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Table 1

An overview of repellent plant efficacy from literature review

Plant	Location	Other names	Repellent compound(s)	Tested mode of use	Repellency % protection	Study type	Ref
MYRTACEAE							
<i>Corymbia citriodora</i>	Australia	lemon	citronellal	30% PMD	96.88%	field study	[35]
	Brazil	eucalyptus	PMD (by	applied	protection from	in Bolivia	
	Bolivia	lemon	product of	topically	mosquitoes for 4		
	China	scented	hidrodistillation)		hours		
	India	gum	(p-menthane-	PMD	90% protection	laboratory	[95]
	Ethiopia	quwenling	3,8-diol)	towelette	from <i>An.</i>	study	
	Tanzania		citronellol	(0.575g)	<i>arabiensis</i> for 6		
	Kenya		limonene	applied	hours		
			geraniol	topically			
			isopulegol				
		δ-pinene	50% PMD	applied	100% protection	field study	[96]
			topically		from <i>An gambiae</i>	in	
					and <i>An. funestus</i>	Tanzania	
					for 6-7 hours		
				20% PMD	100% protection	laboratory	[52]
				(1.7	for 11-12 hours	study	
				mg/cm ²)	against <i>A.</i>		
				applied	<i>stephensi</i>		
				topically			
				20% PMD	100% protection	Laboratory	[42]
				applied	against <i>Ae.</i>	study	
				topically	<i>Aegypti</i> for 120		
					minutes		
				thermal	78.7 % protection	field study	[97]
				expulsion	from <i>An.</i>	in Ethiopia	
				(leaves)	<i>arabiensis</i>		
					76.8% protection		
					from <i>An.</i>		
					<i>pharaoensis</i>		
				direct	70.1 % protection	field study	[97]
				burning	from <i>An.</i>	in Ethiopia	

Plant	Location	Other names	Repellent compound(s)	Tested mode of use	Repellency % protection	Study type	Ref
				(leaves)	<i>arabiensis</i> 72.9% protection from <i>An.</i> <i>pharaoensis</i>		
				periodic thermal expulsion (leaves)	74.5% protection from <i>An. gambiae</i> s.s.	semi-field study in Kenya	[50]
				periodic direct burning (leaves)	51.3% protection from <i>An. gambiae</i> s.s.	semi-field study in Kenya	[50]
				thermal expulsion (leaves)	48.71% protection from <i>An. gambiae s.l.</i>	field study in Kenya	[98]
<i>Eucalyptus</i> spp.	Guinea-Bissau Ethiopia Tanzania Portugal	eucalyptus	1,8-cineole citronellal Z- and α - citral α -pinene	thermal expulsion (leaves)	72.2% protection from mosquitoes for 2 hours	field study in Guinea Bissau	[99]
<i>E. camaldulensis</i>	Ethiopia			thermal expulsion (leaves)	71.9 % protection from <i>An. arabiensis</i> 72.2% protection from <i>An. pharaoensis</i>	field study in Ethiopia	[97]
				direct burning (leaves)	65.3 % protection from <i>An. arabiensis</i> 66.6% protection from <i>An. pharaoensis</i>	field study in Ethiopia	[97]
<i>Eugenia caryophyllus</i> or <i>Syzygium aromaticum</i> or <i>Eugenia aromaticu</i>	India	clove lavang cravinho-da-india	Eugenol carvacrol thymol cinnamaldehyde	100% essential oil applied topically	100% protection against <i>Ae. aegypti</i> for 225 minutes 100% protection against <i>An. albimanus</i> for 213 minutes	laboratory study	[53]
				100% essential oil applied topically	100% protection against <i>Ae. aegypti</i> for 120 min. 100% protection	laboratory study	[23]

Plant	Location	Other names	Repellent compound(s)	Tested mode of use	Repellency % protection	Study type	Ref
					against <i>C. quinquefasciatus</i> for 240 min. 100% protection against <i>An. dirus</i> for 210 min.		
VERBENACEAE							
<i>Lippia</i> spp.	Kenya Tanzania Ghana Zimbabwe	lemon bush	myrcene linalool α -pinene eucalyptol				
<i>L. javanica</i>			alloparinol camphor limonene α -terpeneol verbenone	5mg/cm ² plant extract applied topically alcohol plant extract applied topically	100% protection against <i>Ae. aegypti</i> for 8 hours 76.7% protection against <i>An. arabiensis</i> for 4 hours	laboratory study laboratory study	[100] [101]
<i>L. uckambensis</i>		fever tea		potted plant periodic thermal expulsion (leaves) periodic direct burning (leaves) potted plant	33.3% protection against <i>An. gambiae</i> s.s. 45.9% protection against <i>An. gambiae</i> s.s. 33.4% protection against <i>An. gambiae</i> s.s. 25.01% protection against <i>An. gambiae</i> s.l.	semi-field study in Kenya semi-field system in Kenya semi-field system in Kenya field study in Kenya	[102] [50] [50] [98]
<i>L. cheraliera</i>			eucalyptol caryophyllene ipsdienone p-cymene				
<i>Lantana camara</i>	Kenya Tanzania	lantana spanish flag West Indian lantana	caryophyllene	potted plant potted plant	32.4% protection against <i>An. gambiae</i> s.s. 27.22% protection against <i>An. gambiae</i> s.l.	semi-field study in Kenya field study in Kenya	[102] [98]

Plant	Location	Other names	Repellent compound(s)	Tested mode of use	Repellency % protection	Study type	Ref
		Wild sage		flower extract in coconut oil	94.5% protection against <i>Ae. aegypti</i> and <i>Ae. albopictus</i> for one hour	laboratory study	[103]
				periodic thermal expulsion (leaves)	42.4% protection against <i>An. gambiae</i> s.s	semi-field study in Kenya	[50]
LAMIACEAE							
<i>Ocimum</i> spp.	Kenya	Tree basil	p-cymene	potted plant	39.70%	semi-field study in Kenya	[102]
<i>O. americanum</i>	Tanzania	nchu avum	estragosl		protection against <i>An. gambiae</i> s.s	field study	[98]
	Zimbabwe	lime basil	linalool				
	Nigeria	kivumbasi	linoleic acid	potted plant	37.91%	field study in Kenya	[98]
	Ghana	Myeni	eucalyptol		protection against <i>An. gambiae</i> s.l.		
	Cameroon	madongo	eugenol				
	Eritrea	African	camphor				
	Ethiopia (...)	blue basil	citral	fresh plants combined with <i>O. suave</i> bruised and applied topically	50% protection against <i>An. gambiae</i> s.l.	field study in Tanzania	[104]
		hairy basil	thujone limonene ocimene and others				
				periodic thermal expulsion (leaves and seeds)	43.1.% protection against <i>An. gambiae</i> s.s	semi-field study in Kenya	[50]
				periodic direct burning (leaves and seeds)	20.9% protection against <i>An. gambiae</i> s.s	semi-field study in Kenya	[50]
				100% essential oil combined with vanillin 5% applied topically	100% protection against <i>Ae. aegypti</i> for 6.5 hours 100% protection against <i>C. quinquefasciatus</i> for 8 hours 100% protection against <i>An. dirus</i> for 8 hours	laboratory study	[26]

Plant	Location	Other names	Repellent compound(s)	Tested mode of use	Repellency % protection	Study type	Ref
<i>O. suave</i>				thermal expulsion (leaves)	73.6 % protection from <i>An. arabiensis</i> 75.1% protection from <i>An. pharaoensis</i>	field study in Ethiopia	[97]
				direct burning (leaves)	71.5 % protection from <i>An. arabiensis</i> 79.7% protection from <i>An. pharaoensis</i>	field study in Ethiopia	[97]
				periodic thermal expulsion (leaves and seeds)	53.1% protection from <i>An. gambiae</i> s.s.	semi-field study in Kenya	[50]
				periodic direct burning (leaves and seeds)	28.0% protection from <i>An. gambiae</i> s.s.	semi-field study in Kenya	[50]
<i>O. basilicum</i>				thermal expulsion (leaves)	78.7 % protection from <i>An. arabiensis</i> 79.2% protection from <i>An. pharaoensis</i>	field study in Ethiopia	[97]
				direct burning (leaves)	73.1 % protection from <i>An. arabiensis</i> 70.0% protection from <i>An. pharaoensis</i>	field study in Ethiopia	[97]
				100% essential oil applied topically	100% protection for 70 minutes	laboratory study	[23]
<i>O. kilimandscharikum</i>				thermal expulsion (leaves and seeds)	44.54% protection against <i>An. gambiae</i> s.l.	field study in Kenya	[98]
				thermal expulsion (leaves and seeds)	37.63% protection against <i>An. funestus</i>	field study in Kenya	[98]

Plant	Location	Other names	Repellent compound(s)	Tested mode of use	Repellency % protection	Study type	Ref
				seeds)			
				periodic thermal expulsion (leaves and seeds)	52.0% protection against <i>An. gambiae</i> s.s.	semi-field study in Kenya	[50]
				periodic direct burning (leaves and seeds)	26.4% protection against <i>An. gambiae</i> s.s.	semi-field study in Kenya	[50]
<i>O. forskolei</i>				fresh plants hung indoors	53% protection against mosquitoes entering human dwelling	field study in Eritrea	[105]
<i>Hyptis spp. Hyptis suaveolens</i>	Kenya Tanzania Ghana The Gambiae	bushmint wild hops wild spikenard hangazimu hortelã-do-campo	myrcene	smouldering on charcoal fresh leaves	85.4% repellency against mosquitoes for 2 hours 73.2% repellency against mosquitoes for 2 hours	field study in Guinea Bissau field study in Guinea Bissau	[99] [99]
				periodic direct burning (leaves and flowers)	20.8% repellency against <i>An. gambiae</i> s.s.	semi-field study in Kenya	[50]
<i>Mentha spp. M. piperata</i>	Brazil Bolivia	hortelã-do-campo peppermint		100% essential oil applied topically	100% protection against <i>Ae. aegypti</i> for 45 minutes	laboratory study	[53]
<i>M. arvensis</i>		menta Japanese mint		100% essential oil volatilized in a kerosene lamp	41% protection indoors against <i>Mansonia</i> spp	field study in Bolivia	[9]
<i>Thymus spp. Th. vulgaris</i>	China Former Soviet Union Korea Middle-East Mediterranean	thyme	α -terpinene carvacrol thymol p-cymene linalool geraniol	α -terpinene topically carvacrol topically	97.3% protection against <i>Culex pipiens fallens</i> for 82 min 94.7% protection against <i>C. pipiens fallens</i> for 80 min	laboratory study	[106]

Plant	Location	Other names	Repellent compound(s)	Tested mode of use	Repellency % protection	Study type	Ref
				thymol topically	91.8% protection against <i>C. pipiens sallens</i> for 70 min	laboratory study	[106]
				linalool topically	91.7% protection against <i>C. pipiens sallens</i> for 65 min		
				p-cymene	89.0% protection against <i>C. pipiens sallens</i> for 45.2 min		
				100% essential oil applied topically	100% protection against <i>An. albimanus</i> for 105 minutes and <i>Ae. aegypti</i> for 135 minutes	laboratory study	[53]
				direct burning (leaves)	85-09% protection for 60-90 min	field study	[12]
<i>Pogostemon spp.</i>	China	Patchouli		100% essential oil applied	100% protection against <i>Ae. aegypti</i> for 120 min	laboratory study	[23]
<i>Pogostemon cablin</i>	India Malaysia Thailand	Oriza		topically	100% protection against <i>C. quinquefasciatus</i> for 150 min 100% protection against <i>An. dirus</i> for 710 minutes		
POACEAE							
<i>Cymbopogon spp.</i>	China India Indonesia						
<i>C. nardus</i>	Brazil		citronellal	40% essential oil applied topically	100% protection for 7-8 hours against <i>An. stephensi</i>	laboratory study	[52]
				100% essential oil applied topically	100% protection against <i>Ae. aegypti</i> for 120 min 100% protection against <i>C. quinquefasciatus</i>	laboratory study	[23]

Plant	Location	Other names	Repellent compound(s)	Tested mode of use	Repellency % protection	Study type	Ref
					for 100 min 100% protection against <i>An. dirus</i> for 70 minutes		
				10% applied topically	100% protection against <i>Ae. aegypti</i> for 20 minutes	laboratory study	[42]
<i>C. martini</i>	Tanzania Kenya	palmarosa	geraniol	topically (100% essential oil)	100% protection against <i>An. culicifacies</i> for 12 hours 96.3% protection against <i>C. quinquefasciatus</i> for 12 hours	field study in India	[107]
				topically (100% essential oil)	98.8% protection against <i>C. quinquefasciatus</i> for 10 hours	laboratory study	[107]
<i>C. citratus</i>	USA South Africa Bolivia	lemongrass oil grass	citral α -pinene	topically	74% protection against <i>An. darlingi</i> for 2.5h 95% protection against <i>Mansonia</i> spp. for 2.5 hours	field study in Bolivia	[9]
				Methanol leaf extract applied topically (2.5mg/m ²)	78.8 % protection against <i>An. arabiensis</i> for 12 hours	laboratory study	[108]
				100% essential oil applied topically	100% protection for 30 minutes	laboratory study	[23]
<i>C. winterianus</i>				100% essential oil combined with vanillin 5% applied topically	100% protection against <i>Ae. aegypti</i> for 6.5 hours 100% protection against <i>C. quinquefasciatus</i> for 8 hours 100% protection against <i>An. dirus</i> for 8 hours	laboratory study	[26]

Plant	Location	Other names	Repellent compound(s)	Tested mode of use	Repellency % protection	Study type	Ref	
<i>C. excavatus</i>				alcohol plant extract applied topically	66.7% protection against <i>An. arabiensis</i> for 3 hours	laboratory study	[101]	
<i>Pelargonium reniforme</i>		rose geranium		alcohol plant extract applied topically	63.3 protection against <i>An. arabiensis</i> for 3 hours	laboratory study	[101]	
MELIACEAE								
<i>Azadirachta indica</i>	India	Neem	azadirachtin saponins	direct	76.0% protection from mosquitoes for 2 hours	field study in Guinea Bissau	[99]	
	Sri Lanka			burning (leaves)		24.5% protection from <i>An. gambiae</i> s.s	semi-field study in Kenya	[50]
	China			periodic thermal expulsion (leaves)				
	Brazil Bolivia			1% neem oil volatilized in a kerosene lamp				
Pakistan	Ethiopia	Guinea Bissau	Kenya	Tanzania (...)	2% neem oil applied topically	80% protection from <i>Culex</i> spp.	field study in Bolivia	[35]
ASTERACEAE								
<i>Tagetes minuta</i>	Uganda	Khaki weed		topically	86.4% protection against <i>An. stephensi</i> for 6 hours	laboratory study	[110]	
	Zimbabwe			topically		84.2% protection against <i>C. quinquefasciatus</i> for 6 hours	laboratory study	[110]
	India			topically		75% protection against <i>Ae. aegypti</i> for 6 hours	laboratory study	[110]
				fresh leaves (4Kg)		reduced human landings indoors	field study in Uganda	[111]
<i>Artemisia</i> spp.	India	mugwort	camphor					
<i>A. vulgaris</i>	Egypt	wormwood	linalool					
	Italy	St. Johns plant	terpenen-4-ol					
	Canada	plant	α -and β -thujone					

Plant	Location	Other names	Repellent compound(s)	Tested mode of use	Repellency % protection	Study type	Ref
	USA	Old uncle henry Sailors tobacco	β -pinene				
<i>A. monosperma</i>	Siberia Brazil	Felon herb Naughty man	myrcene limonene cineol	5% leave extract applied topically	100 % protection for 4 hours	field study in Egypt	112
CAESALPINIACEAE							
<i>Daniellia oliveri</i>	Guinea-Bissau The Gambiae	churai santão santang santango		direct burning (bark)	77.9% protection against mosquitoes for 2 hours	field study in Guinea Bissau	[99]
				direct burning (bark)	77% protection against mosquitoes	field study in The Gambiae	113
FABACEAE <i>Glycine max</i>	Worldwide	Soya		2% soya bean oil	100% protection against <i>Ae. aegypti</i> for 95 minutes	laboratory study	[42]
RUTACEAE <i>Zanthoxylum limonella</i>	Thailand	makaen		100% essential oil applied topically	100% protection against <i>Ae. aegypti</i> for 120 min 100% protection against <i>C. quinquefasciatus</i> for 170 min	laboratory study	[23]
				10% essential oil combined with 10% clove oil	100% protection against <i>An. dirus</i> for 190 minutes	laboratory study	[52]
<i>Citrus hystrix</i>	Indonesia Malaysia Thailand Laos	Kaffir lime Limau purut		100% essential oil combined with vanillin 5% applied topically	100% protection against <i>An. stephensi</i> for 8 hours 100% protection against <i>Ae. aegypti</i> for 3 hours 100% protection against <i>C. quinquefasciatus</i> for 1.5 hours	laboratory study	[26]

Plant	Location	Other names	Repellent compound(s)	Tested mode of use	Repellency % protection	Study type	Ref
					100% protection against <i>An. dirus</i> for 2.5 hours		
ZINGIBERACEAE <i>Curcuma longa</i>		Turmeric Curcuma Indian saffron		100% essential oil combined with vanillin 5% applied topically	100% protection against <i>Ae. aegypti</i> for 4.5 hours 100% protection against <i>C. quinquefasciatus</i> for 8 hours 100% protection against <i>An. dirus</i> for 8 hours	laboratory study	[26]