



DISPOSAL OF DEAD BIRDS AND MANURE IN POULTRY FARMS UNDER DIFFERENT PRODUCTION AND MANAGEMENT SYSTEMS IN KHARTOUM STATE, SUDAN

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ABSTRACT

This study was conducted between Dec 2015 and Jan 2018 during dry and wet seasons in two consecutive years with the objective of evaluating the disposal of manure and dead birds in poultry farms located in Khartoum State, Sudan. Seventy four commercial poultry farms (47 broilers and 27 layers) of different production systems (closed, semi closed and open systems) and management systems (cage and floor) were investigated. Data were collected by on farm visits during which interviews, using questionnaires, with the owners and veterinarians of the farms were done. A scoring system which was separated into 2 main categories, external and internal biosecurity, and comprised questions on different dead birds and manure disposal

measures was initiated. Based upon the different weights given according to measures based on risk to each biosecurity measure and (sub) category, a final weight and risk-based score was calculated. The study revealed that only 7 (9.46%) farms disposed their manure and dead birds properly using incineration. Fifty seven farms (77.03%) disposed their manure and dead birds improperly, 8 (10.81%) used burial method and 2 (2.70%) threw dead birds over the fence. The study also showed that final removal methods of dead birds and manure were highly affected by the size of the farm, such as the removal of manure through the dirty area (P-value =.001), separate carcass storage (P-value =.007), and collection of carcasses by the municipality trucks without entering the farm (P-value =.044). The methods of final removal of dead birds and manure were also affected by production system, such as manure being removed through the dirty area (P-value =.003) and whether carcass storage regularly cleaned

and disinfected (P-value =.002). The study also revealed that management system had significant influence on the methods of final removal of manure. This was particularly observed in separate carcass storage (P-value =.005) and the associated regularly cleaning and disinfection (P-value =.037). In conclusion, this study had shown that improper disposal of dead birds and manure were practiced by most of the farms.

INDEX TERMS: Farm Biosecurity, Manure, Dead birds disposal, Incineration.

INTRODUCTION

Modern poultry industry is accused of polluting the environment due to the large amounts of wastes that include solid waste, wastewater, dead embryos, abattoir waste, excreted manure and dead birds.^[1-3]

Blake and Donald^[4] described the current methods used for disposal of poultry carcasses as burial, incineration, composting, and rendering. Ritz^[5] reported that disposal methods available to poultry producers include burial, landfill, composting, incineration and rendering. However, whatever disposal option used, it shall be suitable to the fullest extent possible.^[6] USDA^[7] described three burial techniques, trench burial, landfill, and mass burial sites. For animal disease eradication efforts, trench burial traditionally has been commonly adopted, as a preferred disposal option. While burial is no longer permitted in some countries because of concerns for groundwater quality near burial sites, incineration is a biologically safe method of disposal, although it tends to be slow and expensive even when highly efficient incinerators are used.^[5] Regardless of incineration method used, bacteria, including spore-formers, and viruses should not survive incineration.^[8]

Besides it helps amending the soil, composting yields a disease-free product by converting carcasses resulting from daily mortality into an odorless and humus-like material.^[9,10] Composting include both anaerobic processing of poultry manure and aerobic processing of poultry manure.^[11]

Safe mortality disposal can also be achieved by rendering which is considered as one of the best means for recycling poultry carcasses from the farm that converts carcasses into a protein by-product meal in an environmentally acceptable manner.^[12]

Studies revealed that inappropriate dead bird disposal will lead to the spread of infections and also cause major pollution problems.^[1] Therefore dead birds must be removed from poultry

houses on at least a twice-daily basis. However, studies reported that spread of pathogenic microorganisms during routine pickup and transport presents a substantial threat.^[13] Therefore, the objective of this study was to evaluate the disposal of dead birds and manure in poultry farms located in Khartoum State, Sudan.

MATERIAL AND METHODS

Duration of the study

The duration of this study was two years started from December 2015 and ended in January 2018. Farms were investigated during dry and wet seasons in two consecutive years with total of 2 dry and 2 wet seasons.

Study area

The study covered all Khartoum State districts: Khartoum North, East Nile, Ombada, Omdurman, Jabel Awlya and Khartoum.

Farms population and selection

Seventy four commercial poultry farms (47 broilers and 27 layers) were randomly selected from the lists provided by Ministry of Agriculture, Animal Wealth and Irrigation, Khartoum State. The production systems were identified as closed, semi closed, and open systems. The management in these production systems was the cage and the floor systems.

Design of the questionnaire and scoring system

A questionnaire was designed to describe the biosecurity measures adopted for dead birds and manure disposal at both broiler and layer flocks. Questions were asked on each relevant aspect of dead birds and manure disposal to determine whether or not a preventive measure is applied or whether a specific situation is present or absent. The questionnaire was designed in a way similar to the approach of Gelaude *et al.*^[14]

Data collection technique

Data were collected by on farm visits during which interviews, using questionnaires, with the owners and veterinarians of the farms were performed. After the interview was conducted and the questionnaire was filled in, all poultry houses and other sectors of the farm were visited. This inspection was performed to allow a comparison of the answers given in the questionnaire by the farmer/farm veterinarian and the present situation in the poultry houses. An average farm visit took 2 to 3 hrs.

Prioritization of different biosecurity measures

Prioritization of different biosecurity measures was done based on risk following the Poultry Facility Biosecurity Risk Assessment Guide described by CDFA[15]. The responses for both external and internal biosecurity measures and practices were rated as *Minimal Biosecurity Risk*, *Moderate Biosecurity Risk*, or *High Biosecurity Risk*.

Besides the efficiency in disease transmission of a specific transmission route, the scoring system also took into account the frequency that a transmission route occurs.^[16] When a specific indirect contact with a relatively small probability in transmission of disease occurs at a high frequency, this transmission route will pose a substantial risk^[17] and therefore receives a higher estimated effect.

Analytical Techniques

The data collected by the survey were coded and analyzed using Statistical Packaging for the Social Sciences (SPSS/PC version 21 for windows). Data were analyzed using Descriptive Statistical Analysis. Chi-square was used with the hypothesis that the compliance with biosecurity measures is uniform among all poultry farms. P value less than 0.05 was considered significant.

RESULTS

Table (1) shows that only 7 (9.46%) farms disposed their dead birds and manure properly using incineration. Fifty seven (77.03%) out of the total number of the farms disposed their dead birds and manure improperly. With regards to the disposal of the dead birds, 8 (10.81%) farms used burial method, whereas 2 (2.70%) farms threw dead birds over the fence.

Table 1: Distribution of final removal methods of manure and dead birds.

Type of farm	Final removal of manure and dead birds				Total	P-Value
	Proper incineration	Improper disposal	Burial	Dead birds thrown over fence		
Layer	3 (42.9%)	23 (40.4%)	1 (12.5%)	0 (0.0%)	27 (36.5%)	.305
Broiler	4 (57.1%)	34 (59.6%)	7 (87.5%)	2 (100%)	47 (63.5%)	
Total	7 (9.46%)	57(77.03%)	8(10.81%)	2(2.70%)	74(100%)	

**P-value considered significant at less than 0.05 levels*

Biosecurity risk associated with the methods by which the dead birds and manure removed is shown in Table (2). Almost two thirds (59.5%) of the farms showed high biosecurity risk by

not removing their manure through dirty area. About half of the farms (48.6%) had no separate carcass storage. Slightly more than fifty percent of them (55.4%) collected their dead birds through municipality trucks from inside the farms. Carcass storage was not secured against vermin, dogs or cats in about two thirds of the investigated farms (64.9%), 52 (70.3%) had no regular plans of cleaning and disinfection of their carcass storage, while sixty percent of the farms had no clear policy for their labors to wear protective gloves, or disinfect their hands after manipulating carcasses.

Table 2: Distribution of final removal methods of manure and dead birds based on biosecurity risk.

Removal of manure and dead birds variables	Biosecurity					
	Minimal Risk		Moderate Risk		High Risk	
	No.	%	No.	%	No.	%
Is manure removed through the dirty area?	30	40.5	0	0.0	44	59.5
Is there separate carcass storage?	38	51.4	0	0.0	36	48.6
Can carcasses be collected by the municipality trucks without entering the farm e.g. from the main road?	33	44.6	0	0.0	41	55.4
Is the carcass storage closed so vermin, dogs or cats don't have access to the carcasses?	17	23	9	12.2	48	64.9
Is the carcass storage regularly cleaned and disinfected?	9	12.2	13	17.6	52	70.3
Are gloves worn when manipulating carcasses or are hands washed and disinfected after manipulating carcasses?	23	31.1	6	8.1	45	60.8

Farm size highly affected final removal methods of dead birds and manure such as manure being removed through the dirty area ($P < .001$), presence of separate carcass storage ($P < .007$), or carcasses being collected by the municipality trucks which entered the farm ($P < .044$) and whether carcass storage regularly cleaned and disinfected ($P < .006$) (Table 3).

Table 3: Effect of the size of farm on different final removal methods of manure and dead birds.

Final removal of manure and dead birds variables versus farm size	χ^2	Df	P-value
Can carcasses be collected by the municipality trucks company without entering the farm e.g. from the main road?	9.8	4	.044*
Is the carcass storage closed so vermin, dogs or cats don't have access to the carcasses?	7.9	8	.443
Is the carcass storage regularly cleaned and disinfected?	21.5	8	.006*
Are gloves worn when manipulating carcasses or are hands washed and disinfected after manipulating carcasses?	12.5	8	.130

*P-value considered significant at less than 0.05 levels

χ^2 = chi-square, df= degree of freedom

In addition, final removal methods of dead birds and manure were significantly affected by production system, manure being removed through the dirty area ($P < .003$) and whether carcass storage had not been regularly cleaned or disinfected ($P < .002$) (Table 4). The size of the farm together with system of production did not show a significant effect on the practices of securing carcasses storage, and wearing gloves and washing of hands when manipulating carcasses.

Table 4: Production system and different final removal methods of dead birds and manure based on biosecurity measures.

Final removal of manure and dead birds variables versus production system	χ^2	Df	P-value
Is there separate carcass storage?	1.9	2	.374
Can carcasses be collected by the municipality trucks company without entering the farm e.g. from the main road?	.35	2	.840
Is the carcass storage closed so vermin, dogs or cats don't have access to the carcasses?	8.4	4	.078
Is the carcass storage regularly cleaned and disinfected?	16.9	4	.002*
Are gloves worn when manipulating carcasses or are hands washed and disinfected after manipulating carcasses?	2.2	4	.697

**P-value considered significant at less than 0.05 levels*

χ^2 = chi-square, df= degree of freedom

The final removal methods of dead birds and manure was significantly affected by management system such as separate carcass storage ($P < .005$) and carcass storage had not been regularly cleaned and disinfected ($P < .037$) (Table 5). While removing manure through the dirty area, collecting carcasses by the municipality trucks without entering the farm, securing carcass storage so vermin, dogs or cats don't have access to the carcasses and wearing gloves when manipulating carcasses or washing and disinfecting hands after manipulating carcasses, were not affected by the management system.

Table 5: Management system and different final removal methods of manure and dead birds based on biosecurity.

Final removal of manure and dead birds variables versus management system	χ^2	Df	P-value
Can carcasses be collected by the municipality trucks without entering the farm e.g. from the main road?	.06	1	.508
Is the carcass storage closed so vermin, dogs or cats don't have access to the carcasses?	.6	2	.744
Is the carcass storage regularly cleaned and disinfected?	6.6	2	.037*
Are gloves worn when manipulating carcasses or are hands washed and disinfected after manipulating carcasses?	.3	2	.869

**P-value considered significant at less than 0.05 levels*

χ^2 = chi-square, df= degree of freedom

DISCUSSION

Carcasses of dead birds in poultry farms were reported to be disposed by incineration, deep burial, or dumping as refuse.^[18] Although some researchers recognized incineration as one of the biologically safest methods of dead birds disposal,^[5] others reported that other methods that allow for the biologically and environmentally safe disposal of poultry carcasses should be considered, because no single method will solve the problem completely.^[13]

In this study only about 10% of the investigated farms disposed dead birds properly using incineration, 57 (77.03%) were improperly disposed their dead birds and manure, 8 (10.81%) used burial method and only 2 (2.70%) threw dead birds over the fence, with no statistically significant difference (P-value=.305). Different findings were reported by Moreki et al^[19] who found that the common methods of mortality disposal were through landfill (52%), incineration (20%) and burning (20%).

The present investigation showed that final removal methods of dead birds and manure were highly affected by the size of the farm, such as manure being removed through the dirty area (P-value=.001), separate carcass storage (P-value=.007), or carcasses being collected by the municipality trucks without entering the farm (P-value=.044).

It is well known that the room of carcasses storage has to be located in such a way that the municipality trucks can collect the carcasses without entering the farm. This is because municipality trucks have been reported to be associated with spread of diseases.^[20] In agreement with the present result, a study carried out in Metropolitan Lagos in Nigeria revealed that poultry waste is poorly disposed and transported.^[21] Similar findings were also reported by Moreki et al^[19] who stated that transportation was a major challenge in disposing of poultry waste from farms.

It has been stated that it is highly recommended applying thorough cleaning and disinfection to the dead birds storage room after the collection of carcasses. It is also recommended not to store litter at the poultry farm, as litter can be highly contaminated at the end of the production cycle by different kinds of pathogens.^[22]

This study disclosed that final removal methods of dead birds and manure had been affected by production system, manure being removed through the dirty area and whether carcass storage had been regularly cleaned and disinfected.

Dead birds are always a potential source of infectious agents. Therefore, it is strongly advised to remove them as soon as possible from the stables^[23] and to store them in a well-insulated and cooled place at sufficient distance from the poultry houses.^[24]

CONCLUSION AND RECOMMENDATIONS

In conclusion, this study has shown that improper disposal of manure and dead birds were practiced by most of the farms in the study area. The study also showed that final removal methods of dead birds and manure were affected greatly by the size of the farm and production system as well.

It is recommended that whatever disposal option used, it shall be suitable to the fullest extent possible.

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