COMMERCIAL POULTRY FARMERS' FEED PRODUCTION, FEEDING PRACTICES AND KNOWLEDGE ON AFLATOXINS WITHIN SOME COMMUNITIES IN GREATER ACCRA AND EASTERN REGIONS OF GHANA

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ABSTRACT

Commercial poultry serves as a source of food security, nutrition, and income for many individuals in Ghana. However, poor feed production and improper feeding practices can affect poultry egg production and products quality. This study investigated commercial poultry farmers' feed production, feeding practices and knowledge on aflatoxins in some communities within Greater Accra and Eastern Regions of Ghana. Qualitative research approach design and Semi-structured questionnaires were used for the study. A total of 83 commercial poultry farmers took part in the study. More than 80 % of the farmers used whole maize, wheat bran, rice bran, soya meal and fish meal as common feed ingredients. Most (90 %) of the farmers disclosed that almost all feed ingredients used were susceptible to mold infestation. Majority (76.2 %) of the poultry farmers did not analyze feeds. A high proportion (84.4 %) of the farmers stored feed ingredients and feeds in store-rooms. Majority (72.3 %) of the farmers stored feeds for a shorter period, between 1 and 2 weeks. Among the farmers, 86 % had little to no knowledge on aflatoxins. It is recommended that researchers, regulators, various poultry farmers' associations and Government policy makers should intensify poultry farmers' education on good feed production, appropriate feed practices, and knowledge on aflatoxins to prevent poultry feeds and products from contamination.

Keywords: Commercial Poultry; Poultry Farmers; Feed Production; Feeding Practices; Aflatoxins; Ghana

Introduction

Globally, agriculture is one of the main sectors that help to ensure food safety and economic growth. Livestock production which includes poultry in Ghana is a major sector and it adds approximately 14 % of agricultural Gross Domestic Product (GDP) (Maguregui, 2022). The commercial poultry production in Ghana is the fastest growing agricultural sub-sector due to the fast population growth and urbanization **(**Food and Agriculture Organization (FAO), 2019**).** The commercial poultry industry serves as a source of income, nutrition, and food security for many individuals in Ghana (Adei and Asante, 2012). Chicken is the major poultry breeding sector among the poultry species including ducks, turkeys, and guinea fowls representing about 90 % of the poultry

industry (Yildiz, 2021). Poultry products are thought to be popular and cheaper source of animal protein and easily accessible to clients, especially eggs in Ghana.

Commercial poultry production in Ghana can be grouped into three enterprises, namely, large-scale (over 50,000 birds), medium-scale (10,000 – 50,000 birds) and small-scale (less than 10,000 birds) enterprises (Ashitey, 2017; Maguregui, 2022). Commercial poultry feed is food giving to poultry birds and it is prepared in such a way that it contains essential nutrients for the proper growth of birds (Bukar & Saeed, 2014). Agricultural products including maize, rice, wheat, cotton seeds, soya beans and by-products (for example, maize bran, wheat bran and soya meal) are usually the types of poultry feed ingredients used by commercial poultry farmers for feed preparation (Bale *et al.*, 2015).

In Ghana, Commercial poultry production is burdened with challenges such as high cost of feeds and feed ingredients, covering approximately 60 - 70 % of the total cost of poultry production (Dateh, 2013; Greater Accra Poultry Farmers Association, 2019; Maguregui, 2022). It is important to ensure that feed meant for birds are quality as feed quality influences development and growth of birds. However, feeds and feed ingredients are expensive making it difficult for some poultry farmers to ensure sustainable poultry production. Another challenge facing the commercial poultry production is competition from developed countries such as Brazil that export chicken products to Ghana (Dateh, 2013). Due to the fast opening of restaurants, hotels and fast-food joints, the demand for imported chicken products for continental and local dishes have increased. Imported chicken products appear to be cheaper compared to local chicken products. In addition, they are already processed into pre-cut parts of thigh, legs, wings or whole chicken (Ashitey, 2017).

Aflatoxins are group of fungal toxins which occur naturally in nature (Feddern *et al*., 2013). Aflatoxins are classified into four main groups as B1, B2, G1, and G2. Aflatoxins B1 is considered to be the most toxic and most common in poultry feed ingredients and feeds (Nsiah *et al.*, 2023; Yu, 2012; Zoreky & Saleh, 2017). Ephrem (2015) reported that, aflatoxins producing fungal species and molds naturally originate in the soil and decayed vegetation in which risk of infestation begins with planting and can be worsened later during post-harvest practices such as improper harvesting, handling, poor storage practices (for example, high storage temperature, moisture and relative humidity), processing, and transport practices. Aflatoxins are mainly found on agricultural products such as maize, wheat and soya beans (Cornea *et al.*, 2011).

Ingestion of aflatoxins could affect animals and humans' organs such as the liver and kidney. Some of the economic effects of aflatoxins contamination in poultry production can be poor bird feed utilization, reduce egg production, low growth rate and increase death in birds (Bryden, 2012; Khlangwiset *et al.*, 2011). Controlling and preventing aflatoxins contamination in poultry feeds could be the use of aflatoxin binders (adsorbents or trapping agent), which was reported to be suitable (Jard *et al.*, 2011). These absorbents are compounds that are added to poultry feeds in order to prevent intestinal absorption of aflatoxins by the birds (Jard *et al*., 2011). This study therefore sought to assess commercial poultry farmers' feed production practices, feeding practices and knowledge on aflatoxins within some communities in Greater Accra and Eastern Regions.

Experimental

Research Design

This study used qualitative research approach. Semi-structured questionnaires, which consist of both open and closed ended questions, were used as the main instrument for data collection to obtain information from the commercial poultry farmers in the study communities of the two regions. This type of instrument was used for the data collection because the study population was not too large and the poultry farmers were asked to express their views on some of the questions. The questionnaires were administered to the commercial poultry farmers face to face by the researchers therefore recovering them was not a problem. Table 1 presents a summary of the questionnaire investigation covered within Greater Accra and Eastern Regions.

TABLE 1

Summary of the Questionnaire Investigation covered within Greater Accra and Eastern Regions

Data Classification	Description
Information on commercial poultry feed production, feeding practices and knowledge on aflatoxins.	Type of feed ingredients used by commercial poultry farmers; Source of feed ingredients; Type of feed ingredients susceptible to mold infestation; Laboratory analysis on poultry feeds ingredients and feed; Storage methods and duration of feed ingredients and feeds; and knowledge on aflatoxins by commercial poultry farmers;

Source: Field data (2022)

Study Area

Figure 1 shows the communities within Greater Accra and Eastern Regions in Ghana where this study was carried out. The selection of these regions is as a result of the fact that these two regions are among the most commercial poultry producing regions in Ghana (Greater Accra Poultry Farmers Association (GAPFA, 2021).

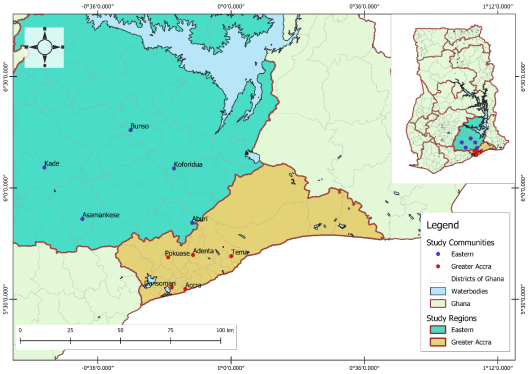

Fig. 1: Map of Ghana showing study areas in Greater Accra and Eastern Regions.
Source: CSIR- Institute of Industrial Research, Thematic Mapping Division (2022)

Greater Accra Region (GR)

The study areas covered within Greater Accra Region included Adenta, Tema, Accra, Dansoman and Pokuase. Greater Accra Region is located in the coastal belt of Ghana and it shares boundaries with Central Region to the west, Volta Region to the east and the Eastern Region to the north. GR is the smallest region of the 16 regions in Ghana in terms of area and the region covers a total surface area of about 3,245 km^2, and this is approximately 1.4 % of the total land area of Ghana (Ghana Statistical Service (GSS), 2021). GR is the most populous region in Ghana having a population of 5,455,692 accounting for 17.7 percent of Ghana's total population of which 49.1 % are male and 50.9 % are female (GSS). The vegetation kind in GR is mostly savanna grassland with mangrove and swampy areas with dispersed forests and has

an annual temperature ranging from 20 °C to 30 °C (Ministry of Local Government and Rural Developments (MLGRD, 2006), an environ good for poultry production. Poultry production in the region is ranked among the first four in Ghana (Ministry of Food and Agriculture (MOFA, 2020). There are about 500 poultry farmers, feed vendors and feed producers in the GR but approximately 90 of them are active commercial poultry farmers (Greater Accra Poultry Farmers Association (GAPFA, 2021).

Eastern Region (ER)

The study areas selected in Eastern Region were Aburi, Koforidua, Bunso, Kade and Asamankese. The Eastern Region is located in the southern part of Ghana. The region is bordered to the south by Central Region and Greater Accra Region, to the east by Volta Region, to the west by Ashanti Region and to the north by Bono East Region. ER has a population of about 2,925,653 accounting for 9.5 % of Ghana's total population of which 1,436,951 are male and 1,488,702 are female (Ghana Statistical Service (GSS), 2021). ER covers an area of 19,323 km^2, and accounts for 8.1% of Ghana's total area (GSS, 2021). The major economic activity in the region is agriculture and it employs approximately 53 % of the population, 10.7 % of the population is in industry and about 22 % in the services sub-sector (Eastern Region Official website, 2016). The region has two main dams, Akosombo and Kpong, which can be used for farming and water transport. The weather, as well as the type of soils of the region promotes cultivation of different crops such as maize which could be the main poultry feed ingredients.

Sampling

A purposive sampling technique was used to select active commercial poultry farmers within Greater Accra and Eastern Regions of Ghana. The commercial poultry farmers, 83 were purposively selected for the study and they were identified through the Association of Poultry Farmers in Greater Accra and Eastern Regions of Ghana. The poultry farmers were selected from 5 communities each from the two regions. The communities included Adenta, Tema, Accra, Dansoman and Pokuase all of Greater Accra Region and Aburi, Koforidua, Bunso, Kade and Asamankese in Eastern Region of Ghana. Out of the 83 poultry farmers, 38 were from GR while 45 were from ER. The study was conducted in January, 2022.

Data Analysis

Data was summarized and analyzed using Minitab Release Version 12 statistical software (2019). Duncan test was used to compare the frequency, percentage and means. One-way analysis of variance (ANOVA) was also used for significant differences ($p < 0.05$) among the commercial poultry farmers from Greater Accra and Eastern Regions.

Results and Discussion

Commercial Poultry Farmers' Feed Production, Feeding Practices and Knowledge on Aflatoxins

Type of Feed Ingredients used by Commercial Poultry Farmers

Majority (more than 80 %) of the commercial poultry farmers in the study regions used

whole maize/maize bran, wheat bran, rice bran, soya meal and fish meal in their feed preparation. However, other feed ingredients such as, cotton seed cake, vitamins, and binders (anti-toxins) were also used in low proportion by some of the poultry farmers (30.1 %). This indicates that, majority of the poultry farmers interviewed prepared feed that contained essential nutrients such as protein, carbohydrates, fat, vitamins and minerals for the proper growth of poultry birds (Bukar & Saeed, 2014). Nonetheless, the nutritional values of these feed ingredients can be affected or reduced by microorganism such as fungi and/or bad storage practices.

Most of the commercial poultry farmers (97.6 %) used whole maize as main ingredient in feed preparation. This finding agrees with a study conducted by Greater Accra Poultry Farmers Association (2019) and Ashitey (2017) who also reported that maize was the main feed ingredient used by poultry farmers in feed formulation in Ghana and it constitutes approximately 60 % of the poultry feed. According to Jacob (2020), maize is a grain mostly used in diets of commercial poultry birds in the United States since it has good energy content and easy to digest by birds. The lower percentage (30.1%) of farmers who treated feed with fungal binders could be attributed to lack of education on the usefulness of anti-toxins or the extra cost for the use of anti-toxins in feed.

Source of Feed Ingredients used by Commercial Poultry Farmers

Table 2 shows commercial poultry farmers' source of feed ingredients for feed preparation. Interestingly, 69.8 % of the poultry farmers interviewed obtained feed ingredients from feed producers whilst 22.9 % of the poultry farmers obtained feed ingredients from feed vendors. The high proportion of the poultry farmers who obtained feed ingredients from feed producers attributed it to its convenience and proximity. Thus, they purchased the feed ingredients from the producers, who then formulate and mill to feed. The remaining poultry farmers (7.3 %) obtained feed ingredients from other source such as the market and poultry feed industries.

TABLE 2

Source of Feed Ingredients used by Poultry Farmers

Source of Feed Ingredients	Study GR	Location ER	Overall
	% (n)	% (n)	% (n)
Feed Producers	36.1 (30)	33.7 (28)	69.8(58)
Feed Vendors	7.2 (6)	15.7 (13)	22.9(19)
Others	2.5 (2)	4.8 (4)	7.3 (6)
Total	45.8 (38)	54.2 (45)	100 (83)

Key: GR- Greater Accra Region, ER- Eastern Region, n- number of commercial poultry farmers, % - percentage of commercial poultry farmers. Source: Field data (2022)

Type of Feed Ingredients Susceptible to Mold Infestation

More than 90 % of commercial poultry farmers reported that almost all the feed ingredients were susceptible to mold infestation. The farmers (96.4 %) reported that maize was more susceptible to mold infestation than the other feed ingredients. Mold infestation in feed ingredients and feeds could be attributed to high moisture content (≥ 15 %), improper storage methods such as poor ventilated storage rooms, placing bags of feed directly on the bare floor or wall, insects and pests in feed and high relative humidity, ≥ 70 % (Smith *et al.*, 2016). Mold may reduce nutritional composition such as protein and carbohydrates

in feed ingredients leading to poor feed qualities. Kelley *et al*. (2012) reported that maize ears are best parts for dominance and colonization of *Aspergillus parasiticus* and *Aspergillus flavus*, leading to aflatoxins infestation. According to Ma *et al*. (2014), substrates that are rich in carbohydrates can promote mold growth as compared to fat and oil, as carbohydrate easily provides carbons which could be suitable for fungal growth (Ma *et al*., 2014).

Laboratory Analysis on Poultry Feed Ingredients and Feeds

Majority (76.2 %) of the commercial poultry farmers do not analyze feed ingredients and feeds in the laboratory before use, as shown in Figure 2. The farmers attributed it to high cost of laboratory analysis and sometimes delay in receiving results from the laboratories. Some of the farmers also depended on poultry feed formulation (volumes of feed ingredients and additives which are mixed to create feed that meet the known nutrient requirements) given to them by resource persons (for example, researchers). Thus, once the feed ingredients are formulated into feed, it is assumed that the feed has the required nutritional/chemical composition and microbial load permissible limits set for poultry feeds by Ghana Standard Authority. However, factors such as improper storage practices (unventilated storage room), high moisture content (above 15 %) and contaminated grains can affect feed ingredients leading to poor feed qualities (Dei, 2017). Moisture is one of the major factors that can promote mold infestation and shelf stability through loss of essential nutrients in poultry feed ingredients and feeds (Atanda *et al*., 2011; Smith *et al*., 2016). High moisture content of feed can increase the growth of microorganism and spoilage, which can pose health problems in poultry birds. Ghana Standard Authority (GSA) has set ≤ 15 % recommended limit of moisture content for poultry feed ingredients and feeds (GSA, 2018).

Surprisingly, only 23.8 % of the farmers analyzed poultry feed ingredients and feeds before use. Some of the research centers where the poultry farmers analyzed the feed ingredients and feeds were Council for Scientific and Industrial Research (CSIR)- Animal Research Institute, CSIR-Food Research Institute, Ghana Standard Authority and Food and Drugs Authority. These research centers report whether or not samples analyzed are within permissible limit set by Ghana Standard Authority and/ or Food and Drugs Authority. These centers also give consultation to clients. The farmers tested for nutritional/chemical composition and microbial contamination/load which included protein, fat, fibre, carbohydrates, moisture content, minerals, vitamins and aflatoxins concentration.

Approximately, 15 % of the poultry farmers disclosed that, they only analyzed feed ingredients and feeds when they encountered problems such as reduced egg production, low feed intake by birds, reduced growth rate and increase susceptibility to diseases which sometimes resulted in death of the poultry birds.

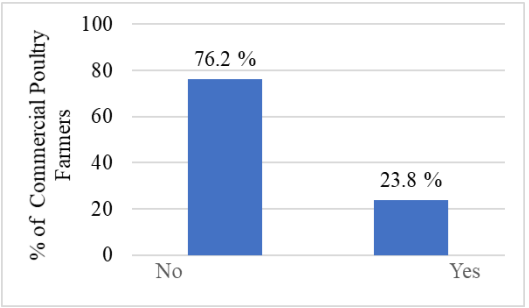

Fig. 2: Laboratory analysis on feed ingredients and feeds. Source: Field data (2022)

Storage Methods used for Feed Ingredients and Feeds by Commercial Poultry Farmers

Figure 3 displays commercial poultry farmers' storage methods used for feed ingredients and feeds. The poultry farmers, 84.4 %, stored feed ingredients and feeds in storerooms (warehouse). A proportion of 15.6 % of the farmers kept feeds and feed ingredients in open-space. Liu (2016) and Smith *et al*. (2016) reported that feed ingredients and feeds stored in dry place with good ventilation and out of direct sunlight can prevent mold growth. The authors further reported that high temperature can have a major impact on the nutritional composition of feed stored, in this case fat may become rancid or proteins may be broken down leading to low feed qualities. Mold grows in moist and warm environs. Feed and food with high moisture content have high water activity (a_w), which can promote microbial activity in feed and food leading to contamination or spoilage (Ashworth & Draper, 1992).

Contaminated feed ingredients and feeds should not be stored in the same place together with uncontaminated ones since there could be transferred of microorganisms from contaminated feed to uncontaminated ones through insects, pests and rodents (termed as cross-contamination). It was also observed that some of the farmers (35 %) stored bags of feed ingredients and feeds on the bare floor without wooden structure such as palate. Some of the bags were also leaned directly against the walls. These storage practices can cause the transfer of moisture through ground and wall condensation into the feed ingredients and feeds which may promote mold growth (Smith *et al*., 2016).

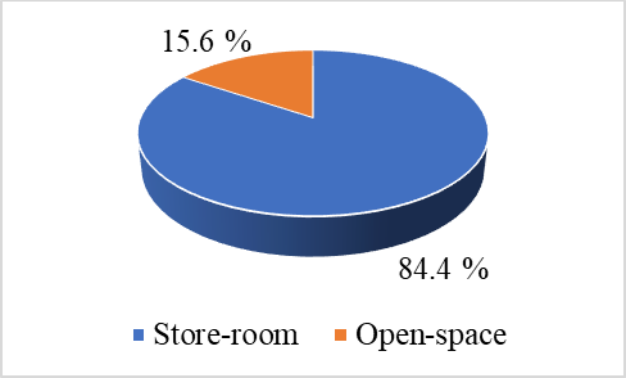

Fig. 3: Storage method used on feed ingredients and feeds by commercial poultry farmers.
Source: Field data (2022)

Storage Duration of Poultry Feeds used by Commercial Poultry Farmers

The study further investigated the storage duration of poultry feeds used by the farmers and the results are shown in Table 3**.** A majority (72.3 %) of the poultry farmers interviewed stored poultry feeds between 1 to 2 weeks. This was related to the fact that the feed could be contaminated or spoilt if kept for a longer period and also due to high feed intake by birds. Rehrahie (2018) reported that 67 % poultry farmers stored their feeds for shorter duration (less than 1 month) which is similar to the present study. The poultry farmers who stored their feeds between 3 to 4 weeks accounted for 13.3 % of the population. A low proportion (6 %) of the poultry farmers stored feeds for

more than 4 weeks. Long storage duration of the feeds by the poultry farmers was attributed to reduction of production cost and availability of feeds at all time.

Poultry feeds which contain low moisture content can be stored for about 1 – 2 months when kept in a drier, cool, well-ventilated storerooms (Liu, 2016). Insects, pests and rodents should be prevented from entering the storerooms in order not to contaminate feeds. Bags of feed must be sealed and placed on wooden structures away from the walls.

TABLE 3
*Sto*rage Duration of Poultry Feed used by Commercial Poultry Farmers

Storage Duration of Feed (Week)	%	n
<1	8.4	7
1-2	72.3	60
3-4	13.3	11
>4	6.0	5
Total	100	83

Source: Field data (2022)

Knowledge on Aflatoxins by Commercial Poultry Farmers

Figure 4 shows commercial poultry farmers' knowledge with respect to awareness, occurrence, promoting factors, as well as the effects on humans, poultry birds feed ingredients and feed. Specific questions asked from the farmers were whether or not they had any knowledge on aflatoxins with respect to its occurrence, transmission, promoting factors and prevention in poultry feed ingredients, feed and products, as well as the effects on poultry birds and consumers. Farmers who had little to no knowledge on aflatoxins were given educational posters and were advice to read more information on aflatoxins on the internet. A greater proportion (86 %) of the poultry farmers had little to no knowledge of aflatoxins. A very low proportion (14 %) of the poultry farmers had knowledge on aflatoxins in poultry feeds and ingredients, through trainings organized by researchers, Poultry Farmers Associations, Non-Governmental Organizations (NGOs) and through the internet. Chavez *et al*. (2016) reported low knowledge of aflatoxins among poultry farmers (78 %) which is similar to the present study. In addition, Kang'ethe & Lang'a (2009) reported that 67 % of the urban farmers do not know the existence of aflatoxins in grains and feeds. However, a study conducted by Nyangi *et al*. (2016) reported that 62 % of farmers in the Babati district of Tanzania were aware (through educational programs organized by researchers and Non-Governmental Organizations) of aflatoxins and their consequences which is contrary to the present study.

Due to aflatoxins serious effect on animals and humans, Ghana and other international countries have set safe permissible limits for feeds and foods. Ghana Standards Authority and United States of America Food and Drugs Authority have set permissible limits of 10 µg/kg and 20µg/kg for aflatoxins B1 and total aflatoxins respectively in poultry feed and feed ingredients (GSA, 2018; US FDA, 2018). For chicken products, GSA and US FDA have set permissible limits of 5 µg/kg and 10 µg/kg for aflatoxins B1 and total aflatoxins respectively.

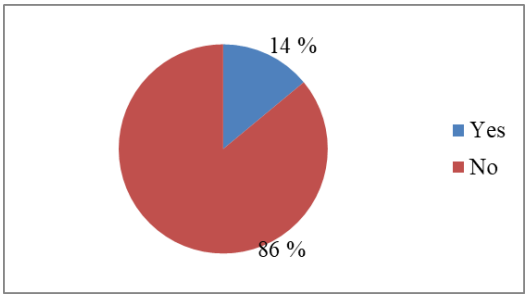

Fig. 4: Knowledge on aflatoxins by commercial poultry farmers.
Source: Field data (2022)

Conclusion

This study has revealed that majority of the commercial poultry farmers in the study areas prepared feeds which could contain essential nutritional composition such as proteins, carbohydrates, fats, minerals and vitamins for poultry birds. However, improper storage practices, for instance, poor ventilated storage rooms, placing bags of feed ingredients and feeds on the bare floor and/or leaning bags directly against the walls, observed in some of the poultry farms could reduce or affect negatively the nutritional composition of the feed ingredients and feed. A greater number of the commercial poultry farmers did not analyze feed ingredients and feeds due to high cost of laboratory analysis among other factors.

It is recommended that researchers, poultry farmers' associations, such as Greater Accra Poultry Farmers Association (GAPFA), Government policy makers, for example, Ministry of Food and Agriculture (MOFA), Ghana and poultry industry regulators, should organize educative programs for poultry farmers on good poultry production practices and knowledge on aflatoxins in order to prevent poultry feeds and products from contamination. In addition, educational tools such as brochures, leaflets, stickers and posters on good poultry production practices and aflatoxins' awareness can be made available to poultry farmers by researchers and regulators.

Conflict of Interest

The authors declare no conflict of interest.

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