will it take to get recovered?

    a) 1 – 5 days b) 5 – 10 days c) more than 10 days

2. During summer, are you forced of give up outdoor activities because of the mosquitos?

    a) We stopped doing work after 5.30 pm because of mosquito bite

    b) No we do the work regularly