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Pitout JDD, Church DL, Gregson DB, Chow BL, McCracken M, Mulvey M, Laupland KB (2007). Molecular epidemiology of CTXM-producing *Escherichia coli* in the Calgary Health Region: emergence of CTX-M-15-producing isolates. *Antimicrob. Agents Chemother.* 51: 1281-1286.

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Full Length Research Paper

Using health education intervention to improve knowledge and practice of prevention of avian influenza among bird handlers in Sokoto, Nigeria

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Zoonotic diseases are under-reported in most parts of the world particularly in developing countries. Approximately 75% of emerging diseases are zoonotic which include avian influenza (AI), Lassa fever and toxoplasmosis. The persistence and spread of avian/fatal avian influenza A (A/H5NI) in poultry and people in Asia, Europe and Africa has led the World Health Organization (WHO) to state that the world is now in a pandemic alert phase. For these reasons, an integrated and cross-sectorial plan was needed which ensures that Nigeria was prepared to address both the causes and consequences of avian and human influenza pandemic. This study was conducted to assess the impact of educational intervention on the knowledge and practice of prevention of AI among bird handlers in Sokoto. A total of 100 male bird handlers in Sokoto metropolis were enrolled for the quasi-experimental study with pre- and post-intervention components in the same group. A set of comprehensive and pre-tested questionnaire was administered to the respondents for information on the socio-demographic characteristics, knowledge and practices regarding AI. The pre-intervention phases involved the application of the questionnaires to the respondents. The intervention measures instituted included health education on causes of AI, clinical features, communicability, prevention, morbidity/mortality patterns and a demonstration session. One month after the intervention, the same set of questionnaires were administered to the study subjects. Scores obtained for knowledge were subsequently graded as adequate ($\geq 50\%$) and inadequate ($< 50\%$). At baseline, 51% of the respondents scored $\geq 50\%$ with a mean knowledge score of 64 ± 7.0 , while at post-intervention, 86% of the respondents scored $\geq 50\%$ with a mean knowledge score of 91 ± 17.64 ($p < 0.0001$). The commonest form of protection adopted by the study subjects was the use of protective clothing, including face masks.

Key words: Avian influenza, bird handlers, health education, preventive measures.

INTRODUCTION

The human population has been on the rise with attendant urbanization resulting in more humans sharing wild life and livestock habitats at the same time developing closer interactions with domestic animals. Increasing globalization, international trade and international movement of humans, goods and animals impact on the global

health from one geographical location to the other. Therefore, protecting the public health where one lives means improving the overall global health (Pappaioanou, 2004). Avian influenza (AI) is a highly contagious disease primarily of birds, and caused by influenza A viruses. It is one of the greatest concerns for public health that has

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Figure 1. Map of Nigeria showing Sokoto state in extreme North West (Red color).

emerged from the animal reservoir (Brown et al., 2006; Capua and Marangon, 2007). The spread of the highly pathogenic avian influenza (HPAI) to countries in which hygienic standards are deficient increases the virus' pandemic potential and raises concerns about food security particularly in rural villages (Capua and Marangon, 2007). Aquatic birds are the sources of AI viruses (Pantin-Jackwood and Swayne, 2009; Krauss and Webster, 2010).

Infection of poultry with influenza A (subtype H5N1) virus is responsible for outbreaks in birds and a human case-fatality rate of 58% (WHO, 2006). The most likely means of transmission is from infected birds to humans and from the environment to humans, but evidence for human-to-human transmission is limited (WHO, 2005). This virus can be transmitted if a person has direct contact with infected poultry or surfaces and objects contaminated by poultry droppings.

Workers in the poultry industry, who commonly have contact with live, sick, or dying poultry, are at higher risk for AI. These workers are at increased risk, because of food handling and preparation of raw poultry meat and products. Concern exists that AI could be transmitted from uncooked birds or bird products to humans (Bridges et al., 2002; Swayne, 2006).

Nigeria with an estimated poultry population of 140 million birds has about 60% of poultry production taking place in small backyard flocks. Outbreaks of AI have been reported from commercial farms in the states of Kano, Kaduna, Plateau, Katsina, Bauchi and Abuja area and to date four patients have been diagnosed with respiratory symptoms and a history of exposure to diseased poultry have been investigated for possible infection. This number includes a woman who died of an acute respiratory illness traced to infection with AI virus (WHO, 2006). Current surveillance for human cases has resulted in the identification of individuals with influenza-like illness who have had a history of exposure to sick or dying birds. An integrated and cross sectoral plan is needed to ensure that Nigeria is prepared to address both the causes and consequences of avian and human

pandemic influenza. Literature search has shown that no interventional studies have been carried out in North Western Nigeria since the advent of avian influenza to improve the knowledge and preventive practices of bird handlers and the public in general. Since the outbreak of the disease, the Sokoto State Ministry of Animal Resources has carried out a series of enlightenment campaigns in the media aimed at creating public awareness on the dangers posed by HPAI virus. However, there is the need to identify bird handlers in strategic market places who are at greater risk of acquiring the deadly virus with the aim of equipping them with preventive measures to stop further spread of the influenza virus since they come in contact with live birds from different geographical localities.

This study is therefore aimed at assessing the effect of health education intervention on the knowledge and practice of preventive measures against AI among bird handlers in Sokoto metropolis.

The research hypothesis was that at the end of the health education intervention, there will be at least 20% improvement in the knowledge and practices related to AI.

MATERIALS AND METHODS

Sokoto state is located in the extreme North West of Nigeria, close to the confluence of Sokoto river and Rima river, sharing borders with Niger Republic to the north, Zamfara state to the east, Kebbi state to the south east and Benin republic to the west (Figure 1). As of 2010, it has an estimated population of more than 4.2 million. Sokoto city is the modern day capital of Sokoto state (and its predecessor, the Northwestern State). The name Sokoto (which is the modern/anglicized version of the local name, Sakkwato) is of Arabic origin, representing suk, 'market'. It is also known as Sakkwato, Birnin Shaihu da Bello or "Sokoto, Capital of Shaihu and Bello").

Being the seat of the former Sokoto caliphate, the city is predominantly Muslim and an important seat of Islamic learning in Nigeria. The Sultan who heads the caliphate is effectively the spiritual leader of Nigerian Muslims. The metropolis is made up of four local government areas namely Sokoto North and South, Dange Shuni and Wamakko. Farming is the main stay of the economy of the state. It has an estimated population of 3 million cattle, 3 million sheep, 5 million goats, 4,600 camels and variable species of poultry including chickens, guinea fowls, ducks and turkeys (Sokoto State Profile, 2013).

This study was a quasi-experimental type with pre- and post-intervention components in the same group. The study population comprised all bird handlers in Sokoto metropolis. Using the formula for comparison of proportions in same group (Kirkwood and Sterne, 2003) and a 24% practice of prevention of AI in a previous study (Abbate et al., 2006), a sample size of 100 was obtained. Cluster sampling technique was applied in the selection of the 100 study subjects. The metropolis has 12 clusters where the bird handlers are found, out of which 6 were selected by simple random sampling technique using roll of papers. The selected respondents were given identification numbers and at the same time their telephone numbers were given to the officials of the Market Poultry sellers association for ease of communication when their presence was needed. Advocacy visits were paid to the officials of the Poultry Association of Nigeria, Sokoto state branch during which the objectives of the study were explained to them and also to solicit for

Table 1. Age distribution of respondents (n=100).

Age (years)	No. (%)
18-27	19 (19)
28-37	24 (24)
38-47	40 (40)
48-57	11 (11)
58-67	6 (6)
Total	100 (100)

Table 2. Educational status of respondents.

Educational level	No. (%)
None	18 (18)
Qur'anic only	45 (45)
Primary	28 (28)
Secondary	9 (9)
Tertiary	0 (0)
Total	100 (100)

their members' cooperation in ensuring the success of the study. A set of comprehensive, pretested questionnaire was administered by 6 trained research assistants on the respondents. Observational checklists were also used to assess the practices of the bird handlers with respect to preventive measures. The questionnaires sought such information as the socio-demographic characteristics, knowledge and practices regarding AI. The study instrument was pretested in a poultry market of another local government area outside the metropolis.

The members of the association in the 6 identified clusters were informed of the research and a day was set aside for the application of the study instruments. The study subjects were grouped into 2 for the purpose of the intervention. Each group was headed by 2 principal researchers. Informed verbal consent was obtained from individual study subjects and they were also given the option of opting out of the study when they so wished. Institutional ethical clearance was obtained from the ethical committee of the Usman Danfodiyo University, Sokoto. The pre-intervention phase of the study involved the application of the study instruments (questionnaires) to the respondents which was followed shortly by the intervention phase. The intervention which was basically health education had a demonstration segment. There were 2 sessions of the health education, each facilitated by 2 principal researchers. The health education sessions took place in the secretariat of the Market Poultry Association, Sokoto state branch located a stone throw from the market, each session lasting three hours. The contents of the health education included the cause of AI, clinical features, differentials, communicability, treatment and prevention, morbidity and mortality pattern all over the world including Nigeria. The demonstration session involved the use of personal protective apparels. There was also a question and answer session that lasted for forty minutes to enable respondents get clarification on some grey areas. Information, education and communication materials used for the health education included posters, flip charts, pictures, etc. The health education sessions were repeated a week after to reinforce the knowledge acquired. One month after the intervention, the same set of questionnaires was administered to the study subjects in the same venue to obtain the post-intervention data. Check list was used in the markets and poultry farms to

Table 3. Length of time handling birds.

Length of time (years)	No. (%)
1-5	27 (27)
6-10	34 (34)
11-15	29 (29)
16-20	10 (10)
Total	100 (100)

Mean=9.1±1.14.

Table 4. Sources of information about avian influenza.

Source of information	No. (%)
Radio/Television	60 (60)
Public enlightenment/lectures	23 (23)
Friends	10 (10)
Others	7 (7)
Total	100 (100)

observe preventive measures by the subjects.

Data collected using the questionnaires was entered into and analyzed using EPI INFO version 3.5.1 (2008) computer software. Cross tabulation of variables was done and level of statistical significance was set at $p < 0.05$. Each correct answer on the knowledge questions was awarded a mark with no marks awarded for wrong answers. Knowledge was graded with scores < 50 and $\geq 50\%$ adjudged inadequate and adequate knowledge, respectively.

RESULTS

A total of one hundred (n=100) respondents participated in the study. The ages of the respondents ranged from 18 to 63 years, 38 to 47 years being the modal class and those above 58 years constituted 6%. The mean age (± 2 standard deviation (SD)) of the respondents was 37 ± 3.34 years (Table 1). All the study subjects were males and Muslims. A total of 45% of them had only Qur'anic education, 18% had no education, while only 9% had secondary education (Table 2). Most of the respondents, 34% had been handling birds for between 6 and 10 years, while only 10% of them handled birds for over 16 years (Table 3). Sixty percent of the respondents have heard of AI, with the media being the commonest source of information followed by public enlightenment campaigns (Table 4). At baseline, 51% of the respondents scored $\geq 50\%$ on the knowledge and prevention of AI (adequate knowledge), with a mean (± 2 SD) knowledge score of 64 ± 7.01 . At post-intervention, 86% of the respondents scored $\geq 50\%$ (adequate knowledge) with a mean knowledge score of 91 ± 17.64 ($p < 0.0001$) (Table 5). The commonest form of personal protection adopted by the study subjects was the use of protective clothing including face masks (Table 6). Results from the

Table 5. Knowledge of AI.

Knowledge of AI	Study phase		Test statistics
	Pre-intervention	Post-intervention	
	No. (%)	No. (%)	
Adequate	51 (51)	86 (86)	$\chi^2=26.79$; df=1; p<0.0001
Inadequate	49 (49)	14 (14)	
Total	100 (100)	100 (100)	

Table 6. Respondents' ways of protection against AI.

Protective measures*	No. (%)
Protective clothing	27 (27)
Face masks	53 (53)
Hand gloves	16 (16)
Boots	21 (21)
Goggles	12 (12)
Washing hands after handling birds	25 (25)
Bathing after handling baths	8 (8)
Use of aprons	17 (17)

*Multiple answers allowed.

application of checklists showed that of the 50 bird handlers in 50 farms surveyed, only 10 used some form of protective clothing with 10 wearing boots. Five out of the 50 farms had their workers wearing masks, hand gloves and aprons, while only one farm had a few of their workers wearing goggles. Forty of these farms did not as a matter of routine practice provide any form of protective clothing for their workers. Although 20 farms claimed that they use soap and water to wash their hands after work, there was really no evidence on ground to justify that claim. Thirty farms used ordinary water for washing after attending to birds. The sanitary condition of most of the farms is everything, but good as only five farms had facilities for proper waste management. Only 3 farms had dips for vehicles and 25 had for humans. It was observed that only 4 farms had good methods of egg collection which prevents the birds coming in contact with the eggs after they are laid.

DISCUSSION

The poultry farmer by virtue of his close contact with birds is among individuals most at risk of contracting AI. The mean age of the respondents in this study was 37 ± 3.3 years, which is similar to the mean age obtained in the study from Nepal, India (Neupane et al., 2012). However, the mean age in our study was lower than 43 years observed in Italy (Abbate et al., 2006) but higher than figures observed in other studies from Zaria and Oyo state of Nigeria (Idris et al., 2009; Fatiregun and Saani,

2008). Findings from this study showed that the mean duration of handling of birds was 9 years which is lower than 12 and 16 years observed in studies from Zaria and Hong Kong, respectively (Idris et al., 2009; Kim et al., 2011). The results of the study showed that 60% of the respondents were aware of the existence of AI, which is lower than the 93 and 97% awareness recorded in similar studies from Oyo state, Nigeria and Nepal, India, respectively (Fatiregun and Saani, 2008; Neupane et al., 2012). In contrast to the level of awareness recorded in this study, other centers have observed lower rates (Eastwood et al., 2009; Blendon et al., 2008). The level of awareness recorded in our study may not be unconnected to the low morbidity and mortality associated with the infection since it was first noticed in Nigeria, compared to that seen in other countries. The commonest source of information on AI in this study was the media (60%), particularly radio and television. The radio is a common household appliance, which is found useful in the information, education and entertainment of the populace. Equally, our respondents are avid listeners of international Hausa service radio stations e.g. British Broadcasting Corporation (BBC), Voice of America (VOA), Radio France International (RFI), De-Welle, Russia, China, etc. This finding is in consonance with those observed in other studies (Abbate et al., 2006; Eastwood et al., 2009; Neupane et al., 2012; Idris et al., 2009; Fatiregun and Saani, 2008). However, the study from Hong Kong, China (Kim et al., 2011) recorded the internet and health talks as the commonest sources of information about AI which may not be unrelated to the level of education of their subjects as compared to this study where majority (63%) of the subjects had no formal education.

At baseline, 51% of the study subjects had adequate knowledge of the cause, mode of transmission and prevention of AI, with a mean knowledge score of 64 ± 7.01 . The level of knowledge exhibited by the respondents may not be unrelated to their exposure to foreign mass media that usually broadcast in the local language, Hausa in the wake of the outbreak of the infection and this had necessitated the setting up of AI desks in all the Local Government Areas of the state. Adequate knowledge of the mode of transmission of AI will invariably assist individuals in protecting themselves from the menace of the infection.

After the intervention, 86% of the subjects had adequate knowledge of AI with a mean knowledge score of 91 ± 17.64 , and this increase in the level of knowledge post intervention was found to be statistically significant ($p < 0.0001$). In agreement with our findings, the study conducted in Vietnam showed high knowledge for AI. However, low knowledge scores were observed in the studies from Zaria, Nigeria and Hong Kong (Idris et al., 2009; Kim et al., 2011).

In the assessment of the respondents' practices aimed at protecting themselves against AI, the commonest measure was the use of face masks (53%). In the wake of the outbreak of AI, the state government, Sokoto state branch of the Veterinary Medical Association (NVMA) and other donor agencies distributed face masks free of charge to the people most at risk, which could have accounted for high proportion of our subjects who used it. Cultures and habits are often difficult to change overnight which accounted for near average use of face masks by the respondents as most opined that for long they have been practicing their trade without contracting any infections. Similar to our findings, the use of face masks was the commonest preventive measure adopted in the study from Italy (Abbate et al., 2006).

However, the use of other personal protective equipment (PPE) was not a routine among our respondents and this is in consonance with the findings from other studies (Fatiregun and Saani, 2008; Idris et al., 2009; Kim et al., 2011; Neupane et al., 2012). Sometimes the low profit margin of these bird handlers makes it difficult to acquire these PPE. It has been observed that the distribution of promotional material during outbreaks of epidemics will instill confidence and demonstrate to the public that health authorities are transparent about the risk and have containment plans in place.

This in turn, has the added benefit of allowing people to accept socially unfamiliar control measures such as wearing masks and home quarantine, before a pandemic occurs. The strategy should also include the promotion of personal infection control practices, such as hand washing and sick leave which are all lifestyle activities that would protect individuals and the community against any communicable disease (Eastwood et al., 2009). Despite World Health Organization (WHO) recommendations on ways to prevent infection with AI virus (WHO, 2006), there has always been low adherence or outright disregard to these recommendations. Hand washing with soap and water was practiced in only 20 out of the 50 farms visited. This practice is in consonance with findings from other centers (Neupane et al., 2012; Kim et al., 2011; Abbate et al., 2006; Idris et al., 2009). It was observed that 30 farms used ordinary water for washing after attending to birds. The sanitary condition of most of the farms is everything but good as only five farms had facilities for proper waste management. Only 3 farms had dips for vehicles and 25 had for humans.

It was observed that only 4 farms had good methods of egg collection which protects the birds against the spread

of infection as the birds do not come in contact with eggs after they are laid. In the market place, the disposal of waste is also poor and birds of different species are mixed together by majority of the sellers. Only few of the sellers separated sick birds from the healthy ones. This underscores the need for regular inspection of farms and other points of sale of birds to ensure adequate sanitation and adherence to safety guidelines. After intervention, it was observed that there was tremendous improvement both in the farms and the markets. Consequent upon the intervention, 30 farms bought boots, gloves, aprons and masks for their workers. As is common with practices in most work places, most workers chose to ignore safety rules thereby increasing their chances of contracting infections.

After the intervention, the sanitary conditions of most farms had improved considerably with most farms initiating a weekly environmental sanitation exercise in the farms and their environs. The provision of dips for vehicles was not done as all the farms claimed it was capital intensive. The training intervention showed considerable increase in the level of knowledge about AI, its cause, transmission and prevention while the subjects exhibited marked improvement in the practices of prevention of AI. Improvement of knowledge of transmission and the use of preventive measures is an important public health strategy for the reduction of the effects of AI and its complications amongst bird handlers.

The mixing of birds of different species reduced considerably; sick birds were often separated from healthy ones, even though the market environmental waste management was yet to be corrected as the disposal was still a major problem.

Conclusions

The health education intervention study has demonstrated increased awareness of AI among the study subjects as 86% of them had a mean knowledge score of 91 ± 17.64 after the introduction of the intervention measures as compared to 51% with a mean knowledge score of 64 ± 7.01 at baseline. The use of media particularly radio was found to be an effective and veritable tool for raising the awareness of bird handlers on topical issues in this environment such as AI. The findings from this study will help relevant government agencies come up with sustainable policies that will nip in the bud lapses in preventive measures in case of future outbreaks. Given the necessary education, bird handlers are more likely to take more proactive measures against the spread of diseases like AI.

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Full Length Research Paper

Efficacy trial on susceptibility of *Amblyomma* ticks for commonly utilized acaricides in North Gondar

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Ticks are blood feeding ectoparasites that induce huge production losses in livestock industry and creating serious public health problems in the world. This study was conducted to assess the efficacy of commonly used acaricides against *Amblyomma variegatum* ticks in North Gondar. The assessment was conducted in laboratory and in the field. For laboratory experiment, adult ticks were collected and exposed to Amitraz or Diazinon. For live animal experiment, sheep infested naturally with *A. variegatum* ticks were kept in door and grouped into three. The first group was treated with Diazinon, the second group with Amitraz, and the last was left untreated as control. In the laboratory, significant difference ($P > 0.05$) was not observed between two acaricides on the killing effect at different concentrations. On live animals, there was a significant ($P < 0.05$) difference between two drugs. More ticks were died in Amitraz treated group than sheep treated with Diazinon. In conclusion, the two acaricides were performing almost equally in the laboratory but Amitraz was better on live animals. To confirm the presence of resistance on live animals, further studies using standard products are needed.

Key words: Acaricides, *Amblyomma* ticks, efficacy, North Gondar, susceptibility.

INTRODUCTION

Tick and tick born diseases (TBD) are widely distributed throughout the world particularly in tropical and subtropical countries, which cause tremendous economic losses in livestock production (Kettle, 1995). The economic losses caused by tick and TBD in cattle alone are estimated at 13.9 to 18.7 billion United States dollar annually worldwide (de Castro, 1997).

The problem is severe in developing countries where the resource for control and eradication is very limited (FAO, 1984). In most parts of Africa, including Ethiopia tick and TBD are economically very important. In Ethiopia, ticks occupy the first place among the external

parasites and the economic loss incurred when they infest livestock, particularly cattle is enormous (Solomon et al., 2001).

Ticks are obligate ectoparasites of most types of terrestrial vertebrates. They are large mites and thus are arachnids, members of the subclass Acari. Tick bites, in addition to causing irritation and infestation, have been implicated in the transmission of serious diseases of livestock such as cowdriosis, babesiosis, anaplasmosis and others. These diseases are important causes of morbidity and mortality in livestock. By creating different grade of lesions on the skin, ticks down grade the quality

of hides and skins up to 20 to 30%. They also predispose animals to secondary attacks from other parasites such as screw worm flies and infection by pathogens like *Dermatophilus congolensis* and other bacterial diseases (Seyoum, 2001; Ghosh et al., 2007). Over 60 tick species are reported in Ethiopia. Especially, *Amblyomma* species are widely distributed and the most economically important ticks since they are known to transmit a fatal disease of domestic and wild ruminants in sub-Saharan Africa (heartwater) (Mekonnen, 1998). *Amblyomma* ticks are large; with three host parasites and long mouth parts which cause serious wounds (Fraser and Mays, 1991). Ticks are controlled by the application of acaricides to the body of the animal. Major chemicals used for this purpose are organophosphates, amidines, and synthetic pyrethroids. Some other compounds (chlorinated hydrocarbons and arsenicals) were used but phased out of the market mainly due to the development of tick resistance (Mekonnen, 1998).

In Ethiopia, acaricides are well utilized for the control of ticks, majority of these chemicals are utilized for two or three decades and it is also common to use acaricidal solutions too frequently at a lower concentration than recommended. All these promote the development of tick resistance against acaricides (Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP), 2010). Different acaricides are imported at the present without proper efficacy test, control and registration (Federal Environmental Protection Agency (FEPA), 2004). The purchase of acaricides by hard currency causes a major drain on the limited foreign exchange available in the country. Farmers and customers utilizing acaricides have complained about their effectiveness to kill or remove all ticks after application.

Moreover, the information about the efficacy of commonly utilized acaricides (Amitraz and Diazinon) on *Amblyomma* ticks in North Gondar zone is limited. Therefore, the objective of this study was to assess the efficacy of commonly used acaricides (Amitraz and Diazinon) against *Amblyomma* species of ticks in the area.

MATERIALS AND METHODS

The study area

The study was conducted from November, 2011 to June, 2012 in North Gondar, at latitude, longitude and altitude of 12.3 to 13.8 North, 35.3-35.7° East and 2,200 meter above sea level, respectively. The rainfall varies from 880 to 1772 mm Hg. The annual mean minimum and maximum temperature of the area varies between 12.3 to 17.7 and 22 to 30°C, respectively. The area has two seasons, the wet season from June to September in which the area gets its majority of rainfall, and the dry season from October to May which receives small and erratic rainfall (central statistical Authority (CSA), 2011).

METHODOLOGY

For laboratory experiment, unattached adult *Amblyomma* ticks were collected on the field and exposed to acaricides (Amitraz and Diazinon). The recommended (1:1000 for Diazinon, 1:625 for Amitraz), double (2:1000 for Diazinon, 2:625 for Amitraz) and half doses were prepared.

One ml of each liquor was added on Petri dish with a filter paper fit at its bottom. Then, the acaricide was evenly distributed and 10 ticks of equal size were placed on each Petri dish and it was closed.

Distilled water was used as a control. The number of ticks live or dead was counted after 24 h of exposure. The experiment was repeated three times for precision. For field trial, sheep infested naturally with *Amblyomma* ticks were kept in door and grouped into three containing five animals in each group. The first group was treated with Diazinon, the second group was treated with Amitraz, and the last group was left untreated as control. Acaricides were sprayed manually by giving more emphasis on tick infested areas. The acaricides' concentration was based on the manufacturer's recommendation for hand spray (1:1000 for Diazinon, 1:625 for Amitraz). The effects of acaricides on ticks were observed after 24, 48 and 72 h of exposure.

Data analysis

The data were recorded in excel spreadsheet. Descriptive statistics (mean, percentage and graphs) were used to express the results. Independent t-test was used to assess the difference between treatment groups. Statistical analysis was performed by using statistical package for social sciences (SPSS) version 19 and P value less than 0.05 was considered significant.

RESULTS

In laboratory

Figure 1 shows that a number of tick died after exposure with acaricides in laboratory at double, recommended and half doses. There was no significant difference ($P > 0.05$) between two acaricides on the killing effect in three different concentrations. The average number of ticks died after distilled water exposure was not more than one.

On live animals

The recommended doses of acaricides were applied on infested live animals. There was a significant ($P < 0.05$) difference between the two drugs. More ticks died in Amitraz treated group than sheep treated with Diazinon (Table 1). In addition to this, it was also observed that more dead ticks were not detached and more engorged ticks were observed in sheep treated with Diazinon.

DISCUSSION

The laboratory result showed absence of significant

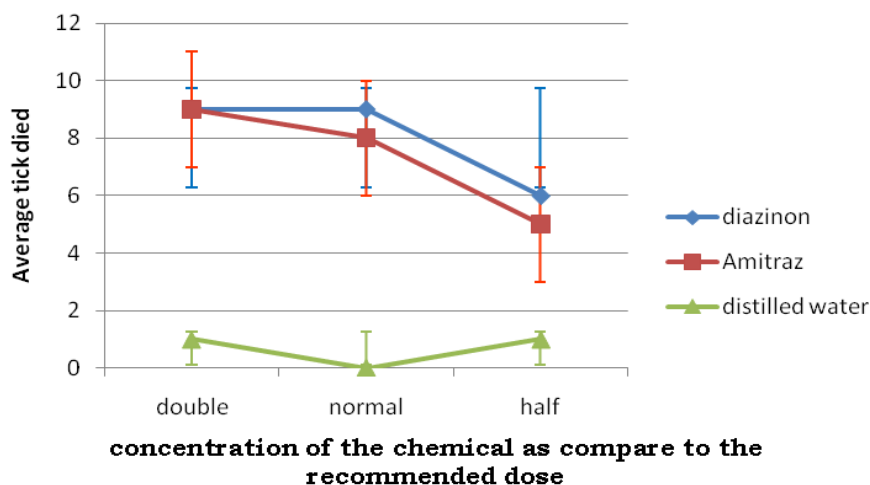


Figure 1. Killing effect of acaricides in the laboratory at double, recommended and half doses.

Table 1. Average tick count before and after treatment in different time interval.

S/n	Group	Average counts			
		Before treatment	After treatment		
			24 h	48 h	72 h
1	Group I (Diazinon)	39	27	14	12
2	Group II (Amitraz)	33	2	1	0
3	control	41	41	40	38

difference between two drugs on killing effect. However, on live animal, Amitraz was more effective than Diazinon. The difference in the result of the laboratory and on live animal may be related with different confounding factors on live animals. Significant proportion of ticks were not dead rather a lot of engorged ticks were observed in Diazinon treated group of sheep. The presence of engorged ticks in Diazinon treated group showed inability of the acaricide to inhibit growth and reproductive capacity of the ticks. This may be related to the decrease in the susceptibility of the tick for Diazinon. Such phenomenon was also complained of by livestock owners in the area. This finding is in line with report of Turkson and Botchey (1999) who reported that field strain of *Amblyomma* is resistant to organophosphates like Diazinon. Emergence of resistant tick against organophosphates acaricides was also stated by Tessema and Gashaw (2010). Eshetu et al. (2013) compared the efficacy of Amitraz and Diazinon on *Amblyomma* and other ticks and found that Amitraz at recommended concentration provides better efficient oviposition inhibition

than Diazinon which agrees with the finding of this study.

The frequency of application of acaricides, dilution rate, storage as well as the quality of the product will affect the effectiveness of an acaricide (Turkson and Botchey, 1999).

The efficacy of Amitraz was compared with cyfluthrin, fipronil and permethrin by Burrige et al. (2003) on *Amblyomma* ticks in United States and found that Amitraz was less effective than others. However, Amitraz is an important acaricide because it does have some valuable properties for tick control. Amitraz has been shown to be an excellent detaching agent, inducing the rapid detachment of live ticks from infested animals (Mekonnen, 2001; Natala et al. 2005). However, some studies have shown that Amitraz can take several days to kill ticks and that some surviving ticks can complete engorgement and lay viable eggs. It is for these reasons that Amitraz is an acaricide useful for tick control but not for tick eradication (Burrige et al., 2003). However, still Amitraz is preferable than Diazinon in inhibiting oviposition (Eshetu et al., 2003). Cyfluthrin, fipronil and permethrin were not

utilized in North Gondar for the control of ticks (Melaku, 2013) and can be used alternatively with other acaricides to reduce the emerging of drug resistance.

Conclusion

In the laboratory, two acaricides were equally performing but on live animals, Amitraz was preferable than Diazinon. Other types or group of acaricide should also be used rather than depending on limited type of acaricides.

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