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Evaluation of Practiced Biosecurity Measures in Selected Broiler Farms across Kabul Province, Afghanistan

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Abstract

Biosecurity is an important tool to exclude potential pathogens from the poultry farms and to maintain the health, welfare and productivity of the stocks. Therefore, a cross-sectional study was designed to evaluate the biosecurity measures practiced in 50 selected broiler farms in four districts of Kabul province of Afghanistan. Data were collected by structured interview using a pre-designed questionnaire. This study revealed that all of the studied farms practiced the biosecurity measures from medium to the high levels, but these levels were not statistically significant based on the study districts and farms size ($p>0.05$). Disinfection of the farms at the end of each production cycle (100%) along with the disinfection of boots (86%) and vehicle (76%) and routine vaccines administrations (98%) were the most common practiced internal biosecurity measures, while inappropriate farm location, insufficient pest control and improper dead bird disposal were the main non-practiced external biosecurity measures in the surveyed farms. Hence, it is highly recommended to the animal health and production authorities to develop and implement specific biosecurity guidelines to the national level using regional and international manuals.

KEYWORDS
Biosecurity measures. Broiler farms, Disinfection, Kabul province, Pest control

INTRODUCTION

Infectious diseases such as highly pathogenic avian influenza (HPAI), Newcastle disease (ND), infectious laryngotracheitis (ILT), infectious bronchitis (IB), Infectious bursal disease (IBD), salmonellosis and chronic respiratory disease (CRD) severely affects the health, productivity and welfare of poultry farms worldwide (Delpont *et al*., 2021). The occurrence of such diseases have been repeatedly reported from Afghanistan (Leslie *et al*., 2008; Munir *et al*., 2012; Sadri *et al*., 2019; OIE, 2020; Sahab *et al*., 2020; Kariithi *et al*., 2021), where small-scale poultry farming play a critical role in income generation, employment, women empowerment and poverty reduction in rural and semi-urban community (Kawsar *et al*., 2013).

Biosecurity is considered as the most cost effective tool in prevention of introduction and spread of pathogens, parasites and pests to and within the farms (Oyeniran *et al*., 2021). Good management practices, flock health monitoring, proper hygienic measures application and isolation of the infected birds are the key principles of biosecurity measures in the poultry farms (Lestari *et al*., 2011; Ahmed *et al*., 2021). Hence, biosecurity measures are applied to reduce the risk of biological hazard before it happens, control the spread of pathogens during the outbreaks of diseases and reduce the consequences of such conditions in the presence of pathogens in the farms (Siekkinen *et al*., 2012). Since majority of the infectious diseases of poultry including HPAI, salmonellosis and campylobacteriosis have zoonotic nature, proper application of biosecurity measures will definitely reduce the risk of zoonotic agents transmission to the farm personnel and eventually the public (Van Limbergen *et al*., 2018).

Afghanistan is an agricultural country where 72% of its population is living in rural areas (NSIA, 2021) and about 80% of the population is involved in agriculture activities (McMahon, 2008). Livestock, especially poultry, is considered the main income source for most of the rural and semi-urban communities in Afghanistan. Based on the survey results conducted from 2002 to 2004, more than 13 million poultry were present in Afghanistan, where 99 percent of them were raised as backyard poultry, which were mostly owned by women and on average, 5.87 chickens were owned per family (FAO, 2008; McMahon, 2008). But, recently there are remarkable development in the poultry sector, where about 10,000 small to large size (<1000 to 150,000) broilers, layers and breeders farms are established throughout the country, and commercial broiler farming become a good source of investment and income generation for lots of people (Sahab *et al*., 2020). It has been estimated that about one billion USD have been invested in the poultry sector in Afghanistan (Kohistani, 2019), which increases the possibility for the country to be nearly self-sufficient in chicken meat in the near future (Berkhout, 2021). According to recent data, Afghanistan has produced 28,850 tons of poultry meat and 22,373 tons of eggs in 2018. In addition, the average per capita consumption of meat in the country is 23.53

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g per day, which is considered very low compared against the neighboring countries consumption (Our World in Data, 2018) and lower than the standard human requirement of 120 g/head/day (Kawsar *et al*., 2013). Based on the above mentioned points and due to the low capital investment and quick return, broiler farming is considered as an important livelihood and income generation source for most Afghan people, where poverty, malnutrition and unemployment are very prevalent in the current situation. The main objective of this study was to evaluate the application of internal and external biosecurity measures in the selected broiler farms in Kabul province of Afghanistan.

MATERIALS AND METHODS

Study area and design

A cross-sectional study was conducted in Kabul province of Afghanistan, from 15th December 2020 to 7th Jan 2021. Based on the last estimation of the National Statistics and Information Authority (NSIA) of Afghanistan, the settled population of Kabul city was estimated to be more than 4.6 million which constituted almost 13.7% of Afghanistan's total population in 2021 (NSIA, 2021). According to the data provided by general directorate of animal health and production of ministry of agriculture, irrigation and livestock (MAIL, 2019) of Afghanistan, currently there are 172 registered poultry farms including 157 broiler and 15 layer that are operating in Kabul province, while no single commercial farm was present in 2003, there were up to one million backyard poultry (chicken, turkey and duck) in Kabul province on that time (FAO, 2008).

Sample size and sampling strategy

Fifty broiler farms from 4 districts of Kabul province, which contained 19 farms from Dehsabz, 12 from Chahar Asiab, 15 from Paghman and 4 farms from Shakardara district were selected by convenience sampling strategy. Farms were selected based on the security situation of the sites, abundant broiler farms in the area and geographical location, and climate conditions of the district.

Data collection method

Face – to – face structured interview using a pre-designed questionnaire and field observation were used for data collection. The questionnaire had four main sections: (1) general information of the farms and their holders; (2) internal biosecurity measures; (3) external biosecurity measures; (4) transgress from biosecurity measures and their consequences for the farms. All the questions were close-ended except one open-ended question regarding farmer's experiences during the outbreaks of diseases that was present at the end of the questionnaire.

The farm biosecurity status score

Biosecurity total scale scores and categorization were calculated based on the indicators of internal and external biosecurity measures described by Van Limbergen *et al*. (2018) and Lestari *et al*. (2011). Based on the extent of biosecurity measures practiced, the studied farms were categorized as follows: (1) low (up to 33%); (2) moderate (34-66%) and (3) high (67-100%). For calculation of the percentages of the above categories, the following formula was used: (Respondent total score/ Total possible score) x 100. For calculation of the total scores, some of the items were combined and the negative worded items were converted. The minimum score a farm could get was 0 and the maximum was 29.

Statistical analysis

SPSS software 20 (IBM, version 20, USA) was used for data analysis. Required frequencies and percentage were calculated in descriptive statistics, while the relationship between dichotomous variables was calculated by Fisher's exact Chi-square test ($\chi 2$; $p \leq 0.05$).

RESULTS

Characteristics of selected farms

The mean number of chickens per studied farm was 4426.0±1546.0 (min 300 – max 8000), where 22% of the farms contained <3000 chicken, 64% of them contained 3001-6000 and the rest of the farms contained >6000 chicken, in which all of the large farms were located in Paghman (57.1%) and Shakardara (42.9%) districts respectively (Table 1). The median age of the chicken during the study period was 25.0±10.0 days old (4 –40 days old), in which almost half of the chicken (45.2%) aged between 26-40 days old. Eight percent of the studied farms were located near river and main streets, while 12% of them were below residential areas; where 10% of both mentioned farms were in Paghman district. All of the studied farms obtained the chicken feed from domestic sources, but 92% of the selected farms purchased and imported their day-old chicks from Pakistan. Although 98% of the selected farms administered routine vaccines (ND, IB, and IBD) to their chickens, none of the holders trained their farm's staff about biosecurity principles (Table 2).

Mortality in the surveyed farms

About two third of the farms experienced 5-10% mortality in the current (64.5%) and previous (62%) production cycles, while farms that were located in Paghman district experienced higher (>10%) mortality than other districts. Mortality was vary based on the biosecurity levels of the selected farms (Table 3), but these variations were not statistically significant ($p>0.05$). Based on the biosecurity level, the mortality rate in the farms were almost the same on both production cycles, however mortality rate was increased along with the age increment of the chicken ($p>0.05$) (Table 3). According to the farm size, 81.2% of the medium sized farms experienced >10% mortality in the previous production cycles, while none of the small sized farms recorded such high mortality in their previous production cycle (Table 2).

Total practiced biosecurity measure scores

As described in the method section, the biosecurity level of all selected farms were categorized in three levels: low, medium and high. Based on the indicators of the practiced measures and total biosecurity scores, all studied farms were categorized in medium (46%) and high (54%) levels of biosecurity. Most of the high level biosecurity farms were located in Paghman (48.1%) and Dahsabz (25.9%) districts, respectively (Table 1).

Internal biosecurity measures

All of the studied farms were disinfected at the end of each production cycle, but the surface of the 20% of the farms were not suitable to be washed, because they were made of un-wash-

Table 1. Characteristics of studied broiler farms in Kabul province, Afghanistan, 2020-2021.

Variable characteristics		District				Total (%[b])
Variable name	Variable categories	Char Asiab n (%[a])	Dahsabz n (%[a])	Paghman n (%[a])	Shakardara n (%[a])	
Farm size	≤3000	3 (27.3)	7 (63.6)	1 (9.1)	0 (0.0)	11(22.0)
	3001-6000	9 (28.1)	12 (37.5)	10 (31.2)	1 (3.1)	32(64.0)
	6001-8000	0 (0.0)	0 (0.0)	4 (57.1)	3 (42.9)	7(14.0)
Age categories	<10 days old	3 (42.9)	1 (14.3)	2 (28.6)	1 (14.3)	7(16.7)
	11 -25 days old	1 (6.2)	13 (81.2)	2 (12.5)	0 (0.0)	16(38.1)
	26-40 days old	7 (36.8)	3 (15.8)	8 (42.1)	1 (5.3)	19(45.2)[c]
Mortality in this cycle	<5%	0 (0.0)	11 (68.8)	5 (31.2)	0 (0.0)	16(33.3)
	5-10%	12 (38.7)	6 (19.4)	9 (29.0)	4 (12.9)	31(64.6)
	>10%	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	1(2.1)
Mortality in last cycle	<5%	3 (37.5)	3 (37.5)	2 (25.0)	0 (0.0)	8(16.0)
	5-10%	8 (25.8)	13 (41.9)	8 (25.8)	2 (6.5)	31(62.0)
	>10%	1 (9.1)	3 (27.3)	5 (45.5)	2 (18.2)	11(22.0)
Biosecurity level	Medium	7 (30.4)	6 (26.1)	8 (34.8)	2 (8.7)	23(46.0)
	High	5 (18.5)	13 (48.1)	7 (25.9)	2 (7.4)	27(54.0)
Geographical location of the farms	Near river and street	1 (25.0)	0 (0.0)	1 (25.0)	2 (50.0)	4 (8.0)
	Below residential area	1 (16.7)	1 (16.7)	4 (66.7)	0 (0.0)	6 (12.0)
	Above residential area	10 (25.0)	18 (45.0)	10 (25.0)	2 (5.0)	40(80.0)
	Total	12 (24.0)	19 (38.0)	15 (30.0)	4 (8.0)	50

[a]within categories; [b]between categories; [c]the difference in the total numbers are due to missing data.

able materials. In addition, farm equipment was cleaned and disinfected in 80% of the studied farms during the disinfection process, while most of the medium sized farms were not subjected to such process. Buried in the dumping sites or landfills were the most practiced actions (80%) for dead bird management, while 4% of the farmers throw out their dead birds to the stray dogs and cats and 8% of the farmers put the dead birds in municipality garbages or throw them out to the stray dogs and cat, while the last two habits were mostly practiced by the small and medium sized farmers (P<0.05). Although 94% of the studied farm workers wore common personal protective equipment (PPE) during their routine activities in the farm, none of the medium sized farms' workers used such equipment during their normal duties.

External biosecurity measures

As shown in Table 2, most of the external biosecurity measures were appropriate in the studied farms. Foot bath or disinfectants for boot disinfection of farm personnel and visitors was present in 86% of the surveyed farms, but most of the farms (85.7%) that did not apply this measure were in medium size. In addition, in 76% of cases, the vehicles were disinfected at the farm entry, but this process was vary based on the farm size (P<0.05). Meanwhile, wild bird and vermin control strategies were applied in 62% of the studied farms; however, more than two third of non-practiced holders were among medium sized farms (P>0.05). Although all of the examined farm holders mentioned some degree of rodent control programs in their farms, most of the saloons and feed silos' structures of the examined farms were vulnerable for rodent entry and activities. Furthermore, more than half (56.0%) of the evaluated farms were located at <500 meters from residential areas and/or other poultry farms, while only 30% were established >1 kilometer far from such locations. Although apparent variations of the farm location were observed based on the studied districts and farm size, these differences were not statistically significant (P>0.05). Meanwhile, 4 farms (8%), mainly medium sized, were located near rivers and streets. Almost all of the studied farms were not applying any program for pest control around their poultry farms and 60% of them have not removed weed from their farm boundaries. Interestingly, dogs and cats were present in 34% of the studied farms with almost equal distribution in all farm size (P>0.05). In addition, 14% of the farm workers raised backyard poultry in their homes. In more than half (54%) of the studied farms, feed storage areas were located adjacent to the bird production saloons, while in only 10% of cases, the feed storage areas were 20 meter away from the saloons. In the meantime, the underground well was the only source of water for drinking and washing purposes of the studied farms, and none of them were controlling the quality of these water sources.

DISCUSSION

To the best of the authors' knowledge, this is the first study which evaluated the practiced biosecurity measures in broiler farms in Kabul province of Afghanistan. Although the apparent variation was observed on the levels of biosecurity among examined farms, these variations were not statistically significant based on the farms size (P>0.05). Almost the same result was found by Dorea *et al.* (2010), stating that farm size did not influence the biosecurity levels of commercial poultry farms. In the present study, 56% of the surveyed farms were located <500 meter from other poultry farms and residential areas. The least recommended distance of the commercial poultry farm from other farms and residential areas is 500 meter, while >1 kilometer is preferred according to standard recommended measures (Stephen, 2012). Seventy percent of examined farms were located <1 kilometer from residential areas or other poultry farms, and a great proportion of the surveyed farms were near river and main streets and/or below residential areas. At the same time, backyard poultry were raised by many of the farm workers which mostly visited their families once per week. Although there are many guidelines and policies regarding the broiler farms location and structures at national, regional and international levels (Lestari *et al.*, 2011; USSEC, 2017), unfortunately such guidelines are absent or not applied properly in Afghanistan. As mentioned, most of the families in Afghanistan raised backyard poultry (FAO,

Table 2. External and internal biosecurity measures practiced in selected Kabul province broiler farms, 2020-2021.

Variable characteristics		Farm size			Total (%[b])	X^2-test *p-value*[c]
Variable name	Variable categories	≤3000 n (%[a])	3001-6000 n (%[a])	6001-8000 n (%[a])		
Presence of disinfectant at farm entry	No	1 (14.3)	6 (85.7)	0 (0.0)	7(14.0)	>0.0.5
	Yes	10 (23.3)	26 (60.5)	7 (16.3)	43(86.0)	
Vehicle disinfection at the farm entry	No	6 (50.0)	6 (50.0)	0 (0.0)	12(24.0)	<0.05
	Yes	5 (13.2)	26 (68.4)	7 (18.4)	38(76.0)	
Wild bird and vermin control strategies	No	2 (10.5)	13 (68.4)	4 (21.1)	19(38.0)	>0.05
	Yes	9 (29.0)	19 (61.3)	3 (9.7)	31(62.0)	
Farm distance from residential areas and other poultry farms	<500 meter	7 (25.0)	16 (57.1)	5 (17.9)	28(56.0)	>0.05
	500-1000 meter	3 (42.9)	4 (57.1)	0 (0.0)	7(14.0)	
	>1000 meter	1 (6.7)	12 (80.0)	2 (13.3)	15(30.0)	
Geographical location of the farm	Near river and street	0 (0.0)	3 (75.0)	1 (25.0)	4(8.0)	>0.05
	Below residential area	1 (16.7))	4 (66.7)	1 (16.7)	6(12.0)	
	Above residential area	10 (25.0)	25 (62.5)	5 (12.5)	40(80.0)	
Feed silo/storage area	Adjacent to the saloon	6 (22.2)	19 (70.4)	2 (7.4)	27(54.0)	>0.05
	10-20 meter away from saloon	4 (22.2)	10 (55.6)	4 (22.2)	18(36.0)	
	>20 meter away from saloon	1 (20.0)	3 (60.0)	1 (20.0)	5(10.0)	
Vermin control program around the farm	No	11 (22.9)	30 (62.5)	7 (14.6)	48(96.0)	>0.05
	Yes	0 (0.0)	2 (100)	0 (0.0)	2(4.0)	
Plant removal from farm boundaries	No	5 (16.7)	20 (66.7)	5 (16.7)	30(60.0)	>0.05
	Yes	6 (30.0)	12 (60.0)	2 (10.0)	20(40.0)	
Presence of dog and cat in the farm	No	6 (18.2)	22 (66.7)	5 (15.2)	33(66.0)	>0.05
	Yes	5 (29.4)	10 (58.8)	2 (11.8)	17(34.0)	
Keeping backyard poultry by the farm staff	No	8 (18.6)	28 (65.1)	7 (16.3)	43 (86.0)	>0.05
	Yes	3 (42.9)	4 (57.1)	0 (0.0)	7 (14.0)	
Disinfection of the farm at the end of each production cycle	Yes	11 (22.0)	32 (64.0)	7 (14.0)	50	
Equipment disinfection	No	1 (10.0)	9 (90.0)	0 (0.0)	10(20.0)	>0.05
	Yes	10 (25.0)	23 (57.5)	7 (17.5)	40(80.0)	
Farm surface washability	No	2 (20.0)	7 (70.0)	1 (10.0)	10 (20.0)	>0.05
	Yes	9 (22.5)	25 (62.5)	6 (15.0)	40 (80.0)	
Dead bird disposal methods	Buried in the dumping site inside the farm	6 (15.0)	27 (67.5)	7 (17.5)	40 (80.0)	<0.05
	Given to the dog and cat	1 (50.0)	1 (50.0)	0 (0.0)	2 (4.0)	
	Put on the municipality garbage/ given to the dog and cat	4 (50.0)	4 (50.0)	0 (0.0)	8 (16.0)	
PPE usage by workers	No	0 (0.0)	3 (100)	0 (0.0)	3 (6.0)	>0.05
	Yes	11 (23.4)	29 (61.7)	7 (14.9)	47 (94.0)	
Routine vaccines administration (ND, IB and IBD)	No	0 (0.0)	1 (100.0)	0 (0.0)	1 (2.0)	
	Yes	11 (22.4)	31 (63.3)	7 (14.3)	49 (98)	
Mortality in the last production cycle	<5%	1 (12.5)	5 (62.5)	2 (25.0)	8 (16.0)	>0.05
	5-10%	10 (32.3)	18 (58.1)	3 (9.7)	31 (62.0)	
	>10%	0 (0.0)	9 (81.8)	2 (18.2)	11 (22.0)	
The whole biosecurity levels of the examined farms	Medium	6 (26.1)	15 (65.2)	2 (8.7)	23 (46.0)	>0.05
	High	5 (18.5)	17 (63.0)	5 (18.5)	27 (54.0)	
	Total	11 (22.0)	32 (64.0)	7 (14.0)	50	

[a]within categories; [b]between categories; [c]Fisher's exact test

Table 3. Effects of practiced biosecurity levels on the mortality rates of the examined broider farms of Kabul province during two production cycles, 2020-2021.

			Mortality rates in the farms							
			Current production cycle			Total (%[b])	Previous production cycle			Total (%[b])
			<5%	5-10%	>10%		<5%	5-10%	>10%	
Biosecurity level	Medium	n (%[a])	6 (27.3)	16 (72.7)	0 (0.0)	22 (45.8)	3 (13.0)	16 (69.6)	4 (17.4)	23 (46.0)
	High	n (%)	10 (38.5)	15 (57.7)	1 (3.8)	26 (54.2)	5 (18.5)	15 (55.6)	7 (25.9)	27 (54.0)
Grand Total		n (%)	16 (33.3)	31 (64.6)	1 (2.1)	48[c]	8 (16.0)	31 (62.0)	11(22.0)	50

[a]within categories; [b]between categories; [c]the difference in the total numbers are due to missing data

2008; McMahon, 2008), and they are regarded as the main source of many outbreaks of infectious diseases including HPAI for commercial farms (Bavinck *et al*., 2009). So, raising the backyard poultry by the farm personnel and present of the farms near or below residential areas poses great risk of infectious diseases transmission to the commercial farm chickens.

Due to the inappropriate structure of the farms and feed silos/ storage area, presence of rodents were expected in all examined farms. In addition to infrastructure damage, spoilage or consumption of stored products and feed, rodents are considered the reservoirs and vectors of many infectious agents and parasites including zoonoses, which can easily transmit and spread the pathogens and parasites between and within farms, contaminating the feed and water sources of the farms (Meerburg and Kijlstra, 2007; Backhans and Fellström, 2012).

More than one third of surveyed farms did not have any specific program for wild bird access control to the farms and their feed storage areas, and most of them did not have vermin control processes in the farms boundaries. It has been proven that continuous and intermittent contacts between wild bird and domestic chicken increases the risks of pathogen spillover between these populations (Velkers *et al*., 2017; Ayala, *et al*., 2020).

Moreover, management of dead birds in the surveyed farms was tremendous, since most of the time, it was buried inside the farms or given to the dogs and cats that were present inside (in 34% of the farms) or outside the farms. It's obvious that dead birds are potential sources of microbial and parasite contamination (Ahmed *et al*., 2021); and careless disposal of such sources facilitate the wide spread of infectious agents and parasites inside the farms and with the help of dogs and cats, to other farms and the environment. These conditions make the poultry industry more vulnerable to infectious diseases outbreaks (Vieira *et al*., 2009), and as a consequence, threaten the health and production of broiler farms in Afghanistan.

CONCLUSION

It has been concluded that the practiced biosecurity measures in surveyed broiler farms in Kabul province are inadequate, in which wild bird, rodent and vermin control and dead bird disposal processes are insufficient in most of the surveyed farms. The location of most examined farms are not acceptable based on the known standard principles and the farm staffs are not trained about biosecurity measures accordingly. Therefore, specific national guidelines have to be developed and adapted based on the available regional and international manuals and the holders should be encouraged and enforced to apply these rules before broiler farm establishment and during their activities.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

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