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QUALITATIVE RISK ASSESSMENT OF AVIAN INFLUENZA VIRUS TRANSMISSION THROUGH INCUBATION EGGS

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SUMMARY

Analysis of literature on avian influenza (AI) virus transmission through incubation eggs and qualitative assessment of risk of incubation egg import to the Russian Federation in the contest of veterinary and sanitary measures against avian influenza currently in place for imported products are presented. Probability of low-pathogenic AI virus transmission through poultry incubation eggs due to possible contamination of the egg and package surfaces with the said agents is indicated. Probability of AI virus transmission through commercial eggs derived from quails, turkeys, geese, chickens is shown to be high. Evidence of actual vertical transmission of highly pathogenic avian influenza virus is limited, however, it is recognized that the infection manifests by systemic lesions in the organs (bursa, thymus, spleen, heart, pancreas, kidneys, brain, trachea, lungs, adrenals and skeletal muscles). It is noted that the virus can persist on bird feathers and in bird meat for a long period. In addition, high humidity, neutral pH level and low temperature are shown to be favourable conditions for the virus survival in the ambient environment. Incubation egg movement restrictive measures are considered the most adequate for prevention of the disease spread between holdings. It is underlined that no country can guarantee the absence of the risk of avian influenza occurrence in avifauna. Anti-AI measures for incubation egg importation recommended by the World Organization for Animal Health are considered adequate for prevention of international disease spread regardless of the virus pathogenicity.

Key words: epidemiology, analysis of import-associated risk, avian influenza

INTRODUCTION

Turnover of incubation eggs is one of the most significant factors for flock maintenance and production rates in the world poultry industry. According to the Institute for Agricultural Market Studies' assessment incubation egg imports had increased more than twice between 2010 and 2015, from 300–330 mln up to 700 mln per year. Domestic production also was on rise increasing by 200–300 mln annually and reached to 2.9 bln in 2015. While experts recognize that there are no precise statistical data for this sector [1]. However, besides evident benefits turnover of incubation eggs is associated with risks of thransboundary spread of avian infectious diseases including avian influenza, Newcastle disease, infectious bursal disease, Marek's disease, turkey rhinotracheitis, duck hepatitis, fowl typhoid, pullorum disease, fowl cholera, mycoplasmosis and ornithosis [10].

Avian influenza virus spread in poultry [22, 28] in addition to its spread in wild birds [24] has had a significant impact on limitation of international trade in poultry products over the last few years.

Taking into account that turnover of incubation eggs is of high importance for the Russian Federation, as well as significance of their import and complicated epidemic situation on avian influenza in the world it would be worth considering the risk of AI virus transmission through incubation eggs.

MATERIALS AND METHODS

Official data of the World Organization for Animal Health (OIE) on avian influenza epidemic situation in various countries in the world were used [30].

Documents, scientific publications and published data on risk assessment were analyzed by traditional analysis methods using content analysis elements as complex logical constructions aimed at showing the substantial content. Assessment of the risk associated with trade in incubation eggs was performed using qualitative risk assessment method [14] modified by N. Murray [20] taking into account commodity-based approach recommended by the OIE [13].

RESULTS AND DISCUSSION

Hazard identification. Pathogen. According to the OIE, avian influenza is an infection of poultry caused by type A avian influenza virus.

The disease is classified into two types depending on the virus pathogenicity: highly pathogenic and low pathogenic avian influenza (HPAI and LPAI) [27].

Asian lineage of H5N1 HPAI is able to infect many poultry and wild bird species and even mammals. Reassortant viruses of such type containing H5N1 virus genome segments (for example, H5N2, H5N5 and H5N8 viruses) were detected in poultry and in mammals [7].

H9N2 AI virus (LPAI) widely spread in poultry in the Near East and Asian countries and was detected in humans [15]. The virus of such subtype was also detected in pigs and in dogs [31].

H5N1 HPAI viruses persist in the environment for a short period as compared to H5 low pathogenic avian influenza viruses [25]. LPAI viruses isolated from wild waterfowl remains infectious for 207 days at 17 °C and for 102 days at 28 °C. Some factors influence the virus persistence in water: temperature, pH level and salinity. The viruses demonstrate the highest stability at pH 7.4–8.2, low temperature (8–17 °C) and low water salinity (0–20,000 ppm) [6, 21].

Field observations carried out by some researchers suppose that LPAI viruses can survive in feces for 105 days under unspecified conditions; AI viruses remained viable for 1–7 days at 15–35 °C under controlled conditions. At lower temperatures (4 °C) the virus survivability in feces varied from less than 4 up to 30–40 days in different experiments. The virus persistence on different surfaces and in soil protected from sunlight varied from 2 days up to more than 2 weeks (and possibly for several months) at 4 °C up to 15–30 °C. The virus can persist on feathers for longer time. In bird meat (pH 7.0) the virus persists for 6 months at 4 °C. Environmental sampling in Cambodia showed that AI viruses could not persist for a long time under tropical climate conditions. Despite of frequent H5N1 Asian lineage HPAIV RNA detection in many samples (for example, in soil and straw) the virus was successfully isolated only once, in one stagnant water body [7].

Russian researchers also noted that high humidity, neutral environment and low temperatures could promote the virus survival in environment [3].

As of January–May 2017, the following type A HPAI virus subtypes were registered in the world: H5, H5N1, H5N2, H5N5, H5N6, H5N9, H7N1, H7N3, H7N9 but H5N8 virus prevailed based on the number of outbreaks. HPAI outbreaks in wild birds and poultry were reported in the following countries: Austria, Algeria, Bangladesh, Belgium, Bulgaria, Bosnia and Herzegovina, Great Britain, Hungary, Vietnam, Germany, Hong Kong, Greece, Denmark, Egypt (endemic since 2008), Israel, India, Iran, Ireland, Spain, Italy, Kazakhstan, Cambodia, Cameroon, China, Cote d'Ivoire, Kuwait, Libya, Lithuania, Macedonia, Malaysia, Mexico, Myanmar, Nepal, Niger, Nigeria, Netherlands, Poland, Portugal, Russia, Romania, Serbia, Slovakia, Slovenia, United States of America, Taiwan, Tunisia, Uganda, Ukraine, Finland, France, Croatia, Czech Republic, Sweden, Switzerland, South Korea, Japan [29].

The following countries were officially registered as LPAI-infected in 2017 (January–May): Germany (H5N1, H5N2, H5N3), Cambodia (H7N3), Libya (H7), Netherlands (H7N9), United States of America (H5N2 – wild birds, H7N9), Taiwan (H5N2), France (H5N1, H5N2, H5N3, H5N9), Chile (H7N6), Republic of South Africa (H5N2, H7N9) [29].

Probability of risk for the virus transmission through commodity. For transmission of avian infectious diseases through incubation eggs their etiological agents should be able to infect targeted poultry species or spread in reproductive tract and persist on egg surface or penetrate though egg shell and infect the egg content prior or after egg laying.

LPAI-caused infection in poultry can result in egg production drop but more often symptoms of respiratory tract infection are registered. The disease manifestations are as follows: ataxia and rarely diarrhea, depression, ruffled feathers. Pancreatic necrosis was reported in turkeys [8].

It should be recognized that there were no reports on infection of bird eggs with LPAI viruses while H7N2 virus infection-associated salpingitis and slight to moderate egg production drop were reported in some studies [9].

Although it is recognized that HPAI infection manifests by systemic lesions in organs (bursa, thymus, spleen, heart, pancreas, kidneys, brain, trachea, lungs, adrenals, skeletal muscles) the evidence of actual vertical transmission of HPAI is limited [16, 25]. H5N2 HPAI virus was isolated from yolk and white of eggs derived from naturally infected [17] and experimentally infected [19] chickens. According to non-published studies cited by D. E. Swayne and J. R. Beck [26], it was demonstrated that HPAI virus was present in 85–100% of eggs placed for incubation 3–4 days after experimental infection of poultry. However, HPAI virus is lethal for embryos and no incubation of infected eggs has been demonstrated in experiments. Epidemic investigation of HPAI spread in Netherlands in 2003 showed that mechanical transmission through contaminated eggs and egg trays could be significant factor for the disease spread [23].

Only one case of transovarian AIV transmission namely A/Silver gull/Astrakhan 458/85 H13N6 virus isolation in cloacal swab from silver gull youngling that had no contact with outside environment was described in reviewed relevant Russian scientific literature [5].

No information on specific cases of LPAI introduction to poultry establishments through introduced/moved incubation eggs was found during the review of foreign and Russian scientific literature. However, based on available data it can be concluded that probability of LPAI virus transmission through poultry incubation eggs appears to be primarily limited to possible contamination of egg surface, package with the said agents while despite of limited evidence of HPAI vertical transmission the HPAI virus was isolated from the egg yolk and surface. Therewith, it is recognized that HPAI causes systemic lesions in organs and probability of HPAI virus transmission through marketable eggs of quails, turkeys, geese and fowl is high and these are confirmed by published studies [12, 17, 18].

Risk mitigation measures. Taking into account limited data on association of natural AI infection with the virus transmission through incubation eggs the OIE Terrestrial Animal Health Code (hereinafter, the Code) recommendations on safe trade in incubation eggs regardless of the virus pathogenicity (Art. 10.4.10) are undoubtedly adequate for international avian influenza spread prevention during export/import.

It may be noted based on analyzed EU measures for avian influenza control [11] that they, inter alia, include bans on egg movements regardless of avian influenza patho-

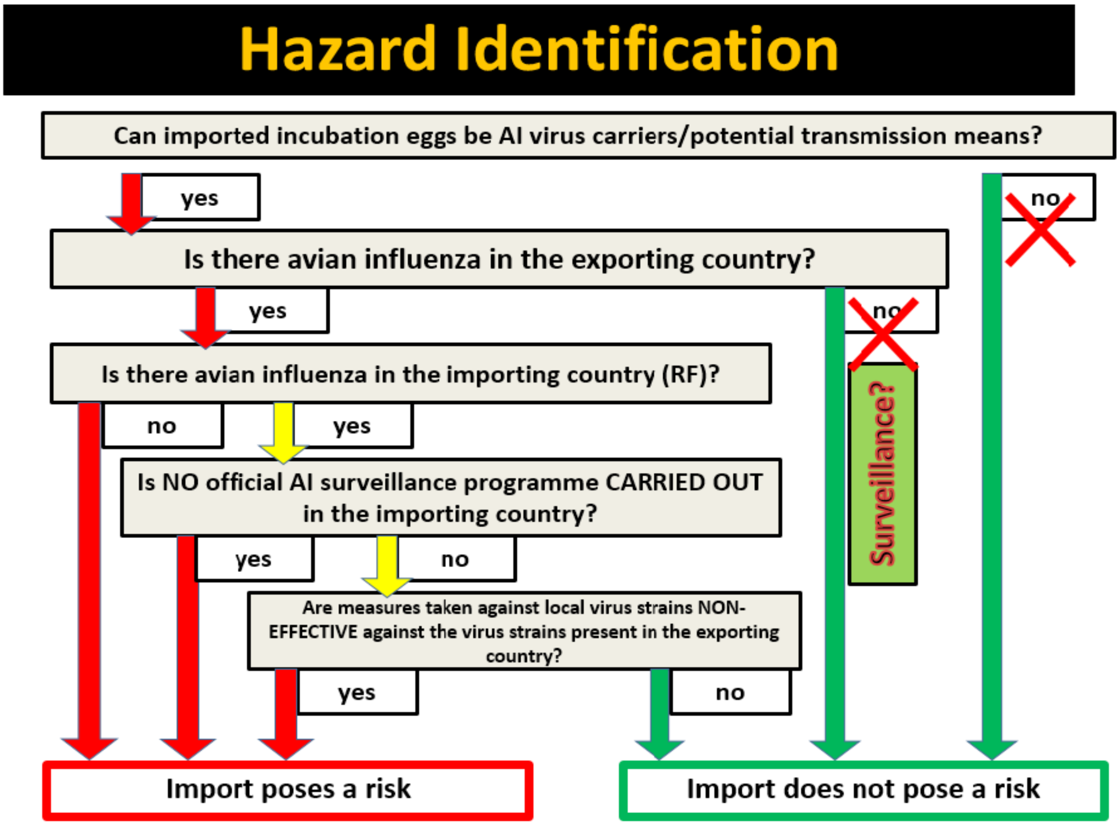

Fig. Results of qualitative assessment of AI risk associated with incubation egg importation to the Russian Federation

genicity. Therewith, eggs as well as poultry, feeds, meat, humans and fomites are considered potential sources of AI introduction to an establishment and AI spread between establishments.

However, breeding establishments that produce incubation eggs and day-old chicks for export carry out tests in accordance with Art. 10.4.32 of the Code [27]. Therewith, it should be noted that according to the said Article additional requirements for surveillance for recognition of AI freedom of the establishment include evidence of HPAI and LPAI infection absence. Poultry kept at such establishments should be tested for the virus detection or isolation based on randomized sampling and using serological methods in accordance with the Code general requirements. The tests should be carried out at intervals that depend on risk of the infection spread but at least every 21 days.

Although diagnostic significance of serological surveys is commonly recognized, the importance of animal clinical examination-based surveillance should not be underestimated. Article 10.4 of the Code states that the main goal of clinical surveillance is detection of AI clinical signs, first of all HPAI signs at flock level.

Monitoring of production indicators such as mortality increase, decrease in feed or water intake, detection of respiratory signs, drop in egg production is a major factor for early detection of both HPAI and LPAI.

Decrease in feed intake and in egg production sometimes is the only indicator of LPAI virus presence. Clinical surveillance and laboratory tests should complement each other and be carried out consecutively to clarify the situation.

Results of serological survey (randomized or stochastic) allow the absence of the infection caused by AI viruses in a country, zone or compartment to be strongly proved. This underlines the importance of thorough documenting of performed tests [27].

Based on data presented in the Figure incubation egg turnover-associated AI virus spread cannot be excluded. Besides, no country has proved yet AI absence in its territory that is why, the associated risk cannot be insignificant (import poses a risk) and evidence of the disease freedom of the commodity source is applicable to individual production establishments (compartments). Standard quarantine measures currently in place in the Russian Federation that are equivalent to the OIE recommendations [2, 4] can be considered effective against avian influenza viruses.

CONCLUSION

Probability of LPAI virus transmission through poultry incubation eggs appears to be primarily limited to possible contamination of egg surface and package while despite of limited evidence of HPAI vertical transmission the HPAI virus was isolated from egg yolk. Taking into account limited data on association of natural AI infection with the virus transmission through incubation eggs the OIE Terrestrial Animal Health Code recommendations are currently the most appropriate for international avian influenza spread prevention during trade regardless the virus pathogenicity.

Risk associated with avian influenza spread (regardless the virus pathogenicity) during trade in incubation eggs providing that the OIE recommended measures were implemented was assessed as "more than insignificant".

Standard quarantine policy of the Russian Federation currently in place in the Russian Federation complies with the OIE recommendations and, consequently, effectively prevents AI introduction with incubation eggs.

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