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Ethnobotanical survey of knowledge and usage custom of traditional insect/mosquito repellent plants among the Ethiopian Oromo ethnic group

Kaliyaperumal Karunamoorthi [a,b,*], Kandan Ilango [c], Aschalew Endale [a]

[a] Unit of Vector Biology & Control, School of Environmental Health Science, Faculty of Public Health, Jimma University, P.O. Box No. 378, Jimma, Ethiopia
[b] Research and Development Center, Bharathiar University, Coimbatore, Tamil Nadu, India
[c] Zoological Survey of India, Tamil Nadu, Chennai, India

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ABSTRACT

Aim of the study: Repellent plants usage is an integral part of Ethiopian tradition and has been practiced over many centuries. Hence, the aim of this study was to assess the knowledge and usage custom of traditional insect/mosquito repellent plants among the Oromo ethnic group in Ethiopia.
Materials and methods: The ethnobotanical survey was conducted between January and March 2009. All 276 household members were interviewed on knowledge and usage custom of traditional repellent plants, using a pre-tested questionnaire in Kofe kebele, Jimma zone, Ethiopia.
Results and Conclusion: 83.6% respondents had adequate knowledge and usage custom regarding insect/mosquito repellent plants. Application of smoke by burning the repellent plant materials was the most common practice. The chi-square test result revealed that there was no statistically significant association found between the knowledge about insect repellent plants and sex (p-value = 0.8912), educational status (p-value = 0.7504), and age (p-value = 0.1631) of the respondents. However, usage custom of repellent plants was significantly associated with sex (p-value = 0.0002) and average monthly income (p-value = 0.0001) although not with educational status (p-value = 0.5206) of the respondents. Repellent efficacy of these plants is undetermined and therefore the scientific validity should be evaluated by conducting further laboratory and field research. Majority of the repellent plants have been used as medicine to treat various ailments by the local community. Furthermore, they are easily available, accessible and affordable therefore usage of traditional repellent plants should be promoted among the local residents in order to reduce vector-borne disease prevalence.

1. Introduction

Insect-transmitted diseases impose an enormous burden on the world's population in terms of loss of life (millions of deaths per year) and morbidity (Jacobs-lorena and James, 2002). Malaria afflicts 90 countries and territories in the tropical and subtropical regions and almost one half of them are in Africa, South of Sahara. The World Health Organization estimates 300–500 million malaria cases annually, with 90% of this burden being in Africa (Breman, 2001; Snow et al., 2005).

Despite significant efforts to control malaria in Ethiopia since 1950s, the disease remains one of the top public health problems in the country. An estimated 68% (50 million people) of the population lives in areas at risk of malaria. Malaria was reported as the primary cause of health problems in 2004–2005 accounting for 17% of out-patient visits, 15% of hospital admissions and 29% of in-patient deaths (CSA, 2006).

Repellents have an important place in protecting man from the bites of insect pests (Kalyanasundaram, 1991). Insect repellents have a unique role in regions where mosquito vectors bite in the early evening since people are often outdoors at this time. Repellents may therefore provide a valuable supplement to bed net use (Moore, 2004). In many parts of the world, plant-derived natural products have traditionally been used as repellents against insects, primarily to avoid annoying biting (Curtis et al., 1991).

Plants have been used since ancient times to repel/kill blood-sucking insects in the human history and even now, in many parts of the world people are using plant substances to repel/kill the mosquitoes and other blood-sucking insects. We are all just around the corner to reinstate chemical substances derived from plants (Karunamoorthi et al., 2008b). There are several plants in sub-Saharan Africa reported to have effective repellent effects against arthropods of vector-borne disease (Curtis et al., 1991; Berger, 1994; Berger and Curtis, 1995; Palsson and Jaenson, 1999). Some of these plants, for example citronella and pyrethrum, have been commer-

* Corresponding author. Tel.: +91 9786956123/+251 913547847; fax: +251 0471111450.
E-mail address: k_karunamoorthi@yahoo.com (K. Karunamoorthi).

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cialised and are effectively used as mosquito repellents (Curtis et al., 1991).

Repellents of plant origin do not pose hazards of toxicity to human and domestic animals and are easily biodegradable (Sharma et al., 1993; Sharma and Ansari, 1994). Local plants with repellent or insecticidal action may play an important role in regions where mosquitoes are biting in the early evening or in situations when there are no enough bed nets to cover all the beds in a house. Burning plants to make smoke or hanging fresh plants to deter nuisance-biting insects entering or resting in houses is widespread in rural communities in Africa (Waka et al., 2004).

Information regarding the links between socioeconomic factors, knowledge and usage custom of traditional insect/mosquito repellent plants, remarkably among unprivileged section of the society in Africa particularly in Ethiopia, is limited (Karunamoorthi et al., 2009). Besides, at the moment repellent of plants origin have been receiving massive attention due to their environmental and user friendly nature and its demands more scientific survey in order to identify a new repellent or an insecticidal plants.

Repellent plants usage custom is a result of thousands of years of experience. This expertise has been passed down many generations chiefly through word of mouth. This mode of information conveyance may result in distortion or loss of indigenous knowledge and usage custom of repellent plants. Therefore, right now documenting and safeguarding these practices are become crucial core issues. Thus, the purpose of this study was to assess the knowledge and usage custom of traditional insect/mosquito repellent plants among the indigenous Ethiopian Oromo ethnic group.

2. Materials and methods

2.1. Description of the ethnobotanical survey area

Kofe kebele is located 359 km away from Addis Ababa, the federal capital city and 7 km south west of Jimma town, Ethiopia. The town altitude about 1850 m above the sea level and mean annual temperature is 18.5 °C. The area has an estimated total number of households and population of 276 and 4875, respectively. The community members are predominantly farmers however, few people involved in pottery profession also. People in clustered homesteads and the typical house are surrounded by a plot of land where maize, millet, false banana, cabbage and pepper are grown.

Houses are traditional tukuls built from mud and covered with thatched roofs. A few relatively wealthier people have houses with roofs of corrugated iron sheet. Malaria is one of the leading causes of morbidity and mortality in the study area. Because of prolonged period of exposure to malaria, the residents have traditionally been applying several repellent plants to drive away biting insects.

2.2. Interview

The interview was carried out by involving all the 276 household members in the study area. To improve the quality of the data, pretesting of the questionnaire was carried out prior to the actual data collection. The questionnaire was tested on ten respondents by the enumerators, in an area different from the study area, but with the similar sociodemographic pattern. One adult from each household was interviewed on the knowledge and traditional uses of repellent plants, using a pre-tested questionnaire specifically designed for this purpose. Male and female respondents from all age-groups were included. To minimize bias information and variables the questionnaire prepared in English language was translated into native local language Oromifa to make it easy to understand and to administer by interviewers and interviewees.

2.3. Ethical considerations

The study was approved by the ethical clearance committee of the Jimma University, Jimma, Ethiopia. Before the commencement of the survey, meetings with community health workers, community leaders and members of the neighbourhood associations were held in which the objectives of the survey were clearly explained. Written consent was obtained from each study participant. Every participant was assured to withdraw the interview at any phase if they wish to do so. However, all the informants were actively involved and no one declined to finish the interview.

2.4. Ethnobotanical data collection

The ethnobotanical survey was carried out from January 2009 to March 2009. A team of well-trained and closely supervised local interviewers conducted the household survey using a pre-tested questionnaire to interview with representative of each household. Interviewers were collected regarding sociodemographic and ethnobotanical data. They were asked to give their knowledge and usage custom about the repellent plants. The main questions focused on (1) usage and knowledge of insect repellent plants, (2) names of plants used or known, (3) insects against which the plants are used, (4) methods of application, and (5) parts of the plant material used as mosquito repellent.

The authors also made observations in the field on the general habitats and the traditional repellent plants collected by accompanying traditional users, translators and field assistants. Specimens of the reported repellent plants were collected during regular walk in the fields. The collected voucher specimens were pressed, numbered, dried, identified and deposited at Jimma University Regional Herbarium and The National Herbarium (ETH) in Addis Ababa University. Identification of specimens was made with the help of herbarium materials, experts and taxonomic keys in the Flora of Ethiopia and Eritrea (Hedberg and Edwards, 1989, 1995; Edwards et al., 1995, 1997, 2000; Hedberg et al., 2003, 2004).

2.5. Statistical analysis

Statistical analysis was carried out using SPSS, version 9.0. Range and mean were analysed and appropriate tables, graphs and percentage were displayed. Level of significance also determined by using 95% of confidence intervals and p-value.

3. Results

3.1. Sociodemographic characteristics of respondents

Sociodemographic characteristics of respondents are shown in Table 1. In the present survey, female respondents constituted 58.7%. Age of the respondents was ranging from $\leq$18 to $\geq$46 years. Just less than half respondents were illiterate (48.9%). The majority of the informants (43.9%) monthly income between 401 and 600 Ethiopian Birr (1$ = 9.99 Eth. Birr). Overall, 83.6% respondents had adequate knowledge and usage custom regarding insect/mosquito repellent plants (Table 1).

3.2. Knowledge of insect/mosquito repellent plants

Ethnobotanical survey results revealed that about nine types of various traditional repellent plants have been most commonly known and used by the local community members in order to drive away and avoid insect/mosquito bites. Just two plants were cited by only one informant and they are known for their fish poisoning activity and not for their repellent properties, therefore they were not included. However, these nine plants are mentioned by more

Table 1
Study of respondents with gender, age, educational status, average monthly income, occupation and knowledge of insect/mosquito repellent plants among the Oromo ethnic group in Ethiopia.

Variables	Frequency	%
Gender		
Male	114	41.3
Female	162	58.7
Age in years		
≤18	7	2.5
19–25	55	19.9
26–30	64	23.1
31–35	96	35.5
36–40	26	9.3
40–45	15	5.3
≥46	13	4.4
Educational status		
Illiterate	135	48.9
1–5th grade	63	22.8
6–10th grade	74	26.8
11–12th grade	4	1.5
Monthly income (Ethiopian Birr)[a]		
<200	11	3.9
201–400	73	26.4
401–600	121	43.9
601–800	48	17.4
801–1000	12	4.5
>1000	11	3.9
Knowledge of insect/mosquito repellent plants		
Yes	231	83.6
No	45	16.4

[a] 1$ = 9.98 Ethiopian Birr.

than one informant as effective against insects/mosquitoes and are listed in Table 2. The most commonly known repellent plants among the local inhabitants are compiled in Table 2 (vernacular names are written in local native language Amharic) etan, kebercho, bisana, neem tree, baya, woira, nech bahir zaf, tid and tej sar.

In addition, the survey also indicated that nearly almost all respondents had easy accessibility and affordability of traditional insect/mosquito repellent plants. All respondents (100%) admitted that nech bahir zaf is extremely accessible as well as affordable. 90.1% of the participants indicated that bisana is easily accessible, while the least accessible is etan. In terms of affordability, the majority of the study participants mentioned that nearly all repellent plan materials are affordable (Table 2).

3.3. Traditional usage custom of insect/mosquito repellent plants

There are various types of application methods adapted by the local community in order to repel the insects/mosquitoes. Application of smoke by burning the plant parts (materials) was one of the most common practices. Nearly all repellent plants materials are burned on a charcoal fire. For example, smoke from burning tej sar fresh leaves is used for covering the floor while neem trees are grown nearby the house and a suspension made of crushed leaves from this plant is sprayed to drive away mosquitoes and other flies as common tradition and custom among the community members (Table 3).

Woira plants are used to produce smoke or hanged on the walls as an ancient custom in the study area. With respect to which parts of the plant material are used as insect/mosquito repellent or to drive away biting insects, the study participants prefer dried leaves followed by the stem. 78.9% of the respondents mentioned that the oleo-gum resin of the plant etan is a popular choice to use against mosquitoes, cockroaches and other flies. Frankincense or olibanum in an oleo-gum resin obtained by tapping etan trees, which is a native plant from Ethiopia (Table 3).

The association between respondent's knowledge and usage custom of insect repellent plants with their educational status, gender, age and monthly income were tested with chi-square analysis and the results are given in Table 4.

4. Discussion

Malaria is one of the major public health problems in Ethiopia. The results of the ethnobotanical survey conducted to assess the traditional knowledge and usage custom of repellent plants to drive away insects among the Oromo ethnic group in Ethiopia clearly revealed that the local inhabitants (83.6%) had ample knowledge and usage custom concerning repellent plants. The study area is one of the major malaria endemic villages in Jimma zone and therefore the knowledge about malaria and importance of repellent plant usage is high among the community members. However, the level of knowledge and usage custom is slightly poorer than a study conducted in Ethiopia, in which 97.2% of the respondents had ample knowledge and usage custom concerning traditional insect/mosquito repellent plants (Karunamoorthi et al., 2009).

The majority of the respondents indicated that they had easy accessibility and affordability of traditional repellent plants. The study area is situated adjacent to a mountainous area and it is supplied with several repellent plants, which are freely available almost throughout the year. Therefore, the local residents easily and freely can obtain the repellent plants. As a result, accessibility and affordability of repellent plants are exceptionally very high among the local residents.

Moreover, using traditional repellent plants to drive away biting insects in Ethiopia is part of their tradition and culture. 53.2% of the participants point out that the least accessible plant is etan (*Boswellia papyrifera*). In Ethiopia, it is distributed in the northern, western and central parts of the country, including Tigray, Gonder, Gojam, Welega, Welo and Shewa regions (Bekele et al., 1993; Chikamai, 2002).

Table 2
Information on repellent plants from ethnobotanical survey in relation with accessibility and affordability between January and March 2009.

Plant species	Vernacular name	Voucher number	Frequency	Percent[a]	Accessibility		Affordability	
					Yes (%)	No (%)	Yes (%)	No (%)
Boswellia papyrifera (Del.) Hochst	Etan	AEG7	218	78.9	116 (53.2)	102 (46.8)	154 (70.6)	64 (29.4)
Echinops species	Kebercho	AEG9	182	65.9	110 (60.4)	72 (39.6)	159 (87.3)	23 (12.7)
Croton macrostachyus Del.	Bisana	AEG4	163	59.0	147 (90.1)	16 (9.9)	141 (86.5)	22 (13.5)
Melia azedarach L.	Neem	AEG5	97	35.1	71 (73.1)	26 (26.9)	64 (65.9)	33 (34.1)
Olea welwitschii (Knobl.) Gilg & Schellenb	Baya	AEG1	65	23.5	55 (84.6)	10 (15.4)	49 (75.3)	16 (24.7)
Olea europaea L.	Woira	AEG8	53	19.2	40 (75.4)	13 (24.6)	46 (86.7)	7 (13.3)
Eucalyptus globulus Labill.	Nech bahir zaf	AEG3	26	9.4	26 (100)	0 (0)	26 (100)	0 (0)
Cupressus lusitanica Mill.	Tid	AEG2	17	6.1	11 (64.7)	6 (35.3)	17 (100)	0 (0)
Cymbopogon citratus (*DC.ex.Nees*) *Stapf*	Tej sar	AEG6	79	28.2	53 (67.0)	8 (33.0)	66 (83.5)	13 (16.5)

[a] Percent do not add up to 100, because of multiple responses.

Table 3
Information on repellent plants from ethnobotanical survey in relation with repellent plant parts used, method of application and types of insects repelled between January and March 2009.

Family name	Plant scientific names	Vernacular name	Frequency	%	Part used	Method of application	Types of insects (taxa) repelled
Burseraceae	*Boswellia papyrifera* (Del.) Hochst	Etan	218	78.9	Resin	Smoke	Culicidae, Dictyoptera and other Diptera
Asteraceae	*Echinops* species	Kebercho	182	65.9	Roots	Smoke	Culicidae, Cimicidae and other Diptera
Euphorbiaceae	*Croton macrostachyus* Del.	Bisana	163	59.0	Leaves	Smoke	Culicidae and Dictyoptera
Meliaceae	*Melia azedarach* L.	Neem tree	97	35.1	Leaves	Growing plant nearby houses and leaf suspension	Culicidae, Muscidae and Siphonaptera
Oleaceae	*Olea welwitschii* (Knobl.) Gilg and Schellenb	Baya	65	23.5	Stem	Smoke	Culicidae and other Diptera
Oleaceae	*Olea europaea* L.	Woira	53	19.2	Stem and leaves	Smoke	Culicidae and other Diptera
Myrtaceae	*Eucalyptus globulus* Labill.	Nech bahir zaf	26	09.4	Leaves and parks	Smoke	Culicidae and other Diptera
Cupressaceae	*Cupressus lusitanica* Mill.	Tid	17	06.1	Leaves	Smoke	Culicidae and other Diptera
Poaceae	*Cymbopogon citratus* (*DC.ex.Nees*) *Stapf*	Tej sar	79	28.2	Leaves	Smoke	Culicidae, Siphonaptera and Phthraptera

Even though etan is a native plant of Ethiopia, it is not present in the study area, but procuring the plant material (resin) from the market is very easy and affordable. The existing modern synthetic chemical repellents are generally more expensive. Besides their toxicity, adverse side effect and few of them require electricity for their usage. Traditional repellent plant products are extremely useful essentially in the inaccessible rural areas, where there is lack of electricity (Karunamoorthi et al., 2008a).

The study final results demonstrated that the local community members are burning almost all repellent plants in order to making smoke to avoid insects/mosquitoes menace and prevent disease transmission. The result of this study is consistent with a study was carried out in Eritrea which found that fresh twigs of *Otostegia integrifolia* and *Nicotiana glauca* are burned on a charcoal fire overnight to drive away biting insects (Waka et al., 2004). A study from rural Guatemala found that >90% of households interviewed burned waste plant materials such as coconut husks to drive away mosquitoes (Klein et al., 1995). In the Western Pacific, in Papua New Guinea, wood is burned in the early evening by up to 90% of the population and was shown to repel 66–84% of the vector *Anopheles karwari* as well as nuisance culicines (Vernede et al., 1994). Another study was conducted in Ethiopia which found that application of smoke by burning the plant parts was one of the common practices among the inhabitants, thus accounts 91.5% (Karunamoorthi et al., 2009).

Up to 100% of Kenyans burned plants to repel mosquitoes (Seyoum et al., 2002), and in Guinea Bissau 55% of people burned plants or hung them in the home to repel mosquitoes (Palsson and

Table 4
Knowledge and usage custom of insect/mosquito repellent plants in relation with gender, educational status, age and monthly income of the respondents among the Oromo ethnic group in Ethiopia.

Sex, educational status, age and monthly income of the respondents	Total number of respondents	Knowledge towards insect/mosquito repellent plants		*p*-Value	Usage custom of insect/mosquito repellent plants		*p*-Value
		Yes	No		Yes	No	
Gender							
Male	114	95	19	$\chi^2 = 0.0200^*$ $df = 1$, $p = 0.8912$	72	42	$\chi^2 = 13.52$, $df = 1$, $p = 0.0002^*$
Female	162	136	26		134	28	
Educational status							
Illiterate	135	89	46	$\chi^2 = 1.21$, $df = 3$, $p = 0.7504$	62	73	$\chi^2 = 2.26$, $df = 3$, $p = 0.5206$
1–5th grade	63	37	26		23	40	
6–10th grade	74	48	26		28	46	
11–12th grade	4	3	1		2	2	
Age in years							
≤18	7	5	2	$\chi^2 = 9.19$, $df = 6$, $p = 0.1631$			
19–25	55	28	27				
26–30	64	39	25				
31–35	96	65	31				
36–40	26	17	9				
40–45	15	12	3				
≥46	13	11	2				
Monthly income							
<200	11				7	4	$\chi^2 = 45.17$, $df = 5$, $p = 0.0001^*$
201–400	73				51	22	
401–600	121				67	54	
601–800	48				9	39	
801–1000	12				2	10	
>1000	11				1	10	

$^*p < 0.05$ statistically significant.

Jaenson, 1999). During our field survey we have witnessed in several occasions that the great majority of the local inhabitants used to burn repellent plants materials to make smoke in order to avoid insect's nuisance nearly every day evening hours. Among poorer section of the society that cannot afford shop-bought personal protection methods and therefore application of smoke by burning the repellent plant parts is one of the common practices among the local inhabitants.

Besides smoking *Olea europaea* plants have been used for hanging on the walls and windows and *Cymbopogon citratus* fresh leaves have been used for covering the floor, both being ancient practice and customs in Ethiopia. In addition, growing the plant *Melia azedarach* nearby houses and spraying the crushed-leaf suspension to drive away mosquitoes and other flies, is another custom. This is consistent with the study of Karunamoorthi et al. (2009) which shows the applications like spraying the extracts by crushing of grinding the repellent plant parts, hanging and sprinkling the leaves of repellent plant on the floor is more common in Ethiopia. In addition, the result is comparable with a earlier report which found that the traditional way of using *Salvia schimperi* against fleas is covering the whole floor of a house with its fresh leaves and flowers (Waka et al., 2004).

The results in this study were consistent with those in a study conducted in Ethiopia which found that spraying the extracts of repellent plant parts by crushing or grinding accounts for 7.53%, while hanging and sprinkling the leaves of repellent plants on the floor accounts for 0.86% and 0.11%, respectively (Karunamoorthi et al., 2009). Similarly, the effect of fresh leaves and shoots of *Ocimum forskolei* hanging on walls at the head and foot of beds was tested in Eritrea against *Anopheles arabiensis* and 53% reduction in mean number of mosquitoes per house was achieved (Waka et al., 2004).

The chi-square test result shows that there was no significant difference observed in the knowledge of the repellent plants between the sex, educational status and age of respondents. The p-value for sex, educational status and age of the respondents were 0.8912, 0.7504, and 0.1631, respectively. This suggests that the plants are well known by all members in the community irrespective of their sex, educational status and age. However, repellent plants usage custom is significantly associated with sex (p-value = 0.0002) and average monthly income (p-value = 0.0001) of the respondents but, there was no significant relationship (p-value = 0.5206) between the educational status and repellent plants usage custom. The present study results are consistent with those of an earlier study carried out to assess the knowledge and usage custom of traditional repellent plants, in which it was found that there, was no significant relationship (p = 0.099) between the age of respondents and knowledge and usage custom concerning insect repellent plants (Karunamoorthi et al., 2009).

5. Conclusion

Indeed usage of repellent plants to drive away biting insects and prevent vector-borne disease transmission is an ancient practice in Africa, particularly in country like Ethiopia. The present ethnobotanical survey results advocate that the local inhabitants had ample knowledge and usage custom of traditional repellent plants. However efficacy of these repellent plants is undetermined and therefore the scientific validity and their efficiency to reduce the man–vector contact should be evaluated by conducting further laboratory and field research. The majority of these repellent plants have been used as medicine to treat various ailments by the local community. Furthermore, they are easily available, accessible and affordable therefore the usage of traditional repellent plants should be promoted among the local residents in order to reduce the man–vector contact as well as vector-borne diseases.

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