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Developing ecofriendly sambrani and mosquito repellent using elephant dung

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Abstract
India is one of the largest Sambrani-producing countries. Sambrani, a globally traded product, is burnt for fragrance. According to Bordoloi & Sharma (2007) [5] approximately, a revenue of Rupees 7.1 billion comes from the total domestic sales of Sambrani. In India significantly, about two-thirds of the domestic usage of sambrani takes place in rural areas (61.23%). Elephant dung is rich in fiber content which makes it as a suitable raw material for manufacturing mosquito repellant and sambrani. Mosquitoes are the most vital carrier of viral diseases in the urban, suburban and rural environments. They are the primary carriers of dengue, malaria, and several other diseases that may even lead to pandemic. Hence, a eco-friendly sambrani and mosquito Repellent Formulation was designed using elephant dung. The burning ability such as initial burning, final burning, flammability, time interval and ash content were recorded for sambrani. Natural ingredients like Tulsi, Neem leaves, Lemon grass oil and Natural gum were used in combination with the elephant dung to reinforce the potency of the mosquito repellent. Smoke toxicity of organic mosquito repellent was evaluated. Emission test for commercial and formulated repellent was also carried out and compared, and it is evident that there is 57% reduction in the carbon-di-oxide emission from formulated repellent than commercial repellent and there are no traces of emission of carbon monoxide from the repellent. This formulation is safe, eco-friendly, cheap, easy to use, and has maximum repellence against mosquitoes. Production of these natural repellents with elephant dung may help to increase the livelihood security of rural poor/tribal people in Tamil Nadu.

Keywords: Elephant dung, Sambrani, mosquito repellent, efficiency test

Introduction
India is one of the largest Sambrani-producing countries. Sambrani, a globally traded product, is burnt for fragrance. The modern era of Sambrani manufacturing in India started first in Thanjavur district of Tamil Nadu and from there it has been gradually expanded to other parts of the neighboring states. Sambrani industry now reigns in Karnataka, Andhra Pradesh, Kerala, Orissa, Gujarat, Dadar and Nagar Haveli, Bihar, Tripura, and Assam. Nearly 1000 Sambrani units are reported to be functioning in Karnataka. Sambrani industry is fast growing industry. According to Bordoloi & Sharma (2007) [5] approximately, the revenue of Rupees 7.1 billion comes from the total domestic sales of Sambrani. It is traditionally used for worship, meditation, prayer, ceremonies, and rituals. These are also used as air fresheners, mosquito repellent, creation of spiritual ambiance and widely used in aromatherapy.

The percentile domestic sale of Sambrani in South-India is .estimated as 35 percent, West-India accounted for 30 percent, North-India for 18 percent & East- India for 17 percent respectively. Significantly, about two-thirds of the domestic consumption of Sambrani takes place in rural areas (61.23%). The demand for Sambrani is increasing day by day both in domestic and export markets due to the availability of improved quality and varieties. The Sambrani industry plays a vital role in India's economy. It is estimated to provide income to 500,000 people, of which, about 90 percent are women. Many raw materials are used for making sambrani and mosquito repellent *viz*., charcoal, wood ash, saw dust and cow dung.

Elephant dung is rich in fiber content which makes it suitable raw material for manufacturing mosquito repellant and Sambrani. An elephant passes out roughly 90 Kg of dung per day, and burning this dung releases very less carbon mono oxide. Sources of green energy are becoming more important day by day. Dwindling fossil fuel supplies and global warming taking its toll, the search for alternate products comes into the limelight. Luckily, some zoos and sanctuaries have started to make use of the resources right under their feet.

Mosquitoes are the most important pests in the urban, suburban and rural environments. They are the primary carriers of dengue, malaria, and several other diseases that cause a tremendous

problem and even lead to death every year. Nearly 700 million people are affected every year by mosquito-borne illnesses resulting in greater than 1 million deaths. Controlling such diseases is extremely difficult due to the higher reproduction rate and development of mosquitoes that are resistant to insecticides and commercially available repellents (Petchimuthu *et al.*, 2019) [3].

Easily available natural resources can be effectively used to control mosquitoes in the environment. Products derived from plants are effective, safe, and extensively used as biologically active compounds in controlling infectious diseases. Animal dung plays a major role since time immemorial and it is considered a third important eco-friendly service rendered by animals. Dung is utilized as a bio fertilizer, cheap fuel, and insect repellent, the latter is to be focused very seriously in the modern era. It is a great business strategy adopted to convert waste into a valuable product (S A Mandavgane *et al.*, 2005).

Elephant dung is a natural, non-polluting mosquito repellent. The smoke repels mosquitoes when the dry dung cake is burnt. Elephants are herbivorous and their dung has a high proportion of undigested plant fibers making the excreta an incredible crude material for mosquito repellent production. As the diet of the cow and elephant is entirely different, the fiber content from the dung of the elephant is more than that of cow dung. This increases the burning capacity of the mosquito repellent. The fume that wafts from the burning elephant dung can be also used as a mild pain killer. This repellent using elephant dung has endless benefits over cow dung with its anti-bacterial properties.

Elephant dung, known to be a natural insect repellent is used as the main ingredient in the development of organic repellent against mosquitoes. It has a high amount of ash, low amount of carbon, and low burning ratio. With this background, studies have been formulated to develop the most effective organic herbal insect repellent to fight against deadly mosquitoes.

Materials and Methods

Study Area

Present study was conducted in FPU (Forest Products and Utilization) Laboratory at Forest Collage and Research Institute Mettupalayam range, Coimbatore ,Tamil Nadu, during January 2022-June 2022. (Longitude of 11.19'N, latitude of 77.56'E).

A. Composition of Elephant dung based Sambrani

T1 – Elephant dung 100g + Sambrani 10% + Neem gum 15% + Eucalyptus oil 1%
T2 – Elephant dung 100g + Sambrani 10% + Neem gum 20% + Eucalyptus oil 1%
T3 – Elephant dung 100g + Sambrani 10% + Moringa gum 15% + Eucalyptus oil 1%
T4 – Elephant dung 100g + Sambrani 10% + Moringa gum 20% + Eucalyptus oil 1%
T5 – Elephant dung 100g + Sambrani 10% + Neem gum 15% + Eucalyptus oil 2%
T6 – Elephant dung 100g + Sambrani 10% + Neem gum 20% + Eucalyptus oil 2%
T7 – Elephant dung 100g + Sambrani 10% + Moringa gum 15% + Eucalyptus oil 2%
T8 – Elephant dung 100g + Sambrani 10% + Moringa gum 20% + Eucalyptus oil 2%
T9 – Elephant dung 100g + Sambrani 10% + Neem gum 15% + Lemon grass oil 1%
T10 – Elephant dung 100g + Sambrani 10% + Neem gum 20% + Lemon grass oil 1%
T11 – Elephant dung 100g + Sambrani 10% + Moringa gum 15% + Lemongrass oil 1%
T12 – Elephant dung 100g + Sambrani 10% + Moringa gum 20% + Lemon grass 1%
T13 – Elephant dung 100g + Sambrani 10% + Neem gum 15% + Lemon grass oil 2%
T14 – Elephant dung 100g + Sambrani 10% + Neem gum 20% + Lemon grass oil 2%
T15 – Elephant dung 100g + Sambrani 10% + Moringa gum 15% + Lemon grass oil 2%
T16 – Elephant dung 100g + Sambrani 10% + Moringa gum 20% + Lemon grass oil 2%

Elephant dung based Sambrani

Base material	Elephant dung	100g	
Sambrani	*Canarium strictum*	10 g Kg^{-1} (10 %)	
Binding	*Azadirachta indica gum*	Mixture 1	Mixture 2
		15%	20%
	Moringa oleifera gum	15%	20%
Fragrance	*Eucalyptus citriodora* oil	1%	2%
	Cymbopogon flexuosus oil	1%	2%

Methodology

i) Material Collection and Processing

Elephant dung was collected from the natural reserve forest and elephant camp at the Mudumalai tiger reserve. The binding material gum was collected from the trees of *Azadirachta indica* and *Moringa oleifera* in natural forests and plantations.

The elephant dung was spread as thin layer and dried in natural sunlight for 48 hours, after drying the elephant dung was powdered by using the pulverizer machine. The collected gum was shade dried. After drying, the gum was powdered. Powdered *Canarium strictum* was added in trace amount.

ii) Methodology

1. A mixture of powdered elephant dung and *Canarium strictum* powder is added with the given ratio at 10:1
2. The gum powder is mixed with hot water and the elephant dung mixture is mixed with gum until it forms as a dough consistency
3. Finally, the dough is stuffed in hand pelletizer which is a mould cylindrical shaped sambrani and shade dried
4. Lemon grass oil was dipped on the stick to give fragrance and further it was kept under sunlight for better drying. Finally, these were packed in a suitable air-tight bag.

Observations

Efficiency

The efficiency of the Sambrani was tested. The test was conducted by burning the elephant dung-based Sambrani and compared with the available commercial Sambrani in market. The burning ability such as initial burning, final burning, time interval flammability and ash content were recorded .Samples were prepared in different ratios and the tests was conducted as per the standard protocols the result was analyzed at different intervals (Hazarika *et al*., 2019) [9]

1. Burning time (min)

Burning time is a time interval between the initial burning to the final burning. The time taken for burning was calculated by the following formula, (Daisy Das *et al*., 2019) [9]

Burning time (min) = FB – IB
Where, IB = Initial burning, FB = Final Burning and the results are expressed in minutes.

2. Flammability
The flammability of the product was tested and characterized based on its flammability by visual observation as outlined by Hazarika *et al*., 2019 [9]

3. Ash content (%)
Three gram (3g) dried sample was taken in open crucible and keeping it in a muffle furnace at about 750°C until constant weight is reached. The ash content was calculated using the following formula as outlined in (ASTM D3172-89(ASTM, 2002)

$$\text{Ash\% (dry basis)} = \frac{(\text{WAA}-\text{TWOC})}{(\text{OSW X DMC})} \text{ x } 100$$

Where,
WAA = Weight after ashing
TWOC = Tare weight of crucible
OSW = Original sample weight
DMC = % solids/100

Elephant dung based Mosquito Repellent

Base material	Elephant dung	100g	
Sambrani	*Canarium strictum*	10g Kg^{-1} (10 %)	
Binding agents	*Azadirachta indica gum*	15%	20%
	Moringa oleifera gum	15%	20%
Fragrance material	*Eucalyptus citriodora* oil	1%	2%
	Cymbopogon flexuosus oil	1%	2%
Repellent material	*Azadirachta indica* leaves	10g Kg^{-1} (10 %)	
	Ocimum tenuiflorum leaves	10g Kg^{-1} (10 %)	

Raw Materials Collection
The raw materials for the preparation of herbal mosquito repellent were collected from the FC&RI Campus. The elephant dung was collected from natural forest and the elephant camp in Mudumalai tiger reserve. Leaves of *Azadirachta india* (neem) and *Ocimum tenuiflorum* (thulsi) were collected from Forest College and Research Institute, Mettupalayam, Coimbatore. The natural lemon grass oil, loban were bought from the commercial market for fragrance.

Method of Preparation
Neem and tulsi leaves were collected and allowed to shade dry. After drying, neem leaves and loban were powered separately. Then it was mixed with the elephant dung in the ratios given above. Neem gum and Moringa gum were added as binding materials as outlined above . Then lemon grass oil was sprayed on the coil to give fragrance and further it was kept under sunlight for better drying. Finally, these coils were packed in a suitable air-tight bag

Observations
Determination of efficiency
The efficiency of the mosquito repellent was tested. The test was conducted by burning the organic herbal mosquito repellent coil and commercial mosquito repellent in seperate closed room containing approximately 100 numbers of mosquitoes and the death: live ratio was checked manually. The number of dead and dropped-down mosquitoes were counted and the result was analyzed at different intervals (Ramya *et al.,* 2019)

Smoke toxicity test
Experiments were conducted in a glass chamber which has a measuring window situated at the mid-bottom of one side of the chamber. The experiment chamber was tightly closed smoke and toxicity was tested with commercial mosquito coil and herbal mosquito repellant at different time intervals by observing the dead dropped down mosquitoes (Gopeswar Mukherjee and Sandipan Ghosh., 2019)

Smoke emission test (%)
A smoke emission test was conducted to measure the Carbon monoxide and Carbon dioxide level of the organic herbal mosquito repellant by using a carbon monoxide detector and carbon dioxide meter. A smoke meter was used to measure the amount of carbon-di-oxide and carbon monoxide emission from both the herbal mosquito repellent coils and commercial mosquito repellent. (Ramya *et al.,* 2019) [3]
Smoke emission tests were performed in the Department of Agricultural Engineering, TNAU, Coimbatore. It was carried out by use of an approved and calibrated smoke meter .Coil was prepared and tested by burning the coil inside the smoke emission box. (Model: AZ7755).

Results and discussion
1. Testing quality parameters of elephant dung based Sambrani
The result of the study revealed that, treatment T_{14} has recorded the maximum burning time (25.30 min) followed by T_8 (24.25 min) where as treatment T_3 had recorded the minimum (20.20 min). Treatment T_{14} had better flammable ability (15 sec) whereas treatment T_{11} recorded poor flammable ability (28sec). With respect to ash content T_3 registered minimum ash content (0.409g) and the maximum ash was recorded in T15(0.588g). The similar results were observed by Hazarika *et al.,* (2019) [9] in elephant dung based Mosquito Repellant.

Table 1: Evaluating the burning properties

S. No.	Sample	Burning time (Minutes)	Flammability (seconds)	Ash content (g)
1.	T_1	20.35	19	0.435
2.	T_2	22.45	18	0.428
3.	T_3	20.20	18	0.409
4.	T_4	23.32*	22*	0.488
5.	T_5	21.02	21	0.498
6.	T_6	23.09	20	0.509
7.	T_7	20.23	18	0.545*
8.	T_8	24.25**	16	0.476
9.	T_9	21.20	23**	0.577**
10.	T_{10}	22.80	16	0.543*
11.	T_{11}	20.22	28**	0.598**
12.	T_{12}	22.85	18	0.487
13.	T_{13}	20.35	20	0.549*
14.	T_{14}	25.30**	15	0.435
15.	T_{15}	21.23	19	0.588**
16.	T_{16}	24.22**	22*	0.422
MEAN		22.23	19.50	0.50
SED		0.46	1.13	0.02
CD P=(05)		0.92	2.28	0.04
CD P=(01)		1.23	3.04	0.06

Results and Discussion

1. Testing quality parameters of elephant dung based Mosquito Repellent

A. Smoke toxicity Test (Kranti Sharma *et al*., 2017) [4]

Present investigations revealed that the maximum number of mosquitoes dropped down while using commercial repellant followed by the herbal repellant. It was noticed that 90-95% of mosquitoes dropped dead while using commercial repellant, 80-85% by herbal repellant. According to Palanisami *et al*. (2014) [1], the drop of mosquitoes increased with the application of the commercial repellent and they concluded that when there is increase in burning time of herbal repellent, the same herbal repellant can also reduce the mosquitos to 95%(equal to commercial repellant)

Elephant dung alone or in combinations with those obtained from other mosquito repellent plant species, could be potentially used for the preparation of mosquito repellent products. Based on these observations, it is clear that the burning of mosquito repellant prepared with elephant dung can reduce the mosquito population without releasing of toxic chemical gases.

Table 2: Comparative efficacy of herbal mosquito repellent with commercial mosquito

S. No.	Time (Min)	Type of Repellent Used	Observations Recorded
1	30 min	No coil used	Numerous mosquitoes
2	30 min	Commercial oil	95 per cent mosquitoes reduced.
3	30 min	Herbal mosquito repellent	85 per cent of mosquitoes reduced

B. Smoke Emission Test (Ramya Petchimuthu *et al*., 2019) [3]

Smoke emission test was performed to measure the emission of carbon monoxide and carbon dioxide from the commercial and herbal repellant. It was observed that the organic, herbal insect repellant emits less carbon monoxide and carbon dioxide than commercial mosquito coils. The Similar results were observed by Ramya Petchimuthu *et al*. (2019) [3] in elephant dung based Mosquito repellant

Table 3: Smoke Emission Test

Types of repellent	Trial	Emission	
		Carbon Monoxide Co [% V/V]	Carbon Dioxide Co_2 [% V/V]
Commercial mosquito repellent	Trial 1	0.048	0.15
	Trial 2	0.032	0.10
Organic herbal mosquito repellent	Trial 1	0.015	0.03
	Trial 2	0.012	0.01

Conclusion

The usage of elephant dung for the production of Sambrani and mosquito repellant has not been reported before. This study developed eco-friendly Elephant dung based Sambrani and mosquito repellant with long-lasting protection which is safe for human life, with no side effects. It can be used as an alternative to commercially available products**.** The results of this investigation indicated that elephant dung could be used to formulate beneficial products.

The ingredients of elephant dung and phytochemical compounds of plant extract are responsible for mosquito repellence. The mosquito coils available on market create heavy smoke that can lead to respiratory problems, especially for patients with Asthma, COPD, and other respiratory diseases. This formulation is safe, eco-friendly, cheap, easy to use, and has maximum repellence against mosquitoes. Production of these natural repellents with elephant dung may help to improve the livelihood security of rural poor/tribal people in Tamil Nadu.

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