

Formulation and Evaluation of Mosquito Repellent Candles using Dried Catnip Leaves

¹Apurva Shelar, ²Yash Maid, ²Arpit Mehta, ²Nikita Mhamunkar,
²Hridaya Naik, ²Jidnyasa Narayankar

Assistant Professor, Department of Pharmaceutics¹

Student, Bachelor of Pharmacy²

Sinhgad Institute of Pharmaceutical Sciences, Lonavala, India

Abstract: A mosquito is a little fly that is a member of Culicidae family. They are said to be among the deadliest insects on the planet, spreading illness and taking millions of lives in the process. For many years, diseases spread by mosquitoes have been the primary cause of illness and mortality in humans.

Types of Mosquito Repellents: 1) Physical methods of Mosquito Repellent 2) Mechanical method of mosquito repellent 3) Chemical method of mosquito repellent. In this research focuses on natural method of mosquito repellent property. The Active constituent used is dried leaves of catnip. Various other ingredients like sawdust, camphor, eucalyptus oil was used. It's burning time, smoke visibility was seen. The main purpose of this formulation is to make a mosquito repellent which is free from side effects and does not cause any irritation and harm to the Humanlives..

Keywords: Mosquito Repellent, Catnip, mosquito repellent methods

I. INTRODUCTION

As everyone is aware, a mosquito is a little fly that is a member of the Culicidae family. They are said to be among the deadliest insects on the planet, spreading illness and taking millions of lives in the process. For many years, diseases spread by mosquitoes have been the primary cause of illness and mortality in humans.^[1] One of the most unsettling bloodsucking insects that affect people is the mosquito. Numerous mosquito species from the genera Anopheles, Culex, and Aedes are known to act as disease-causing agents, carrying pathogens that cause Dengue fever, malaria, yellow fever, Japanese encephalitis, and other ailments.^[2] In more than 100 countries, almost 40% of the global population is at risk of infection. Worldwide, 2500 million individuals contract different diseases carried by mosquitoes each year.^[3]

Of the 500 species of Anopheles mosquitoes known to science, more than 50 species can spread malaria by the bite of a female insect carrying the infection. Currently, vector management is the only appropriate preventive intervention available, and there is no effective prophylactic anti-malarial vaccination. Therefore, one of the most effective ways to lower the occurrence of disease is to guard against mosquito bites.

It has long been recognized that using repellents to shield humans from mosquito bites is a necessary component of a comprehensive, integrated approach to manage insect-borne diseases. Chemicals like dimethyl phthalate, allethrin, N, N-diethyl medallid acid amide, and N, N-metatuamide (DEET) are used in the production of the majority of commercial repellents. Chemical repellents have been shown to have negative effects on synthetic fabric and plastic, as well as toxic reactions like allergy, dermatitis, and neurological and cardiovascular side effects that are typically reported after improper application. As a result, it has been determined that these products are not safe for the general public's health and should be used with caution. The regular application of chemically derived synthetic repellents to manage mosquito populations has upset natural ecosystems, leading to pesticide resistance, a rise in mosquito populations, and detrimental effects on non-target animals.^[4]

Mosquito Borne Diseases:

Mosquitoes have been implicated in a number of human illnesses since prehistoric times. Mosquitoes are present outside of tropical and subtropical parts of the planet and number about 3500 species. The main genera that carry diseases that cause human disease are Culex (West Nile, Japanese encephalitis, filariasis), Aedes (yellow fever, dengue,

chikungunya), and Anopheles (malaria, filariasis). Throughout her lifespan, a female mosquito consumes blood on several occasions to fulfil the development of her eggs. By injecting potentially infectious saliva into the host animal, the pathogens fulfil a necessary stage of their life cycle and grow within the salivary glands of the mosquito. Because of this, female mosquitoes are perfect carriers of a wide range of blood-borne infections and dangerous human diseases. Malaria has long been regarded as one of the main causes of death in India. According to historical accounts, the 1950s saw an estimated 75 million cases and 0.8 million deaths annually from malaria in India. Plasmodium vivax Grassi and Feletti, Plasmodium malariae Feletti and Grassi, Plasmodium ovale Stephens, and Plasmodium falciparum Welch are protozoal parasites that cause malaria. These parasites are spread by Anopheles mosquitoes. Studies reveal that a number of conditions must be met for any form of malaria to be endemic in a given area. These include the existence of a sizable population of capable anopheline mosquitoes that exhibit a sufficient preference for human blood, as well as an exposed human population that contains a sufficient number of malaria carriers and susceptible individuals to allow the chain of infection to continue.

According to reports, there are around 500 million cases of dengue haemorrhagic fever (DHF) and 100 million cases of dengue fever worldwide each year, with a fatality rate of approximately 5%. Aedes mosquito breeding areas proliferate, population increase, unchecked urbanization in tropical and subtropical nations, and ineffective mosquito control are thought to be contributing factors to the global resurgence and spread of dengue fever and DHF epidemics. Encephalitis, which is more common in the tropics and affects children and adolescents, is one of the main causes of acute encephalopathy. Mosquitoes are known to transfer the Japanese encephalitis virus mostly to undernourished children from low-income rural families. They multiply in close proximity to pigs and other animal reservoirs.^[5]

The Mosquito Life Cycle:

All across the world, with the exception of Antarctica, are mosquitoes. These insects have two wings and are members of the Diptera order. Human bites are mostly caused by members of the genera Anopheles, Culex, and Aedes. In North America alone, there are about 170 species of mosquitoes. Mosquitoes need an area with standing water in order to develop. Generally speaking, they have adapted to finish their life cycle in a variety of aquatic environments, including as freshwater, brackish water, saltwater marshes, old tires, or tree holes. There are four phases in a mosquito's life cycle. The female mosquito deposits her eggs—up to several hundred at a time—on the water's surface or in a place that frequently floods. Certain species' unhatched eggs can endure weeks or months of desiccation before becoming viable again when the ideal circumstances for hatching present themselves. Most species' eggs hatch in two to three days, and the larvae then spend roughly a week feeding on organic debris in the water before developing into pupae. The pupae spend two to three days at the water's surface before changing into adult mosquitoes.

Certain species' unhatched eggs can endure weeks or months of desiccation before becoming viable again when the ideal circumstances for hatching present themselves. Most species' eggs hatch in two to three days, and the larvae then spend roughly a week feeding on organic debris in the water before developing into pupae. The pupae spend two to three days at the water's surface before changing into adult mosquitoes.

Mosquitoes only bite females. While female mosquitoes need a blood meal in order to lay eggs, male mosquitoes mostly dine on the nectar of flowers. Typically, they feed every three to four days, with a female mosquito consuming more blood during a single meal than it weighs. Some mosquito species bite mostly during the day, whereas others prefer to feed at dusk or night.

Certain mosquito species exhibit zoophilia, meaning they prefer to feed on animals, while others display anthropophilia, meaning they prefer the blood of humans. Seasonal host swapping provides a means of animal-to-human disease transmission in certain mosquito species. (It is important to note, though, that HIV cannot be spread by mosquitoes because the virus does not live or replicate in them and the blood from the victim of the previous bite does not flow into the next person during consecutive feedings. Furthermore, the majority of HIV-positive individuals have such low circulating viral loads that there is a theoretical less than one in ten million chance that an HIV infection will be spread by a mosquito bite.^[6]

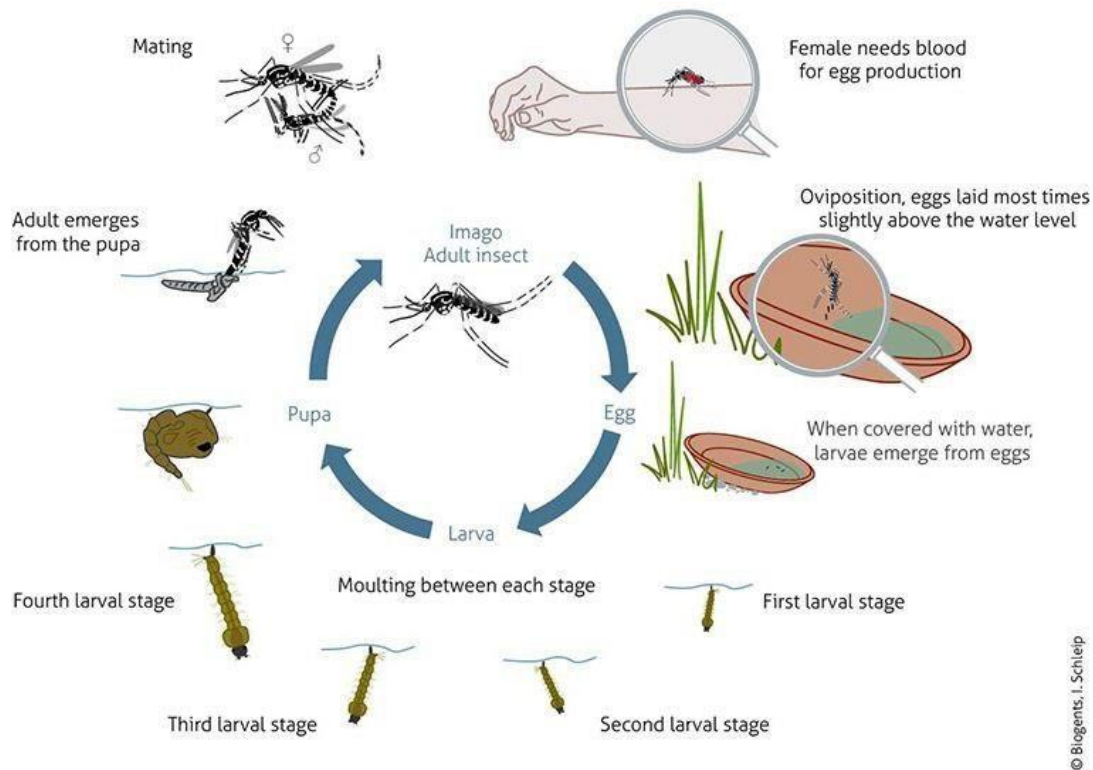


Figure no : 1 Mosquito Lifecycle

Various Plant Based Used as Repellents:^[4]

Citronella:

In several investigations, the repellent effect of citronella was examined. An essential oil called citronella is taken from the stems and leaves of many lemongrass plants (*Cymbopogon* spp.). It was discovered that citronella made from lemongrass repels *Anopheles culicifacies* 100% of the time for 11 hours. Additionally, it was stated that citronella might ward off *Anopheles Virus* and *stephensi* for six and eight hours, respectively.

Peppermint:

The hybrid mint known as peppermint was created by crossing spearmint (*Menthaspicata*) and water mint (*Menthaaquatica*). It has a high menthone, menthol, and methyl esters content, as well as medically active constituents. *Anopheles annularis*, *Anopheles culicifacies*, and *Anopheles subpictus* are totally repelled by 1 ml of peppermint oil in a field trial when applied without dilution for 11, 9.6, and 7.3 hours.

Cinnamomum:

Cinnamomum is a genus in the Lauraceae family of plants, some of which are being studied for their antibacterial properties using essential oils extracted from their leaves and bark. According to reports, 20% oil solutions containing cinnamon (*Cinnamomumzeylanicum*) and camphor (*Cinnamomumcamphora*) had a 100% repellent effect on *An. stephensi*.

Catnip (*Nepetacataria*):

A perennial plant, catnip is a member of the Labiatae family of mints. This herb is found in the plateaus of Iran and central Asia, having expanded from central Europe. The 20% oil solution of catnip proved to be effective in keeping *Anopheles* mosquitoes away, providing 100% protection against *An. stephensi* for eight hours. However, against *Anopheles gambiae*, the percentage of catnip that is dose-herb repellent was 17%, 97%, and 100% respectively.

Myrtle (*Myrtuscommunis*)

Myrtle belongs to the Myrtaceae family, which shares a botanical relationship with eucalyptus. The effectiveness of myrtle as a repellent was examined in two investigations. With a mean percentage repellency of 42.8% and a full protection duration of 6.5 hours against *An. stephensi*, the 20% myrtle oil solution demonstrated good efficacy in deterring *Anopheles* mosquitoes. *An. stephensi* is repelled by 50% concentration of myrtle for 4.36 hours.

Neem (*Azadirachtaindica*)

Widely planted in India's tropical regions, neem is a multipurpose tree. Two investigations looked at neem's repellent effect on several *Anopheles* species. *An. arabiensis* was completely protected for three hours by the 20% neem oil, which had a mean percentage repellency of 71%. It was discovered, however, that neem extract had no effect on *An. Gambiae*.

Types of Mosquito Repellents:^[7]

Physical methods of Mosquito Repellents-

The physical barriers that keep mosquitoes away provide protection against bites. The physical means of repelling mosquitoes include draining stagnant water into rain gutters, plastic covers, old tires, buckets, and so forth. To ensure that mosquitoes cannot find the ideal location to lay their eggs, it is highly desired to replace the water in bird baths, fountains, pools, rain barrels, etc. on a regular basis—at least once a week. Additionally, it's advised that you dress in long sleeves, especially in the morning and evening. Fixing windows and door screens is necessary to further keep mosquitoes out of the house. This category contains coils, mosquito nets, and other commercially marketed repellents. In especially when sleeping, mosquito netting is said to provide a greater level of security than coils and other repellents. These nets act as a barrier to prevent insects like mosquitoes from attacking people.

Mechanical methods of Mosquito Repellents-

It was well known that yellow light attracted fewer mosquitoes than white lights and this aspect can be used as a mechanical device for mosquito repellent. Other approaches that fall under the mechanical methods of mosquito repellents include the Electric Mosquito Zapper, Mosquito magnets, etc. An Electric Mosquito Zapper operates by using ultraviolet light to trap mosquitoes and then kills them as they come into contact with their lethal electric charge dose.

Chemical methods of Mosquito Repellents:

The best way to protect yourself from insects is to use a chemical repellent. These repellents can help prevent and manage insect-borne diseases like measles, Lyme disease, dengue fever, bubonic plague, West Nile fever, and others. This can be further classified into two groups, based on the source of the chemical repellents.

Naturally obtained Mosquito Repellents:

At the community and human level, natural resources with demonstrated insecticidal or repellent properties have been crucial in halting the spread of vector-borne diseases. Since the beginning of human civilization, humans and mosquitoes have coexisted in close proximity. To protect ourselves from mosquito bites and diseases carried by their vectors, natural resources have been utilized. Personal protection techniques have been discovered as a result of the development and promotion of these herbal insect repellents since ancient times.

Synthetically obtained Mosquito Repellents:

Although chemicals derived from plants have been utilized for a long time to repel mosquitoes, they nevertheless have certain drawbacks. Plant-related mosquito repellents have not been as well evaluated as synthetic repellents. Comparatively speaking, the effectiveness of these herbal repellents seems to wane more quickly and last less time. As a result, these substances only provide temporary protection and require frequent reapplication. Due of the drawbacks of using natural plant resources as repellents—such as their expensive cost and short repellent period—a great deal of study was conducted to create a synthetic alternative. Although there are numerous different natural and artificial materials that can deter insects, only four main materials—DEET, Icardin, Citrioldiol, and IR3535—are approved for use as insect repellents in the US and the EU. They all function in the same way—producing an odor that keeps insects away—but they each have slightly distinct characteristics and ways of working.

II. HERBAL MOSQUITO REPELLANT OPTIONS:^[8]

Mosquito Repellent Gel:

DEET-based insect repellents are not advised for use on people with urea cycle diseases, such as ornithine transcarbamylase (OTD) deficiency, as they have been shown to be relatively detrimental to these persons. These circumstances highlight the growing need for natural mosquito repellents that are affordable, effective, safe for the environment, and biodegradable.

A mosquito repellent gel formulation based on carbopol 940 was created in response to an impending global need. It was made by combining the essential oils of *Cymbopogon citratus*,

Murraya koenigii, *Cymbopogon nardus*, *Tridax procumbens*, *Eucalyptus globules*, and

Azadirachta indica, and assessing its appearance, pH, viscosity, spreadability, extrudability, swelling index, and accelerated studies. The potential to deter mosquitoes was assessed and concurrently contrasted with the positive control (Odomos®). This gel formulation may be an efficient, affordable, and convenient way to prevent mosquito-borne diseases, like malaria, dengue, etc. in the lower classes of society in a number of developing countries where the majority of people lack access to mosquito nets, pricy mosquito repellent creams, and various physical methods.

Mosquito Liquid Repellent:

In order to keep mosquitoes away, utilize repellents. Nowadays, a lot of people use liquid repellents to keep mosquitoes away. The bottle of Liquidator insect repellent is filled with the product, and it features a graphite rod in the center. The liquidator has a heating coil. When the repellent chemical comes into touch with the heated rod, it releases a fume that prevents the mosquitoes' sensors from working. Mosquitoes' chemosensors are blocked by the repellent's fumes, making it impossible for them to detect humans.

Mosquito Repellent Stick:

Because of its repellent properties, mosquitoes shouldn't use it. People are looking for mosquito repellent sticks made from herbal plants that are low toxicity and safe. Numerous plants can be found in areas with essential oils, which have been shown to be safe to use as a repellent for mosquitoes.^[9]

Mosquito Repellent Lotion:

Numerous research has been done on the usefulness of using natural components to make mosquito-repellent lotions. One such study was done by, which examined the efficiency of lemon peel extract as a repellent against the *Aedes aegypti* mosquito. The study's findings demonstrated that 5% concentration of lemon peel extract was effective at keeping the *Aedes aegypti* mosquito at bay. Subsequent research on the usefulness of lime peel extract in deterring mosquitoes revealed that the extract was up to 98% efficient at keeping mosquitoes away from higher concentrations of essential oils extracted from the peel. For eight hours, at 45%. Santya has studied the ability of sweet kaffir lime peel extract (*Citrus hystrix*) to ward off dengue fever mosquitoes. The findings of her research indicate that *Ae. aegypti* and *Ae.*

Mosquito Repellent Spray:

A liquid or aerosol known as mosquito repellent spray is sprayed to the skin or clothing to keep mosquitoes from biting. It has an active component (such DEET, picaridin, or IR3535) that repels mosquitoes. Most pharmacies and grocery stores sell over-the-counter mosquito repellent spray. Use the mosquito repellent spray as directed on the product label on exposed skin and clothing. Reapply the spray as instructed, being sure to do so especially after perspiring or swimming. Using insect repellent spray is a good method of avoiding mosquito bites. It's crucial to utilize it appropriately and adhere to the product label's instructions.

Diseases including yellow fever, dengue fever, and malaria can be spread via mosquito bites.



Figure No 2: Mosquito Repellent Marketed Product

III. MATERIAL AND METHOD

1) Bees Wax

Beeswax (also known as ceraalba) is a natural wax produced by honey bees of the genus *Apis*. The wax is formed into scales by eight wax-producing glands in the abdominal segments of worker bees, which discard it in or at the hive. The hive workers collect and use it to form cells for honey storage and larval and pupal protection within the beehive. Chemically, beeswax consists mainly of esters of fatty acids and various long-chain alcohols. Beeswax has been used since prehistory as the first plastic, as a lubricant and waterproofing agent, in lost wax casting of metals and glass, as a polish for wood and leather, for making candles, as an ingredient in cosmetics and as an artistic medium in encaustic painting.



Figure No 3: Beeswax

2) Camphor

Campure Power is made from Camphor (an extract of the pine tree) and is therefore an ORGANIC product, making it safe around children, pregnant women, older people and pets. Breathe easy knowing your family isn't inhaling dangerous chemicals camphor is known for its robust aroma that reaches every corner of the house, so there is no way mosquitoes can find any place to hide and even if they do, the smell will make them come out of the corners and send them out of your house.



Figure No 4: Camphor

3) Catnip

Nepetacataria, commonly known as catnip, catswort, catwort, and catmint, is a species of the genus *Nepeta* in the family Lamiaceae, native to southern and eastern Europe, the Middle East, Central Asia, and parts of China. It is widely naturalized in northern Europe, New Zealand, and North America. The common name catmint can also refer to the genus as a whole. The names catnip and catmint are derived from the intense attraction about two-thirds of cats have toward the plant (alternatives exist, such as valerian root and leaves). Catnip is also an ingredient in some herbal teas valued for its sedative and relaxant properties.



Figure No 5: Catnip

4) Eucalyptus Oil

Eucalyptus is a tree. Its leaves and oil have been consumed, chewed, and applied to the skin for many conditions. Eucalyptus contains many different chemicals. These chemicals might have various effect in the body. Also, some research suggests that eucalyptus may have activity against bacteria and fungi.



Figure No 6: Eucalyptus Oil

IV. METHOD OF PREPARATION:

1. Take a beeswax and weigh the beeswax accurately.
2. Cut the beeswax in small cuts and melt the beeswax in a beaker with the help of a heating mantle.
3. After the properly melting add camphor and let it melt.

4. After they are properly melted add catnip powder and eucalyptus oil.
5. Pour the above mixture in a suitable size mould.
6. Allow the mould to be cooled at room temperature.

Formulation:

Formulation Table 1

Ingredients	Quantity
Gum Acacia	10gm
Camphor	2gm
Catnip Powder	5gm
Eucalyptus oil	3ml
Saw Dust Powder	4gm

Table No:1



Figure No 7: Formulation No. 1

Formulation Table 2

Ingredients	Quantity
Artificial Candle Wax	10gm
Camphor	2gm
Catnip Powder	5gm
Eucalyptus oil	3ml

Table No: 2



Figure No 8: Formulation No 2

Formulation Table 3

Ingredients	Quantity
Bess wax	30 gm
Camphor	5 gm
Catnip Powder	15 gm
Eucalyptus oil	10 ml

Table No : 3



Figure No 9: Formulation No.3

V. EVALUATION PARAMETER

1. Organoleptic test of repellent candles:^[9]

This test was done visualising the formulation to evaluate the texture, colour and scent.



Figure No 10: Organoleptic Test

2. Burning time (minutes):^[10]

Mosquito repellent cone from each formulation were burned and time was noted down.



Figure No 11: Burning Test

Smoke visibility:

Individually each mosquito repellent cone was burned and its smoke visibility was checked.



Figure No 12: Smoke Visibility Test

Irritation test:

Individually each mosquito repellent cone was burned and its irritancy was checked.



Figure No 13: Irritation Test

5. Testing mosquito repellent activity of mosquito repellent candle:

The mosquito repellent cones were burned in the room for 30 min. Reduction in mosquito number was observed.

VI. RESULT

- The formulation and evaluation of mosquito repellent candle containing dried leaves of catnip, bees wax, camphor, eucalyptus oil was done.
- The burning time for this formulation was found to be 10 min.
- Smoke visibility: Smoke is visible.
- Aroma was pleasant.
- Irritation test: No Irritation caused.

VII. CONCLUSION

Through present work, it is revealed that catnip leave powder shows very good mosquito repellent activity. So, catnip dry powder along or in a combination can be used as a very good mosquito repellent. Many products can be made by using various combinations of catnip leaves powder, Bess wax, camphor and eucalyptus oil like Spray, cream, liquidator, cone, candle and coil etc to get more effective mosquito repellent activity. By promoting more use of natural mosquito repellent, one can reduce the noxious effect of synthetic mosquito repellents on human health and environment. Also, natural mosquito repellent is inexpensive, easy to use and easily available and shows maximum repellent activity against mosquito. Hand-made mosquito repellent candle is less harmful to health as compared with marketed synthetic coil. Through present research, it is clearly seen that catnip powder shows excellent mosquito repellent activity when used in combination with other herbal powders or alone. More stimulated test and trials are required for commercialization of mosquito repellent candle.

REFERENCES

- [1]. Dhanaventhara N, and Balasubramani G 2023, Development and Evaluation of LowCost Herbal Based Mosquito Repellent Spray, Journal of Xidian University, 17(4), pp.15-24.
- [2]. Ranasingh M, Arambewela L and Samarasinghe S 2016, Development of herbal mosquito repellent formulations, Int J Pharm Sci Res, 7(9), pp.3643-48.
- [3]. Pawar S, Gujar M. P., Yadav P. P., Supugade V. B. &Patil, R. G. (2019), Use of various plant extracts as herbal mosquito repellent spray,Global Journal for Research Analysis, 8(9), pp.33-34.
- [4]. Asadollahi A., Khoobdel M., Zahraei-Ramazani A., Azarmi S. and Mosawi S.H.2019. Effectiveness of plant-based repellents against different Anopheles species: a systematic review, Malaria Journal, 18(1), p.436.
- [5]. Kalita B., Bora S. and Sharma A.K. 2013, Plant essential oils as mosquito repellent-a review, Int. J. Res. Dev. Pharm. Life Sci, 3(1), pp.741-747.
- [6]. Fradin M.S. 1998, Mosquitoes and mosquito repellents: a clinician's guide, Annals of internal medicine, 128(11), pp.931-940.
- [7]. Gupta D.K., Gupta R. and Tiwari A. 2022. Novel Formulation and Evaluation of Poly Herbal Mosquito Repellent, Research Square, pp.1-20
- [8]. Shivhare R.S., Kamble M.A., Mahapatra D.K., Ingole A.R. and Baheti J.R. 2018, Development of mosquito repellent gel formulations from various natural volatile oils: comparative study with the marketed formulation odomos®, Journal of Drug Delivery and Therapeutics, 8(6), pp.106-110.
- [9]. Saini S., Varshney H. & Singh A. (2024), Formulation and evaluation of mosquito repellent candles, International Journal of Pharmaceutical Sciences, 2(4), 680-690.
- [10]. Singh V.K., Singh R.K., Mishra B. and Singh D.2021, Formulation and evaluation of eco-friendly handmade herbal mosquito repellent cone, International Journal of Pharmaceutics and Drug Analysis, pp.230-235.