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Review

Plant based products: Use and development as repellents against mosquitoes: A review

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ABSTRACT

Global warming and deforestation have resulted in the relocation of many living creatures including insects during the recent years. This has affected the population balance of disease vectors including mosquitoes resulting in outbreaks. Traditionally, mankind has been using plants as means of protection from the mosquitoes which are considered to be environment friendly unlike the synthetic chemicals that cause major risk to human health and the ecosystem. Researchers explored mainly, essential oils and traditional plants using different testing methodologies to find out repellent molecules effective against mosquitoes which is the main focus of this review. Among the promising plant species, *Eucalyptus* spp., *Ocimum* spp. and *Cymbopogon* spp. are the most cited. Data of repellency produced from the bioassay systems is difficult to quantify because of different parameters, testing system and standards of material used against mosquitoes. Mainly, the human forearm based bioassays have been used with different sizes of treatment area in the laboratory and the results have not been tested in the field conditions for residual activity. In addition, effectiveness of essential oils and their protection time can be increased by using vanillin as synergist and formulation techniques like microencapsulation and nanoemulsion. There is a need to develop an alternate in vitro bioassay system that can address the problems of uniformity of the results.

Contents

1. Introduction

Since the beginning of life in the world, survival for existence among different creations led to the adaptation and extinction. Nature has given rights and mechanisms to every living organism to fight for its survival. In this competition of

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Table 1
An overview of repellent plant against mosquitoes from literature review.

a): Essential oils

Plant	Part/source	Conc./dose rate	Part/area treated	Mosquito	Protection/%Rep	Time (h)	Ref
Allium sativum	Bulb	0.1 mL of 10% Soln	30 cm^2 of arm	*Ae. aegypti*	100	0.52	[77]
Cinnamomum zeylanicum	Bark	1.0, 2.5, 5 mg/cm^2	25 cm^2 of arm	*Cx. tritaeniorhynchus*	83.4	1	[83]
Citronella	Commercial	1 g of 60%Soln	3 × 10 cm of arm	*Ae. aegypti*	80	1	[63]
		1 g of 40%Soln			69	1	[63]
Conyza newii	Commercial	0.5 mL of 0.01% to 10%	Wrist to elbow	*An. gambiae*	45	0.05	[35]
Corymbia citriodroa	PMD	20%	Elbow to finger tips	*Ae. aegypti*	100	2	[49]
	PMD	50%		*An. gambiae, An. unestus*	100	7	[75]
	Commercial	0.1 mL of 20% PMD (1.7 mg/cm2)	3 × 10 cm	*An. stephensi*	100	12	[37]
		30% applied topically			96.3	4	[50]
	PMD	0.8 g/arm	PMD towelette (0.575 g) applied topically	*An. arabiensis*	90	6	[47]
Cymbopogan citratus	Leaves	1.0, 2.5,5 mg/cm^2	25 cm^2 of arm	*Cx. tritaeniorhynchus*	100	1	[83]
	Leaves, stem	0.025 mL of 0.02, 0.10, 0.21*mg/cm^2	12 cm^2	*Ae. aegypti*	100*	3 min*	[78]
	Commercial	0.1 mL of 100%Soln	3 × 10 cm	*Ae. aegypti*	100	0.5	[14]
		3 mL of 25% Soln.	600 cm^2 on leg	*Mansonia* sp.	94.7	2.5	[76]
	Stem	0.1 mL of 10% Soln.	30 cm^2 of arm	*Ae. aegypti*	100	1.47	[77]
		3 mL of 25% Soln.	Leg surface area of 600 cm2	*An. darlingi*	74	2.5	[76]
C. martini	N.I	1 mL pure oil	Leg, neck, hand	*An. culicidacies*	100	12	[46]
				Cx. quinquefasciatus	98.8	10	[46]
				Cx. quinquefasciatus	95	12	[46]
C. nardus	Commercial	10%	Elbow to finger tips	*Ae. aegypti*	100	0.33	[49]
	Leaves, Stem	0.025 mL of 0.02, 0.10, 0.21*mg/cm^2	12 cm^2	*Ae. aegypti*	88*	4 min*	[78]
	Plant oil	100 μl of pure oil	30 cm^2 of arm	*Ae. aegypti*	100	0.83	[79]
	Stem	0.1 mL of 10% Soln	30 cm^2 of arm	*Ae. aegypti*	100	1.47	[77]
	Commercial	0.1 mL of 40%Soln	3 × 10 cm of arm	*An. stephensi*	100	8	[14]
		0.1 mL of 100%Soln		*Cx. quinquefasciatus*	100	1.6	[14]
				An. dirus	100	1.16	[14]
				Ae. aegypti	100	2	[14]
	Plant oil	100 μl of pure oil	30 cm^2 of arm	*Cx. quinquefasciatus*	100	1.66	[79]
Citrus sinensis	Fruit	0.1 mL of 10% Soln	30 cm^2 of arm	*Ae. aegypti*	100	0.51	[77]
	EO, N.I.	100 μl of pure oil	30 cm^2 of arm	*Ae. aegypti*	100	0.5	[79]
				Cx. quinquefasciatus	100	1	[79]
Curcuma longa	Plant Oil	100 μl of pure oil	30 cm^2 of arm	*Ae. aegypti*	100	0	[79]
				Cx. quinquefasciatus	100	2.14	[79]
Dianthus caryophyllum	Flower	10% Soln		*Ae. aegypti*	94	8	[42]
Eucalyptus globules	Leaf	0.1 mL of 10%Soln	30 cm^2 of arm	*Ae. aegypti*	100	1.36	[77]
Eucalyptus citriodora	N.I	100 μl of pure oil	30 cm^2 of arm	*Ae. aegypti*	100	0	[79]
				Cx. quinquefasciatus	100	0.5	[79]
Eugenia caryophyllus	Leaves	1 mL pure oil	Between wrist and elbow (650 cm^2)	*Ae. aegypti*	100	3.75	[53]
				An. albimantis	100	3.5	[53]
		0.1 mL of 100%Soln	3 × 10 cm	*Cx. quinquefasciatus*	100	4	[14]
				An. dirus	100	3.5	[14]
				Ae. aegypti	100	2	[14]
Ferronia elephantum	Leaves	1.0*, 2.5 mg/cm^2	25 cm^2	*Ae. aegypti*	100	2.14*	[80]
Glycine max		2%	Elbow to finger tips	*Ae. aegytpi*	100	1.58	[49]