Development and Study of Plant Based Mosquito Repellent Cakes in Combination with Natural Binders

Satish D. Patil1* and Smita T. Morbale1

1K.E.S. Anandibai Pradhan Science College, Nagothane, Raigad, Maharashtra, Pin-402106, India.

ABSTRACT

Background and Objective: Plants are perceived as a safe and trusted means of mosquito bite prevention. Many plant extracts and oils repel mosquitoes, with their effect lasting from several minutes to several hours. The present investigation is aimed to evaluate the mosquito repellent activity of Calendula officinalis (Marigold leaves), Citrus madurensis (Calamondin leaves), Carica papaya (Papaya leaves), Origanum vulgare (Oregano leaves), in combination with natural binders.

Materials and Methods: In present work we have produced an effective and purely natural mosquito repellent cakes using marigold leaves, calamondin leaves, papaya leaves, oregano leaves, and to determine if the component present on them are suitable as mosquito repellent. To recognize this new combination and in addition use of natural binder in making these mosquito cakes is innovation of method. Evaluation was carried out in a net cage (45 cm×30 cm×25 cm) containing 100 blood starved mosquitoes.

Results: Study provides an herbal repellent with long lasting protection, safe for human life, and human with no side effect. The combination Paste of leaves + charcoal + 20% cow dung was found to be more repellency against mosquitoes under study.

*Corresponding author: E-mail: smita77zambre@yahoo.com;
Conclusion: Discovery of natural products, with potent phyto-constituents that have insecticidal properties, may help overcome problems of chemical insecticide resistance. Nature is the best combinatorial chemist to offer numerous natural products compounds from medicinal plants which can be effective as medicines, antibacterial, antifungal, insect repellent, cosmetics etc.

Keywords: Marigold leaves; calamondin leaves; papaya leaves; oregano leaves; natural binder.

1. INTRODUCTION

Repellency of plant material has been exploited for thousands of years by man, most simply by hanging bruised plants in houses, a practice that is still in wide use throughout the developing countries. Plants have also been used for centuries in the form of crude fumigants where plants were burnt to drive away nuisance mosquitoes and later as oil formulations. Plant-based repellents are still extensively used in this traditional way throughout rural communities in the tropics because for many of the poorest communities the only means of protection from mosquito bites that is available[1-3]. “Natural” smelling repellents are preferred because plants are perceived as a safe and trusted means of mosquito bite prevention. Many plant extracts and oils repel mosquitoes, with their effect lasting from several minutes to several hours. Their active ingredients tend to be highly volatile, so although they are effective repellents for short period after application, they rapidly evaporate leaving the user unprotected.

The exception to this is para-methane 3, 8 diol, which has a lower vapour pressure than volatile monoterpenes found in most plant oils and provides very high protection from a broad range of insect vectors over several hours[4] .

In consideration of disadvantages of commercial mosquito coils mosquito repellents based on chemicals has a remarkable safety profile, but they are toxic against the skin and nervous system like rashes, swelling, eye irritation, corneal damage, liver damage, asthma, brain swelling in children, an anaphylactic shock, and low blood pressure. All the mosquito coils registered and sold contain synthetic pyrethroid like d-allethrin, d-transallethrin and transfluthrin as active ingredients. However even though they are effective many people dislike smell of these mosquito repellents and feels that they are harmful to health. Attempts have been made here to find out new active ingredients especially derived from natural plants to replace synthetic pyrethroid [5-8]. Methods used in preventing the spread of mosquito borne diseases include vector control, disease prevention using drugs and vaccines and prevention of bites using insecticides, repellents and nets [9]. In present we tried to develop mosquito repellent cakes using marigold leaves, calamondin leaves, papaya leaves, oregano leaves in combination with different natural binders.

2. MATERIALS AND METHODS

2.1 Collection of leaves

Calendula officinalis (Marigold leaves), Citrus madurensis (Calamondin leaves), Carica papaya (Papaya leaves), Origanum vulgare (Oregano leaves), were collected from nearby botanical garden in the month of april 2021. Bundles of leaves were cut into small pieces with the help of sterile sharp scissors.

2.2 Preparation of Leaf Cakes

Cut leaf pieces were dried for two days and grounded into paste using electrical grinder by adding distilled water. The different natural binders that are coconut shell powder, potato starch, Corn starch were used to mix with above leaves paste. Final paste of above leaves with binders is caked to form cost-effective herbal mosquito repellant.

The different natural binders (100g each) were purchased commercially from local vendors. Different natural binders used were Charcoal powder, potato starch, corn starch, coconut shell powder, and cow dung. The same procedure was followed for different combinations using different natural binders for the preparation of cakes.

3. RESULT AND DISCUSSION

Controlling mosquitoes is of utmost importance in the present scenario with rising number of mosquito borne diseases [10]. Advantages of natural mosquito repellent are minimum cost, complete accessibility, enhanced tolerance, more protection and fewer side-effects. Many plant extracts have been identified as having insect-
repellent effects and there has been increasing research in the last decade proving plant based mosquito repellents.[11-15] The different combinations and ingredients used for present study are as shown in Table 1.

Table 1. Natural ingredients and natural binders in making herbal mosquito repellant

| Material used         | Quantity |
|-----------------------|----------|
| Calamondin leaves     | 20 grams |
| Marigold leaves       | 30 grams |
| Papaya leaves         | 20 grams |
| Oregano leaves        | 30 grams |
| Charcoal              | 10 grams |
| Natural Binder        | 20 grams |
| Water                 | 100 ml   |

Fig 1. shows leaves selected for present study and Fig 2. explains preparation of mosquito repellent cakes. Details of ingredients required for herbal mosquito repellent are 20 gms of calamodin leaves, 20 gms of papaya leaves, 30 gms of marigold leaves and 30 gm of Oregano leaves, were collected and cleaned thoroughly. All leaves were cut into smaller pieces and ground into Domestic mixer. The ground leaves were sundried for about 2 days. The dried leaves were powdered using mortar and pestle. To this mixture 20 gm of selected natural binders and 10 gm of charcoal was added with 100 ml of water. The liquid is heated at 60°C and the entire mixture was being made thick and cooled afterwards. Mosquito repellent paste has been slowly poured into the small sized Petri dish. The paste is sundried for about 36 hrs and then dried cake is removed tested for analysis.

Evaluation was carried out in a net cage (45 cm×30 cm×25 cm) containing 100 blood starved mosquitoes. They were subjected to evaluation process by counting the mosquitos’ death rate, landing and baiting of mosquitoes. The results are summarized in Table 2. The mosquitoes used in this experiment were caught using a net while biting humans between 7 pm and 10 pm. Mosquitoes were starved for 24 hours and placed in the cage (45×15×30 cm). Test timing was between 7 pm and 10 pm since the mosquitoes typically bite at night. The percentage repellency rate with respect to different natural binder is as shown in Fig. 2.

Fig. 1. Papaya (a), Marigold(b), Calamondin(c), Oregano(d), plant leaves used for preparation of mosquito repellant cake

Fig. 2. Preparation of mosquito repellent cakes
Table 2. Some observed parameters for herbal mosquito repellant cake with respect to time taken to burn, % repellency action and side effects

| Name of the sample                        | Dry Weight of cake (gm) | Weight of ash (gm) | Time taken to burn (Min) | Time of observation after burning of mosquito repellent | % repellency action | Side effects  |
|-------------------------------------------|-------------------------|--------------------|--------------------------|--------------------------------------------------------|--------------------|---------------|
| Paste of leaves + charcoal + commercial starch | 10                      | 3                  | 12                       | After 10 min                                           | 75                 | No irritation |
| Paste of leaves + charcoal + coconut shell powder | 12                      | 3.5                | 15                       | After 10 min                                           | 80                 | No irritation |
| Paste of leaves + charcoal + cow dung      | 20                      | 6.8                | 21                       | After 10 min                                           | 90                 | No irritation |
| Paste of leaves + charcoal + corn starch   | 18                      | 7                  | 23                       | After 10 min                                           | 70                 | No irritation |
| Paste of leaves + charcoal + potato starch | 13                      | 4.8                | 22                       | After 10 min                                           | 75                 | No irritation |

Fig. 3. The percentage repellency rate with respect to different natural binder
Table 3. Comparative efficiency of herbal mosquito repellent

| Time     | Type of Repellent Used                  | Observed Results                                      |
|----------|----------------------------------------|-------------------------------------------------------|
| 6-7 pm   | No commercial mosquito repellent.      | Numerous mosquitoes                                    |
| 7-8 pm   | Commercial coil                        | 100% of the mosquitoes were greatly reduced           |
| 8-9 pm   | No commercial coil                     | No of mosquitoes increased greatly                     |
| 9-10 pm  | Herbal mosquito repellent cake         | 85% of the mosquitoes were greatly reduced            |

We also studied comparison between present herbal mosquito repellent cake and other commercial products available in the market and results are summarized in Table 3.

### 3.1 Statistical Analysis

The data were analyzed using the one-way analysis of variance and Dunnett’s test. Statistical evaluations were performed using Graphpad prism and differences were considered statistically significant at $P < 0.05$.

Mosquito repellency observed with respect to different natural binders is as shown in Fig. 3 and calculated by formula, %Mosquito repellency = \((\text{Number of specimens escaped} + \text{Number of specimens dead}) \times 100\)/ Number of specimens exposed.

### 4. CONCLUSION

The Mosquito repellent produced from marigold leaves, colamondin leaves papaya leaves and oregano leaves with natural binders thereby reduces the product cost. These could be in form of spray, cream, liquidator, coil, candle and sticks, and could be prepared using suitable carries/solvents/diluents, to get better protection from mosquito bites. The mosquito repellent prepared with above different formulas was given for use by inhabitants of different localities. It provides an herbal repellent with long lasting protection, safe for human life, human and domestic animal skin with no side effect. This report is the preliminary work done however further extensive study with varying concentration of ingredients as well natural binders recording of mortality time and comparing with chemical based formula in the artificial mosquito coils need to be performed.

An attempt has been made to evaluate the role of medicinal plant extracts for their repellent activity and its possible formulation. The results reported in this study open the possibility for further investigations of the efficacy of repellent properties of natural products [16]. Nature is the best combinatorial chemist to offer numerous natural products compounds from medicinal plants which can be effective as medicines, antibacterial, antifungal, insect repellent, cosmetics etc.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

### REFERENCES

1. Moore SJ, Lenglet A, Hill N: Plant-Based insect repellents. Insect Repellents: Principles Methods, and Use. Edited by: Debboun M, Frances SP, Strickman D. Boca Raton Florida: CRC Press; 2006.
2. Moore SJ, Hill N, Ruiz C, Cameron MM: Field evaluation of traditionally used plant-based insect repellents and fumigants against the malaria vector anopheles darlingi in Riberalta, Bolivian Amazon. J Med Entomol. 2007; 44(4):624-630.
3. Trumble JT. Caveat emptor: safety considerations for natural products used in arthropod control. Am Entomol 2002;48:7-13
4. Maia, M.F., Moore, S.J. Plant-based insect repellents: a review of their efficacy, development and testing. Malar J. 2011;10:S11-1475.
5. Mandalgane SA, Pattalwar VV, Kalambe AR. Development of cow dung based herbal mosquito repellent. Natural product radiance. 2005;4(4):270-273.
6. Katz TM, Miller JH, Herbert AA (Insect repellents: Historical perspectives and new Developments. J Am Acad Dermatol. 2008;58(5):865-871.
7. Kim JK, Chang SK, Jong KL. Evaluation of repellency effect of two natural aroma mosquito repellent compounds, citronella and citronellal. Entomol Res. 2005;35(2):117-120
8. V Mulla MS, Thavara U, Tawatsin A. Mosquito burden and impact on the poor: measures and costs for personal protection in some communities in
9. Sharmila MA, Priya PS, Boobalan S. Development of mosquito repellent finished cotton fabric using eco-friendly Cymbopogan citros oil. International Journal of Science, Technology and Management. 2015;4(2):96-101.

10. Fradin M S Mosquitoes and Mosquito Repellents: a clinician's guide. Ann Int Med. 1998; 128: 931-940.

11. Trivedi A, Rai P, Kumar J. Formulation of low smoke herbal mosquito repellent sticks by using different essential oils. TPI, 2018;7(4):173-175

12. Dhanalakshmi S, Dhivya C, Harikrishnan N, Development of eco-friendly mosquito repellents with emphasis on herbal formulation and evaluation. Drug Invention Today. 2018;10(3).

13. Kanethi P, Rajitha I, Padma A. Development of Eco-friendly mosquito repellent printed textiles with synthesized Ocimum basilicum leaf dye extract. IJMR 2020;7(4):31-38.

14. Elsayed GA, Hassabo AG. Insect repellent of cellulosic fabrics (A Review). Letters in applied bioscience. 2021;11(1):3181–3190.

15. Raveen R, Kamakshi KT, Deepa M, Arivoli S, Tennyson S. Larvicidal activity of Nerium oleander L. [Apocynaceae] flower extracts against Culex quinquefasciatus Say [Diptera: Culicidae]”. International Journal of Mosquito Research. 2014;1(1):8-42.

16. Effiom OE, Avoaja DA, Ohaeri CC. Mosquito repellent activity of phytochemical extracts from peels of Citrus fruit species. Global J Sci Frontier Res Int. 2012;12:1-8.

© 2021 Patil and Morbale; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

https://www.sdiarticle4.com/review-history/71640