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Plants Used to Control Mosquitoes and Treat Mosquito Related Diseases in Maasai-land of Longido District, Tanzania

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Authors' contributions

This work was carried out in collaboration between all authors. Authors EI and SA designed the study, performed fieldwork and the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author WK contributed to study conception, design, revision and final approval of the manuscript.

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ABSTRACT

Aim: This paper provides an understanding of the ethnobotanical knowledge of medicinal plants used to control mosquitoes and handle mosquito related diseases among the Maasai living in Olmolog and Engarenaibo division of Longido district, Arusha, Tanzania.
Methods: Data were collected between March, 2014 to March, 2015 through semi-structured questionnaires involving male and female heads of the households (Bomas), participant observations, as well as focus group discussions (FGD) with knowledgeable tribe leaders (Leingwenanis) and other key informants in the area. Qualitative and quantitative data analysis was done using the Statistical Package for Social Science and Ms Excel computer software tools. A total of 174 participants were interviewed on the use of ethno-medicine to control mosquitoes and treat mosquito related diseases.

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Results: About 35% of the respondents indicate to use treated bednets while 41% of interviewed respondents mentioned to use combination of methods including keeping home premises clean, followed by only a few (2%) who claimed to use repellent plants/herbs. Knowledge on medicinal plants used for malaria remedies was immense, and seemed to be a preferred treatment before consulting medical personnels. This was evident in FGD where the Maasai communities indicated to rely more on malaria parasite treatment by taking some herbal remedies that clears the parasites in the blood than using plants for controlling/killing mosquitoes. Majority of respondents were aware of diseases caused by mosquitoes with frequency mention of malaria (75%). *Tagetes minuta* (Nang'ongudeyo), *Cynodon plectostachyus* (Emurua) and *Azadirachta indica* (Mwarobaini) were frequently metioned as mosquito repellent plants and obtained from the study areas. Likewise, *Salvadora persica* (Oremit/Mswaki) and *Osyris abyssinica* (Olesai) were highly ranked as effective anti-malarial plants.

Conclusion: There is great need to conserve the documented plant species used in control of mosquitoes and treat mosquito related diseases in the area concurrently preserving the indigenous knowledge amidst a rapidly changing Maasai society as well as unpredicted climate changes.

Keywords: Ethnobotany; mosquito control; mosquito related diseases; Maasai; Longido district.

1. INTRODUCTION

Medicinal plants play a crucial role in health care needs of people around the world especially in developing countries [1,2]. Communities, through time, have discovered innumerable plant species with various medicinal uses, and accumulated considerable ethnobotanical knowledge to enhance the quality of their lives. These plant species form an essential contribution to health care, providing the only effective medicine for the significant proportions of the population, where other forms of medication are either unavailable or unaffordable [2]. An estimated 80% of the population in Africa rely largely on these plant-based drugs for their primary health care needs, and in coming decades a similar percentage of the world population may well rely on plant-based medicines [2]. Medicinal plants also play a key role in the development and advancement of modern medicine by serving as a starting point for the development of novelties in drug discoveries [3] with approximatedy 25% of drugs being derived from plants and many others are synthetic analogues built on prototype compounds isolated from plants. According to Mesfin et al. [4] traditional knowledge of medicinal plants and their use by indigenous healers and communities are not only useful in planning for conservation of cultural and biodiversity but also for community health care and drug development. In Tanzania rural societies, the use of medicinal plants exists to provide alternative and as a primary health care systems, despite the presence of modern healthcare systems. For the Maasai societies, medicinal plant resources are valuable resources and a neccessity due to their normadic life style. The Maasai are highly involved in migratory herding looking for water bodies and grazing land for their cattles and therefore highly susceptible to mosquito attack. In most cases, due to inadequate health services centres they rely on medicinal plants. The Maasai are well known to use medicinal plants to handle both human and livestock diseases, however, the ethnobotanical knowledge regarding use of plant to handle mosquito and treat mosquito related diseases especially around the Longido area is not well established. It is behind this background that a study was conducted to provide a scientific understanding of medicinal repellent plants available within the Maasai land of Longido district. Specifically the study aimed to document the local peoples' knowledge on existence of mosquitoes in the area including diseases caused, their breeding sites, and preventive measures. Also, to examine the local peoples' indigenous knowledge on use of medicinal plants to control mosquito and cure mosquito related diseases. The information is important to various stakeholders not only in order to preserve the indigenous Maasai knowledge of Longido but also forms basis for conservation of these potential resources while assisting the government to implement the strategy to mitigate some impacts of climate change.

2. MATERIALS AND METHODS

2.1 Study Area

Longido district (2º 44'57'' S and 36º 41' 54'' E) is one of the six districts in the Arusha region. The District was created in 2007 and it is surrounded by Rombo District Councils to the East, Ngorongoro to the West, Monduli and Arusha

Districts to the South and Siha District Council to the South East. To the North lies the Republic of Kenya. The population in Longido District according to the 2012 National Census is 123,153 of which males are 60,199 and 62,954 are females [5]. Average house hold size is 4.5. The District has an area of 7,782 sq.km of which 6,392.35sq.km is grazing land (82.14%), 1,023.90 sq. km is arable land (13.6%), 292.23 sq. km is land under cultivation and 365.78 sq. km (4.7%) is under forest reserve. Longido district is recorded as one of the driest areas in Tanzania, with temperature ranges from 20℃ – 35℃ [5]. The study was conducted in six villages of purely pastoralism in (Lerang'wa, Matale A, Ngereiyani, Tingatinga, Sinya, and Lesing'ita) and others two villages that practice agro-pastolist (In the Kitendeni and Olmolog villages). In total 8 villages were surveyed 2 from Engarenaibo division and 6 villages from Enduiment division both allocated in Longido district in Arusha region. The village lies around Enduimet Wildlife Management Area (EWMA) which is a Tanzania-Kenya trans-national migratory route and dispersal area for many fauna including the African elephant migratory. The dominant ethnic groups in Longido district are the Ilkisongo Maasai, but on the more west Kilimanjaro mountain area also includes a large group of Chagga, Mbulu, Arusha, Pare and Meru ethnic groups. The land use is dominated by pastoralist, although most people in enduimet practice a combination of agriculture and livestock herding.

2.2 Data Collection Methods and Analysis

Ethnobotanical data were collected from different stakeholders using semi-structured interviews, focus group discussions and participants observations from 174 respondents drawn from eight villages around Enduimet WMA i.e Lerang'wa (16), Matale (28), Ngereiani (30), Kitendeni (18), Tingatinga (23), Sinya (14), Lesing'ita (26) and Olmolog (19). The villages were drawn from six wards of Olmolog, Tingatinga, Sinya and Kamwanga of Eduimet division and Mundarara and Matale wards in Engarenaibo division. Focus group discussion was held with four groups of Laibon, Leigwenani, members of village Health committees (VHC) and Village Natural Resource Committees (VNRC) who represented the community in the villages. The information collected included knowledge on existence of mosquitoes in the area, breeding sites, diseases caused and preventive measures. Further, information on local name of the traditional medicinal plant used to control mosquitoes and/or cure mosquito related diseases were asked. The collected qualitative and quantitative data were analyzed descriptively using the Statistical Packages for Social Sciences (SPSS) and Ms. Excel computer software tools. During face to face interviews and focus groups discussions, a local Maasai guide who also acted as interpreters used to translate any venacular word from some respondents. The documented plants were identified by a botanist from the Department of Botany, University of Dar es Salaam and voucher specimen deposited at the Institute of Traditional Medicine Herbarium at Muhimbili University of Health and Allied Sciences, Tanzania.

3. RESULTS

3.1 Socio-economic Characteristics of Respondents

The majority of interviewed respondents from the eight surveyed villages around Enduimet WMA were female (68%), married (80%), Maasai by ethinicity (89%) and have stayed in the area for more than 15 years (Table 1). About 53% of the respondents had 6 – 10 household members, 48% had attained primary education level followed by 44% who had no formal education. Most of the respondents were aged between 36 – 50 years (36%), followed by 34% who were aged between 16 - 35 years. The majorities of respondents mentioned agriculture and livestock to be their main source of household income (62%). About 38% of respondents own 1 – 2 ha of land; followed by 34% who own 3 – 5 ha, majority of the respondents also owning houses which are built in mud and grass (57%). There were however very few respondents with houses built in bricks and grass and/or iron sheets roofing as shown in Table 1.

3.2 Respondents' Knowledge, Practice and Perception on Mosquitoes Type, Multiplication, Diseases and Preventive Measures

When respondents were asked to mention the types of mosquitoes existing around their areas, 43% of respondent described the existence of small black mosquitoes with white dots indicating *Anopheles* species, followed by 18% of respondents who mentioned the existence of both small black with white dots and big brownish mosquitoes (Culicine mosquitoes).

Table 1. Socio-economic characteristics of respondents in the surveyed villages around EWMA of Longido district, Tanzania

Village	Total	Engarenaibo division			Enduiment division				
		Lesing'ita	Matale	Ngereiani	Tingatinga	Sinya	Lerang'wa	Kitendeni	Olmolog
Sex									
Female	68 (118)	69 (18)	68 (19)	73 (22)	65 (15)	71 (10)	75 (12)	61 (11)	58 (11)
Male	32 (56)	31 (8)	32 (9)	27 (8)	35 (8)	29 (4)	25 (4)	39 (7)	42 (18)
Age group in years									
< 15	4 (7)	nr	7 (2)	nr	17 (4)	7 (2)	nr	nr	nr
16 - 35	34 (59)	45 (11)	32 (9)	46 (14)	22 (5)	21 (3)	50 (8)	28 (5)	21 (4)
36 - 50	36 (62)	36 (10)	39 (11)	27 (8)	22 (5)	72 (10)	25 (4)	28 (5)	47 (9)
> 50	26 (46)	19 (5)	22 (6)	27 (8)	39 (9)	nr	25 (4)	44 (8)	32 (6)
Marital status									
Married	80 (139)	96 (25)	82 (23)	80 (24)	74 (17)	72 (10)	74 (12)	83 (15)	69 (13)
Single	11 (19)	4 (1)	11 (3)	17 (5)	22 (5)	14 (2)	13 (2)	nr	5 (1)
Widow	8 (14)	nr	7 (2)	3 (1)	4 (1)	14 (2)	13 (2)	11 (2)	21 (4)
Divorced	1 (1)	nr	nr	nr	nr	nr	nr	6 (1)	5 (1)
Education level									
No formal education	44 (77)	58 (15)	57 (16)	40 (12)	26 (6)	36 (5)	38 (6)	61 (11)	32 (6)
Primary school	48 (84)	42 (11)	39 (11)	57 (17)	56 (13)	57 (8)	56 (9)	33 (6)	47 (9)
Secondary school	5 (8)	nr	nr	3 (1)	9 (2)	nr	6 (1)	6 (1)	16 (3)
Higher education	1 (1)	nr	nr	nr	nr	nr	nr	nr	5 (1)
Others	2 (4)	nr	4 (1)	nr	9 (2)	7 (1)	nr	nr	nr
Time of residential stay									
<= 1 year	5 (9)	nr	11 (3)	3 (1)	13 (3)	nr	12 (2)	nr	nr
2 - 5 yrs	4 (7)	4 (1)	3 (1)	3 (1)	9 (2)	nr	nr	nr	10 (2)
6 - 10 yrs	2 (4)	nr	nr	3 (1)	4 (1)	nr	nr	nr	11 (2)
11 - 15 years	7 (12)	4 (1)	7 (2)	14 (4)	nr	7 (1)	13 (2)	11 (2)	nr
> 15 yrs	72 (142)	92 (24)	79 (22)	77 (23)	74 (17)	93 (24)	75 (12)	89 (16)	79 (15)
Ethnic groups									
Maasai	89 (153)	100 (26)	96 (27)	77 (23)	83 (19)	93 (13)	75 (12)	83 (15)	95 (18)
Mbulu	1 (3)	nr	nr	nr	nr	nr	13 92)	6 (1)	nr
Others	10 (18)	nr	4 (1)	23 (7)	17 (4)	7 (1)	12 (2)	11 (2)	5 (1)

Village	Total	Engarenaibo division			Enduiment division				
		Lesing'ita	Matale	Ngereiani	Tingatinga	Sinya	Lerang'wa	Kitendeni	Olmolog
Household size									
1 – 5 members	13 (23)	19 (3)	18 (5)	10 (3)	28 (5)	13 (3)	7 (1)	4 (1)	10 (2)
6 – 10 member	54 (93)	69 (11)	61 (17)	67 (20)	33 (6)	35 (8)	43 (6)	69 (18)	37 (7)
> 10 members	33 (58)	12 (2)	21 (6)	23 (7)	39 (7)	52 (12)	50 (7)	27 (7)	53 (10)
Type of owned house									
Mud & grass roof	58 (102)	92 (24)	64 (18)	57 (17)	53 (12)	65 (9)	44 (7)	39 (7)	45 (8)
Mud & Iron roof	14 (24)	8 (2)	11 (3)	3 (1)	30 (7)	21 (3)	18 (3)	17 (3)	11 (2)
Bricks & grass roof	6 (10)	nr	11 (3)	13 (4)	nr	nr	Nr	nr	16 (3)
Bricks & iron roof	16 (28)	Nr	11 (3)	27 (8)	17 (4)	7 (1)	19 (3)	22 (4)	23 (5)
Others e.g wooden	6 (10)	nr	3 (1)	nr	nr	7 (1)	19 (3)	22 (4)	5 (1)
Household Income sources									
Agriculture	5 (9)	nr	4 (1)	nr	13 (3)	nr	25 (4)	nr	5 (1)
Livestock keeping	14 (24)	15 (4)	24 (7)	7 (2)	13 (3)	35 (5)	13 (2)	nr	5 (1)
Petty Trading	5 (9)	nr	4 (1)	17 (5)	4 (1)	7 (1)	Nr	nr	5 (1)
Agric & Livestock	61 (107)	66 (17)	68 (19)	66 (20)	48 (11)	29 (4)	56 (9)	78 (14)	69 (13)
Agric., Livestock & Petty trading	14 (24)	19 (5)	nr	10 (3)	22 (5)	29 (4)	6 (1)	22 (4)	11 (2)
Others	1(1)	nr	nr	nr	nr	nr	nr	nr	5 (1)
Land ownership & access									
1 – 2 ha	38 (66)	46 (12)	36 (10)	30 (9)	48 (11)	50 (7)	38 (6)	22 (4)	36 (7)
3 – 5 ha	34 (59)	31 (8)	46 (13)	33 (10)	22 (5)	21 (3)	38 (6)	39 (7)	36 (7)
6 – 10 ha	19 (34)	15 (4)	14 (4)	20 (6)	13 (3)	29 (4)	12 (2)	33 (6)	23 (5)
> 10 ha	8 (13)	8 (2)	nr	17 (5)	13 (3)	nr	12 (2)	6 (1)	nr
None	1 (1)	nr	4 (1)	nr	4 (1)	nr	nr	nr	nr

Note: Numbers in parentheses are frequencies of response; nr = No response

However, there were 35% of respondents who provided uncertain answers (Table 2). The majority of respondents (65%) were aware of places where mosquitoes multiply by frequently mentioning stagnant water and bushes. With regards to preventive measures to mosquitoes bite, about 41% of respondents indicated use of combinations of interventions such as keeping home premises clean, filling –up stagnant water areas, clearing bushes as well as use of mosquito bed nets. Also, about 35% of respondents claimed to prevent mosquitoes using bed nets while only 2% used plants/herbs repellent (Table 2). Majority of respondents were aware of diseases caused by mosquitoes and among the diseases that were mentioned included malaria (75%), elephantiasis (5%). Others diseases mentioned were yellow fever (5%) and HIV/AIDS (5%) while about 15% of respondents were uncertain of the answers.

The Chi square statistics revealed significant difference in knowledge where mosquitoes multiply (p=0.01) with female being more knowledgeable than their male counterparts (Table 3). Further analysis by chi-square revealed significant difference in knowledge on mosquito prevention (p=0.04) with more female claiming to use mosquito nets as well as a combination of methods than their male counterparts (Table 3). Despite the fact that majority of interviewed respondents (59%) agreed that it is possible to rely on plants as insecticides to handle mosquitoes and other related diseases (Table 2) most of these were female (p =0.05; Table 3). This was followed by 36% of respondents who claimed the impossibility of relying on plants as insecticides.

Analysis of respondents' knowledge of malaria in terms of transmission and symptoms by age, sex and level of education indicated that people aged between 26-50 followed by those above 50 years were very knowledgeable of malaria (p <0.05) (Table 4). For sex there was significant difference on the knowledge (p <0.05) where female were more knowledgeable than male. There were no significant differences in the knowledge with regard to the education level (p >0.05) as shown in the detailed Table 4.

Table 2. Knowledge, practice and perception on mosquitoes types, multiplication, diseases and preventive measures (N= 174)

Variable	*No	%
Knowledge about Types of mosquitoes in the area		
Small black with white dot-Anopheles	75	43
Big Brown-Culicine	9	5
Both Anopheles and Culex	31	18
Uncertain of the types	61	35
Knowledge of diseases caused by mosquitoes		
Elephantiasis	9	5
Malaria	131	75
Yellow fever	9	5
HIV	9	5
Not certain	17	10
Knowledge of places of mosquito breeding		
Water and air	5	3
Water and bush	113	65
Stagnant water alone	21	12
Air alone	7	4
Bush alone	17	10
Uncertain	10	6
Practice of mosquito prevention		
Using treated bednet	61	35
Using plants/herbs	3	2
Filling stagnant water bodies	2	1
Using insecticides residual sprays	9	5
Keeping home premises clean	21	12
All of the above	71	41
Uncertain of the method	9	5
Perception of using herbs/plant to control mosquitoes		
Yes I can rely on plants	103	59
No I cannot rely on plants	63	36
Uncertain	10	5

Table 3. Percentage distribution of responses on mosquito multiplication and control by gender (N= 174)

Variable	Male	Female	Total
Knowledge of places of mosquito breeding			
Water and air	Nr	4 (5)	3 (5)
Water and bush	61 (34)	68 (80)	65 (114)
Stagnant water alone	20 (11)	9 (10)	12 (22)
Air alone	Nr	6 (7)	4 (7)
Bush alone	18 (10)	6 (7)	10 (17)
uncertain	2 (1)	8 (9)	6 (10)
	Total		**100 (174)**
Practice of mosquito prevention			
Using treated bednet	28 (15)	32 (45)	35 (61)
Using plants/herbs	nr	3 (3)	2 (3)
Filling stagnant water bodies	nr	1 (1)	1 (2)
Using insecticides residual sprays	4 (2)	6 (7)	5 (9)
Keeping home premises clean	19 (10)	9 (11)	12 (21)
All of the above	44 (22)	44 (48)	41 (71)
Uncertain of the method	5 (3)	5 (6)	5 (9)
	Total		**100 (174)**
Perception of using herbs/plant to control mosquitoes			
possible	41 (23)	67 (79)	59 (103)
Not possible	54 (30)	27 (32)	36 (63)
uncertain	5 (10)	6 (7)	5 (10)
	Total		**100 (174)**

Table 4. Percentage distribution of responses on malaria knowledge by age, sex and education level in the study area

Variable	Responses (%)			χ2 (*p* -value)
	Yes	**No**	**Not sure**	
Age group				
less than 15	14 (1)	86 (6)	nr	
16 – 35	78 (46)	22 (13)	nr	
36 – 50	95 (59)	3 (2)	2 (1)	39.89 (0.00)
> 50	85 (36)	11 (5)	4 (2)	
Total	**83 (145)**	**15 (26)**	**2 (3)**	
Sex				
Female	85 (100)	14 (17)	1 (1)	
Male	80 (45)	16 (9)	4 (2)	1.79 (0.04)
Total	**83 (145)**	**15 (26)**	**2 (3)**	
Education level				
No formal education	87 (67)	9 (7)	4 (3)	
Primary education	77 (65)	23 (19)	nr	
Secondary education	100 (8)	nr	nr	
Higher education	100 (1)	nr	nr	11.7 (0.16)
Others e.g. Adult etc	100 (4)	nr	nr	
Total	**83 (145)**	**15 (26)**	**2 (3)**	

Further scrutiny from the correspondents mentioned several plants which upon ranking we report about twenty (20) that had been mentioned at least more than five times to be used either to control mosquitoes or treat mosquito related diseases. *Tagetes minuta* (Leng'ongudeyo), *Cynodon plectostachyus* (Emurua), *Azadirachta indica* (Mwarobaini) *Ocimum bacilicum* (Nang'ongudeyo), *Lippia javanica* (Osinoni) and *Hyptis suaveleons* (Olemuran) were frequently mentioned as mosquito repellents and obtained from the study areas (Table 5). Likewise, *Dobera Salvadora persica* (Oremit), *Osyris abyssinica* (Olesai), *Albizia anthelmintica* (Olmukutani) and *Rhamnus staddo* (Olkokola) were highly ranked as effective anti-malarial drugs (Table 5). On the other hand literature search supported these claims for the plant species with exception of *Commiphora merkeri* (Oldemwai) and *Orobanche ramosa* (Olwai) which for the first time are being reported for treatment of symptoms associated with chest and abdominal pain (Table 5).

Table 5. List of medicinal plants used to handle mosquito related diseases around EWMA of Longido district, Tanzania

	Botanical name	Voucher specimen number	Local name	Frequency mentioned	Disease condition or symptoms treated	Parts used	Related Pharmacological activity*
1.	*Salvadora persica* var *persica* (Salvadoraceae)	EI 49	Oremiti/Mswaki	82	Malaria	Barks/Leaves/Roots	Used for malaria treatment [6,7,8]
2.	*Osyris abyssinica* (Hochst.) A. Rich. (Santalaceae)	TM 13	Alaisai/oleisai	50	Induce vomiting to remove bile during malaria	root	pregnancy, swollen breast [9]
3.	*Albizia anthelmintica* Brongm. (Mimosaceae)	EI 1	Olmukutani	45	Skin rashes, Intestinal worms, Gout, Diarrhea, Rheumatism,	Roots /Barks/Leaves	malaria, tapeworms [7,10]
4.	*Ocimum bacilicum* L.. (Lamiaceae)	EI 48	Nang'ongudeyo, Naing'ong'odeyo	34	Mosquito repellent	Whole plant	Mosquito repellency [11]
5.	*Rhamnus staddo* A.Rich. (Rhamnaceae)	EI 21	Olkokola/Orokonyili	33	Joints pains, Backache, Inflammations, Venereal diseases, kidney, Gout, Digestion	root	Exhibit anti-plasmodial activity [12]
6.	*Cynodon plectostachyus* (K. Schum) Pilg (Gramineae)	TM 23	Emurua	24	Mosquito repellent	Whole plant	NA
7.	*Olea europeana* L. ssp. africana(Mill.) P. S. Green (Oleaceae)	EI 23	Ororieni/Mserefu	20	Malaria, Intestinal worms, Backache, Vomiting, insecticide	Barks/Leaves/Roots	Exhibit ant-plasmodium activity and -larvicidal activity [13]
8.	*Balanites aegyptiaca* (L.) Delile (Balanitaceae)	EI 36	Orng'oswa	17	Malaria, Stomach ache	Barks/Roots	Treatment of malaria, dysentery, diarrhea, jaundice, epilepsy, yellow fever and the plant also has insecticidal, antihelminthic, antifeedant, molluscicidal and contraceptive activities [9,14]
9.	*Aloe lateritia* Engl. (Aloaceae)	ITM 1896	Olsukuroi	16	Pneumonia, Infants fever, Ulcer, Malaria, venereal diseases, Tumors	Roots/Leaves	decoction used against malaria [15]
10.	*Rhus vulgaris* (Anacardiaceae)	ITM 551.0606	Endukushi	14	Induce vomiting, Malaria,	Roots	Larvicidal activity [16]
11.	*Azadirachta indica* A. Juss. (Meliaceae)	ITM 3080	Mwarobaini	13	Insecticide	leaves	Control mosquito larvae in different breeding sites [17]

	Botanical name	Voucher specimen number	Local name	Frequency mentioned	Disease condition or symptoms treated	Parts used	Related Pharmacological activity*
12.	*Achyranthes aspera* var perphyristachya Hook. F. (Amaranthaceae)	ITM 3693	Olekidong'o	11	Malaria	Roots	Exhibit anti-plasmodial activity & used for control mosquito larvae [18,19]
13.	*Commiphora merkeri* Engl. (Burceraceae)	EI 34	Oldemwai/Olndemwai/Oltemwai	11	Tuberculosis, Chest pains, Asthma	Latex	NA
14.	*Boscia angustifolia* A. Rich. (Capparidaceae)	EI 51	Oloreroi, Oloireroy	10	poisonous	root	Anti-malarial treatment [12]
15.	*Orobanche ramosa* L. (Orobanchaceae)	TM 32	Engifumu/Olwai	10	Infertility, kidney, pain	Roots/Leaves	NA
16.	*Zanthoxylum usambarense* (Engl.) Kokwaro (Rutaceae)	TM 12	Oleisuki/Oloisuki	10	Rheumatism, Backache, Venereal diseases, Fever, Joints, Cough, Blood cleanser	Barks/Leaves/Roots	Anti-plasmodial activity [20,21]
17	*Lippia javanica (Burm. F.) Spreng* (Verbenaceae)	LEP 694	Osinoni	8	Mosquito repellent, Fever, Venereal diseases	Leaves/aerial parts, roots	used to treat fever ; mosquito repellent [22]
18	*Tagetes minuta* L. (Asteraceae)	EI 68	Leng'ong'odeo	8	Mosquito repellent	Leaves/aerial parts	Mosquito repellents [23]
19	*Hyptis suaveleons* (Lamiaceae)	TMP 108	Olemuran	7	Mosquito repellent	Leaves/aerial parts	Mosquito control [24,25]
20	*Osyris lanceolata*, Hochst & Steud. Ex A. DC (Santalaceae)	ITM 6239	Alasaseiyi	7	Insecticide, Diarrhoea, Infertility, Fever, Joints, Backache, Kidney cleanser	Leaves/barks	diarrhea and worms [26]

**NA-No information retrieved on control of mosquitoes and treat mosquito related diseases*

4. DISCUSSION

This study documented plants used in control of mosquitoes and treat mosquito related diseases among migratory communities of Longido district with the target that Elders and herdsmen are involved in availing knowledge on prominent plants used in the area. According to the World Health Organization [27,28] traditional medicine remains the popular primary health care among rural communities of the world due to its readily accessible, affordable and more importantly being an integral part of traditional cultural beliefs and practices. These facts indeed support the findings to why Longido Maasai people are still dependent on their traditional based primary health system in treatment of malaria related symptoms using herbs despite the on-going government campaign for popularizing utilization of formal modern health care facilities such as dispensaries and health centres [29]. However, the interviewed respondents also reported to use the existing community based programs such as use of bed nets and adherence to environmental rules to control mosquitoes around the houses and destructions of mosquito breeding sites as the way to fighting Malaria. Sometimes these methods being used concurrently with local methods such as fumigation using herbs or repellent plants. A similar trend of using plants to tackle a certain health problem alongside with other preventive methods has been reported [6,7,30,31].

Despite the fact that respondents from the villages who practice purely pastoralism in Lerang'wa, Matale A, Ngereiyani, Tingatinga, Sinya, and Lesing'ita and others villages that are agro-pastolist in the Kitendeni and Olmolog villages were involved to generate the required data, respondents who had knowledge of medicinal plants that are used for mosquito repellent was low compared to those who had knowledge of medicinal plant used for malaria treatments. When emphasis was made by clarifying to respondents to mention plants used for repelling/killing insects or mosquitoes, the response was that, Maasai communities do not devote much effort to get rid of mosquito population or bites rather they concentrate on treatment of malaria parasite when fall sick. This is done by taking some herbal remedies that clear the parasite in the blood as it was enlightened during focus group discussion because every group mentioned many plants that are used for malarial treatment and very few anti-mosquito plants were been mentioned (Table 4).

Among mosquito repellent plants mentioned include *Tagetes minuta* (Leng'ongudeyo), *Cynodon plectostachyus* (Emurua), *Azadirachta indica* (Mwarobaini) *Ocimum bacilicum* (Nang'ongudeyo), *Lippia javanica* (Osinoni) and Hyptis suaveleons (Olemuran) also been obtained from the study areas. *Olea europeana* (oroireroi) is a plant species which grow as a tree that was among highly ranked, also exhibit both as insecticide and anti-malarial drug [10] hence wealth been considered in conservation to sustain its benefits to the Maasai communities. Likewise, *Salvadora persica* (Oremit), *Osyris abyssinica* (Olesai), *Albizia anthelmintica* (Olmukutani) and *Rhamnus staddo* (Olkokola) were highly ranked as effective anti-malarial drugs the claim which is justified [7,9,10,12]. These plants are suitable for sustainable uses in rural community as well as good candidate for research in the development of repellents or medicinal agents especially for the Maasai normadic people or other population.

Further results indicate that, women were more knowledgeable than men in dealing with mosquito prevention and control and had much knowledge on plants used in prevention and treatments. The diverse knowledge was evidenced by the use of same local names to different popular species exhibiting repellency properties as being referred as "Nang'ongudeyo/ Leng'ongudeyo" but was not the same plant to other villages after reconfirming the voucher specimen. Likewise, the highly ranked antimalarial plant was confirmed to be *Salvadora persica* (Salvadoraceae) and not *Dobera loranthifolia* (Salvadoraceae) which in the vernacular Maasai are both being refereed as Oremit or Mswaki. This indicates the great role of ethnobotanical field survey studies and community participation into sorting out health problems that affect daily health lives and in their local context. Despite the fact that only few respondents had practices of using repellent plants, nevertheless, significant population had good knowledge and altitude of using plants as one source of control of mosquitoes and treat mosquito related diseases.

5. CONCLUSION AND RECOMMENDATION

The Maasai people have diverse indigenous knowledge with regards to medicinal plants used

to handle mosquitoes, insects and other human disease conditions. The huge diverse IK of the Maasai need to be documented preserved with concurrently domestication of potential medicinal plants to ensure sustainable use for the present and future Maasai generations and beyond.

CONSENT

During reconnaissance studies, the officers at the Region, District and Village levels were informed of the study objectives. The interview was done to villagers after participants' acceptance to participate in the study by signing the written informed consent forms.

ETHICAL APPROVAL

The scientific protocols and ethical clearance to conduct the study was approved by the University Senate (MU/DRP/AEC/Vol. XVIII/67), upon recommendation from the Senate committee of Research and Publication-MUHAS, Tanzania.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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