Formulation and evaluation of eco-friendly handmade herbal mosquito repellent cone
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Abstract
A mosquito belongs to the insect-family Culicidae, order Diptera, suborder Nematocera and class Insecta. Mosquito act as vector which carries many disease causing parasites and viruses. Preventing mosquito spread is immensely necessary to stop spread of various contagious diseases. Now days, uses of plant based mosquito repellent have increased as synthetic repellents contains many noxious chemicals which can cause possible toxicity like skin toxicity and causes swelling, redness, itching and many health problems. The herbal mosquito repellent cones were prepared by using saw dust, cow dung, gum acacia, neem powder, eucalyptus powder and lemon grass powder. Lemon grass has insecticidal property. Saw dust increases the combustion. Gum acacia act as binder. Cow dung shows antioxidant and mosquito repellent property. Neem has mosquito repellent property. Herbal mosquito repellent cone were prepared by hand rolling method. The evaluation parameters of herbal mosquito repellent cone contain burning time (min), smoke visibility, odor, irritation test, ash weight (g.) and mosquito repellent activity. The formulation LNC containing lemon grass powder along with neem powder and cow dung in equal ratio shows best activity and maximum effectiveness in reducing mosquito number in comparison with all other formulations. In present study, the powders used in formulation were herbal based and eco-friendly and producing no side-effect on use. Here an attempt has been made to find out the novel formulation of different herbal plant powders containing alone and with combination for mosquito repellent cone.

Keywords: Mosquito repellent, contagious diseases, burning time.

Introduction
Mosquito are one of the most disturbing and blood sucking organism that disturbs Homo sapiens sapiens[1]. Mosquito species included in the genera Anopheles, Aedes and Culex are vectors for the various disease pathogens like malaria, dengue fever, myiasis, yellow fever, encephalitis etc. The death rate increased to one million as of 2018, according to the American Association of Mosquito control. High fever and chills are its symptoms [2, 3, 4]. Mosquito work as a vector for many deadly disorders that transfers the virus or parasite from one person to another person or in animals also [5]. Globally, mosquito borne diseases are increasing because of high rate of reproduction and development of resistance of insecticides in mosquito [6]. Both male and female mosquito survives on plant juice. Male mosquito do not bite human beings but the female mosquito suck human blood after mating as proteins is required for the maturation of eggs [7]. Chemical mosquito repellent have been extensively used to control the rate of mosquito either by killing or even preventing mosquito to bite the human beings or even killing mosquito’s larvae at breeding sites [2]. Many of the plant extracts have beneficiary effect to health when consumed for longer time period. The oldest book of Hindu civilization is the Rig-Veda in India, written 5000 years ago. Much more higher and...
modified use of plant material occurs in Atharvana Veda. Atharvana Veda had an Upaveda called Ayurveda. Charaka Samhita and Sushruta are famous treaties of Ayurveda. The Charaka Samhita includes 395 medicinal plants, 57 drugs of animal origin, 64 minerals as therapeutic agents [8]. Now days, mosquito have developed resistance which causes a need to develop an alternative method of mosquito control. For an effective formulation of repellent, one need check its toxicity problem which should match with the increased incidence of insect resistance. Globally, chemical larvicides are also used to control mosquito’s population but these chemicals are toxic to humans, plants and animals.

According to WHO pesticide evaluation, major insecticides used in the Americas is the pyrethroids and organophosphates. Examples of chemical-based insect repellents used for mosquito are DEET [9] (N, N diethyl- m-toluamide) it is a registered pesticide, but possible side effects and warnings include: skin and eye irritation, insomnia etc. Permethrin, resmethrin and sumithrin are some synthetic pyrethroids used to kill adult mosquito. Many plant extract are also used in mosquito repellents. Researchers are finding that many plant based mosquito repellent not more effective than DEET [4] like Neem powder, eucalyptus powder etc [2].

Butylated Hydroxy Toluene (B.H.T) - is an antioxidant, which cause hepatic or renal toxicity after ingestion or inhalation is used in various repellents.

Aerosols mosquito repellent damage the health and environment, also very expensive commercially and cause many harm to common people. Because of this reason one need to develop a safe herbal mosquito repellent [10, 11]. Plants based repellent work as emerging source for mosquito control and are used mainly to due to its insecticides or repellent properties. Plant powders are naturally occurring and have characteristic strong odor. Plant powder is generally green in color and has fine particles [2].

**Advantages of herbal mosquito repellent**

Non-poisonous, inexpensive, eco-friendly, easily available, non-irritant, easy to make, also act as insect repellent [12].

Table 1: Herbal Drug information used in preparation of Mosquito repellent.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Plant Part</th>
<th>Medicinal Importance</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Neem leaves (Azadirachta indica)</td>
<td>Anti-helmenthic, antifungal, antidiabetic, antibacterial, antiviral, contraceptive and sedative.</td>
<td><img src="image" alt="Neem leaves" /></td>
</tr>
<tr>
<td>2.</td>
<td>Lemon grass (Cymbopogon citratus L.)</td>
<td>Natural insect repellents</td>
<td><img src="image" alt="Lemon grass" /></td>
</tr>
<tr>
<td>3.</td>
<td>Eucalyptus leaves (Eucalyptus globulus L.)</td>
<td>Insecticide and miticide</td>
<td><img src="image" alt="Eucalyptus leaves" /></td>
</tr>
</tbody>
</table>
Materials
Raw material used for production of the herbal mosquito repellent cone were saw dust, cow dung, gum acacia, neem powder, eucalyptus powder and lemon grass powder. Different ingredients used in the preparation have different function.
Gum acacia is an excellent binder. Saw dust will enhance the combustion power. Lemon grass has medicinal property and insecticide ability. Cow dung smoke is potential antioxidant and also act as mosquito repellent. Neem has anti-viral and mosquito repellent property.

Plant powder and excipients used to make mosquito repellent cone
Dried Pyrethrum flower: Dried flower head of Chrysanthemum cinerariifolium. It is potent insecticidal, Neem: obtained from Azadirachta indica is a widely available plant with many good properties, neem is an excellent mosquito repellent, Lemon grass oil: obtained from Cymbopogon nardus plant. strong scent of it irritates the mosquito, Camphor: white and oily resin of the tree Cinnamonum camphor 13–16, Acorus calamus: Contains the compound β- asaron which has anti-feedant and larvicidal properties, Benzoin: The resin obtained from the aromatic tree Styx genus. Its odour also repels mosquitoes, Joss/Jigat powder: Bark powder of the Persea marcantha tree, Gum acacia- used as a binder and Cow Dung: Anti-oxidant and mosquito repellent. Herbal drug information is given in Table 1.

Methods
Collection of leaves
Fresh leaves were collected from herbal garden of BN College of Pharmacy and after that washed with tap water and kept for air drying for 3 weeks.

Drying, grinding and screening of herbal powder
All dried leaves are subjected for grinding by using grinder mixer and after that screening of powder by help of sieves was performed. The powder should be very fine or else there would be problems in the binding and burning. The prepared raw material is shown in figure 1.

Preparation of herbal mosquito repellent cone:
Weighed the dried powder individually and transferred in mortar and pestle, mixed well then water was gradually added to the fine powder until it attains wet mass (damp mass) like consistency. It should be well mixed and not too watery otherwise it creates problem in making cone. Cones were prepared by hand rolling method. Same methods were followed for all formulation. Formulation information was given in table 2. The cones were dried for few hours under shade. Hot air oven at 50°C for 6 hrs can also be used to dry the cones faster (figure 2). Dried cone were then dipped in peppermint oil. Finally cones were packed in a airtight polybag and stored at room temperature (figure 3).
Individually each mosquito repellent cone was burned and its odor was checked.

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

**Ash weight (g.)**
Ashes of each formulation were individually taken and carefully weight on weighing machine using butter paper.

**Testing mosquito repellent activity of mosquito repellent cone using mosquito net cage method**
About 20 mosquitos were transferred in the net cage. The mosquito repellent cones were burned in the room for 1 hour. Reduction in mosquito number was observed (table 3).

**Results**
The formulation LNC containing lemon grass, neem and cow dung shows the best result as mosquito repellent. The burning time was longest for this formulation when compared with all other formulation. Smoke visibility was also high. Aroma was also most pleasant. Ash weight was minimum for this formulation and shows maximum mosquito repellent activity when compared with other formulation.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Formulation no.</th>
<th>Burning time (minutes)</th>
<th>Smoke visibility</th>
<th>Odor</th>
<th>Irritation test</th>
<th>Ash weight (g.)</th>
<th>Mosquito repellent activity (number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>L</td>
<td>High</td>
<td>Satisfactory</td>
<td>No</td>
<td>0.8</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>E</td>
<td>Low</td>
<td>Good</td>
<td>No</td>
<td>1.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>N</td>
<td>High</td>
<td>Good</td>
<td>No</td>
<td>0.9</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>LNE</td>
<td>High</td>
<td>Satisfactory</td>
<td>No</td>
<td>0.3</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

**Evaluation Parameters:**

*Burn time (minutes):* Mosquito repellent cone from each formulation were burned and time was noted down.

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

*Odor*

**Table 2:** various formulation containing herbal powder ingredients.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Formulation no.</th>
<th>Herbal powder ingredients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>L</td>
<td>Lemmon grass</td>
<td>100%</td>
</tr>
<tr>
<td>2</td>
<td>E</td>
<td>Eucalyptus ME</td>
<td>100%</td>
</tr>
<tr>
<td>3</td>
<td>N</td>
<td>Neem</td>
<td>100%</td>
</tr>
<tr>
<td>4</td>
<td>LNE</td>
<td>Lemmon grass + Neem + Eucalyptus</td>
<td>33.33% + 33.33% + 33.33%</td>
</tr>
<tr>
<td>5</td>
<td>LNC</td>
<td>Lemmon grass + Neem + Cow dung</td>
<td>33.33% + 33.33% + 33.33%</td>
</tr>
<tr>
<td>6</td>
<td>EN</td>
<td>Eucalyptus + Neem</td>
<td>50% + 50%</td>
</tr>
<tr>
<td>7</td>
<td>LNEC</td>
<td>Eucalyptus + Lemon grass + Neem + Cow dung</td>
<td>25% + 25% + 25%</td>
</tr>
<tr>
<td>8</td>
<td>LN</td>
<td>Lemmon grass + Neem</td>
<td>50% + 50%</td>
</tr>
</tbody>
</table>
Discussion

In this present research work, an attempt is done to prepare herbal mosquito repellent cone using saw dust and cow dung as fillers along with herbal powder of lemon grass, neem and eucalyptus. Also supporting excipients are added to the preparation. Here, different combination of herbal powder is tested as mosquito repellent cone. Some combination of herbal powder shows excellent property as mosquito repellent. Evaluation parameters of herbal mosquito repellent cone are shown in Table 3. It contains burning time (minute), smoke visibility, odor, irritation test, ash weight (g.) and mosquito repellent activity. Smoke visibility shows the volume of smoke released from the mosquito repellent cone and gives an idea that natural mosquito repellent and natural pesticides is always better than synthetic preparations. All eight formulations are also tested in mosquito affected areas. At burning time, it was observed that up to 95% of mosquito number was greatly decreased. Formulation LNC containing lemon grass powder along with neem powder and cow dung shows maximum effectiveness in reducing mosquito number when compared with all other formulation. Also aroma of this formulation was most satisfactory. Formulation LNEC also shows very good mosquito repellent property as here cow dung reduces the excessive irritancy caused by eucalyptus powder. Formulation LNE also shows good mosquito repellent property. That’s why use of natural mosquito repellent cone is more holistic and better option than synthetic mosquito repellent cone as it is more effective as well as environmental friendly also.

Conclusions

Through present research paper work, it is revealed that lemon grass powder and neem powder shows very good mosquito repellent activity. So, Lemon grass along or in a combination can be used as a very good mosquito repellent. Many products can be made by using various combinations of lemon grass powder and neem powder 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 cone are less harmful to health as compared with market synthetic coil. Through present research,
it is clearly seen that Lemon grass 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 cone.

References