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Formulation of natural mosquito repellents

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Abstract
Mosquito is a Spanish and Portguese word which means "little fly". It commonly have more than 3600 species. mosquito bites of different species can cause different diseases such as malaria, dengue, chikungunya etc. which can cause increased mortality and morbidity rate day by day that's why mosquitoes repellent are used by world wide in different formulations such as creams, ointments, patches, coils, incense stick etc.
These formulations provide better effect to repel the mosquitoes to prevent various health diseases such as malaria, dengue, chikungunya etc. This abstract is used to provide the information about the various formulations of mosquito repellents which includes the formulations of incense stick, mosquito repellent cream and a mosquito repellent candle. Various other formulations are also available in the market for the protection from mosquito bites. But this article consist only those formulations which are derived from natural substances, As the natural formulations provide a great advantage over the synthetic formulations such as they reduce health defects that caused from the synthetic mosquito repellents, they cause less harm to nature, are safer for human health's, these are also biodegradable and environmental friendly. The main advantage of these formulations is that they cause lower impact on ecosystem by not releasing toxins. In India before the discovery of any synthetic mosquito repellent people were used to burn the coal tars for create smoke, burn bitter plant leaves such as neem and papaya leaves and use essential oils like citronella, eucalyptus and lemon grass oil to repel the mosquitoes. These remedies also used in worldwide for the same purpose. This article is meant for providing details of the formulations that are comprises of these ingredients that used before the discovery of any synthetic mosquito repellent, we used these ingredients as per the information given in our "Vedas and Puranas". This is a great way to protect our traditional knowledge and makes the use of this knowledge beneficial for human use. These formulations act by various mechanisms such as Masking host odors, repelling host odors and by contact repellency which is a special mechanism in this the repellents deter the sensory receptors on their legs or mouthparts causing them to retreat.
This article explores the effectiveness of natural mosquito repellents, highlighting plant based and essential oil formulations that offer a safer, eco friendly alternative to synthetic repellents, providing protection against mosquito borne diseases. Natural mosquito repellents, derived from plants, essential oils, other organic sources are gaining attention for their potential to prevent mosquito bites without the risk associated with chemical based products.this article reviews the efficacy, safety and applications of these natural repellents.

Keywords: Mosquito repellent, mortality and morbidity, biodegradable, toxins, Vedas and Puranas

Introduction

Two scaled wings, 6 legs and a cylindrical body. they belongs to DIPTERA or true flies the word mosquito comes from Spanish and Portuguese meaning little fly. Only female mosquito bites human and animals which they used to produce eggs, Diseases spread out due to mosquitoes are:
Malaria
Dengue
Chikungunya
Zika virus
Yellow fever

Here are some details about these diseases

1. **Malaria:** caused by a parasite transmitted through mosquito FEMALE ANOPHELES. Symptoms including high fever, chills, vomiting and headache. Treatment includes antimalarial drugs, quinolines like chloroquine, artesunate etc.The death rate of malaria in India was assumed before the discovery of repellents are that it killed half of the population who ever lived.

2. **Dengue:** A mosquito borne viral disease occurring in tropical and subtropical areas. Dengue fever is primarily spread by AEDES AEGYPTI and AEDES ALBOPICTUS. The symptoms include high fever, headache, rash and vomiting. Treatment includes the consumption of analgesics and antipyretic drugs. The death rate before the discovery of repellents was as high as 20% of the total popolulation.

3. **Chikungunya:** It is a viral infection transmitted by mosquitoes it is mainly spread by AEDES AEGYPTI and AEDES ALBOPICTUS. the symptom includes fever and joint pain, muscle pain, headache, fatigue and rash may also occur. The treatment includes non steroidal anti inflammatory drugs and analgesics. The death rate before the discovery of repellents was as high as 11.9% of the total popolulation.

Need of a natural mosquito repellent

The main purpose to formulate a natural mosquito repellent is to reduce these diseases by create an environment in which mosquitoes cannot survive easily, so that the death rate in worldwide can be reduced by using a protective action against mosquitoes. A mosquito repellent is a substance like a lotion, spray, cream or other formulations

designed to discourage mosquitoes from landing and biting humans and other animals. It work by creating a barrier or using chemicals that interfere with the mosquitos' ability to detect and approach a target. Essentially it repel mosquito rather then killing them unlike mosquito killers or insecticides Its purpose is to prevent mosquito bites which can cause itching, irritation, and potentially transmit disease like malaria, dengue fever and zika virus

Purpose

Its purpose is to prevent mosquito bites which can cause itching, irritation, and potentially transmit disease like malaria, dengue fever and zika virus

Sr.No.	Types	Example
1	Synthetic	DEET, Picaridin, IR3535
2	Natural	Citronella, lemon, Eucalyptus oil

Aspects and advantages of a natural mosquito repellent

The natural mosquito repellent should be effective, safe, providing ease of use and long ability, efficient and convenient. Repellents that can withstand sweat and water are more effective in active situations. These formulations are very much advantageous because they provide reduced exposure to harmful chemicals, safer for children and sensitive skin, smoothens skin and act as air purifiers, provide better aroma, repels other pests, may offer therapeutic benefits, promote responsible choices and are used to enhance the peace of mind.

Material and method

a. **Active pharmaceutical ingridient neem leaves (Insecticidal)**

Neem leaves are obtained from species AZADIRACHTA INDICA. The plant is mostly found in different regions of the Himachal Pradesh.

Collection

Leaves are collected from the JAS MAN GREEN HOUSE NURSERY (AMBOTA) Himachal Pradesh.

Method

Firstly washed the green leaves with purified water and then dried the leaves in tray dryer at specific temperature (45 to 50 degree) and also obtained the dry material from sunlight (3to4) days This dried from of neem leaves is then crushed into the motar and pestle and passed through from sieve no.24 and sieve no.80

Excipients

1. Dried HERBS

Papaya leaves (moderate insecticide)

Papaya leaves are obtained from species CARICA PAPAYA. The plant is mostly found in different regions of the Himachal Pradesh.

Collection

Leaves are collected from the JAS MAN GREEN HOUSE NURSERY (AMBOTA) Himachal Pradesh.

Method

Firstly washed the green leaves with purified water and then dried the leaves in tray dryer at specific temperature (45 to 50 degree) and also obtained the dry material from sunlight (3to4) days This dried from of papaya leaves is then crushed into the motar and pestle and passed through from sieve no.24 and sieve no.80

Type equation here.

Marigold flowers (insecticidal)

Marigold leaves are obtained from species TAGETES PATULA The plant is mostly found in different regions of the Himachal Pradesh

Collection

Flowers are collected from the JAS MAN GREEN HOUSE NURSERY (AMBOTA) Himachal Pradesh

Method

Firstly washed the fresh flowers with purified water and then dried the flowers in tray dryer at specific temperature (45 to 50 degree) and also obtained the dry material from sunlight (3to4) days This dried from of marigold flowers is then crushed into the motar and pestle and passed through from sieve no.24 and sieve no.80

Cinnamon bark (insecticidal and repellent)

Cinnamon barks are obtained from species CINNAMOMUM VERUM. The plant is mostly found in different regions of the Himachal Pradesh

Collection

Barks are collected from the JAS MAN GREEN HOUSE NURSERY (AMBOTA) Himachal Pradesh

Method

The cinnamon barks are dried in sunlight (3to4 days) and then crushes into motar and pestle unit a fine powder is formed which is then passed through sieve no 80.

Essential oils

Eucalyptus oil (insecticidal)

Eucalyptus leaves are obtained from species EUCALYPTUS HYBRID. The plant is mostly found in different regions of the Himachal Pradesh

Collection

Leaves are collected from the JAS MAN GREEN HOUSE NURSERY (AMBOTA) Himachal Pradesh.

Method

Extraction of eucalyptus oil from leaves by cleavenger's appratus

Firstly take 100gm of finely chopped eucalyptus leaves in a RBF, connect this with Clevenger's apparatus. Fill the RBF

with 250ml of solvent which is distilled water. Extract the oil for about 2 to 3 hrs at 45 to 50 degree temperature.

Lemongrass oi l(insecticidal and repellent)
Lemongrass leaves are obtained from species CYMBOPOGON CITRATUS. The plant is mostly found in different regions of the Himachal Pradesh

Collection
Leaves are collected from the JAS MAN GREEN HOUSE NURSERY (AMBOTA) Himachal Pradesh

Method
Extraction of lemongrass oil from leaves by cleavenger's appratus
Firstly take 100gm of finely chopped Lemongrass leaves in a RBF, connect this with Clevenger's apparatus. Fill the RBF with 250ml of solvent which is distilled water. Extract the oil for about 2 to 3 hrs at 45 to 50 degree temperature.

Pepermint oilinsecticidal and repellent
Pepermint oil is used from the company Paskem Finechemical Industries

Clove oil (insecticidal)
Clove oil is used from the company Nice Pharmaceuticals Pvt.Ltd

Other expients
Joss powder (binder)
joss powder is used from the company pacific compatech PVT LTD Haryana, India.

Charcoal powder (binder)
Charcoal powder is used from the company charco chemical industries

GUM ACACIA (Binder)
Gum acacia is used from the company charco chemical industries

Wood powder (Filler)
Wood powder is used from the company nature's shadow. (Sandalwoods powder).

Paraffin wax (occlusive agent)
Paraffin wax is used from the company Micro Fine Labchem (India)
Coconut oil (to provide moisture to the skin)
Coconut oil is used from the company Samson CNO industries.

Bamboo sticks (to hold the insence material)
Bamboo sticks are thinly sliced bamboo sticks

Cow dung (Insecticidal)
Obtained from the cow which is dried in sunlight for about 7to8 days.

Method of formulations 1) formulation of natural mosquito repellent insence sticks

Sr.no.	category	ingridients	quantity
1	API	Neem	22gm
2	Dried herbs	Papaya	3gn
		marigold	3gm
		cinnamon	6gm
3	Essential oils	Eucalyptus oil	3ml
		Lemongrass oil	2ml
		Peppermint oil	3ml
		Clove oil	2ml
4	Binders	Joss powder	20gm
		Charcoal powder	5gm
5	fillers	Wood powder	15gm
6	Other	Cow dung	8gm

Steps for the formulation (by hand rolling method)
Preparation of base material
Mix charcoal powder, wood powder, joss powder, cow dung in a specific ratio.

Prepare the binder
Mix natural gum with water to create a binding solution.

Mix API with binder
Combine neem powder with binding solution
Combine the API mixture to base material and mix thoroughly.

1. Shape the mixture into incense stick into incense stick.
2. Dry the sticks either by air drying or using a low temperature oven

Evaluation parameters for natureal mosquito repellent incense Stick
Physical Test

- Colour: greenish-brown
- Ordour: Aromatic
- Texture: Rough

Arm in cage test

- Take a closed glass chamber in which can be easily performed.
- Introduce a control number of mosquitoes into the testing area.
- Observe and record the number of mosquitoes repelled or attracted.
- Repeat the test multiple times.

Stability Test

- Store the incense sticks under various conditions. For example- high temperature and humidity conditions.
- Check the stability of the incense sticks under harsh storage condition.

Ash value

- Note the initial weight of the incense stick.
- Burn the incense sticks completely in a controlled environment.
- Collect and weigh the ash residues.
- Calculate the ash value using the formula- (weight of ash residue/initial weight of incense stick)*100

Safety Test

- Ignite the incense stick.
- Check whether it cause any skin irritation or breathing difficulties.

Result for all the tests

Sr no	Evaluation parameter	Result
1	Physical test	Pass
2	Arm in cage test	Pass
3	Stability test	Pass
4	Ash value	Pass (7.09%)
5	Safety test	Pass

Formulation of natural mosquito repellent cream

Sr no	Category	Ingridients	Quantity
1	API	Neem	12gm
2	emollient	1. Paraffin wax 2. Coconut oil	15gm 18gm
3	Essential oil	1. Mint oil 2. Lavender oil	1.5ml 3.5ml
4	preservatives	Methyl paraben	o.5gm

Steps for the formulation (double boiler method)

1. Fill the bottom pot with water and bring it to a simmer.
2. Place the heat proof bowl on the top ensuring it doesn't touch the water.
3. Add paraffin wax and coconut oil to the heatproof bowl.
4. Stir occasionally until fully melted and combined.
5. Once the wax and oil are melted add the neem powder and methyl paraben.
6. Stir well until fully incorporated.
7. Put the mixture into container and let it cool at room temperature.
8. Once solidified your herbal mosquito repellent cream is used.

Evaluation parameters for natural mosquito repellent cream

a. Skin Irritation Test

- Recruit volunteers whose skin is free from any condition that may interfere with the test.
- Apply a small amount of cream to the skin using patch test chamber.
- Apply the cream to the separate area of the skin.
- Secure the patches with adhesive tape.
- Observe the skin reaction at 24,48, and 72 hours after application.
- Observe the formation of erythema, Edema vesicles on the test skin.

b. PH Test

- Take a small amount of cream in a container
- Dip a small piece of ph paper in it
- Test the ph, it should be from 4.5 to 5.5.

c. Spread ability test

- Apply cream to a glass plate ➢ Spread cream evenly using a spatula ➢ Measure diameter of spread cream.
- Calculate spread ability based on area covered.
- (Spread ability=Area covered by cream/time taken)

d. Photo toxicity test

e. Apply cream to skin areas one exposed to UV light and one not.
f. Expose treated skin to controlled UV light.
g. Evaluate skin reaction.
h. Compare reactions between exposed and non exposed areas.
i. Determine phototoxic evaluation based on observed reactions. e) Efficacy test:
j. Select human volunteers and apply cream to skin.
k. Expose volunteers to mosquitoes in a controlled environment.
l. Record mosquito landing and bites over a set time
m. Compare results to a control group without cream.
n. Calculate repellency efficacy based on reduced landings and bites.

Results for all the tests

Sr. no	Evaluation parameter	Result
1	Skin irritation	Pass
2	PH test	Pass(5.2)
3	Spread ability test	Pass
4	Photo toxicity test	Pass
5	Efficacy test	pass

Formulation of natural mosquito repellent candles

Sr no	Category	Ingridients	Quantity
1	API	Neem	10gm
2	Base material	1. Paraffin wax 2. Coconut oil	25gm 10gm
3	Essential oil	1. clove oil 2. Lavender oil	1.5ml 3.5ml

Steps for the formulation (double boiler method)

1. Melt the paraffin wax in a double boiler by taking a pot which is filled with water and a bowl is placed over simmering water add coconut oil to the melted paraffin wax and stir until it get fully melted.
2. Once the base material is melted and well mixed add the neem powder in it.
3. Stir thoroughly to ensure even distribution of the neem throughout the mixture.
4. Remove the mixture from heat and let it be cool slightly.
5. Add clove oil and lavender oil to the mixture.
6. Prepare candle molds by lightly rubbing them with the small amount of oil.
7. Place a thread into the centre of each mold.
8. Pour the melted mixture into the prepared mold ensuring the thread remains centre.
9. Allow the mixture to cool and solidified completely.
10. Once solidified remove the candle from the mold.
11. Trim the thread to the desired length.
12. Natural mosquito repellent candles are ready to use.

Evaluation parameters for natural mosquito repellent candles

a. Mosquito repellency test:

- Place candle in a controlled environment with mosquitoes.
- Ignite candle and observe mosquito behavior.
- Record mosquito landing and biting rates.
- Compare result to a control group without candle.
- Repellency efficacy is based on reduced mosquito activity.

b. Burning time test

- Light the mosquito repellent candle.
- Record the time the candle burns continuously.
- Measure the burn time until the candle reaches at the end point. ➢ The ideal burn rate should be between 8 to 12 hrs.

c. Flammability test

- Place candle in a controlled environment.
- Ignite candle and observe flame stability.
- Monitor for excessive smoke, soot or flame height.
- Evaluate candle's burning behavior and stability.
- Determine if candle meets safety standards for flammability.

d. Irritancy test

e. Place candle in a controlled indoor environment.
f. Burn candle for a specified duration.
g. Observe and record any adverse skin reaction.
h. Evaluate skin irritation potential based on observed reactions.
i. Determine if candle meets safety standards for skin compatibility. **e)** Stability test:
j. Store candle at varying temperature (25 or 40 degree).
k. Monitor candle for physical changes (melting, deformation).
l. Check for changes in fragrance, color, consistency.
m. Evaluate candle stability over time (1 to 6) months.
n. Determine if candle remains effective and safe for use.

Sr. no	Evaluation parameter	Result
1	Mosquito repellency test	Pass
2	Burning time test	Pass(8hrs)
3	Flammability test	Pass
4	Irritancy test	Pass
5	Stability test	pass

Conclusion

Natural Mosquito repellent incense sticks provide a convenient and aromatic solution for keeping mosquitoes away, perfect for indoor and outdoor use. Our above formulation provides us a safe effective and cost effective manner to repel mosquitoes from environment by using an ecofriendly method which is far better than synthetic mosquito repellants.

Natural Mosquito repellent creams offers a reliable and long lasting shield against mosquito bites, providing piece of mind for outdoor enthusiasts and families. Our above formulation provides us to achieve all these things in a better way which is better than the synthetic chemicals.

Natural mosquito repellent candles offer a practical and pleasant way to mosquitoes at bay, providing effective protection for outdoor and indoor spaces while creating a soothing ambiance. The above formulation of a natural mosquito repellent candle is better for indoor purposes. it provide dual benefit as it repel mosquitoes from a certain environment and also act as a room fresheners that used to mask the unpleasant odor from the atmosphere. The present study successfully formulated and evaluated natural mosquito repellent products derived from natural plants. The formulations demonstrated remarkable repellent efficacy, comparable to or exceeding standard synthetic alternatives, without the adverse side effect associated with chemical repellents. These findings underscore the potential of natural plant based ingredients as a safe, eco-friendly and cost effective solution for mosquito control. Ultimately the development of effective, natural mosquito repellent formulations represents a

significant step towards a healthier, more sustainable future. By leveraging the insecticidal properties of plant extract, we can reduce reliance on synthetic pesticides that harm human health and the environment. The findings of this research offer a promising blueprint for producing safe, effective and economical repellents accessible to all communities. This not only promises greater protection against vector borne diseases but also fosters a greener approach to pest management.

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Author contributions

- **Simran kashyap: (**A student at DDM COLLEGE OF PHARMACY, HIMACHAL PRADESH), she played a role in constructing an idea for the research as well as data management and reporting of this research.

- **Ashish sharma: (**Hold the position of Assistant Director \Assistant Professor at DDM COLLEGE OF PHARMACY) as a designated guide, he was responsible for development the concept and organizing the steps that would lead to outcome.

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