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Research Article

Awareness and Prevalence of Mosquitoes Causing Malaria in Farm Animals

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Abstract

The study was conducted to investigate the awareness and prevalence of mosquitoes causing malaria in farm animals. A total of 71 respondents were used for the awareness study using a well structured questionnaire and a total of 51 Adult mosquitoes were collected from the animal in the study area for the prevalence study. Data generated were subjected to statistical analysis using Statistical Package for Social Sciences (SPSS version 16). Results revealed that the highest age group of the respondents was 20–25 years (56.3%). The average mean of their knowledge of the effects of mosquitoes on livestock animals ranges from 2.70-3.35. This is above the benchmark of 2.50. Thus, most of the respondents are aware of the effects mosquitoes can pose to livestock animals. In addition, the average mean of their knowledge of the effects of mosquitoes on livestock animals ranges from 2.70-3.35, which is above the benchmark of 2.50. Thus, most of the respondents are aware of the effects mosquitoes can pose to livestock animals. The species of the mosquitoes showed that *Quinquefasciatus* were 31.4%, *Poicilipes* were 33.3%, Pipiens were 33.3% and Taylori were 2%. Various species of mosquitoes causing malaria in farm animals were *Quinquefasciatus* (31.4%), *Poicilipes* (33.3%), *Pipiens* (33.3%), and *Taylori* (2%). The highest number of male mosquitoes was found in *Pipiens* (40.0%) while the highest female mosquitoes were observed among Poicilipes (36.71%). However, the Chi Square test shows there was no significant effect of species on gender of mosquitoes in the study area. The prevalence of the mosquitoes causing malaria in farms studied is of great concern and efforts should be made to make livestock farmers aware of the impact of mosquitoes of the health of livestock animals and proactive efforts should be taken to eliminate them from farms without hurting the livestock animals.

Keywords: Mosquitoes; Farm Animals; Awareness and Prevalence; Malaria

Introduction

Malaria is one the most challenging disease affecting both farm animals and humans. Mosquitoes are widely present at animal farms, and their blood-feeding behavior (feeding on myriad hosts) makes them an efficient vector for many pathogens of human and animals. Rearing of livestock such as cattle, goat or poultry animals is an important part of people's livelihoods in rural areas of Africa [1], where malaria risks is higher than in urban areas [2]. At the household-level, the presence of farm animals such as cattle may reduce or enhance the risk of malaria infection. However, it has been shown that livestock indirectly attracts more mosquitoes to human settlements through host derived signals. Thus having a livestock station within a human settlement increases the attraction of zoophilic mosquitoes and the human biting rate [3]. Although clear differences in host preference exist among malaria vector species, the final blood meal host of a mosquito depends on a complex set of fac-

tors, such as the availability and abundance of hosts [4]. However, it is believed that genetic diversity has been shaped by past population processes and will also affect the sustainability of species and populations in the future [5]. Studies have shown geographical barriers to be a major determinant of genetic diversity of mosquitoes compared to the geographic distance [6]. Hence, due to this backdrop this study tends to investigate the prevalence and genetic diversity of malaria causing mosquitoes in farm animals.

Material and Methods

Study area

The study area involved animal farms within and around the University of Port Harcourt, Obio Akpor Local Government Area, Rivers State. These animal farms were located within 4.900° N, 6.9200° E coordinates. They are the ruminant farms of the University of Port Harcourt demonstration farm and the Poultry farms at Omuokiri, Aluu. The ruminant farm includes the pig farm, goat farm and cow farm while the poultry section consisted of broiler farms.

Sample collection

A total of 51 adult female mosquitoes were collected from the animal farms following the methods described by Mboera [7] within a month study cycle. Thirty one (31) samples were collected from the ruminants' farm (12 from cow farm, 13 from the pig farm and 6 from the goat farm). While a total of 20 samples were collected from the poultry farm. The sample collection was done using spray sheet collection method with pyrethrum spray catches. A method considered most successful in capturing anthropophagic (human biting) and endophilic mosquitoes [8]. It is also considered far less ethically objectionable in areas of multidrug resistance [9]. Also, the mosquito collection was conducted using modified light traps. This was conducted during the night hours using mechanical aspirator with the aid of flashlight [10]. Each mosquito sample was preserved individually in an Eppendorf tube each which was sterilized before used. The samples were stored dry on 50g of silica gel for species-specific molecular assays, PCR and DNA identification.

Data analysis

Data were subjected to statistical analysis using Statistical Package for Social Sciences (SPSS) version 16. Descriptive statistics such as means, frequencies and ratios were determined and illustrated with appropriate tables and figures. Descriptive statistics were used to report socio-demographic characteristics. Comparisons of associated variables and relationships were made with inferential statistics using Chi-square test of significance. A p-value of ≤ 0.05 was considered significant.

Results and Discussion

Socio–economic characteristics of respondents

Table 1 represents the Socio–economic characteristics of respondents and their demographic percentage. A total of 71 respondents were obtained from the various departments in the Faculty of Agricultural Sciences, University of Port Harcourt of various age groups; < 20 years (15.5%), 20–25 years (56.3%), 26–30 years (25.4%) and least age group > 30 years (2.8%) in various levels, from 100 to 500 level students, graduates and post-graduates students. The highest number of respondents that fell between ages 20 and 25 years is expected as this is the average age of undergraduate students in Nigerian universities. This report is in line with that reported by Hilary., *et al*. [11] when they assessed gender and age differences in the study plan of university students. In addition, Dozie., *et al*. [12] in their work on knowledge and attitude towards cervical cancer: a case study of undergraduate students in Imo State, Nigeria reported that the majority (81.7%) of the respondents was aged between 21 - 30 years with a mean age of 25 years.

Table 1: Socio–economic characteristics of respondents.

Variables	Frequency	Percent
Age		
< 20 years	11	15.5
20 - 25 years	40	56.3
26 - 30 years	18	25.4
> 30 years	2	2.8
Total	71	100.0
Department		
Agricultural Economics and Extension	24	33.8
Animal Science	32	45.1
Crop and Soil Science	7	9.9
Fisheries	3	4.2
Forestry and Wildlife Management	2	2.8
Food Science and Home Management	3	4.2
Total	71	100
Level		
100 level	9	12.7
200 level	8	11.3
300 level	10	14.1
400 level	12	16.9
500 level	20	28.2
Extra year	1	1.4
MSc	1	1.4
Graduate	10	14.1
Total	71	100

Awareness of mosquitoes as a challenge to livestock production

The percentage frequency and mean of the response on the awareness of mosquitoes as a challenge to livestock production among the population of study is shown in Table 2. The average mean ranges from 3.00-3.73. This is above the benchmark of 2.50. Thus, most of the respondents are aware of the challenges mosquitoes pose to livestock. The knowledge of the effects of mosquitoes on livestock animals was measured by the response from the population of study. The table also shows the percentage frequency and mean of their response. The average mean of their knowledge of the effects of mosquitoes on livestock animals ranges from 2.70-3.35. This is above the benchmark of 2.50. Thus, most of the respondents are aware of the effects mosquitoes can pose to livestock animals. Nguyen-Tien *et al*. [13] while assessing the knowledge and practice on prevention of mosquito-borne diseases in livestock-keeping and non-livestock-keeping communities in Hanoi city, Vietnam reported that the participants possessed basic knowledge on mosquito-borne diseases with an average score of 18.3 out of 35. The sources of their awareness could be from their fellow farmers, extension agents, radio, television or social media. Similar results have been reported by Nguyen-Tien *et al*. [13] and Anand *et al*. [14].

Table 2: Awareness of mosquitoes as a challenge to livestock production.

S/no	Item	Strongly agree (%)	Agree (%)	Disagree (%)	Strongly disagree (%)	Total (%)	Mean
1	Mosquitoes do bite livestock animals	45.1	50.7	4.2	0	100	3.41
2	Malaria is caused by protozoan Plasmodium parasite and is spread by the female Anopheles mosquitoes.	73.2	26.8	0	0	100	3.73
3	The male mosquito feeds on plants and nectars and therefore does not spread the disease.	36.6	52.1	11.3	0	100	3.25
4	There are four parasite species causing malaria and these are; *Plasmodium Falciparum, Plasmodium vivax, Plasmodium malaria, and Plasmodium ovale.*	33.8	60.6	5.6	0	100	3.28
5	*Plasmodium falciparum* is the most deadly of all the species	32.4	60.6	7.0	0	100	3.25
6	*Plasmodium knowlesi* is a zoonotic species that cause malaria among monkeys and exist in certain areas of the South East Asia	14.1	71.8	14.1	0	100	3.00
7	The primary mode of malaria transmission is by the bite of the mosquitoes	63.4	29.6	7.0	0	100	3.56
8	Adult females lay 50-200 eggs per oviposition. Eggs are laid singly directly on water and are unique in having floats on either side.	54.9	43.7	1.4	0	100	3.54
9	Eggs are not resistant to drying and hatch within 2-3 days, although hatching may take up to 2-3 weeks in colder climates	28.2	66.2	5.6	0	100	3.23
10	There are over 40 species of Anopheline mosquitoes that transmit malaria	63.4	9.9	1.4	0	100	3.13

Effects of mosquitoes on livestock animals

Table 3 shows the knowledge of the effects of mosquitoes on livestock animals as measured by the response from the population of study. The table also shows the percentage frequency and mean of their response. The average mean of their knowledge of the effects of mosquitoes on livestock animals ranges from 2.70-3.35, which is above the benchmark of 2.50. Thus, most of the respondents are aware of the effects mosquitoes can pose to livestock animals. According to Lee [15], mosquito bites may result in increased stress and pain, which reduces livestock fitness, weight gain, and animal welfare. He further stated that mosquito feeding may also result in pathogen transmission between livestock reservoirs (epizootics) and incidentally humans (zoonotic diseases). Jackman and Olson [16] also explained the effects of mosquitoes on livestock. They emphasized that biting female mosquitoes not only irritate people and animals, they can also transmit many diseases

such as encephalitis which is an inflammation of the brain caused by certain viruses transmitted by mosquitoes. Dengue, or break-bone fever is another effect of mosquitoes as well as malaria which is an acute or chronic disease caused plasmodium. Dog heartworm is caused by a mosquito-borne filarial worm (a threadlike parasite) called *Dirofilaria immitis*. Adult stages of this worm amass in the heart cavities of dogs and cats, causing heart damage, blockages and eventually death if the infestation grows too large.

Table 3: Effects of mosquitoes on livestock animals.

S/no	Item	Strongly agree (%)	Agree (%)	Disagree (%)	Strongly disagree (%)	Total (%)	Mean
1	Animals tormented by mosquitoes do not feed properly.	29.6	52.1	16.9	1.4	100	3.10
2	If attacked by mosquitoes, cows give less milk	19.7	59.2	19.7	1.4	100	2.97
3	Mosquitoes also transmit dog heartworm and can also carry the virus that causes myxomytosis in rabbits.	11.3	50.7	35.2	2.8	100	2.70
4	Some of the diseases caused include Rift Valley fever, encephalitis, heartworm in dogs and malaria	19.7	56.3	22.5	1.4	100	2.94
5	Cattle, sheep, goats, camels and human suffer clinical symptom of diseases and some indigenous breeds tend to be more resistant	38.0	59.2	2.8	0	100	3.35
6	Beef cattle, sheep, and poultry may suffer losses in weight.	43.7	43.7	12.7	0	100	3.31
7	Mosquitoes may transmit viruses that cause encephalitis in horses.	16.9	60.6	19.7	2.8	100	2.92
8	Third, mosquito problems can decrease property values and cause labor problems.	19.7	59.2	15.5	5.6	100	2.93
9	Horses infected by West Nile virus have over a 30 percent chance of dying or becoming disabled.	21.1	60.6	15.5	2.8	100	3.00
10	Farm workers may refuse to work if a serious mosquito problem exists.	32.4	53.5	11.3	2.8	100	3.15

Prevention of mosquitoes in livestock farms

The percentage frequency and mean of the response on prevention of mosquitoes in livestock farms among the population of study is shown in Table 4. Various prevention methods were itemized and responses were measure as percentage frequency and mean, the prevention methods itemized were: Prevention or eliminating any waste water that stands for longer than 4 days. (This includes water in ruts or unnecessary containers), Keep weeds down around ponds, ditches, and in shallow wetlands, irrigate properly so that all surface water is gone within 4 days, biological and chemical control of mosquitoes, use screens on windows and doors, repair holes in screens to keep mosquitoes outdoors, use of air conditioning, stop mosquitoes from laying eggs in or near water, practice yard hygiene and essential oils as an alternative repellant and their respective average mean are 3.76, 3.48, 3.56, 3.61, 3.41, 3.63, 3.28, 3.44, 3.72 and 3.37. In addition, the percentage frequency and mean of the response on Prevention of mosquitoes in livestock farms among the population of study. From the table, various prevention methods were itemized and responses were measure as percentage frequency and mean, the prevention methods as activities were; Prevent or eliminate any waste water that stands for longer than 4 days. (This includes water in ruts or unnecessary containers), Keep weeds down around ponds, in ditches, and in shallow wetlands, irrigate properly so that all surface water is gone within 4 days, Biological and chemical control of mosquitoes, use screens on windows and doors, Repair holes in screens to keep mosquitoes outdoors., Use of air conditioning, Stop mosquitoes from laying eggs in or near water. Practice Yard Hygiene and Essential oils as an alternative repellant and their respective average mean are 3.76, 3.48, 3.56, 3.61, 3.41, 3.63, 3.28, 3.44, 3.72 and 3.37. The results presented here are similar to those reported by Lee [15]. Furthermore, Jackman and Olson [16] listed different mosquitoes control measures as sanitation (removing food, water, and shelter), habitat disruption (draining the water where mosquitoes breed), biological control (using mosquito fish, nematodes, and *Bacillus thuringiensis* israeliensis toxin and *Bacillus sphaericus*), mechanical control (maintaining window screens and altering building designs), personal protection (wearing protective, lightcolored, loose-fitting clothing; using repellents; and avoiding activities in areas when mosquitoes are active) and chemical suppression (using insecticides against adults and/or larvae)

Table 4: Prevention of mosquitoes in livestock farms.

S/no	Item	Strongly agree (%)	Agree (%)	Disagree (%)	Strongly disagree (%)	Total (%)	Mean
1	Prevention or eliminating any waste water that stands for longer than 4 days. This includes water in ruts or unnecessary containers.	77.5	21.1	1.4	0	100	3.76
2	Keep weeds down around ponds, in ditches, and in shallow wetlands.	60.6	29.6	7.0	2.8	100	3.48
3	Irrigate properly so that all surface water is gone within 4 days	64.8	28.2	5.6	1.4	100	3.56
4	Biological and chemical control of mosquitoes can supplement these essential preventative measures	63.4	33.8	2.8	0	100	3.61
5	Use screens on windows and doors.	49.3	42.3	8.5	0	100	3.41
6	Repair holes in screens to keep mosquitoes outdoors.	69.0	25.4	5.6	0	100	3.63
7	Use air conditioning, if available.	42.3	43.7	14.1	0	100	3.28
8	Stop mosquitoes from laying eggs in or near water.	52.1	39.4	8.5	0	100	3.44
9	Practice yard hygiene	73.2	25.4	1.4	0	100	3.72
10	Essential oils as an alternative repellant.	50.7	36.6	11.3	1.4	100	3.37

Species distribution of mosquitoes causing malaria in farm animals

Table 5 shows the various species distribution of mosquitoes causing malaria in farm animals as analyzed. *Quinquefasciatus* were 31.4%, *Poicilipes* were 33.3%, *Pipiens* were 33.3% and *Taylori* were 2%. Various species of mosquitoes causing malaria in farm animals were *Quinquefasciatus* (31.4%), *Poicilipes* (33.3%), *Pipiens* (33.3%), and *Taylori* (2%). These species are similar to those reported by Jackman and Olson [16]. Mohammed *et al.* [17] reported that Culex species of mosquitoes are the most widespread mosquito species across the world and are known to be highly opportunistic, feeding on humans and livestock. However, this specie of mosquitoes was not found in the study area.

Table 5: Species distribution of mosquitoes causing malaria in farm animals.

Species	Frequency	Percent (%)
Quinquefasciatus	16	31.4
Poicilipes	17	33.3
Pipiens	17	33.3
Taylori	1	2.0
Total	51	100.0

Gender distribution of mosquitoes causing malaria in farm animals

The gender distribution of mosquitoes causing malaria in farm animals is presented in Table 6. Male and female mosquitoes represent 29.4% and 70.6% respectively of the 51 mosquitoes causing malaria found in farm animals. In table 6, it shows the gender distribution of mosquitoes causing malaria in farm animals. It was found that male and female mosquitoes represent 29.4% and 70.6% of the 51 mosquitos causing malaria in farm animals. The percentage distribution of male species of mosquitoes causing malaria in farm animals with a total count of 15 are; *Quinquefasciatus* (33.3%), *Poicilipes* (26.7%), *Pipiens* (40.0%) and *Taylori* (0.0%). While, the percentage distribution of female species of mosquitoes causing malaria in farm animals with a total count of 36 are; *Quinquefasciatus* (30.6%), *Poicilipes* (36.71%), *Pipiens* (30.6%) and *Taylori* (2.8%). The high number of female mosquitoes shows that the animals in these farms will be exposed to malaria [16].

Table 6: Gender distribution of mosquitoes causing malaria in farm animals.

Sex	Frequency	Percent (%)
Male	15	29.4
Female	36	70.6
Total	51	100.0

Species and gender distribution of mosquitoes causing malaria in farm animals

Table 7 and Figure 1 present the species and gender distribution of mosquitoes causing malaria in farm animals. The percentage distribution of male species of mosquitoes causing malaria in farm animals with a total count of 15 are; *Quinquefasciatus* (33.3%), *Poicilipes* (26.7%), *Pipiens* (40.0%) and *Taylori* (0.0%). While, the percentage distribution of female species of mosquitoes causing malaria in farm animals with a total count of 36 are; *Quinquefasciatus*

(30.6%), *Poicilipes* (36.71%), *Pipiens* (30.6%) and *Taylori* (2.8%).
This results are in line with that reported by [16].

Table 7: Species and gender distribution of mosquitoes causing malaria in farm animals.

			Mosquitoes Species				Total
			Quinquefasciatus	***Poicilipes***	***Pipiens***	***Taylori***	
Sex	Male	Count	5	4	6	0	15
		% within sex	33.3%	26.7%	40.0%	0.0%	100.0%
	Female	Count	11	13	11	1	36
		% within sex	30.6%	36.1%	30.6%	2.8%	100.0%
Total		Count	16	17	17	1	51
% within sex		31.4%	33.3%	33.3%	2.0%	100.0%	

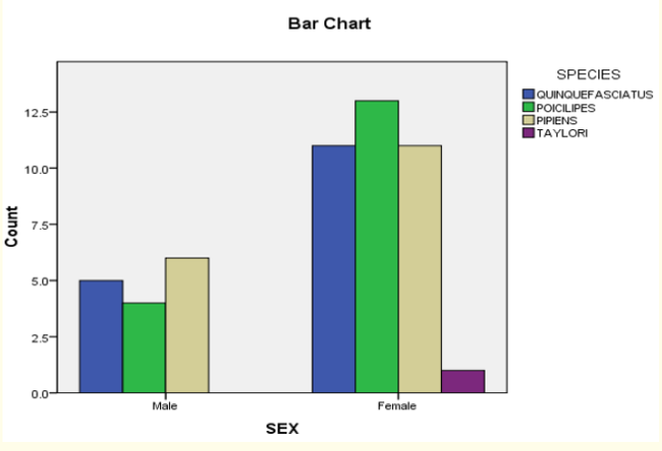

Figure 1: Bar chat showing species and gender distribution of mosquitoes causing malaria in the study area.

Chi-Square Tests of significance in species and gender distribution of mosquitoes causing malaria in farm animals

Table 8 shows the results of the species and gender distribution of mosquitoes causing malaria in farm animals using Chi-Square Tests. The following values were obtained: Pearson Chi-Square (1.009, df = 3), Likelihood Ratio (1.292, df = 3) and Linear-by-Linear Association (.002. df = 1). The following values were obtain based on the Chi-Square tests are; Pearson Chi-Square, 1.009, df = 3; Likelihood Ratio, (1.292, df = 3) and Linear-by-Linear Association (.002. df = 1). The Chi Square test shows there is no significant effect of species on gender of mosquitoes in the study area. This shows that the prevalence of a sex of mosquitoes does not vary with the species concerned [8].

Table 8: Chi-Square Tests of significance in species and gender distribution of mosquitoes causing malaria in farm animals.

Parameter	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.009	3	0.799
Likelihood Ratio	1.292	3	0.731
Linear-by-Linear Association	.002	1	0.966
No of Valid Cases	51		

Conclusion

The current results showed that the level of awareness of the impact of mosquitoes causing malaria in farm animals among students of Faculty of Agriculture, University of Port Harcourt, Nigeria is above average. The prevalence of mosquito species causing malaria in farm animals in Obio Akpo Local Government Area is still high. The genetic diversity of mosquito species found in the farm animals population increased with increase in humidity and decreased with increase in temperature. The research has identified at both natural and laboratory populations of mosquitoes causing malaria, attempting to piece together some of the factors that contribute to variability in susceptibility to disease causing pathogens among farm animals. It is evident that vector competence is a complex attribute influenced by both ecological and genetic factors. All these need to be critically considered and evaluated in our search for appropriate, alternative methods to controlling mosquito-vectored diseases.

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