

*Full Length Research Paper*

# Veterinary Biosecurity Risk Associated with Avian Imports at Khartoum International Airport, Sudan

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This study was aimed to assess the quality level of the Sudanese standards and risks associated with the importation of hatching eggs and day old chicks as well as the sanitary measures in place based on the international (OIE) standards. Data were collected from the Federal Ministry of Animal Resources and Fisheries (FMARF), the Sudanese Standards and Metrology Organization (SSMO) and from World Animal Health Organization (OIE). For that purpose, risk assessment was used as described in Section 2 of the (OIE, 2009). The results showed that a total of (11,241,209) chicks, and (62,3070,30) layers and broilers hatching eggs were imported into the Sudan during the period 2005 to 2009 from 14 countries, which may comprise potential risk of introducing avian influenza (AI) and many other diseases into the country. In viewing the poultry health status in the exporting countries, the avian influenza is endemic in Egypt, which represented the main exporting country of the two commodities in 2005. In 2006, about 18.3% (out of 235,626 susceptible population) were infected with avian influenza (AI) and 43.2% (n = 101,814) were destroyed for the same reason. Moreover, the Sudanese standards of hatching eggs and day old chicks had not been set according to scientifically based risk estimations and the sanitary measures in place were less stringent to achieve the appropriate level of protection. Therefore, a multidisciplinary scientific risk analysis following OIE standards are recommended for the importation procedures and setting the Sudanese standards.

**Key words:** Hatching eggs, day old chicks, standards, importation, Sudan.

## INTRODUCTION

The nature of the poultry and poultry products commodities flow in the international trade comprises risks of introducing and spreading of diseases from country to country, which leads to probable outbreaks and unwanted impacts that permanently occur in all corners of the world. Some of the poultry diseases agents have regional impact; while others spread further for example, pandemic of highly pathogenic avian influenza (HPAI) that occurred in many countries in Asia, Europe and Africa since 2003. Because of the pressure of liberalized trade, the increasing demands of poultry industry inputs nationally, and the avian diseases globally, there is a need for transparent processes to arrive at decisions which minimize the risks, considering

the competency of the veterinary services in controlling the disease and ensuring the safety of these commodities. The World Trade Organization (WTO) standards are intended to provide clear identifiable references that are recognized internationally and encourage fair competition in free-market economies. The OIE codes are recognized by the WTO as primary reference guides for international trade of animals and animal's products. The chapter on import risk analysis in the OIE terrestrial animal health code has been extensively revised to reflect recent changes in this field of veterinary epidemiology.

Since poultry industry sector has become very crucial to the Sudanese economy, with its considerable participation in food security, the government along with coordination and communication with various stakeholders should protect it from all probable diseases. This preliminary import risk analysis is an attempt intended as a decision-making tool to develop appropriate

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regulatory conditions with mitigations to address potential risks of poultry diseases introduction into the Sudan via Khartoum airport. The objectives of this research were:

1. To assess the probable risks associated with importation of hatching eggs and day old chicks
2. To evaluate the quality level of the Sudanese standards of hatching eggs and day old chicks based on the international standards.
3. To evaluate the sanitary measures in place for the importation of hatching eggs and day old chicks

## **MATERIALS AND METHODS**

### **Area of study**

Khartoum International airport (KIAP) is the major international airport in Sudan, situated in 15° 35' 22" North, 32° 33' 11" East in Khartoum town, one of the three towns comprising Khartoum capital. It forms the exit of imported commodities to other states by road network. KIAP is the only entry point through which 100% of the total amount of hatching eggs and day old chicks come into the country.

### **Staff**

#### **A. Staff of the Sudanese standards and metrology organization airport – branch**

4 Veterinarians  
4 Accountants  
4 Drivers

#### **B. Staff of the Quarantine and Meat Hygiene Department (QMHD) at the airport**

23 Veterinarians  
3 Technicians  
3 Labors  
1 Accountant  
1 Driver

#### **Sanitary procedures at Khartoum airport for the importation of hatching eggs and day old chicks consignments**

A joint committee composed of the Quarantine and Meat Hygiene Department (QMHD) (FMARF), and the Sudanese Standards and Metrology Organization (SSMO), working 24 h a day, inspecting the imported consignments of hatching eggs and day old chicks. The following steps are implemented by the joint committee as standard national procedures:

1. Preliminary verification of documents of the consignments
2. Visual inspection:  
Upon arrival in Khartoum airport, the consignments are visually inspected by the joint committee of Veterinary inspectors from (QMHD) and SSMO.
3. Verification of the consignments with the documents.
4. Certification of veterinary health certificate and quality certificate, or rejection of the consignment according to the findings.
5. There is no animal quarantine facility at the Khartoum international airport.
6. Neither the (QMHD) nor the (SSMO) collect samples and laboratory tests prior to issuance of entry permit of the commodities.

### **Data collection**

Data were collected from the monthly and the annual reports in the period from 2005 to 2009, from the Federal Ministry of Animal Resources and Fisheries (FMARF). Data on National Standards were collected from the Sudanese standards and Metrology Organization (SSMO) – National Standard Directorate and the Khartoum airport branch. Data on risk analysis were collected from the OIE terrestrial animal health code 2009 and some other thesis. Data on exporting country poultry health status are collected from the official website of OIE World Animal Health Information Department (WAHID). Other data were collected from the Argentina veterinary services and WTO and SPS agreement

### **Data analysis**

Data of the imported consignments of hatching eggs and day old chicks were presented in tables and figures as frequency and percentage. Comparisons of the national standards of hatching eggs and day old chicks with the OIE recommendation, and national procedures of importation of hatching eggs and day old chicks were presented in tables.

### **The preliminary risk analysis**

#### **Risk analysis questions**

1. Were the consignments of hatching eggs and day old chicks considered as potential hazards?
2. What was the likelihood of a HPAI entering, establishing or spreading in Sudan by the importation of these commodities?
3. Can the etiological agents HPAIV be detected by the Sudanese measures at the Khartoum Airport?
4. What were the magnitudes of harm that will result from HPAI to poultry, human life or health, and the environment?

The methodology used in this risk analysis followed the guidelines as described in Section 2 of the OIE (2009). Preliminary qualitative risk analysis steps are:

#### **Hazard identification**

Identification of the influenza virus (AIV) which could potentially produce adverse consequences associated with the importation of hatching eggs and day old chicks.

#### **Risk assessment**

1. Release assessment – the likelihood of the (AIV) being imported in the hatching eggs and day old chicks
2. Exposure assessment – the likelihood of the animals or human in Sudan being exposed to the potential hazard of avian influenza.
3. Consequence assessment – the consequences of entry, establishment or spread of the (AIV).
4. Risk estimation – a conclusion on the risk posed by the (AIV), consisted of integrating the results from release assessment, exposure assessment, and consequence assessment to produce qualitative measures of health and environmental risks. If the risk is no-negligible, then the organism was classified as a hazard.

#### **Risk management**

The recommended options to manage the risk of introducing the avian influenza into Sudan.

## RESULTS

Compared with a similar developing country, the Sudanese procedures for the importation of hatching eggs and day old chicks were not based on scientific risk analysis. For instance, there were no documented procedures for a formal decision based on risk analysis as well as no laboratory tests were conducted (Table 1). Comparisons of the Sudanese standards of hatching eggs and day old chicks with the international recommendations revealed that the OIE recommendations were not specified in the Sudanese standard of hatching eggs and day old chicks, the rest of the criteria are presented in (Table 2). Regarding the Sudan poultry health status, about 18.3% (out of 235,626 susceptible population) were infected with avian influenza (AI) and 43.2% (n = 101,814) were destroyed due to the same reason in 2006, while infectious bursal disease (IBD) was reported in 2008: out of 6000 susceptible population 68.3% (n = 4,100) were infected (Table 3). A total of 11,241,209 chicks, and 62,307,030 layers and broilers hatching eggs were imported into the Sudan in the period 2005 to 2009 from 14 countries, which may comprise potential risk of introducing avian influenza (AI) and many other diseases into the country. In viewing the poultry health status in the exporting countries, the avian influenza is endemic in Egypt, which represented the main exporting country of the two commodities in 2005 and was resolved in the rest of the countries according to the OIE notification. Ommat and Elhaj Soleiman were the most importing companies of hatching eggs and day old chicks during the period 2005 to 2009. Results are summarized in (Tables 4 and 5, Figures 1 and 2).

## DISCUSSION

This research was designed to assess the probable risks associated with importation of hatching eggs and day old chicks, to evaluate the quality level of the Sudanese standards and the sanitary measures in place based on the international standards. The results showed that the importation of hatching eggs and day old chicks comprises potential risk of introducing avian influenza and many other diseases into the country, and the Sudanese standards of hatching eggs and day old chicks have not been set according to scientifically based risks estimations and the sanitary measures in place are less stringent to achieve the appropriate level of protection. The SPS agreement strongly encourages members to base their health regulations to protect against the animal and public health risks associated with the importation of animals and animal products on OIE international standards such as the terrestrial code, requiring WTO members to harmonize their sanitary and phytosanitary measures on the standards guidelines and recommendations produced, (OIE –Terrestrial Animal

Health Code, 2009), unless relevant standards are absent, or there is scientific based risk analysis justification for a more stringent level of protection than that provided by a standard, (SPS agreement, 2009).

Since Sudan is now negotiating for WTO accession and soon will be a WTO member, Sudan should put in place standards and measures that are required to achieve its health protection objectives, providing measures that are technically and economically feasible. Despite the fact that it was set by specialized technical committee from different institutions the, Sudanese standards for importation of hatching eggs:

1. Has not stated sanitary requirements, and has not specified any hazard, despite the potential hazards that associated with commodity in the OIE code.
2. The status of vaccination of the parent stocks against the poultry diseases are not specified.
3. The status of parent stocks of freedom from OIE-listed diseases is not specified.
4. There is no indication of compliance with international hygiene and disease security procedures referred to in Chapter 6.4 of OIE terrestrial code for establishments/hatcheries from which the hatching eggs come.
5. Laboratory tests to monitor poultry diseases are not stated in this standard.
6. The text of the standard is published only in Arabic language, and it is not circulated to stakeholders, there is a need to publish the standard in English as well for all interested parties nationally and internationally.

Also, the Sudanese standards for importation of day old chicks shown in Table 4:

1. The Sudanese standard of day old chicks has stated several (OIE)–listed diseases as the primary hazards associated with initiating importation of this commodity from foreign regions, but it was not set according to the OIE recommendations.
2. The standard stated that samples should be taken from every consignment to monitor the immune response against only two diseases (Salmonellosis, mycoplasmosis). The OIE stated many other serious diseases, for example, AI IB, MD, etc... and are recommended to be tested to check the presence of the agents, besides assessing the immunity against them. The diseases that are subjected to laboratory tests should be determined by scientific assessment.
3. There is no indication to the laboratory tests methods approved by the Sudanese veterinary authority in the certificates required by this standard. The OIE has listed the approved and alternative laboratory tests methods recognized in the international poultry trade. The Sudanese standard should specify the laboratory tests methods that are recognized by the Sudanese authority.
4. There is no indication of compliance with international hygiene and disease security procedures referred to in

**Table 1.** Comparison between Sudan and Argentina in procedures of importation of hatching eggs and day old chicks.

Activity/ status	Sudan	Argentina
WTO membership	Observer	Member 1995
OIE membership	Yes	Yes
National standard of hatching eggs and day old chicks conformity with the OIE standards	No	Yes
Import risk analysis	No documented procedure for a formal decision making process, based on risk analysis was presented.	Conducted
Quarantine and control measures at the airport	Visual inspection. No quarantine facility. Infected commodities cannot be detected.	Hatching eggs are hatched at the airport
Laboratory tests	No laboratory test is conducted, (only visual examination). And the shipment is released in no time after that	Serological tests are conducted for END, AI, mycoplasmosis, and <i>Salmonellosis</i> , (these hazards are determined by import risk analysis). And the shipment is released after approx. 10

Chapter 6.4 of OIE terrestrial code for establishments/hatcheries from which the day old chicks come.

5. The text of the standard is published only in Arabic language, and it is not circulated to stakeholders, there is a need to publish the standard in English as well for all interested parties nationally and internationally.

As seen from the results the Sudanese standards of hatching eggs, and day old chicks have not been set according to scientifically based risks estimations, and so, have less stringent imports requirements when compared with the international standards, this cannot achieve the appropriate level of protection (ALOP).

Comparing with the procedures applied in a similar developing country (Argentina) (Table 3), there was no animals quarantine facility at the Khartoum airport. A quarantine station approved by the Sudanese veterinary authority should be established at the Khartoum airport and all the consignments of hatching eggs and day old chicks should pass through this quarantined station before the entry into the country.

Sampling of every consignment of day old chicks to monitor the chicks' immunity against (Salmonellosis, mycoplasmosis) is not practiced in the procedures, though it was stated in the Sudanese standard of importation of day old chicks, these two diseases and others determined according to scientific risk assessment should be sampled, then the consignments release depend on the test results.

The type and method of transportation of chicks' consignments from the airport depend on the wishes of the consignees. Sometimes, they are carried in public transportation, which are not subjected to disinfection and sterilization that may enhance transmission of disease

agents to or from the chicks. Transportation from the airport should be considered as part of the importation procedures, and only specified vehicles designed specifically for this purpose are allowed to transport the day old chicks.

Animal health and epizootics diseases control (AHEDC) - Federal Ministry of Animal Resources and Fisheries (FMARF) facilitated by an extensive and well resourced veterinary infrastructure. Has the capacity to design prevention, control and eradication programs for selected diseases and has the expertise to assess their disease control efforts on a scientific basis, but the poultry health and diseases control programs has just started in the last few years despite the importance of commercial poultry industry to the national economy, which started long time ago and there are other poultry diseases affecting this sector.

In this study, the chicks hatching eggs as well as the fomites (contaminated packing materials, bedding and vehicles), may serve as potential sources of poultry diseases agents into the Sudan. The avian influenza is the only disease that is subjected to official control program; it was developed in response to the escalating global threat of the disease and not as a scientific prioritization of poultry diseases. Fundamental review is needed to monitor other poultry diseases and assess their impacts on the aviculture, public health, economy and the environment in Sudan. The importation of the hatching eggs and day old chicks comprises potential risk of introducing AI and many other diseases into the country, as stated in the OIE chapter 10, Terrestrial code

**Table 2.** Comparison between the Sudanese standards of hatching eggs and day old chicks with the OIE recommendations.

Criteria	OIE recommendation	National standard of hatching egg	National standard of day old chicks
Hazard identification in the hatching eggs and day old chicks trade	Avian chlamydiosis, IB, ILT, mycoplasmosis ( <i>Mycoplasma gallisepticum</i> - <i>Mycoplasma synoviae</i> ), fowl cholera, fowl typhoid, HPAI and LPAI, IBD, Marek's disease, ND, pullorum disease, avian tuberculosis.	Not specified	Fowl cholera, <i>Salmonella pullorum</i> - <i>Salmonella gallinarum</i> , fowl tuberculosis, avian leukosis, Marek's disease, fowl pox, IB, IBD, ILT, ND, asperogelosis,
Vaccinated or not vaccinated against	IB, ILT, HPAI, NAI, FC, IBD, MD	Not specified	DOC and parent and grand parents should be vaccinated against MD, IB
Day old chicks show no clinical signs of	Salmonellosis, chlamidiosis	_____	Fowl cholera, fowl tuberculosis, avian leukosis, Marek's disease, fowl pox, IB, IBD, ILT, ND, asperogelosis, <i>S. pullorum-gallinarum</i>
Day old chicks parents/hatcheries free from	Salmonellosis, IB, ILT, HPAI, NAI, mycoplasmosis, FC, Pullorum disease, IBD.	_____	-Salmonellosis, mycoplasmosis, <i>Escherichia coli</i> -Fowl plague, ND, FC, salmonellosis, CRD, fowl pox 90 days prior to exportation.
Day old chicks parent vaccinated against	IB, ILT, FC, IBD	_____	Not specified
Hatching eggs parents/hatcheries free from	Salmonellosis, ILT, HPAI, NAI, IB, mycoplasmosis, avian tuberculosis, pullorum disease	Not specified	_____
Hatching eggs and day old chicks parent vaccinated against	Marek's disease	Not specified	MD, IB
Come from establishments/ hatcheries which comply with the hygiene and disease security procedures referred to in Chapter 6.4.	Yes	Not specified	Not specified
Identified diseases subjected to laboratory tests	All the listed disease with the OIE approved lab. tests in the terrestrial manual	Not specified	Samples should be taken from every consignment and monitor the immune response against salmonellosis and mycoplasmosis.

Approved laboratory tests methods

ELISA, HIT, VNT Agent id. AGID, ELISA, agg.

Not specified

Not specified

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Tuberculin test

IB, Infectious bronchitis; ILT, infectious laryngotracheitis; FC, fowl cholera; IBD, infectious bursal disease; ND, Newcastle disease; MD, Marek's disease; CRD, chronic respiratory; ELISA, enzyme-linked immunosorbent assay; VN, virus neutralization test; HI, haemagglutination inhibition test.

**Table 3.** Summary of OIE-listed poultry diseases/infections present in Sudan 2005 to 2009.

Year	OIE-Listed disease	Occurrence	Serotype (s)	New outbreaks	Total outbreaks	Control measures	Routine Vaccinated	Susceptible	Cases	Deaths	Destroyed	Ring vaccinated
2005	New castle disease (ND)	+	No	6	6			130539	32366 (24.8%)	130 (0.1%)	0	130539
2006	Highly pathogenic avian influenza (HPAI)	+	H5N1	21	21	Qi S Z V	874000	235626	43050 (18.3%)	43050 (18.3%)	101814 (43.2%)	0
	New castle disease (ND) <i>M. gallisepticum</i>	+	No	3	3	....	....	715	705 (98.6%)	18 (2.5%)	0	1300
2007	New castle disease (ND)	+	No	4	4			....	....	....	....	....
	Infectious bursal disease (IBD)	+	....	....	....	M Qi V T	69000	....	....	....	....	....
		+	....	....	....	M Qi V T	9000	....	....	....	....	....
	Infectious bursal disease (IBD)	+	No	4	4	Z	....	6000	4100 (68.3%)	2685 (44.8%)	0	0
2008	<i>M. gallisepticum</i>	+	No	1	1	T	....	245003	30090 (12.3%)	5357 (21.9%)	0	0
	Pullorum disease	+	No	2	2	T		245023	30096 (1.2%)	5359 (2.2%)	0	0
2009	New castle disease (ND) (domestic)	+	....	....	....	Qf Z V	485200	....	....	....	....	....
	Avian infectious bronchitis (IB) (Domestic)	+	....	....	....	T	....	....	....	....	....	....
	Infectious bursal disease (IBD)	+	No	1	1	Z V	136138000	1800	200 (11.1%)	100 (5.5%)	100 (5.5%)	1600

Source: OIE, World Animal Health Information Database (WAHID), 2005 to 2009. Legend: Qf, precautions at the borders; M, monitoring; Te, screening; Gsu, general surveillance; Tsu, targeted surveillance; Qi, movement control; S, stamping out; Sp, modified stamping out; Z, zoning; Vp, vaccination prohibited; V, routine vaccination; T, treatment; Cr, control of wild reservoir; Cn, control of arthropods.

2009. NAI viruses must be considered to have the potential to lead to the development of disease and are classified as potential hazards in the hatching eggs and day old chicks' commodities. There are also a number of non-NAI subtypes with the capacity to cause disease in poultry. The full potential for such disease relationships is not understood and genetic changes in non-NAI strains, or encounters with new potential hosts, may result in disease. Therefore, all avian influenza viruses are classified as potential hazards in hatching eggs and day old chicks' commodities. Sudanese standards are of less stringent imports requirements which cannot meet the appropriate level of protection ALOP from hazards associated with them, so the risk estimation is high. Secondly,

there is no laboratory tests conducted by the national veterinary authority is required in the procedures (except monitoring the level of immunity against salmonellosis, mycoplasmosis stated in the standard of day old chicks - which is not practiced -) only the visual examination to the consignments is practiced, so the AIV and any other disease

**Table 4.** Exporting countries notifications of Avian Influenza to the OIE and dates resolved.

Country	Date of notification	Disease	Reason for notification	Disease manifestation	No of outbreaks	Date resolved
Egypt	18/02/2006	HPAI	Reoccurrence	Clinical disease	1086	Endemic disease 07/07/2008
France	20/02/2006	HPAI	Reoccurrence	Clinical disease	38	18/04/2006
France	05/07/2007	HPAI	First occurrence	Clinical disease	3	14/08/2007
France	02/02/2009	LPAI	Reoccurrence	Clinical disease	2	17/04/2009
France	16/11/2009	LPAI	Reoccurrence	Sub-clinical	1	02/03/2010
France	21/01/2010	Pandemic A/H1N1 virus	Emerging disease		1	01/02/2010
Germany	16/02/2006	HPAI	Reoccurrence	Clinical disease	123	03/09/2006
Germany	18/12/2007	HPAI	Reoccurrence	Clinical disease	3	28/01/2008
Germany	26/06/2007	HPAI	Reoccurrence	Clinical disease	301	30/10/2007
Germany	10/10/2008	HPAI	Reoccurrence	Sub-clinical	1	14/10/2008
Germany	17/10/2008	LPAI	Reoccurrence	Clinical disease	35	18/02/2009
Jordan	27/03/2006	HPAI	First occurrence	Clinical disease	1	27/03/2006
K.S.A.	31/03/2007	HPAI	First occurrence	Clinical disease	1	27/03/2007
K.S.A.	19/11/2007	HPAI	Reoccurrence	Clinical disease	29	29/01/2008
South Africa	03/07/2006	HPAI	Reoccurrence	Clinical disease	24	26/07/2006
U.K.	06/04/2006	HPAI	Reoccurrence	Clinical disease	1	01/05/2006
U.K.	13/11/2007	HPAI	Reoccurrence	Clinical disease	2	29/04/2008
U.K.	03/02/2007	HPAI	Reoccurrence	Clinical disease	1	25/06/2007
U.K.	25/05/2007	LPAI	First occurrence	Clinical disease	1	15/06/2007
U.K.	15/06/2007	LPAI	Reoccurrence	Sub-clinical	1	06/07/2007
U.K.	11/01/2008	HPAI	Reoccurrence	Clinical disease	2	27/03/2008
U.K.	05/06/2008	HPAI	New strain	Clinical disease	1	20/08/2008
U.K.	18/09/2009	Pandemic Influenza A H1N1	Emerging disease		7	15/01/2010
U.S.A.	03/04/2007	LPAI	Reoccurrence	Sub-clinical	1	06/05/2007
U.S.A.	23/07/2007	LPAI	Reoccurrence	Sub-clinical	1	20/09/2007
U.S.A.	23/07/2007	LPAI	Reoccurrence	Sub-clinical	1	04/08/2007
U.S.A.	04/09/2008	LPAI	Reoccurrence	Sub-clinical	1	29/10/2008
U.S.A.	11/06/2008	LPAI	Reoccurrence	Sub-clinical	1	14/07/2008
U.S.A.	30/11/2009	Pandemic A/H1N1 influenza virus	Emerging disease		1	21/12/2009

\*Source: OIE World Animal Health Information Database 2005 to 2009.

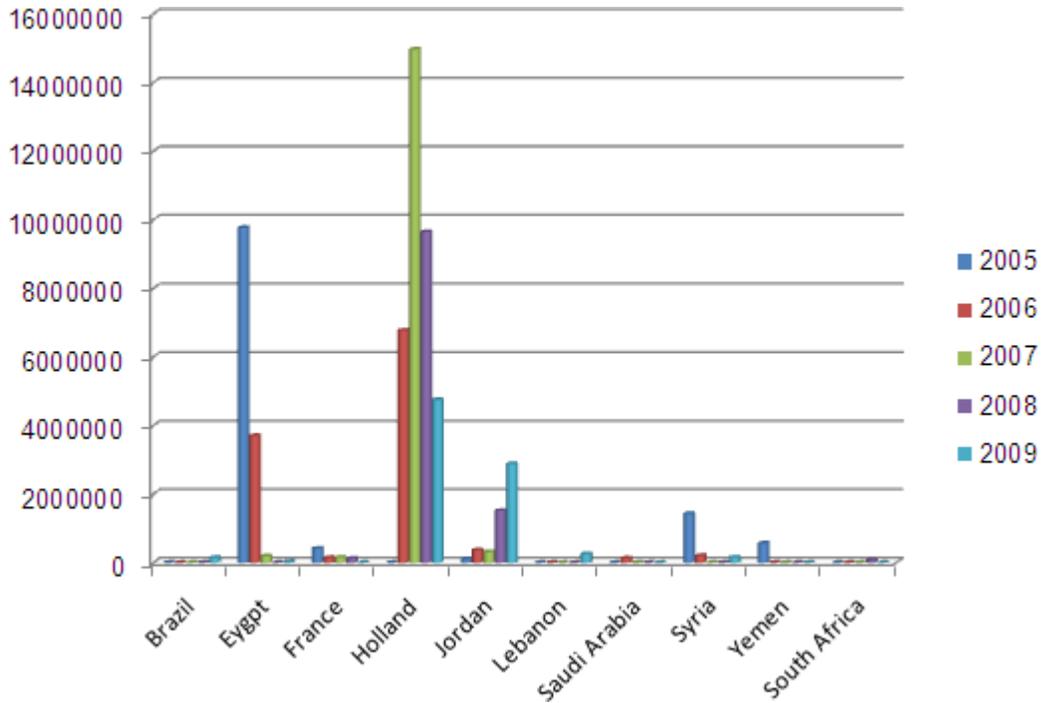
etiologi- cal agents cannot be detected at the Khartoum airport and the risk estimation is high. There is lack of bio- security measures in the handling and the equip- ments used and transportation of consignments of the hatching eggs by the labors and inspectors at the airport.

Other factors including the behavior of some importing company sales systems distribute to their clients near the airport and in the streets directly after being released

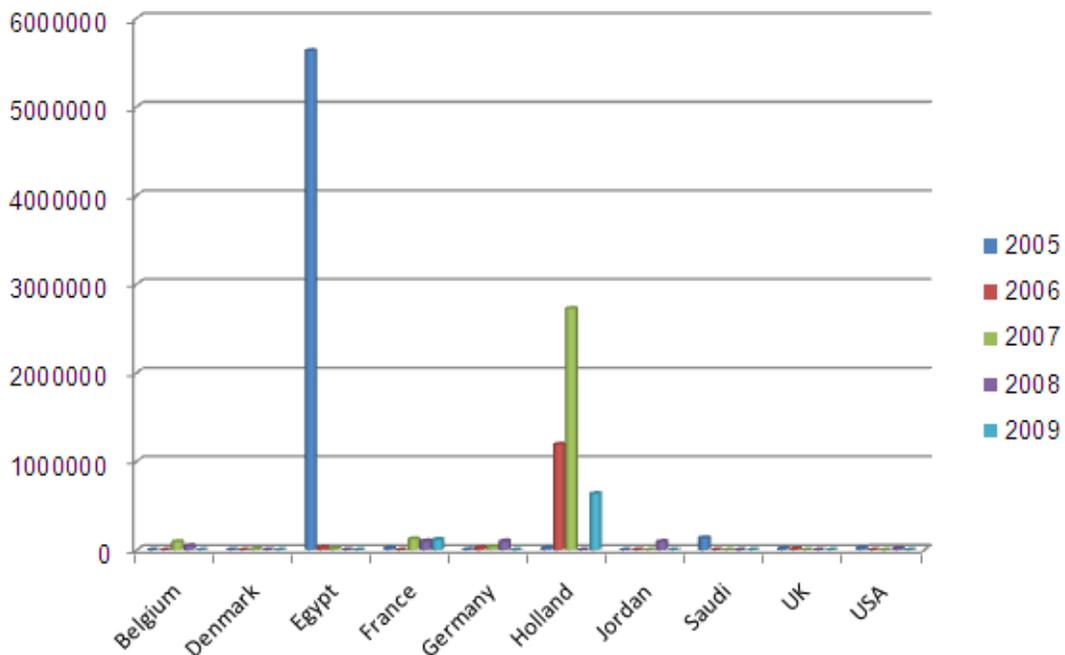
from the airport which comprise risk of introducing the pathogen to man and poultry, The packing materials (plastic crates) of chicks consignments are used for other products for example, packing of vegetables...etc. it also comprises potential risk of spreading the pathogens; the wide range marketing distribution of poultry products (layers and broilers chicks, table eggs, chickens, etc...) all over the Sudanese states, lack of biosecurity in the

**Table 5.** Estimation of AI exposure risk of the imported consignment of hatching eggs and day old chicks to the poultry population in Sudan.

<b>Company</b>	<b>Hatching eggs</b>	<b>Day old chicks</b>	<b>Risk factors</b>	<b>Risk estimation</b>
Abdelmoty	0	260268	-Sales systems of some importing companies depend on distribution of chicks to their clients near the airport and in the streets,	Exposure risk is high
Abosharaf	65520	0		
Abayazid	29790	0		
Acolid	4233420	365321		
African Co	28800	18000	-Sometimes the chicks consignments are transported from the airport in public vehicles	
Alpha	0	81154	(spread the HPAIV to man and animal)	
Anfal	70560	430960	-The packing materials (plastic crates) of chicks consignments are used for other products	
Apico	2520	0	For example, packing of vegetables...etc.	
Arab co	8763080	476002		
Asaad	0	309220		
Bahry poultry	0	139560		
Beit Elsharg	0	1067600	-Marketing distribution of the products (layers and broilers chicks, table eggs, chickens) in almost all the states.	
Coral	6498880	153544		
Elfao	114480	0		
Elghaly	0	25000	-Lack of biosecurity	
Elgaris	693360	439272	Transmission through contaminated fomites	
Elghar	783360	38160	(crates and vehicles)	
Elgariya	38160	430400		
Elhaj Soleiman	99000	1341857	Vaccination crews	
Elshaheed	1009800	82700	Wild birds	
Elsyal	78480	42984	Labors	
Eltaef	170640	786832	Visitors	
Eltarfa	57240	20800		
Elwafa	174400	26700		
Enma	2692520	470659		
Fordan	90000	0		
Gabis	76320	0		
Garovet	72000	136172		
Hadir	0	514128		
Hamza farm	0	184400		
Hivet	0	283610		
Jammaa	0	41600		
Kados	0	12000		
Kairat Elnil	0	10000		
Khalifa Gandor	1763820	467960		
Kweitya	150560	1099900		
Lana	0	80000		
Mico	0	806574		
Mony	0	210000		
National project	101540	103840		
Ommat	13209940	529371		
Sanhory	0	45900		
Salsabeel	7119220	276008		
Shibeeka	4711200	0		
Sonata	0	12572		
Tarig Razaz	3325300	203140		
Zasco	106110	842212		
<b>Total</b>	<b>56330020</b>	<b>13367048</b>		



**Figure 1.** Quantities of imported hatching eggs from the different origins during the period 2005 to 2009. Source: Federal Ministry of Animal Resources and Fisheries monthly reports 2005 to 2009.



**Figure 2.** Quantities and origins of imported day old chicks, to Sudan, during the period 2005 to 2009. Source: Federal ministry of animal resources and fisheries monthly reports 2005 to 2009.

custom and culture practiced in handling of the poultry products, transmission through contaminated fomites (crates and vehicles), vaccination crews, wild birds, labors, visitors etc.,. These entire factors contribute in

distributing the introduced pathogens to the population at risk in the country, and the overall estimation of spreading the pathogen is high. The exposure assessment for AI viruses is considered to be

non-negligible. Because entry, exposure, and consequence assessments are non-negligible, the risk estimate is non-negligible and avian influenza viruses are classified as a hazard in the commodity. Therefore, risk management measures can be justified.

## RECOMMENDATIONS

Based on the results of this study, the following are recommended:

1. The Sudanese veterinary authorities should adopt the OIE standards and recommendations, as indicated in articles 10.4.7, 10.4.8, 10.4.10, 10.4.11, OIE - Terrestrial Animal Health Code 2009.
2. All consignments of hatching eggs and day old chicks must be quarantined approved by FMARF in the Khartoum airport and samples are tested using methods described in the OIE manual of diagnostic tests and vaccines for terrestrial animals for avian influenza viruses and completed with negative results prior to clearance.
3. Science based- risk analysis following OIE standards should be undertaken, by a multidisciplinary team in setting and updating the:
  - i) Preparedness contingency plans for controlling animal diseases
  - ii) Sudanese standards of animals and animals' products generally and standards of day old chicks and hatching eggs in particular, publishing them in both Arabic and English and be circulated to relevant partners, applied, monitored in a professional and transparent manner, so that a safe international trade in animals and animal products can be guaranteed.
4. Provide reliability to quality assessments and certifications SSMO and the national veterinary services should always co-operate on the basis of sound scientific principles, technical, ensuring transparency, address any weaknesses identified.
5. Conduction of database capacity systems - in both SSMO and the national veterinary services - of animal and animals' products besides efficiency in reporting systems that consistently provide valid and precise analysis. Furthermore, because of the complexities involved, the conduction of a full import risk analysis is now regarded as a distinct scientific discipline; training is essential, and learning from already conducted import risk analysis is highly recommended.

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