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Immunogenicity and efficacy of a bivalent vaccine against infectious bronchitis virus

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Abstract

Infectious bronchitis (IB) is a highly contagious viral disease and is responsible for considerable economic losses in the poultry industry, worldwide. To mitigate the IB-associated losses, multiple vaccines are being applied in the sector with variable successes and thus necessitating the development of a potent vaccine to protect against the IB in the poultry. In the present study, we investigated a bivalent live attenuated vaccine consisting of IB virus (IBV) strain H120 (GI-1 lineage) and D274 (GI-12 lineage) to evaluate its protection against heterologous variant of IBV (GI-23 lineage) in chicken. Protection efficacy was evaluated based on the serology, clinical signs, survival rates, tracheal and kidney histopathology and the viral shedding. Results demonstrated that administering live H120 and D274 (named here Classivar®) vaccine in one day-old and 14 days-old provided 100 % protection. We observed a significant increase in the mean antibody titers, reduced virus shedding, and ameliorated histopathology lesions compared to routinely used vaccination regimes. These results revealed that usage of different IBV vaccines combination can successfully ameliorate the clinical outcome and pathology in vaccinated chicks especially after booster vaccination regime using Classivar®. In conclusions, our data indicate that Classivar® vaccine is safe in chicks and may serve as an effective vaccine against the threat posed by commonly circulating IBV strains in the poultry industry.

Introduction

Infectious bronchitis (IB) is a highly contagious viral respiratory disease of poultry caused by infectious bronchitis virus (IBV) [1,2]. The IBV strains can potentially mutate and lead to continuous emergence of a number of serotypes or genotypes, worldwide [3]. Because of adaptive evolution, genetic diversity of coronaviruses is mediated through recombination events and mutations such as substitutions, deletion, and insertion within the viral genome. The low proofreading capacity of RNA-dependent RNA polymerase is attributed to the high mutation rates, whereas recombination results from a unique template copy-choice mechanism during the RNA replication [1,2,4,5]. Continuous

emergence of variant IBV strains is often responsible for devastating IB outbreaks in even vaccinated chicken flocks [1,2,4,5].

Previous studies in Egypt have shown that multiple IBV variants were circulating in the Egyptian poultry flocks. Emergence of new IBV variants with nephropathogenic properties is characteristic for the recent outbreaks in Egypt during the last decade causing great economic losses in the poultry industry [[6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16]]. The GI-23 lineage of IBV has been reported throughout the Middle East and North Africa [17], Iraq [18], Turkey [19], Libya [20] and Egypt [[6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16]]. The high incidence of IBV outbreaks in vaccinated poultry flocks is attributed to the circulation of Egyptian variant-2 viruses, which display high genetic differences compared to all imported IBV vaccines and have multiple amino acid substitutions at antigenic epitopes [21,22]. In field conditions, chickens are simultaneously exposed to different IBV variant strains. Therefore, new vaccines cannot be produced against every evolving strain [23,24]. However, new vaccines such as IBV strain 793B [25], IB strain QX-like vaccines [26] or IB-VAR2 [27,28] were used to improve the protective levels. Previous studies have revealed that cross-protection between different IBV strains could range from very poor to moderate. Therefore, it is imperative to assess the cross-protection of vaccine combinations against IBV strains of different serotypes as an alternative approach to control IB in the poultry industry.

Compared to vaccination with one serotype, the usage of different combinations of live IBV vaccines can induce stronger and wider protection against heterologous variant IBV strains [[29], [30], [31]]. Terregino et al. [30] have reported simultaneous or alternate usage of Ma5 and 793B strains, which has induced high levels of protection against heterologous IBV types such as D1466 or QX strains. This protection might be attributed to increased cellular and local immune responses [22,24]. In order to identify additional combination for better vaccination, this study was designed to evaluate the protection conferred by a bivalent live attenuated IBV vaccine (H120 classical strain and D274 variant strain) against challenge with heterologous Egyptian variant IBV (GI-23 lineage). The applied vaccine approached offered full protection, significant increase in the mean antibody titers, reduced virus shedding, and ameliorated histopathology compared to routinely used vaccination regimes.

Section snippets

Viruses and animals

The IBV classic strain H120 (GI-1 lineage) and variant D274 strain (GI-12 lineage) were kindly provided by the Animal and Plant Health Agency, UK and University of Arkansas, USA; respectively. Both viruses were propagated in 9-day old specific pathogen free embryonated chicken eggs (SPF-ECEs). The allantoic fluid was harvested, dispensed into vials, lyophilized and stored at −80 °C as a master seed. The Classivar® is a registered trade name at the General Organization for Veterinary Services…

Evaluation of vaccine safety and immune responses

Three vaccinated groups were observed for 14 days post-vaccination and no clinical, local, systemic and necropsy lesions were noticed compared to birds in negative control group. On day 14 (day of booster vaccination), chicks of group I, II and III exhibited significantly higher antibody titre ($p < 0.05$) compared to non-vaccinated negative control group (Fig. 2a). On the other hand, on day 21 of age (day of challenge), vaccinated groups that received booster dose groups IV, V and VI) showed…

Discussion

Despite widespread vaccination with live attenuated or inactivated IBV vaccines worldwide, the Egyptian poultry industry has recently faced an increasing incidence of IB outbreaks [[6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16]]. The partial cross-protection and widespread of multiple IBV genotypes and serotypes in the poultry industry has led to the failure of currently available vaccines which are either based on classical (Mass 41 and H120) and/or variant (D278, CR88 or 4/91)…

Conclusions

Our study provides an evidence for the efficacy of a bivalent H120 and D274 (Classivar®) vaccine candidate against Middle Eastern variant GI-23 IBV strains with full protection to reduce the economic losses caused by variant IBV infections. Likewise, our findings indicated that booster vaccination regimes are better than single vaccination regimes that show high antibody titers with significant reduction in virus shedding and histopathological alterations compared to challenged non-vaccinated…

Declaration of Competing Interest

All authors declare that there is no conflict of interest.…

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