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FORMULATION AND EVALUATION OF PLANT BASED MOSQUITO REPELLENT CANDLES.

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Abstract: The present study is aimed to formulate mosquito repellent candles using various herbs having mosquito repellent activity and evaluation of their comparative performance and with the marketed sample against mosquitoes. Literature review was conducted to select the herbs and volatile oils with mosquito repellent properties. Selected herbs are cinnamon leaf, cinnamon bark, lemon grass, neem, chrysanthemum and volatile oils are rosemary oil, thyme oil and clove oil. These are grouped into two separate formulations to evaluate the higher repellency among the candles. Formulation 1 was prepared by incorporating cinnamon bark, cinnamon leaf, rosemary oil and thyme oil into beeswax whereas formulation 2 was prepared by using neem leaves, chrysanthemum flowers, lemon grass extract and clove oil as actives. These candles are evaluated by various parameters such as weights, burning time, irritancy, emission production. Further evaluated by rearing mosquitoes in screen cage to estimate mosquito repellency among the candles.

Mosquito repellent activity of F1 was found to be in 1hour whereas the repellent activity of F2 was found to be in 1hour. Among the both candles, F shown higher repellency compered to F. When compared to the standard the F1 and F2 shown inferior activity. Prepared F1 and F2 can be used for indoors protection from mosquito bites. Although, stability, safety and other factors need to be considered for regular usage.

Index terms*: Mosquito repellent candles, Mosquitoes, Cinnamon bark, leaf, Lemon grass, Thyme, Chrysanthemum, Rosemary.*

I. INTRODUCTION

Mosquitoes are responsible for spreading various diseases. They can be vector-borne, parasitic or bacterial diseases. In tropical regions, mosquitoes have higher rate of spreading diseases. Some of the major diseases caused by a mosquito bite are malaria, dengue, chikungunya, zika virus, yellow fever (19).

More than 700,000 deaths annually are due to vectors and diseases caused by them individually comprises of 17% of infectious diseases. India hosts about 415 species of mosquitoes, of which 20 have been identified as primary or secondary disease-causing species (17).Various conventional practices adopted for mosquitoes control such as indoor practices(staying indoors, usage of medicated and non-medicated nets, usage of mosquito repellents)(23,24,25) and outdoor practices (removal of stagnant water, using larvicide & insecticide)(24,25).

From the ancient era, plant-based repellents have been used as one of the protections approaches against mosquitoes. The knowledge of reported mosquito repellent properties of plants from the generations and studies resulted in the development of plant-based repellents as an alternative to chemical repellents (2). The literature review proposed herbs such as lemon grass, lavender, peppermint, cinnamon, thyme, eucalyptus, marigold, neem, rosemary, clove, turmeric, chrysanthemum (1-13). Many researchers succeeded in formulating plant-based repellent for regular use.

The present study is aimed to formulate mosquito repellent candles using various herbs having mosquito repellent activity and evaluation of their comparative performance and with marketed one against mosquitoes.

II. MATERIALS

Cinnamon bark and leaves were purchased from D-mart, Madhapur, chrysanthemum flowers and neem leaves were procured from nearby garden, essential oils of rosemary, thyme and clove were procured from Burgoyne and co., New Delhi, India. Camphor was obtained from local market. Beeswax was purchased from SD chem limited, Mumbai, India. All the obtained materials are of laboratory grade

III. METHODS

F1 and F2 candles were prepared based on the procedure given by Sanjay Tanaji Shelake et al.,2023:11(6).

PREPARATION OF F1 CANDLE

The active ingredients used in formulation -1 were cinnamon bark & leaf, rosemary oil, thyme oil. Finely powdered cinnamon bark & leaf, camphor was taken into a china dish. To that, rosemary and thyme oils were added and mixed properly. Simultaneously, beeswax was melted on water bath in another china dish. After completion of melting, the mixture of active ingredients was added in to the beeswax with continuous stirring for the uniform distribution of active ingredients. Later, it was poured into a candle mould containing wick and allowed it to cool at room temperature for half an hour. Then, the candle was removed from the mould carefully.

Table 1: Composition of F1 candles

S.NO	INGREDIENT USED	COMPOSITION	QUANTITY
1.	Beeswax	60%	9gm
2.	Cinnamon bark	8%	1.2gm
3.	Cinnamon leaf	8%	1.2gm
4.	Rosemary oil	8%	1.2gm
5.	Thyme oil	8%	1.2gm
6.	Camphor	8%	1.2gm

F1 candle

Ingredients used in formulation of F1 candles

PREPATION OF F2 CANDLE

The active ingredients used in formulation -2 were neem, chrysanthemum, lemon grass and clove oil. Finely powdered neem leaves, chrysanthemum flower petals, camphor and lemon grass leaf extract were taken into a china dish. To that, clove oil was added and mixed properly. The remaining procedure followed was similar to the procedure which was used for preparation F1 candle.

Table 2: Composition of F2 candle

S.NO	INGREDIENTS USED	COMPOSITION	QUANTITY
1.	Beeswax	60%	9gm
2.	Neem	8%	1.2gm
3.	Chrysanthemum	8%	1.2gm
4.	Lemon grass	8%	1.2gm
5.	Clove oil	8%	1.2gm
6.	Camphor	8%	1.2gm

F2 Candle

Ingredients used in formulation of F2 candles

EVALUATION OF CANDLES

1. Weights of the candles

The weights of formulation-1 and formulation -2 candles were measured by placing them on analytical balance. Their respective weights were noted.

2. Burning time

The time required for complete melting of the candle when ignited with fire is called it's burning time. The candles of both formulations are lighted individually and started the stopwatch as soon as the candle was lit. Allowed the candles burn continuously. Stopped the stopwatch when candle has burned out completely. Noted the melting time of each candle.

3.Irritancy

Irritancy factors include teary eyes and irritating cough. These were evaluated to know the tendency of candle emissions to cause eye and respiratory irritation. Two formulated candles were lighted to evaluate above factors.

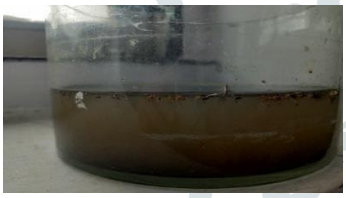
4. Emissions

Emission factors include soot production and fragrance emissions. The soot and strength of the fragrance produced by the candle while burning was evaluated by lighting the candles of formulation 1 and 2.

5.Evaluation of mosquito repellent activity

During rainy season, the mosquito larvae were collected from Durgam cheruvu lake, Madhapur. These larvae were placed in a net cage and supplemented daily with fish food. After the growth of larvae into mosquitoes are feed with sucrose solution and these are transferred to another cage.

13, 5-7 days old mosquitoes were placed in the net cage. The candles were lighted and placed beside the mosquito net cage. The duration of exposure was hours. The behavior of the mosquitoes such as freely moving in the net, aligned on the net, struggling for life, no movement and lying on the floor were observed, recorded for both the candles (28, 29).



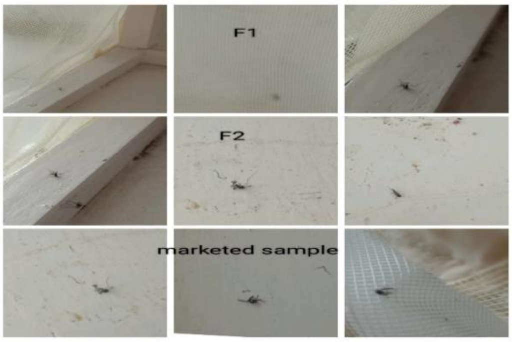
Mosquito larvae in collected water

Screen cage for the evaluation of the mosquitoes

F1

F2

Marketed sample



IV RESULTS

4.1 Evaluation of mosquito repellent candles

The prepared candles are evaluated for their weights, melting time, irritancy and emissions. The results were tabulated.

Table 6 indicating the results of evaluation parameters of candles of F1 and F2

S.NO	PARAMETERS	F1	F2
1.	Weight*	14.8gm	15.1gm
2.	Burning time	40min	43min
3.	Irritancy	No teary eyes and cough	No teary eyes and cough
4.	Emissions	Mild soot was produced but has strong odour	Mild soot was produced but has pleasant odour

*The average weights of 3 candles.

4.2 Screening results of the candles

The formulated candles are tested for mosquito repellent activity and the behavior of the mosquitoes was compared within two formulations (F1&F2).

Table 7 indicating the behavior of mosquitoes in presence of F1 candle in 1 hour

Duration (min)	Number of mosquitoes freely moving	Number of mosquitoes aligned to the net	Number of mosquitoes lying on the floor	Repellency
30min	3	7	2	33%
30min	2	6	2	

Table 8 indicating the behavior of mosquitoes in presence of F2 candle in 1hour

Duration (min)	Number of mosquitoes freely moving	Number of mosquitoes aligned to the net	Number of mosquitoes lying on the floor	Repellency
30min	2	7	4	53.8%
30min	1	5	7	

Table 9 indicating the behavior of mosquitoes in presence of marketed sample in 1 hour

Duration (min)	Number of mosquitoes freely moving	Number of mosquitoes aligned to the net	Number of mosquitoes lying on the floor	Repellency
30min	1	5	5	72.7%
30min	0	3	8	

The mosquitoes with no movement lying on the floor are noted for 1hour for 30 min. The results of F1, F2 & marketed formulations are showed 4,7& 8respectively with no movement of mosquitoes. The number of freely mosquitoes during the first 30min are more when compared to the other 30min. Most of the mosquitoes showed shifting behavior i.e they moved away from candle and aligned on the net. When both formulated candles compared, F2 showed better results than F1. These formulations found to be inferior when compared to marketed sample.

V.CONCLUSION

- Two formulations of mosquito repellent candles were prepared using selected herbs and volatile oils.
- Both the candles F1 and F2 are evaluated for their weights, which were found to be 14.9 & 15.1 respectively.
- The evaluation of burning time, irritancy and emissions production from the candles has been conducted. The candles displayed mild sooth production with no irritation to eyes and throat. F1 candle showed mild strong odour whereas the F2 candled showed pleasant odour.
- The mosquitoes, collected were reared for 5-7 days and the repellency activity was commenced.
- F1& F2 mosquito repellent activity was compared with marketed sample. The repellency activity of F1 candle was found 33% to be whereas the repellency activity of F2 candle was found to be 53.8%. The repellency activity of marketed candle was found to be 72.7%.
- F1, F2 & marketed sample candles are observed for mosquito behavior and number of mosquitoes with no movement were found to be 4 ,7& 8respectively.
- Formulation developed with combination of neem, chrysanthemum, lemon grass & clove oil (F2) has effective repellency when compared to the formulation developed with combination of cinnamon leaf & bark, rosemary& thyme oils(F1).
- It is concluded that the candles developed with neem, chrysanthemum, lemon grass & clove oil is an effective formulation and protection against mosquito bites.
- Further studies are needed demonstrate safety, stability and field experience to demonstrate suitability for regular use needed to be carried out.

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