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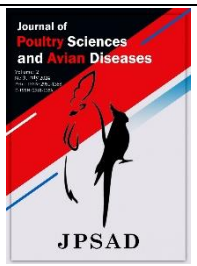

Assessment of Biosecurity Limitation in Live Poultry Markets Inyaounde, Center Region of Cameroon

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A B S T R A C T

In the poultry value chain, live animal markets are common hotspots for dispersing multiple infectious diseases. This work was initiated to assess biosecurity practices in the poultry market. For this purpose, a survey was conducted in 8 live poultry markets in Yaoundé, in combination with a questionnaire-based survey with the stakeholders of the livestock markets. The data collected were analyzed using descriptive statistics. The results revealed that all the markets (100%) were not only used for selling live poultry, and the birds were not confined. In all the markets (100%), poultry was sold without any disinfection observed, and no program was implemented to fight against rodents. The introduction of birds into the market without quarantine was observed at 33.9%; 46.9% of traders and slaughtering persons were working together in closed proximity, birds were kept in wooden cages on the ground in all the market (85.8%) and, when transported inter-urbanely the birds were kept in plastic cages (100%). Cages were piled on top of one another (61.4%) had poultry of different breeds (30.3%) and of different ages (100%). All traders do not put on clean uniforms reserved for their poultry selling activities only, and they do not carry out any medical check-ups. Most customers (72.8%) slaughtered their birds in the market, and the unsold birds (100%) were not returned. Stray dogs, rodents, and cats were found in the market (100%). It was concluded that there is a limited application of biosecurity measures in the live poultry markets in Yaoundé, which, therefore, represents a risk of the dissemination of high pathogenic avian/zoonosis diseases. Live bird market stakeholders should be educated on adhering to biosecurity measures and practices.

Keywords: *Live poultry markets, management practice, biosecurity, Yaoundé.*

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1 Introduction

The poultry industry is of great importance in Cameroon's economy as it provides essential food items, such as eggs and chicken meat, to citizens (1). Amongst these poultry breeds, broiler production is the fastest growing sub-sector, even if it is mainly associated with small and medium-sized farms with flock sizes varying from 50 – 20,000 birds. Poultry meat production in the country has increased 18 folds from 81,000 tons in 1971 to 135,000 tons in 2015 (2). Despite this achievement, the per capita availability of poultry meat in the country is only 1.5kg, much less than the requirement of 10.5kg recommended by the National Institute of Statistics. Moreover, the poultry sector in Cameroon is persistently confronted with highly contagious and fatal diseases like Marek, Newcastle, Coccidiosis, Gumboro, or Chronic Respiratory diseases (3). The diseases have a huge negative impact on poultry production and rentability (4). The success of the poultry requires adopting good biosecurity practices (5). which is the most effective and inexpensive disease control measure (6). Biosecurity in poultry refers to practices and measures taken to limit, control, or prevent the introduction and dissemination of infectious diseases in the farm's premises and facilities (7). A biosecurity program uses a combination of physical barriers such as fences, mesh wire, and directed actions to prevent the introduction or minimize the spread of infectious disease-causing agents, including the use of footbaths, carwash deep, and disinfection of farm equipment (4). With the increase in global and local movement of people and livestock, trade in livestock and livestock products, spread of livestock and plant diseases and pests, spread of invasive alien species, and development and use of genetically modified organisms, it has become important for governments to take biosecurity measures to protect their territories, citizens, livestock, plant life and environment from associated risks. Previous research shows that the lived poultry market constitutes a major source of germs, at times highly pathogenic, like the avian influenza virus H5N1 (HPAIV). The sale of live poultry in the market has always existed and still exists in big markets in many countries and constitutes an emergent phenomenon in certain African regions (8). Most consumers consider live poultry markets from low-income communities as fresher environments, cheaper, and highly accessible. It is also an important source of livelihood for many small and medium businesses (9, 10). In the live poultry market of Africa, the animals are held in cages/tanks and are stressed. Birds from different areas are close to each other, leading to ideal conditions for disease contagion (11). Animals are often slaughtered on-site and hung or placed in the open air without ice or refrigeration (12). In the live poultry markets of Yaoundé, many birds come from different parts of the parts from other regions of the country, and this favor spread favors the eases all over the country. (13, 14).

However, more attention should be paid to implementing biosecurity measures in LPM, and most of the research in the country has focused on the farm sector (15). Our study aimed to assess biosecurity knowledge at the market level across Yaoundé and identify biosecurity and hygiene practices associated with the risk of and protection from avian diseases.

2 Material and Methods

2.1 Study area

This study was conducted in the Yaoundé urban council area from February to August 2023; in the center region, this area was selected because of its demographic importance and the large live poultry market. Yaounde is located within 3°52'N latitude and longitude 11°31'E. It has a high temperature of 20- 28°C between January and May and a low temperature of 19 -26°C between July-December, that is, an average annual temperature of 21.1°C; during this study, the average temperature was 26°C. It has an annual rainfall of 2064mm per year. The center region in which Yaoundé is the capital is bordered to the north by the Adamawa region, to the south by the Southern region, to the east by the Eastern region, and to the west by the Littoral and West region. It has a distinct wet and dry season, fluctuating in four phases, supporting agricultural activities and poultry production in the locality (16).

2.2 Study population

Interviews were conducted with different actors involved in the poultry sectors, namely farmers, those trading (selling) live poultry, live poultry transporters, slaughtering points (makeshift abattoir boys), consumers, and those managing the different markets selected (Veterinary services, council authority, and traders' representatives).

2.3 Study design

A questionnaire on biosecurity in the live poultry market elaborated by the FAO (17) was used as a basement method and adjusted according to the realities of the live poultry

markets in Cameroon. The questionnaire was divided into 3parts concerning the basic principles involved in biosecurity measures such as isolations, traffic control, and disinfection. The livestock ministry agents for the Mfoundi division help facilitate the survey work and justify the project's authenticity. They also help enforce collaboration with the entire poultry chain in the market to fill out a structured questionnaire regarding all possible risk factors and common practices about disease dissemination and transmission for data collection. The questionnaire was pre-tested before the actual work began.

2.4 Sample size

Eight markets were selected in reasoned sampling based on their importance in several poultry species and several poultry traders (higher in number compared to the other markets). After that, the survey questions were randomly subjected to 254 poultry farmers /traders, abattoir boys, and drivers transporting live birds to the market based on their important roles in the live poultry market chain. The sample size of each actor was as follows: traders/farmers/veterinary services/ council workers 200, transporters 20, and abattoir boys 34.

2.5 Validity and Reliability of Questionnaire

The validity of the questionnaire was tested using content validity; the questionnaire was adjudged 'satisfied' by professionals in the field of Agricultural Economics, that is, lecturers in the faculty of Agronomy and Agricultural Sciences. The reliability of the instrument was tested using the test-retest technique.

2.6 Data analysis

Data collected in the field were introduced into Microsoft Excel for classification and codification. They were further subjected to descriptive statistics using SPSS 20.0. The results obtained were expressed as relative frequencies in percentages. The Chi2 test was also used to evaluate the link between the percentage obtained and different parameters, like the transportation hygienic conditions.

3 Results

Table 1 shows biosecurity practices associated with disease control and prevention. In the live poultry market of Yaounde, 72% of the sellers kept the birds in distinct cages but without allowing a proper distance between the cages. 78.7% kept sick birds in separate cages, while 18% sold sick birds at reduced prices to customers. No program was put in place to fight against rodents in the markets. In all the studied markets, stray animals such as stray cats and dogs were noticed.

Table 1. Biosecurity practices are associated with disease control and prevention.

Parameters	Modalities	Nº Responded	(%)	Ñ
Cages for sick birds	N	157	78.7	200
	n	43	21.3	
A place for offloading cars	N	00	0.0	20
	n	20	100	
Spacing cages	N	128	64.2	200
	n	72	35.8	
Selling in distinct boxes	N	144	72.0	200
	n	56	28.0	
Birds slaughter in markets	N	25	72.8	34
	n	9	27.2	
Stray dogs/cats	N	254	100	254
	n	00	0.0	
Fight against rodents	N	00	0.0	254
	n	254	100	

N= number of persons that responded positively, n= number of persons that responded negatively
Ñ= total number of persons in the samplings.

The majority (89.5%) washed their hands and feeds with soap before and after carrying out touching these birds on the various farms. However, they did not use reserved uniforms (clothing) kept only to carry out these operations with clean towels and hand napkins. Most surfaces used in slaughtering birds are made of wood (16%), and 6% use knives with wooden handles. Cleaning, washing, and disinfection of the market is not effectively done in 50% of the surveyed markets, and the cages are cleaned, washed, and disinfected in 62.5% regularly. The quality of products

used for disinfections is Javel water, which will not produce a better sanitary result. Dead birds are not properly disposed of but are thrown into dirty cans and dirt hips in the markets without examination. This disposal method accounts for about 62.5%. These consumers always manipulate and palpate the birds before buying to verify and appreciate their weight (97%). Boiled eggs are also sold in the market, need to be better prepared, and have dirty shells (12%).

The isolation measures practices in the Yaoundé poultry market are resumed in Table 2. From this table, it appears that birds were kept in distinct cages by 81.2%of respondents but without allowing a proper distance between the cages by the different poultry traders. The percentage of those keeping sick birds in separate cages was 78.6%. Different types of cages are used in the poultry markets. Wooden cages were used, but plastic cages were used more because they preferred to transport birds. Most of the birds sold in the market were of mixed breeds ranging from local, exotic, broilers, and old layers. No distance separates the place where birds were sold to their slaughtering spot (81.9%). Most markets were classical, where other things and animals were sold without proper fencing separating the market so that poultry could be displaced on sale.

Table 2. Isolation measures practiced in the live poultry markets in Yaounde.

Parameters	Modalities	Responses	%	Ñ
Close markets	N	0.0	0.0	254
Separate ways in and out	n	100	100	
Other markets inside	N	49	19.3	254
	n	205	80.7	
Moving orderly	N	0.0	0.0	254
	n	100	100	
Cages on others	N	123	61.4	200
	n	77	38.6	

N= number of persons that responded positively, n= number of persons that responded negatively
Ñ= total number of persons in the samplings.

3.1 Practically controlled movement in the market.

Table 3 represents the results of the surveyed market regarding orderly and practical movement control.

Table 3. Control movement in the live poultry markets in Yaoundé.

Parameters	Modalities	Responses	%	Ñ
Plastics or metal cages	N	220	100	220
	n	00	00	
Wooden or bamboo cages	N	189	85.8	220
	n	31	14.2	
Cages on grounds	N	106	53.1	200
	n	94	46.9	
Abattoir/	N	6	18.1	34
Sells space	n	28	81.9	
Birds are taken back to the	N	00	00	200
farm.	n	100	100	
Birds in cages	N	185	84.3	220
	n	35	15.7	

N= number of persons that responded positively, n= number of persons that responded negatively
Ñ= total number of persons in the samplings.

Generally, cages containing birds are placed on the ground (53.1%). For 81.9% of the respondents, there is no separation between the points of selling poultry and the slaughtering spot. Also, in the surveyed markets, there is no point of entry or exit, making it impossible to control people's movements in the markets. 72.8% customers (buyers) slaughtered their birds in the markets. Fortunately, birds not sold are not returned to their farms of origin.

3.2 We are evaluating biosecurity applied in the market.

Globally, different live poultry markets studied in Yaoundé had no cleaning management strategy (Table 4). All the poultry farmers/traders do not have authorization certificates to sell birds; no sales or mortality records were kept. Birds that are not sold are kept in the market in their cages or magazines, and feed is exposed to rodents present in the market since these birds cannot be sold in 1 day. In all the studied markets, stray cats were mainly observed.

In addition, 81.1% of the poultry was sold in one week, with a limited case of poultry put under quarantine (33.9%). In the entire market (100%), live animals other than poultry, such as small ruminants, were present.

Table 4. Evaluating biosecurity applied in the area of management mechanism in the live poultry markets in Yaounde

Parameters	Modalities	Markets responses	(%)	Ñ
Work clothing	N	00	0.0	254
	n	254	100	
Certificate authorizing sells	N	00	0.0	254
	n	254	100	
Follow up managing	N	00	00	254
	n	254	100	
Scarcely healthy birds' outlets	N	167	72.0	220
	n	53	24.0	
No Quarantined birds	N	132	66.1	200
	n	68	33.9	
Birds sold in a day	N	00	0.0	200
	n	200	100	
Birds sold in a week	N	162	81.1	200
	n	38	18.9	
Game water birds live.	N	206	81.1	254
	n	48	18.9	
Cage décor with items	N	150	57.1	200
	n	50	42.9	
Cages can hold feeds/water	N	135	67.7	200
	n	65	32.3	
Feed/ water supplied	N	161	73.2	220
	n	59	26.8	
	N	00	0.0	
Feed protected	n	200	100	200

N= number of persons that responded positively, n= number of persons that responded negatively

Ñ= total number of persons in the samplings.

In most of the studied markets (81%), different species of poultry, such as local birds, broilers, old layers, pigeons, guinea fowl, ducks, and turkeys, that had been raised in a free-ranging system of poultry husbandry before being taken to the market were found.

3.3 *We are evaluating Hygienic measures in the live poultry market in Yaoundé.*

In the studied markets, poultry farmers/traders do not wear clean uniforms as a means of identification, and no resting period was observed in the market annually (Figure 1). Cleaning, washing, and disinfection of the market are not effectively done in 50% of the surveyed markets, and the cages are cleaned, washed, and disinfected regularly only by 62.5% of users. Dead birds are not correctly disposed of but are thrown into dirty cans and dirt hips in the markets without examination. This disposal method accounts for about 62.5%. Waste and dirt were cleaned almost regularly, and drops in dirty baskets in the market or dirt hips piled up not far from where the poultry is sold in the market. Cleaning was done a day or a week before evacuating the pile of dirt. These farmers are not organized in association but have a chairperson overseeing and representing them.

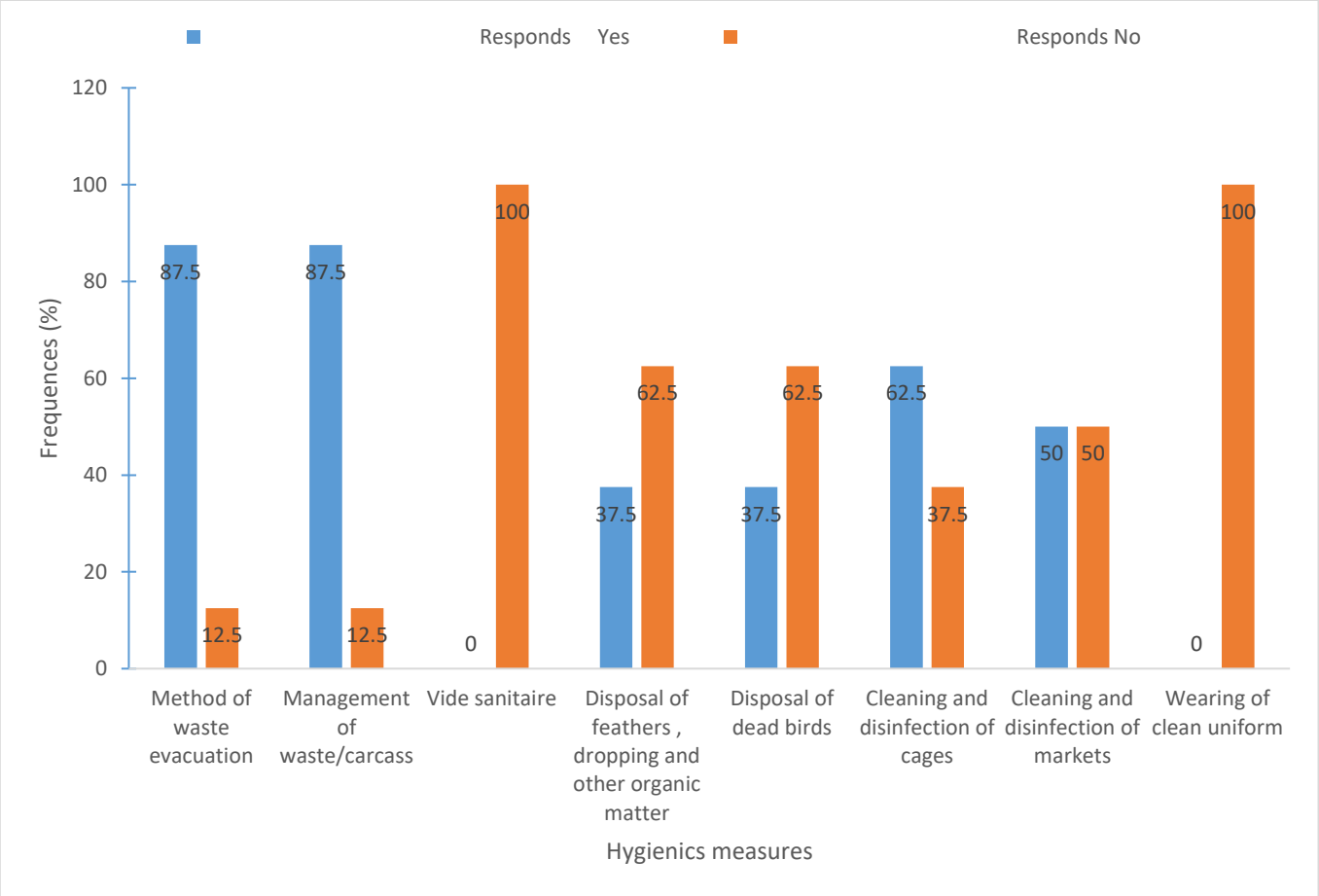

Figure 1. Hygienic practices are carried out in the market.

3.4 *Biosecurity methods applied by other actors involved in the live poultry market in Yaoundé.*

3.4.1 *Live Poultry Transporter.*

The transporting of live poultry in Yaoundé uses various common means of transportation (taxis, cars, buses, personal cars, wheelbarrow trucks) after visiting many other farms by these transporters (rural markets) in search of poultry. Figure 2 represents the level of personal hygiene of transporters in the markets.

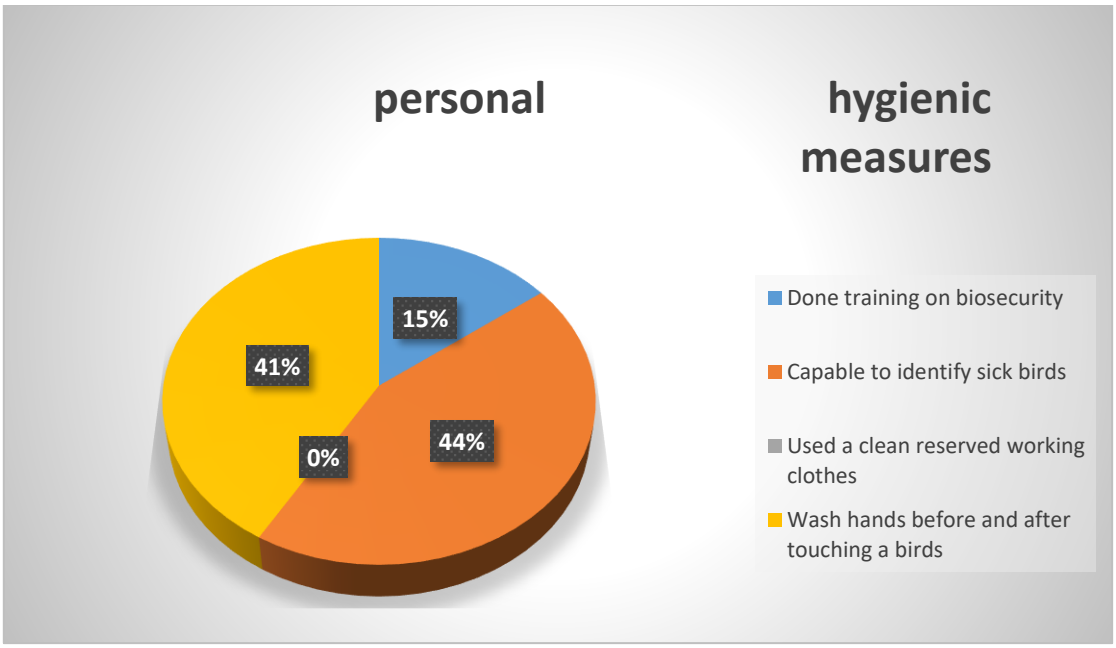

Figure 2. Personal hygienic measures by poultry actors.

This figure revealed that transporters are also farmers/traders. Among them, only 31.6% have done a small amount of biosecurity training through seminars and workshops offered by veterinary pharmaceutical companies. The majority (89.5%) washed their hands and feet with soap before and after touching these birds on the various farms, but they did not use reserved uniforms (clothing), which were kept only to carry out these operations with clean towels and hand napkins.

The equipment used to appreciate the practical, hygienic conditions based on transporting birds is presented in Table 5.

Table 5. Equipment used to transport birds based on hygienic practices applied.

Variables	Mode	Market responses	(%)	Ñ
Wooden cages	N	11	53.1	20
	n	9	46.9	
Plastic /metallic cages	N	17	84.3	20
	n	3.0	15.7	
Cages identified by mark	N	00	0.0	20
	n	20	100	
Cages for droppings	N	00	0.0	20
	n	20	100	
Birds transport car/push	N	2	8.3	20
	n	18	91.7	
Cages disinfects	N	3	16.5	20
	n	17	83.5	

N= number of persons that responded positively, n= number of persons that responded negatively
Ñ= total number of persons in the samplings.

Generally, 53.1% of transporters use wooden cages, and 84.3% use plastic or metallic cages, but the cages are either identified by marks or any cage used for disposing of droppings (Table 6). Most transportation is done by different means, like cars and motorcycles, and few use push or wheelbarrows in the markets, like 8.3%. A minority, 16.5%, wash and disinfect their cages before and after transporting their birds.

As farmers/traders are also transporters, they take all precautions and verifications on the bird's health condition before transporting/ (purchasing) since they too are retailers to sell, and all the birds not sold are not taken back to their

farms of origin but instead kept in cages and feeds in the markets until all are sold. During transportation, birds of all ages are transported together in identical vehicles and of different breeds.

The Evaluation variables linked to biosecurity applied on transporters are presented in Table 6.

Table 6. Evaluating the transportation condition of birds to the market.

Parameter	mode	Markets responses	(%)	Ñ
Wooden cages	N	117	53.1	220
	n	103	46.9	
Plastic /metallic cages	N	185	84.3	220
	n	35	15.7	
Cages identified by mark	N	00	0.0	220
	n	220	100	
Cages for drooping's	N	00	0.0	220
	n	220	100	
Birds transport car/push	N	18	8.3	220
	n	202	91.7	
Cages disinfects	N	36	16.5	220
	n	187	83.5	
Negotiator Do not get to farms	N	58	26.4	220
	n	162	73.6	
Respect restrictions	N	132	60.2	220
	n	88	39.8	
Remove sick/dead birds	N	60	27.2	220
	n	160	72.8	
Drooping evacuated	N	73	33.1	220
	n	147	66.9	

N= number of persons that responded positively, n= number of persons that responded negatively
Ñ= total number of persons in the samplings.

3.5 Live poultry traders and abattoir men in the Markets

From the results obtained from the various traders investigated, most were retailers, and those involved in slaughtering were working with these retailers in live poultry markets; fewer were wholesalers (8%), and 40% were retailers that only sell live birds (Figure 3). The cages were of medium sizes, containing 20 – 50 birds per cage. These retailers could identify sick birds (94.7%). These live poultry traders could wash their hands and feet with Savon before and after visiting the market or touching the birds or meat after slaughtering. However, there is no medical check-up or follow-up for these persons' health statuses to be known, and a medical certificate is established. They could not be identified in the market by any neutral by using a unique outfit or uniform. Most surfaces used in slaughtering birds are made of wood (16%), and 6% use knives with wooden handles. Many got their birds in the market live and slaughtered in the market, and few took them home. 18% sells sick birds at reduced prices to consumers. These consumers always manipulate and palpate the birds before buying to verify and appreciate their weight (97%). Boiled eggs are also sold in the market, are not well prepared, and have dirty shells (12%).

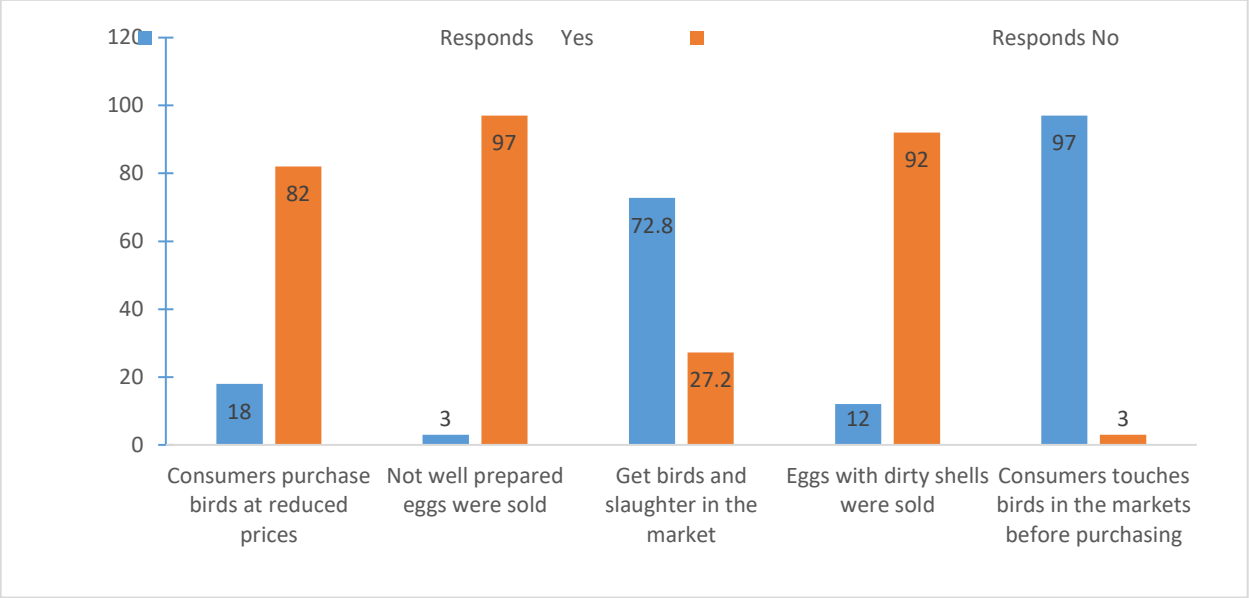

Figure 3. Traders/abattoir personnel's sanitary measures.

3.6 Biosecurity Limitation

3.6.1 Limitations on the transportation of live poultry

Transporting live birds to the market in Yaoundé is not done in an orderly or unique way since the farmers/ traders use different means of transportation (taxis and other means). Before getting to the markets, these taxis could transport birds and other animals (rabbits) from different farms and locations. The taxis are either going to an individual's location or a familiar place, like for poultry traders. Many other different poultry species (local fowl, broilers, old layers, guinea fowl, duck, and turkeys) were transported along the way together in the same wooden or bamboo cages, and no age distinction was considered. Eggs from different layer farms were transported on carton crest designs, and poultry was carried to the market.

3.6.2 Limitation observed in the live poultry markets in Yaoundé

The market is not organized in distinct sections or separated from the larger part of the classical market setting; there is no specific place for offloading birds, vehicles, washing, or antemortem findings (resting place for inspection).

The proximity between the slaughtering spot and the selling place (Figure 4a) and the cages with birds inside are always piled up on top of one another (Figure 4b) without any waste disposal management scheme, and the birds are inside piled cages in the market without the cages been place singly (Figure 4c).

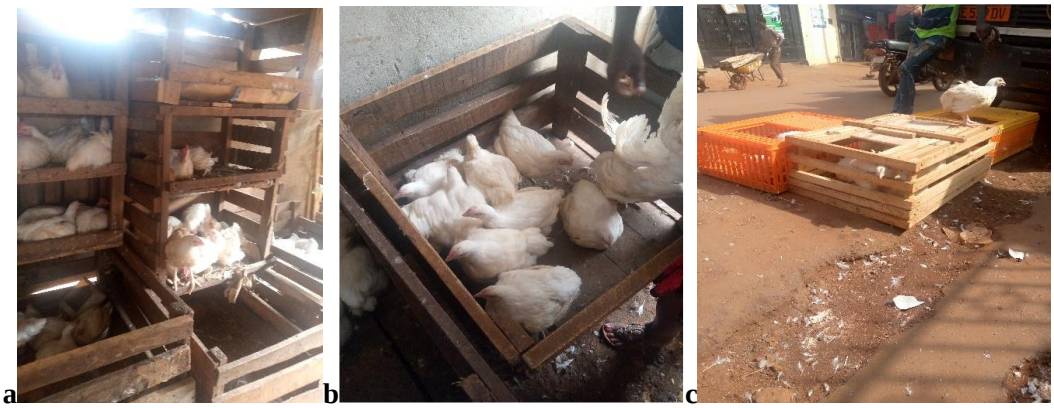

Figure 4. a, b, and c, respectively: cages piled on one another, customers touching the birds, and birds on the floor beside the road.

Different breeds of birds are kept together in the same cage in the market (Figure 4 a and b) and with the cages containing birds on the ground (Figure 5 c, d, and e).

Figure 5. a, b, c, d, and e, respectively: birds besides fruits, poultry on the floor, poultry sold besides vegetables in the market, the slaughter spot in the open-air space so uncared for and dirty, and birds kept in the market besides feeds.

4 Discussion

Biosecurity is a subject that is taken more and more seriously and with urgency in the developed world than in the less developed world; in this regard, with modernization, there is a displacement of persons, food items, avian products, diverse foodstuffs across inter frontiers lines, productions and transformations of finish products, distribution chains of food from plants and animals' origin; dissemination of avian and human diseases across frontiers is inevitable. New international technologies on the rise with legal obligations that are incertitude, like the COVID-19 testing, are all important for growth and development in the 21st century, and the subject of biosecurity that embodies bio-exclusion, bio-containment, and disease surveillance are all of almost importance to be taken into proper applicable measures.

Many of these biosecurity measures should be taken more seriously in Africa. Many have ideas on this, but they are limitedly applicable in the country, especially in the market, which is a meeting point for everyone or most.

FAO (17) did a study to show that more live poultry markets are in urban areas. It is not easy to control the circulation of people, animals, equipment, and cars in Cameroon. However, it is still worse because many of these markets are along the roadsides. As our markets are not isolated and separated uniquely for live poultry only (offloading, car wash, antemortem, abattoir, sales places), what is making the application of biosecurity measures in the live poultry markets difficult, although the way the markets are constructed not following the norm, sitting market should be unique only to deals in the trading of poultry (17). In this setting, there will be maximum reductions in contamination and the dissemination of avian diseases.

Movement is not in a unique direction, and there needs to be a clear separation between the slaughtering point (abattoir) and the sales points (81.9%). This result agrees with Garber *et al*. (18), who reported that traders often need to divide poultry holding, slaughtering, and selling into different zones, which would facilitate cross-contamination in the live bird market, which has many types of live poultry.

The traders visit many farms (rural farms) to purchase live poultry. This practice could be a source of dissemination of avian diseases from market to market, farm to farm, farm to market, and vice-versa. Barkok also cited this practice (19) in Morocco.

Many of these birds were in wooden cages, making disinfection difficult, and others in plastic and metallic cages and even on the ground (53.1%). In this particular point, Wang et al. (20) highlight that poultry-related tools should be considered the main objects to be cleaned and disinfected. Moreover, the lateral disposition of the cage reported in this study was inappropriate as it increases contamination risk. It was shown that cage arrangement is an important factor in contamination by the influenza virus. Vertical stacking effectively controlled the distribution of fecal matter, which could reduce the market contamination rate (21).

Poultry is brought to the market by different means of transportation or by public transport without a specific means of transporting birds to the market, whereas in Abidjan, it is not the case 3.3% use personal cars, 96.7% use specific locations for deliveries, 27.3% trucks, buses 84.1%, 9.1% uses taxis and 6.1% bikes (22). In addition, transportation is done on different farms, and poultry of different ages and breeds are transported in the same car, posing a risk factor of disseminating avian diseases between different ages and breeds of poultry. This finding is in close agreement with Brown and Sarah (23), who reported that transportation facilities are the route for introducing and disseminating avian diseases.

The other poultry species sold in the market and the trader's stocks (birds in cages) constitute a risk factor since no sanitary health inspection is one. More so, these traders get into the farms (73.6%) to select their birds without respect for biosecurity measures that restrict them from transporting birds from a farm experiencing a contagious disease outbreak.

Most birds arriving at the market are retailed and distributed to other markets, constituting a risk factor in disseminating avian diseases that cannot be neglected.

The slaughtering spots in the markets are in open airspace, and many are in the market, hence exposing birds on the floor. These slaughtering spaces are usually in very poor hygienic conditions with insufficient tap water supply, but rainwater is collected in containers and used in the market. Materials for cleaning, washing, and disinfection are limited (17). Traders need a clean and reserved working uniform to be identified in the market.

No period of inactivity (vide sanitaire) in the poultry market is observed annually. Only during avian influenza outbreaks do veterinary services go to the market and disinfect cages and the entire poultry market. On the contrary, in Abidjan, the veterinary services minimize these important risk factors on biosecurity measures by putting in place a no trading period (vide sanitaire) once a year, usually after a festive period, all the markets are clean, washed, and disinfected (22). As stipulated by the FAO, the live poultry market is an important source of infection. Pathogenic agents could persist and accumulate in the long run where no vide sanitaire is observed.

Cleaning, washing, and disinfection of the cages are done regularly (83.5%). No proper waste disposal scheme has been implemented (e.g., for drooping, feathers, dead birds, and other organic waste). This piled dirt in the market is disposed of by the hygienic-sanitary company after being there for a week, causing nausea. It is similar in Abidjan, just that their dead birds are given to non-Muslims to consume, which poses a danger to consuming dead birds (19). This practice contradicts the recommendation on biosecurity measures (17). The most important measures to protect human health, poultry, and the farm against pathogenic infections are never selling or purchasing sick poultry, even at reduced prices, and never offering or selling dead poultry.

Proper disposal of dead birds in the live poultry market should be provided; carcasses, organs, and blood waste (Liquid and solid) are dangerous. Stagnations of this waste in the market, to be evacuated in a week, accumulate pathogenic agents like viruses, bacteria, and parasites in the environment with other harmful scavengers like rodents, inserts, stray dogs, and cats, which are potential reservoirs for pathogenic agents (24).

Most traders/ farmers could identify sick birds but could not ensure a better biosecurity measure. They isolate and separate sick birds in different cages but still pile those cages on top of one another, carrying healthy birds, and at the same time, they try to treat them to reduce economic loss. Dead birds are piled and thrown in plastic to avoid suspicion from veterinary services that their flock could suffer from the highly pathogenic avian influenza virus. If notified by the veterinary services, a sample could be taken to the laboratory

for proper diagnosis. There is no medical check-up done on these farmers/ traders, and slaughtering persons could contaminate the carcasses with pathogenic infections like bacillus tuberculosis, which is an endemic infection in Cameroon.

In the market, consumers touch the birds to appreciate their weight before purchasing them to slaughter at home or in the market. The FAO observed this practice (17), which is frequent in Africa. This practice is a risk factor that limits biosecurity measures since it could lead to the dissemination of avian diseases by customers. These birds do not undergo proper sanitary measures control. Those purchasing sick birds at reduced prices pose a public health hazard.

Limited birds are kept quarantined (33.9%) in the mark, et, and the birds are sold within 1 week (81.1%). In contrast, Boka (19) reported that all birds are quarantined before introducing new birds in Abidjan. The difference is evident because, in Yaoundé, fewer farmers have participated in training programs in biosecurity measures. However, in Abidjan, at least the head of poultry traders has participated in a biosecurity training program (19).

The live poultry markets in Yaoundé are accessible by stray dogs and cats. There is no program to fight against rodents despite their presence in the market. However, it is normal to integrate a program to fight against pathogenic carriers (dogs, cats, insert, rodents, guinea pigs) to be put in place in all markets to minimize the introduction and dissemination of pathogenic agents, which is also a risk to animals and human's health (17).

5 Conclusion

This study looked at how limited biosecurity practiced in the live poultry markets could be a risk factor in disseminating avian diseases, posing health hazards to persons and birds in the live poultry. The results concluded that limited biosecurity practices are observed in the Yaounde live poultry market. There is no structured way of transporting birds to the market; birds get into the market daily from many poultry farms. No waste disposal method is used, and many wooden cages are used. Limited washing and disinfection of cages before and after transportation were recorded.

In summary, biosecurity measures were limitedly applied in the live poultry markets in Yaoundé. This finding reinforces the need to substantially improve the environmental hygiene of LBMs in Zhejiang province.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

MKH designed the study, conducted the data collection and analysis, interpreted the results, and reviewed the manuscript. TC generated the research idea, participated in the design, conducted the study, collected data, analyzed, and wrote the manuscript. TCD, CP, and DAE participated in the study design and manuscript reading.

Data Availability Statement

The data produced and examined during this study are not openly accessible but can be obtained from the corresponding author upon a reasonable request.

Ethical Considerations

This questionnaire-based survey was conducted under the ethical oversight of the Faculty of Agronomy and Agricultural Sciences, University of Dschang (Cameroon); informed consent was obtained from all participants and data were collected anonymously and kept confidential.

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References

1. Mube H, Kana J, Tadondjou C, Yemdjie D, Manjeli Y, Teguia A. Laying performances and egg quality of local barred hens under improved conditions in Cameroon. Journal of Applied Biosciences. 2014;74:6157-63. [DOI]
2. Keutchatang FDPT, Tchuenchieu AK, Nguegwouo E, Mouafo HT, Ntsama ISB, Kansci G, Medoua GN. Research Article Occurrence of Total Aflatoxins, Aflatoxin B1, and Ochratoxin A in Chicken and Eggs in Some Cameroon Urban Areas and Population Dietary Exposure. 2022. [PMID: 35726322] [PMCID: PMC9206572] [DOI]
3. Owono FO. LE CAMEROUN ET LA DIPLOMATIE ENVIRONNEMENTALE (1964-2015): Université de Yaoundé 1 (Cameroun); 2021.
4. Singh M, Kaur P, Singla LD, Kashyap N, Bal MS. Assessment of risk factors associated with prevalence of gastrointestinal parasites in poultry of central plain zone of

Punjab, India. Veterinary World. 2021;14(4):972. [PMID: 34083948] [PMCID: PMC8167519] [DOI]
5. Van Limbergen T, Dewulf J, Klinkenberg M, Ducatelle R, Gelaude P, Méndez J, et al. Scoring biosecurity in European conventional broiler production. Poultry Science. 2018;97(1):74-83. [PMID: 29077940] [DOI]
6. Scott AB, Singh M, Groves P, Hernandez-Jover M, Barnes B, Glass K, et al. Biosecurity practices on Australian commercial layer and meat chicken farms: Performance and perceptions of farmers. PloS one. 2018;13(4):e0195582. [PMID: 29668707] [PMCID: PMC5906091] [DOI]
7. Eltholth MM, Mohamed RA, Elgohary FA, Abo Elfadl EA. Assessment of biosecurity practices in broiler chicken farms in Gharbia Governorate, Egypt. Alexandria Journal of Veterinary Sciences. 2016;49(1). [DOI]
8. Hafez HM, Attia YA. Challenges to the poultry industry: current perspectives and strategic future after the COVID-19 outbreak. Frontiers in veterinary science. 2020;7:516. [PMID: 33005639] [PMCID: PMC7479178] [DOI]
9. Petrikova I, Cole J, Farlow A. COVID-19, wet markets, and planetary health. The Lancet Planetary Health. 2020;4(6):e213-e4. [PMID: 32559435] [DOI]
10. Zhong S, Crang M, Zeng G. Constructing freshness: the vitality of wet markets in urban China. Agriculture and Human Values. 2020;37(1):175-85. [DOI]
11. Keutchatang FDPT, Ntsama ISB, Nama GM, Kansci G. Biosecurity practices and characteristics of poultry farms in three regions of Cameroon. Journal of World's Poultry Research. 2021;11(1):64-72. [DOI]
12. Soon JM, Wahab IRA. On-site hygiene and biosecurity assessment: A new tool to assess live bird stalls in wet markets. Food Control. 2021;127:108108. [DOI]
13. Dessie T, Ogle B. Village poultry production systems in the central highlands of Ethiopia. Tropical Animal health and production. 2001;33:521-37. [PMID: 34632120] [DOI]
14. Moffo F, Mouiche MMM, Kochivi FL, Dongmo JB, Djomgang HK, Tombe P, et al. Knowledge, attitudes, practices and risk perception of rural poultry farmers in Cameroon to antimicrobial use and resistance. Preventive veterinary medicine. 2020;182:105087. [PMID: 32726706] [DOI]
15. Kouam MK, Jacouba M, Nsangou IN, Teguia A. Assessment of biosecurity level in small-scale broiler farms in the Western highlands of Cameroon (Central Africa). Tropical animal health and production. 2018;50(7):1529-38. [PMID: 29687218] [DOI]
16. Ngoran SD. Socio-environmental impacts of sprawl on the Coastline Of Douala: options for integrated coastal management: diplom. de; 2014.
17. FAO. A Guide on Biosecurity in the Poultry Market in West Africa. 2010:p98.
18. Garber L, Voelker L, Hill G, Rodriguez J. Description of live poultry markets in the United States and factors associated with repeated presence of H5/H7 low-pathogenicity avian influenza virus. Avian diseases. 2007;51(s1):417-20. [PMID: 17494597] [DOI]
19. Barkok A. Revue du secteur avicole-Maroc. 2007.
20. Wang X, Wang Q, Cheng W, Yu Z, Ling F, Mao H, Chen E. Risk factors for avian influenza virus contamination of live poultry markets in Zhejiang, China during the 2015–2016 human influenza season. Scientific Reports. 2017;7(1):42722. [PMID: 28256584] [PMCID: PMC5335333] [DOI]
21. Indriani R, Samaan G, Gultom A, Loth L, Indryani S, Adjid R, et al. Environmental sampling for avian influenza virus A (H5N1) in live-bird markets, Indonesia. Emerging infectious diseases. 2010;16(12):1889. [PMID: 21122218] [PMCID: PMC3294595] [DOI]
22. Boka EEJ. Pratique des mesures de biosécurité dans les marchés de volailles vivantes en Côte d'Ivoire: cas du district d'Abidjan. Doctorat en médecine vétérinaire de l'université Cheikh Anta Diop de Dakar. 2009;133.
23. Brown VR, Bevins SN. A review of virulent Newcastle disease viruses in the United States and the role of wild birds in viral persistence and spread. Veterinary research. 2017;48:1-15. [PMID: 29073919] [PMCID: PMC5659000] [DOI]
24. Mensah-Attipoe J, Toyinbo O. Fungal growth and aerosolization from various conditions and materials. Fungal infection. 2019:1-10. [DOI]