Determination of Knowledge Based on Aflatoxin Poisoning among Broiler Farmers in Nairobi City County, Kenya

ABSTRACT

Background: There is a scarcity of information concerning knowledge of aflatoxin contamination of feeds among farmers even in aflatoxin-prone regions in Kenya. Thus, knowledge of aflatoxins in feeds among poultry farmers is of paramount importance in designing plans to minimize risks of aflatoxin exposure. Therefore, this study sought to assess the Determinants of Knowledge on Aflatoxin Among Broiler farmers in Nairobi City County, Kenya.

Methodology: The study utilized an analytical cross-sectional study design. A total of 240 farmers were sampled from a population of 600 farmers within Nairobi City County. A structured questionnaire was administered to farmers within Nairobi City County. SPSS version 26 was used to analyze the data descriptively. Results were presented in tables and figures. Ethical approval was sought from relevant authorities and parties before the commencement of the study**.**

Results: Results from the study show that the majority of the farmers (58.2%) had knowledge of aflatoxin. There was a significant association ($p<0.05$) between the socio-demographic characteristics of farmers and knowledge of aflatoxin.

Conclusion: The study concludes that the farmers had adequate knowledge of aflatoxin occurrence in feeds and methods to reduce the contamination. There is a need for continuous sensitization of farmers on aflatoxin, particularly on feed management practices by the Ministry of Agriculture and Ministry of Health Division of Public Health in Kenya.

Keywords: Aflatoxin; contamination; detoxification.

1. INTRODUCTION

Aflatoxins are a group of extremely lethal, carcinogenic fungal metabolites produced mainly by *Aspergillus flavus, A.parasiticus, and A. nomius* [1,2]. Aflatoxin B_1 (AFB_1) is considered to be a carcinogen type 1 by the International Agency for Research on Cancer [3,4]. The US Food and Drug Administration (FDA) terms aflatoxins as an inevitable food contaminant that regularly contaminates agricultural products worldwide and largely in developing countries [5]. About 600 million (1 in 10 people globally) suffer from food-borne intoxications leading to about 420, 000 deaths annually resulting in the loss of 33 million Disability Adjusted Life Years (DALYs). A considerable fraction of this burden is heavily felt in the African continent where unsafe food is responsible for about 91 million cases of food-borne diseases yearly and out of these 137,000 die prematurely [6].

In Kenya since 2004, aflatoxin epidemics among subsistence farmers have recurred yearly in the Eastern Province and the enormity of exposure to Aflatoxins could be higher than reported due to the lack of robust surveillance systems [7,8]. Aflatoxin adulteration of poultry feed and raw feed ingredients is a serious concern globally [9]. Close to 5 billion people in developing countries are at risk of chronic exposure to aflatoxins [10].

The main key players i.e. farmers in developing countries that could have a substantial role in the control of aflatoxins have inadequate knowledge of the causes, effects, and control measures of aflatoxins [11]. Consequently, they are not keen on incurring the costs of controlling aflatoxin contamination owing to the fact that most of their dealings are in informal markets without strict regulations [11]. This is attributed to the lack of knowledge and alternatives for the disposal of contaminated cereal at the household level and ultimately it is fed to domestic animals [12].

Nairobi unlike other towns in Kenya has been found to be the largest ultimate destination for poultry countrywide and is also the main entry and transfer point for poultry within the East African Community [13]. In Nairobi City, no data or information is readily available on the knowledge of aflatoxin among broiler farmers and whether the farmers' have sufficient knowledge of proper feed management practices. Therefore, this study aimed at assessing the knowledge of broiler farmers on Aflatoxin within Nairobi City County on aflatoxin.

2. METHODOLOGY

2.1 Study Area

The study was conducted in Nairobi City County. Nairobi is the capital city of Kenya and is one of Africa's strategic financial, business, transport, communications, non-governmental organizations, and diplomatic capital. Nairobi city county population is about 4.397 million according to the 2019 census [14] therefore chicken production is expected to rise to meet this growing population. Nairobi County unlike other counties serves as the major harbor for the broiler market across the country and beyond [13]. The consumption of broiler meat in Nairobi County is projected to rise to 30.5 thousand metric tonnes by the year 2030 and thus to cater to this escalating demand, broiler and feed production is expected to rise [15].

Table 1. Sampling frame: Number of farms sampled per sub-county

Sub-county	Total number of farms	Number of farms sampled
Westlands	100	40
Kasarani	200	80
Embakasi Central	75	30
Embakasi East	100	40
Dagoreti South	75	30
Dagoreti North	50	20
Total	**600**	**240**

2.2 Study Design, Sampling, and Sample Size Determination

The study utilized a cross-sectional study design by administering structured questionnaires. The study used a multistage cluster random sampling technique (two stages) to select the sub-counties and wards where the questionnaires were administered to 240 respondents from a population of 600 as shown in Table 1. Systematic random sampling was used to select the farms where the questionnaires were administered and every 3rd (as shown in equation 2) farm was sampled until the desired sample size was attained. Proportionate distribution of the sample was employed where 40, 80, 30, 40, 30, and 20 respondents were interviewed in Westlands, Kasarani, Embakasi Central, Embakasi East, Dagoreti South, and Dagoreti North respectively.

2.2.1 Sample size determination for Cross-sectional Design

Since the population is less than 10,000, Yamane *et al* formula (Yamane *et al.*, 2002) were used to determine the sample size as shown below.

$n = \frac{N}{1+Ne^2}$ Equation 1

Where n- estimated sample size N- Estimated population size e- Margin of error (0.05)

$$n = \frac{N}{1 + Ne^2} = \frac{600}{1 + 600x0.05^2} = 240$$

240 was the number of farmers sampled from each ward in the six sampled sub-counties within Nairobi City County.

Systematic random sampling formula;

$K = N/n$ 600÷240= 2.5 rounded off to 3 Equation 2

2.3 Data Analysis and Ethical Consideration

Statistical Package for Social Sciences (SPSS) version 26 was used to analyze the quantitative data from questionnaires. Data were subjected to descriptive analysis to determine proportions and the chi-square test was used to determine the association between variables. Qualitative analysis was done using NVIVO software and the data were subjected to thematic analysis.

3. RESULTS

3.1 Knowledge on Aflatoxin

Fig. 1 shows that the farmers who had knowledge on aflatoxin were (58.2%). The knowledge of aflatoxin was the mean of responses from the respondents based on various knowledge parameters asked as shown in Table 3.

The sociodemographic characteristics of farmers as shown in Table 2 show that most farmers were ≤50 years old (34.7%). The study also shows that most of the farmers were female (63.2%). The study further indicates that the majority of the farmers were married (88.3%). The farmers' level of education from study shows that most of the farmers had a secondary level of education (67.8%).

The results in Table 3 indicate that the majority of the farmers had reared broilers between 1-5 years (43.9%) and most of them kept <500 broilers (75.6%) in their farms. The majority of the farmers agreed that there is a possibility of fungal toxins to be found in feed (80.3%), to be transferred from feed to the broiler (79.5%), and that the fungal toxins can affect the poultry's health (80.3%). The results further indicate that the majority of the farmers (94.5%) had heard about aflatoxins and most of them were able to detect molds in feed (84.1%). The results also show that in the event that the feeds are contaminated with aflatoxin, the majority of the farmers (59.6%) reported that they will continue feeding the broilers with the adulterated feed. The results further show that most of the farmers (91.6%) had no knowledge on the possibility of detoxifying fungal toxins in feed. Those who knew (8.4%) about the possibility of detoxifying fungal toxins in feed stated the following methods can be used; boiling, sun drying, grinding, good storage, heating, mixing with toxin binder, and sieving.

The results also show that most of the farmers (95.4%) did not feed their broilers with any other feed other than commercially processed feed. To add on, (4.6%) of the farmers reported that they fed the broilers on other feeds together with the commercially processed feed and they further added that they fed the broilers on greens, kitchen refuse, leftovers, *ugali (corn)*, grounded maize, bran, and maize.

3.1.1 Factors associated with knowledge on Aflatoxins

Statistical analysis revealed that there was a significant association ($p<0.05$) between age and level of education with knowledge of aflatoxins as shown in Table 4.

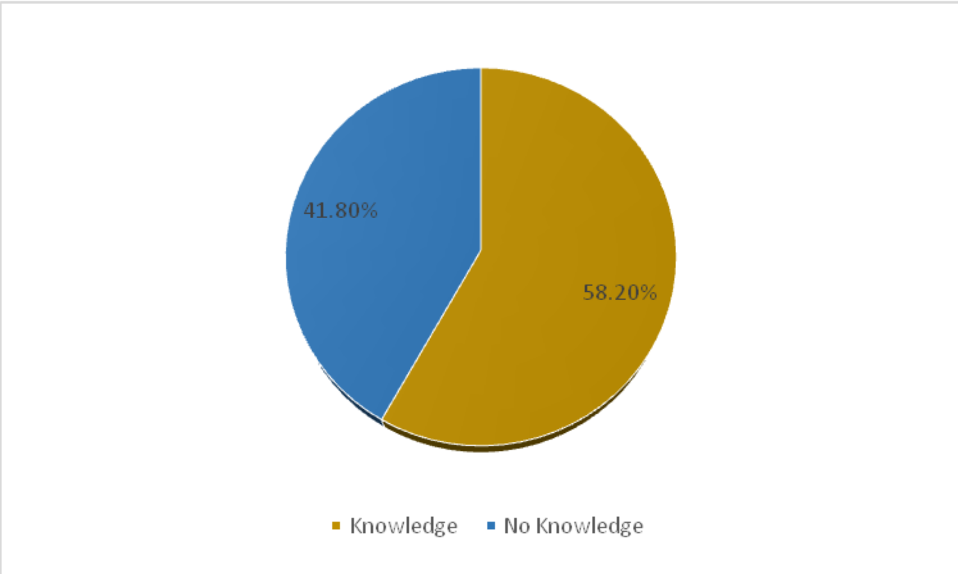

Fig. 1. Proportion of farmers with knowledge on aflatoxin in the study area

Table 2. Sociodemographic characteristics of the respondents in the study area

Variable	Category	Frequency n (%)
Age of participants	21-24	9(3.8%)
	25-29	8(3.3%)
	30-34	13(5.4%)

	35-39	41(17.2%)
	40-44	42(17.6%)
	45-49	43(18%)
	>= 50	83(34.7%)
Sex	Male	88(36.8%)
	Female	151(63.2%)
Marital status	Married	211(88.3%)
	Divorced	5(2.1%)
	Single	23(9.6%)
level of education	Primary	29(12.1%)
	Secondary	162(67.8%)
	Tertiary	48(20.1%)

Table 3. Knowledge of farmers on Aflatoxin based on various parameters

Knowledge parameter	**Response**	**Proportion n (%)**
Period of rearing chicken	<1 year	15(6.6)
	1-5	100(43.9)
	6-10	83(36.4)
	>10	30(13.2)
Number of broilers kept in the farm	<500	170 (75.6%)
	501-1000	35 (15.6%)
	1001-2000	12 (5.3%)
	>2000	8 (3.6%)
Possibility of fungal toxins to be found in feed	Yes	192 (80.3%)
	No	47 (19.7%)
Possibility of fungal toxins to be transferred from feed to poultry	Yes	190(79.5%)
	No	49 (20.5%)
The possibility that fungal toxins in feed can affect poultry health	Yes	192 (80.3%)
	No	47 (19.7%)
Heard about aflatoxins	Yes	225 (94.5%)
	No	13(5.5%)
Ability to detect molds in feed	Yes	201 (84.1%)
	No	38 (15.9%)
Action taken with feeds found contaminated with aflatoxin	Dispose	30 (13%)
	Continue feeding	137(59.6%)
	Alternative use	63 (27.4%)
Possibility of detoxifying fungal toxins in feed	Yes	20 (8.4%)
	No	217 (91.6%)
Are broilers fed on any other feed other than the commercial feed	Yes	11(4.6%)
	No	227 (95.4%)

Table 4. Association between sociodemographic characteristics and knowledge of aflatoxin

Variable	**Category**	**Yes**	**No**	**Chi square (*X^2*)**	**P value**	**Remark**
Sex	Male	67 (28.8%)	20(8.6%)		**0.169**	
	Female	123(52.8%)	23(9.9%)	**1.896**		Not significant
Marital status	Married	165(70.8%)	40(17.2%)		**0.446**	
	Divorced	4(1.7%)	1(0.4%)			Not significant
	Single	21(9%)	2(0.9%)	**1.616**		

Education level	Primary	17(7.3%)	9(3.9%)		**0.035**	
	Secondary	133(57.1%)	27(11.6%)			Significant
	Tertiary	40(17.2%)	7(3%)	**5.174**		
Age	21-24	3(1.3%)	4(1.7%)		**0.047**	
	25-29	6(2.6%)	2(0.9%)			
	30-34	11(4.7%)	2(0.9%)			
	35-39	35(15%)	5(2.1%)			Significant
	40-44	31(13.3%)	11(4.7%)			
	45-49	36(15.5%)	5(2.1%)			
	≥50	68(29.2%)	14(6%)	**11.055**		

Table 5. Association between sociodemographic characteristics and knowledge on signs to suspect aflatoxin contamination

Variable	**Category**	**Yes**	**No**	X^2	**P value**	**Remark**
Sex	Male	71(31.8%)	12(5.4%)		**0.510**	
	Female	115(51.6%)	25(11.2%)	**0.435**		Not significant
Marital status	Married	164(73.5%)	32(14.3%)		**0.179**	Not significant
	Divorced	2(0.9%)	2(0.9%)			
	Single	20(9%)	3(1.3%)	**3.445**		
Education level	Primary	19(8.5%)	8(3.6%)		**0.043**	
	Secondary	126(56.5%)	25(11.2%)			Significant
	Tertiary	41(18.4)	4(1.8%)	**5.246**		
Age	21-24	7(3.1%)	1(0.4%)		**0.697**	Not significant
	25-29	7(3.1%)	1(0.4%)			
	30-34	8(3.6%)	4(1.8%)			
	35-39	33(14.8%)	7(3.1%)			
	40-44	33(14.8%)	4(1.4%)			
	45-49	33(14.8%)	8(3.6%)	**3.850**		
	≥50	65(29.1%)	12(5.4%)			

Table 6. Association between knowledge and sources of information on Aflatoxin

Variable	**Not Aware**	**Aware**	X^2	**P value**	**Remark**
Reading	28(12.1%)	203(87.9%)	2.768	0.046	Significant
Mass media	140(60.6%)	91(39.4%)	1.121	0.290	Not significant
Seminars	52(22.5%)	179(77.5%)	9.661	0.002	Highly Significant
Friends &neighbors	69(29.9%)	162(70.1%)	0.182	0.669	Not significant

Table 7. Knowledge on signs to suspect the presence of fungal toxins in feed

Response	**Abnormal color**	**Abnormal consistency**	**Bad odor**	**Insect/larva presence**	**Impaired animal health/death**
Yes	53 (22.3%)	195 (85.1%)	187 (79.6%)	101(43.5%)	124 (54.6%)
No	185 (77.7%)	34 (14.9%)	48 (20.4%)	131(56.5%)	98 (45.4%)

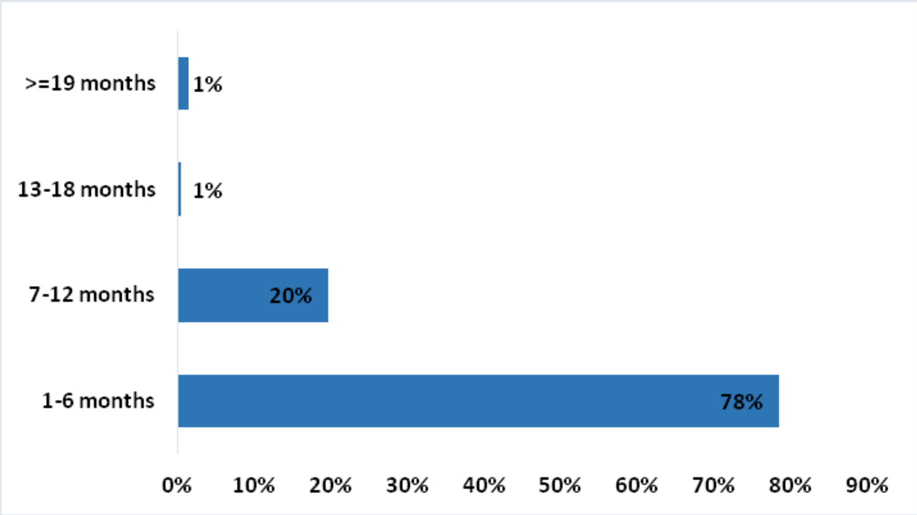

Fig. 2. Length of time farmers heard about aflatoxin

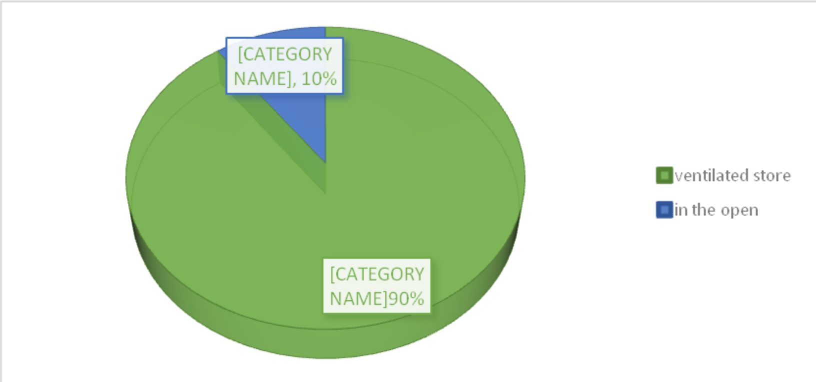

Fig. 3. Place where broiler feed is stored

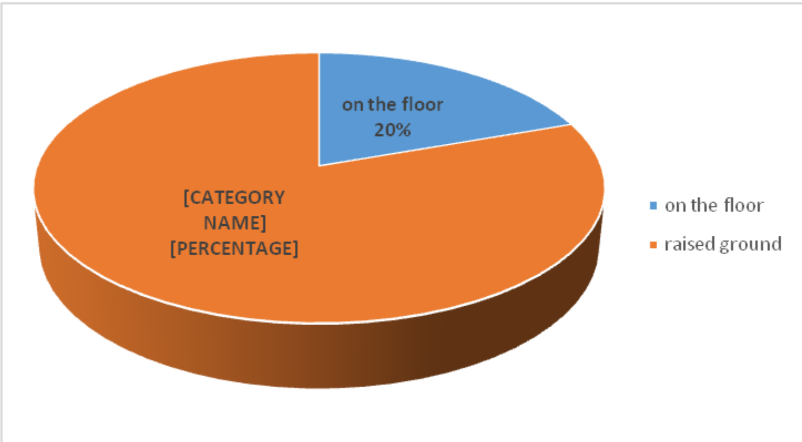

Fig. 4. Broiler feed storage surface

Table 5 shows that there was a significant association (p<0.05) between the level of education and knowledge of signs to suspect aflatoxin contamination in broiler feed.

There was a significant association (p<0.05) between knowledge of aflatoxins among farmers and source of information through which farmers heard about aflatoxin as reading and seminars were significant as shown in Table 6.

Table 7 shows that the majority of the farmers were knowledgeable on the signs used to suspect fungal contamination in feed as (85.1%) of the farmers were able to identify abnormal consistency, (79.6%) bad odor, (43.5%) presence of insect/larva and (54.6%) impaired animal health /deaths. However, the majority of the farmers (77.7%) did not know how to identify abnormal colors in feed.

Fig. 2 shows that most farmers (78%) had heard about aflatoxin between 1-6 months ago while few farmers (1%) had heard about aflatoxin 13-18 months ago and >=19 months ago.

On the farmers' feed storage practices, the study observed that most of the farmers (90%) stored their broiler feed in well-ventilated stores whereas (10%) stored their broiler feed in the open as shown in Fig. 3.

On feed placement methods used by the farmers, the study observed that the majority of the farmers (80%) placed their broiler feed on the raised ground whereas (20%) of the farmers placed their broiler feed on the floor as shown in Fig. 4.

Fig. 5 indicates that (76%) of the farmers bought broiler feed on a weekly basis, (10%) of the farmers bought broiler feed on a monthly basis, (8%) bought fortnightly, and lastly (6%) bought broiler feed on a daily basis.

Broiler feeds were inspected the study observed that (84%) of the feed was in good condition (non moldy and loose), (15%) was moldy and loose and lastly (1%) was moldy and compact (cake-like) as shown in Fig. 6.

Findings from the Focus Group Discussion show that the respondents had knowledge of the presence of aflatoxin in food and feed, signs of feed contaminated with the fungal toxin, and on prevention and control of aflatoxin. On the contrary, the respondents did not have knowledge on aflatoxin carryover, on measures taken with feed found contaminated with fungal toxins/aflatoxin and on detoxification of contaminated feed. This is shown in Table 8.

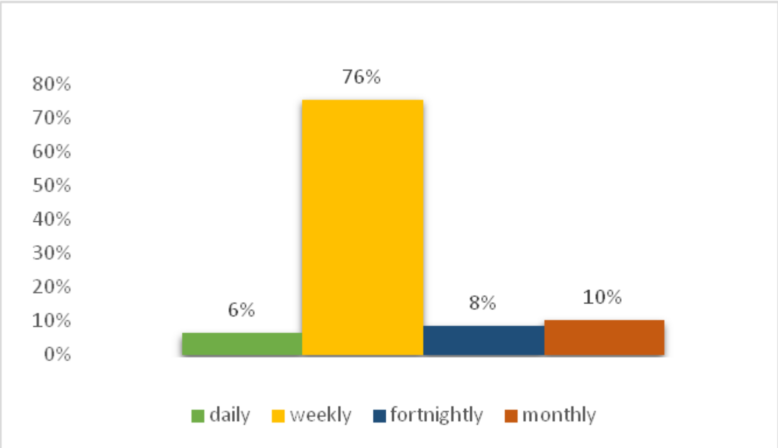

Fig. 5. Frequency of purchase of broiler feed

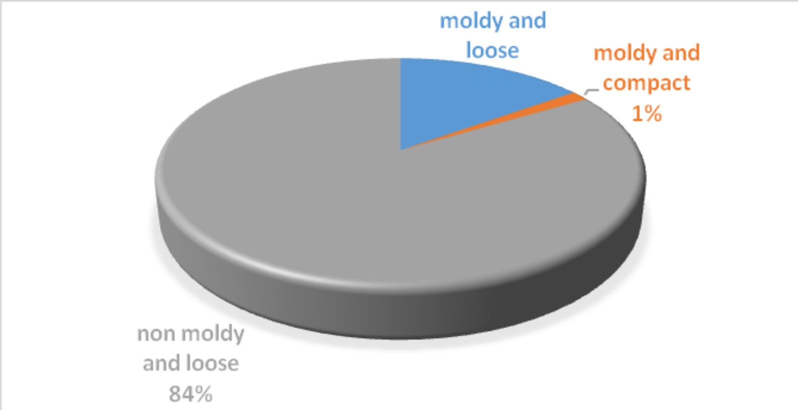

Fig. 6. State of broiler feed

Table 8. Focus Group Discussion on Farmers' knowledge on Aflatoxin

Parameter	FGD 1	FGD 2	Total
Knowledge on the presence of aflatoxin in food and feed	√	√	**2**
Knowledge on causes of aflatoxin in feed	√	**x**	**1**
Knowledge on aflatoxin carryover in animal products	**x**	**x**	**0**
Knowledge on signs of feed contaminated with the fungal toxin	√	√	**2**
Knowledge on health impacts of aflatoxin	√	**x**	**1**
Knowledge on measures taken with feed found contaminated with aflatoxin/fungal toxins	**x**	**x**	**0**
Knowledge on prevention and control of aflatoxin	√	√	**2**
Knowledge on detoxification of contaminated feed	**x**	**x**	**0**
Knowledge on how to place and store feed	√	√	**1**

KEY: √ Had knowledge x Had no knowledge

4. DISCUSSION

By and large, farmers and the general public in developing countries know little concerning aflatoxins and their related health impacts [16]. Studies conducted in various regions of the world demonstrate that the knowledge on aflatoxin is low. Part of the documented levels are for instance, 25% in Vietnam [17], 6% in Zimbabwe [18], 12% in Ethiopia [19], and 20% in Tanzania [20,21].

The proportion of farmers who had knowledge on aflatoxin in the current study was (58.2%), this was slightly higher than the value reported by Nakavuma *et al* (2020) (52.9%) [22]. Makau et al. (2016) [23] reported 38.5% of farmers had knowledge on aflatoxin while Marechera and Ndwiga (2014) reported (92.5%) of farmers had knowledge on aflatoxin in the lower eastern part of Kenya [24]. This high level in Eastern Kenya was because the region has suffered numerous aflatoxin epidemics in humans in earlier years and the area is categorized as an aflatoxin hot spot and also numerous studies have been conducted in the area and farmer awareness has been increased due to numerous seminars and workshops conducted in the area. Studies have reported that the knowledge of aflatoxins and other mycotoxins varies with several socio-demographic characteristics [12]. For example, in Kenya, women were found to be more knowledgeable of the dangers of mycotoxins and were more careful to moldy feeds than men [12]. In Vietnam, young farmers (at age of 21-29) were found to be more knowledgeable about aflatoxins in crops than the older population [17]. In Tanzania, studies have established that education level has a positive effect on aflatoxin awareness [21,25]. In Ghana, it was established that the field of study mainly life sciences has a positive impact on aflatoxin awareness [26]. In Ethiopia, farmers were found to be less knowledgeable on aflatoxins than persons in other occupations [27].

In Ethiopia, farmers were found to be less knowledgeable compared to persons in other professions [28]. Information on knowledge of aflatoxin among farmers in Kenya and other countries is scarce. To add on, the existing reports are more inclined towards awareness of aflatoxins in food crops such as groundnuts and maize than feeds. Furthermore, existing reports focusing on awareness of aflatoxins in feeds are deficient in crucial facts that would be essential in the mitigation of challenges linked to aflatoxin presence in feeds [29]. Additionally, the reports are sketchy in indicating the burden in specific localities. There is a scarcity of information concerning knowledge of aflatoxin adulteration of feeds among farmers even in aflatoxin-prone regions. This stalemate can lead to the transmission of unknown levels of aflatoxin to humans and animals and consequently ruin the health of the public. Farmers' knowledge in resolving a farming problem may be regarded as the initial step toward identification and modeling mitigation measures [29]. Thus, knowledge of aflatoxins in feeds among poultry farmers is of paramount importance in designing plans to minimize risks of aflatoxin exposure.

In Tanzania, studies have established that education level has a positive effect on aflatoxin awareness [21,25]. Most respondents interviewed in the present study (67.8%) had attained a secondary level of education with only a few who had attained a tertiary education level. However, this was inconsistent with the study by Nyangaga whereby the larger proportion of the farmers had attained a tertiary level of education [30]. Studies from various countries have reported that the level of education has an impact on aflatoxin awareness. In Tanzania, studies have revealed that education level has a positive effect on knowledge of aflatoxin [31,32] as illustrated in this study.

The present study reports that most of the farmers heard about aflatoxin through mass media and seminars. This suggests that mass media and seminars are currently the best channels to convey information regarding aflatoxin to farmers and the general population. On the contrary, the percentage of farmers who heard about aflatoxin through reading was the least and this suggests that there could be the inadequacy of written materials on aflatoxins, low reading drive-by farmers, or the materials are too advanced for the farmers. This was in agreement with the findings reported by Ayo et al. (2018) [29].

The current study reported that a higher proportion of the farmers were knowledgeable on the occurrence of fungal toxins in feed this was consistent with the findings reported by Ayo et al. (2018) in Tanzania [29]. However, this was inconsistent from studies from various settings that reported that farmers have low awareness on the concept of aflatoxins [33,34,20]. Most farmers from the present study had knowledge on the possibility of mycotoxins in feed affecting poultry/ animal health and experimental results from various studies support this phenomenon [35,36]. Acute levels (high) of mycotoxins are lethal within a short period of time while chronic levels (low) lead to death after a relatively long period of time causing immunosuppression, increase in susceptibility and opportunistic diseases. Mycotoxin adulteration of feeds is also linked to impaired health and consequently leads to low production performance and may lead to animal death [37].

Additionally, the majority of the farmers from the present study reported that there is a likelihood of mycotoxins being transferred (carried over) from feed to the tissues of poultry/animals, however, this disagrees with a study done in Tanzania where a majority of the farmers reported that the transfer of mycotoxins from feed to poultry/animal is not possible [29]. The results of the study in Tanzania were consistent with a report by Kiama et al. [12] on the perception of dairy farmers in Kenya, which revealed that the consumption of moldy food by humans is unsafe but consuming products from animals fed on moldy feeds is harmless. Other reports by Grace (2015) and Okoth (2016) (disagree with this perception [37,38]. Their findings proved that mycotoxins ingested with feeds by animals are assimilated into body tissues and subsequently transferred to humans in the food chain.

The findings of this study illustrate that farmers were knowledgeable on the signs of feed contamination with mycotoxins and are able to identify various signs that indicate contamination such as abnormal consistency, bad odor, presence of insects/larvae, and impaired animal health/ death. These indicators and signs were also found in an on-farm study by Golob (2007) on approaches to control mold and mycotoxin development in feeds [39]. Golob (2007) reported that these suggestive signs are instrumental in identifying moldy feeds that are suspected to be contaminated with aflatoxins. Nonetheless, it is important to note that the lack of these signs does not warrant that the feeds are safe. Numerous studies have reported that it is impossible to have mycotoxin-free feeds under normal conditions. Results from these studies have shown that feed discoloration and off-smell are useful indicative factors to suspect feed adulteration and probably the presence of aflatoxins and other fungal toxins. Furthermore, the majority of the farmers from the current study reported that they did not know any indicator to suggest the presence of these toxins in feeds. Studies have reported that the lack of ability to suspect and identify feed degeneration and adulteration using fast rapid tests could lead to exposure to aflatoxin adulteration of feeds thus posing a risk to human consumers [39].

A high proportion of the respondents (84.1%) from the present study reported that they were able to detect the presence of molds in feed this agrees with the findings by Ayo et al (2018) in Tanzania who reported similar findings [29]. These results are in agreement with an on-farm study by Golob [39] where he reported that although fungal toxins in feeds are not visible, molds growing on feeds are visible. The farmers stated that molds often change color and have an effect on the appearance of the feed on which they are developing [39].

Findings from the present study show that most of the farmers (59.6%) will continue feeding their poultry/animals with feed found to be contaminated with fungal toxins. This finding was supported by Focus Group Discussion with farmers as they reported that owing to the high cost of feeds and the lack of knowledge on the action to take in such cases, they will continue to feed their animals on these feeds as they also fear making losses. This was contrary to the finding by Golob where he reported that feeds contaminated with molds produce an unpleasant/off smell. It is clear that the manifestation of mold in feeds is a good indicator of the likelihood of contamination of feed with fungal toxins which is instrumental in aiding the farmer to make decisions on disposing of the feeds [39]. It is therefore clear that from the current study, farmers were unaware of the action taken with contaminated feed. An inspection of broiler feed through observation in the current study revealed that a higher proportion (84%) of the farmers had feeds that were in good condition that is non-moldy and loose. This implies that the majority of the farmers were keen on good feed storage practices.

The majority of farmers (91.6%) from the present study had no knowledge on the possibility of detoxifying fungal toxins in the feed while fewer respondents (8.4%) had knowledge on the possibility of detoxifying feed found contaminated with aflatoxins. Those who knew further stated the following methods can be used; boiling, sun drying, grinding, good storage, heating, and sieving. Studies have shown that farmers lack knowledge and options for the disposal of contaminated cereal at the household level and ultimately it is fed to domestic animals [12]. It is clear that farmers in the present study are not knowledgeable on the methods of detoxifying aflatoxins in feed and this was also evident from the Focus Group Discussion where the farmers reported that they are not aware of the methods to be employed. To add on the farmers reported from the Focus Group Discussion that they did not have knowledge of the use of toxin binders and even reported they have never heard of them. The findings of the current study were disagrees with the study done by Ayo et al (2018) where the study reported that the proportion of farmers who had knowledge on the possibility of detoxifying fungal toxins in feed was higher than those who did not have the knowledge [29]. The methods that the farmers from the study by Ayo et al (2018) reported to use in detoxifying feeds suspected to be contaminated with fungal toxins are use of soda ash, plant ashes, charcoal, salt, and some herbs. Ashes have been used in treating animal feeds for other uses such as decreasing ant nutritional factors in monogastric animals and fiber digestibility improvement [40,41]. Some compounds in form of antioxidants from plant sources have a counteractive effect against the oxidative stress induced by aflatoxin in the animal body after absorption [42].

It is therefore evident that the knowledge on the methods of detoxifying aflatoxin in adulterated feeds is lacking and much needs to be done to bridge this gap as contaminated animal feeds are a major source of exposure to human consumers [43].

In the present study, the farmers had knowledge on mycotoxin prevention strategies, for instance, good storage practices as this was evident in the following areas; the majority of the farmers (90%) stored their feeds in well-ventilated stores and a majority (80%) of them placed the poultry feed on raised ground. Studies have shown that improper storage practices for instance stack piling of feeds and storing feeds on bare floors and other poor bulk management practices of feeds, including extended time in storage, predispose feeds to adulteration with aflatoxin-forming fungi [44,23]. In the present study, most of the farmers bought their feeds weekly hence most feeds do not stay for long in storage.

5. CONCLUSION

The study concludes that the farmers' knowledge on aflatoxin was average. Reports from Focus Group Discussion show that farmers did not have knowledge on carryover, measures taken with feeds found contaminated with fungal toxins/aflatoxins, detoxification of contaminated feed, and knowledge on signs to show that a broiler has been infected with aflatoxin. The study concludes that there is a significant association ($p<0.05$) between the sociodemographic characteristics of farmers and knowledge on aflatoxin as this is in agreement with other studies.

There is a need for continuous sensitization of farmers on aflatoxins particularly in feed management through extension services by the Ministry of Agriculture and Ministry of Health Division of Public Health both at the county and national levels, to safeguard the public from exposure to aflatoxin contamination.

CONSENT

Consent was sought from each participant on voluntary basis before participating in the study.

ETHICAL APPROVAL

Approval to carry out the study was obtained from Kenyatta University graduate school. Ethical approval was obtained from Kenyatta University Ethical and review committee Approval number (PKU/2163/II307). A research permit to carry out the study was obtained from National commission for Science, Technology and innovation (NACOSTI) license number (NACOSTI/P/20/8037. Authorization was also obtained from the Ministry of Agriculture, Division of Veterinary Services before commencement of the study.

ACKNOWLEDGEMENTS

The authors would like to convey their sincere appreciation to the farmers in Nairobi City County, Kenya where the study was carried out for their willingness to participate in this study and to all those who contributed to the success of this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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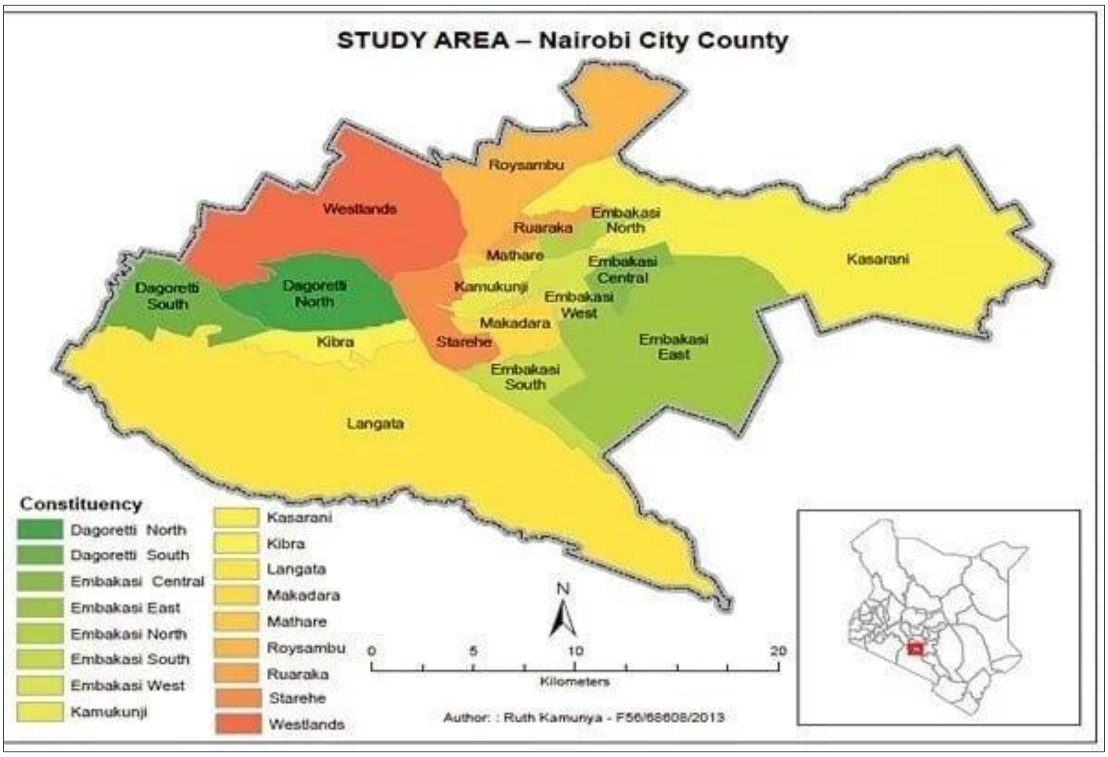
APPENDIX



Map of Nairobi City County
(Source: Ruth Kamunya, 2013)