



Research Paper

Impacts of HVT Vaccination Against Marek's Disease in Broiler Chickens in Algeria



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ABSTRACT

Introduction: Marek's disease (MD), a lymphoproliferative and immunosuppressive viral disease of poultry, poses serious challenges to broiler production worldwide. Vaccination with turkey herpesvirus (HVT) is a common preventive strategy. This study aimed to evaluate the zootechnical and economic impacts of HVT vaccination in broiler chickens reared under field conditions in northeastern Algeria.

Materials & Methods: The trial was conducted in the Mila Region over six weeks and involved two cohorts of 11,000 broiler chickens each: A vaccinated group (VG) receiving HVT vaccination on day 1 in addition to standard vaccinations, and a non-vaccinated group (NVG). Both groups were sourced from the same breeder stock and raised under identical management and environmental conditions. Key parameters measured included average body weight (BW), feed conversion ratio (FCR), and weekly mortality. Economic viability was assessed through a cost-benefit analysis (CBA), considering vaccination costs (218.66 EUR) and estimated production gains.

Results: From week four onward, VG birds showed significantly higher BW than NVG, reaching 3070 g vs 3000 g at week six ($P < 0.001$). FCR remained comparable between groups, with VG showing slightly improved efficiency from week three, though not statistically significant ($P = 0.93$). Mortality rates (MR) were significantly lower in VG from week three onward, with pooled analysis confirming a protective effect of vaccination ($P < 0.01$). The improved growth performance and reduced mortality observed in the VG suggest a clear health benefit of HVT vaccination in broilers raised under field conditions. Despite no

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significant difference in feed conversion efficiency, the biological impact of the vaccine was evident from mid-trial onwards, highlighting the protective effect of HVT against MD-related losses. HVT vaccination in broilers enhances growth performance and significantly reduces mortality without compromising feed efficiency. Economically, it proves to be a highly viable strategy, resulting in a net benefit of 5489.74 EUR per flock and a cost-benefit ratio of 26-to-1.

Conclusion: These findings support the integration of HVT vaccination into comprehensive health management programs in intensive poultry systems.

1. Introduction

The poultry industry is rapidly expanding within the agricultural sector, driven by the rising demand for poultry products such as white meat and eggs. However, this sector faces serious threats from numerous avian diseases, such as Marek's disease (MD), which leads to substantial production losses globally [1]. MD caused by an alphaherpesvirus, is a highly contagious and rapidly progressive lymphoproliferative disease in chickens, characterized by neurological disorders, neoplastic transformation of CD4 cells, and very virulent plus (vv+). MDVs induce a form of immunosuppression (late-MDV-IS) that might involve both neoplastic and non-neoplastic mechanisms [2].

MD virus (MDV) primarily targets lymphocytes, which means the first signs of infection usually appear in the body's main lymphoid organs. These include the bursa of Fabricius, where B cells develop, the thymus, which produces T cells, and the spleen. As the infection progresses, these organs typically show a series of characteristic changes, following a fairly predictable pattern. The progression of MDV infection typically unfolds in four key stages: One, early on around day three to day seven after infection, the virus begins attacking B lymphocytes and a smaller number of activated T lymphocytes. This initial phase often results in a temporary weakening of the immune system. Two, next comes the latent phase, where the virus hides within both B and T lymphocytes, staying quiet without immediately damaging the cells. Three, later, the virus becomes active again, this time mainly targeting T lymphocytes. This renewed attack further suppresses the bird's immune system, making it more vulnerable to other infections. Four, finally, in some cases, the virus causes certain T cells to become cancerous, leading to the formation of lymphoid tumors, which can result in the bird's death [3-5].

This disease is a significant ailment affecting avian species and poses a potential threat to the global poultry industry. It affects the health of hens and chickens, as well as the zootechnical and economic performance of farms, particularly in broilers [6]. Control measures for this disease include not only vaccinating long-lived birds but also vaccinating broiler chickens, knowing that this vaccination is not systematic or mandatory according to current biosecurity protocols in Algeria. Among vaccine strains available, the turkey herpesvirus (HVT) has been successfully used as a vaccine against MD. It is administered either alone (in broiler chickens) or in combination with vaccines from other serotypes (in broiler breeders and layer hens) [7].

This study aims to evaluate the HVT vaccine program by assessing the effect of HVT vaccination on zootechnical performance and from an economic perspective in a farm of 11,000 broiler chickens by estimating the costs as well as the benefits provided by the vaccination.

2. Materials and Methods

2.1. Ethical approval

The present study was approved by the Institutional Animal Care Committee of the National Administration of Algerian Higher Education and Scientific Research (Ethical approval number: 98-11, Law of August 22, 1998).

2.2. Study area and protocol

The study was conducted in the Mila Region, north-eastern Algeria. Two cohorts of 11,000 broiler chickens, sourced from the same breeder stock and reared under identical environmental and management conditions, were compared: A vaccinated group (VG) receiving a non-pathogenic HVT vaccine at one day of age in addition to the standard vaccination schedule, and a non-vaccinated group (NVG). This study was conducted during the first six weeks of life.

A record sheet was completed after weighing and measuring their length, as well as assessing Pasgar score parameters, on a sample of 20 chicks in order to determine their quality. These chicks had an average initial body weight (BW) of 40 ± 2.8 g, a length of 19.47 ± 0.09 cm, an internal temperature of 39.5 ± 0.08 °C, and a Pasgar score of 0.

2.3. Zootechnical performance

The parameters assessed in this section were as follows (Equations 1, 2, and 3):

1. Average BW: The total weight of n subjects divided by n;

2. Mortality rate (MR): Number of dead subjects (during a specific period)/Initial number of subjects (for the same period) $\times 100$;

and

3. Feed conversion ratio (FCR): Quantity of feed (g) (during a specific period)/Weight gain (g) (for the same period).

2.4. Economic analysis

To determine whether vaccinating broiler chickens is economically viable, we followed the cost-benefit analysis (CBA) approach, which involves translating into monetary terms both the costs of vaccination and the benefits gained from vaccination. The vaccination costs include the cost of the vaccine, the cost of vaccine administration, and the cost of anti-stress treatment. The principle of estimating the benefits of a control action involves evaluating the losses in the absence of vaccination. We estimated the potential consequences of MDV infection in a flock of broiler chickens that have not been vaccinated with MDV.

This was obtained by calculating the difference in production parameters between the two groups, VG and NVG.

2.5. Statistical analysis

The statistical analysis of the obtained results was performed using Student's t-test and ANOVA tests with the IBM SPSS software, version 25.0 (IBM SPSS Statistics, IBM Corp, Armonk, NY, USA, 2017). The difference was considered statistically significant when $P < 0.05$.

3. Results

Over the first six weeks, both VG and NVG broilers demonstrated steady weight gain, starting around 145–150 g in week one and reaching roughly 3,000 g by week six; however, from week four onward, VG birds maintained a consistent 70–120 g advantage (1,770 g vs 1,650 g in week four, 2,450 g vs 2,350 g in week five, and 3,070 g vs 3,000 g in week six), with lower variability than NVG, indicating that HVT vaccination did not hinder—and may subtly enhance—growth performance (Table 1).

Assuming independent two-sample t-tests on the week-6 weights ($n=11,000$ per group), the difference of 70 g (3,070 g vs 3,000 g) with standard deviations of 228.35 g and 317.37 g yields a test statistic of $t \approx 18.8$ and a two-tailed P-value effectively equal to zero ($P < 0.001$), indicating a highly significant difference in mean weights at week six.

Throughout the first six weeks, FCR was largely similar between VG and NVG broilers, with VG showing a slight but non-significant improvement from week 3 onward (e.g. 1.35 ± 0.15 vs 1.44 ± 0.36 in week 3 and 2.09 ± 0.08 vs 2.19 ± 0.15 in week 6) (Table 2), and statistical analysis confirmed no significant difference in overall FCR ($P=0.93$).

Table 1. Weights of the two groups during the first six weeks of life

Groups	Weights					
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
NVG	150±14.83	510±41.69	1040±103.26	1650±203	2350±246	3000±317.37
VG	145±13.06	515±52.78	1060±68	1770±149.74	2450±125	3070±228.35

VG: Vaccinated group; NVG: Non-vaccinated group.

Table 2. FCR of the two groups during the first six weeks of life

Groups	FCR Results					
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
NVG	1.6±0.39	1.06±0.46	1.44±0.36	1.76±0.21	1.63±0.4	2.19±0.15
VG	1.64±0.25	1.05±0.13	1.35±0.15	1.69±0.15	1.57±0.2	2.09±0.08

VG: Vaccinated group; NVG: Non-vaccinated group.

Table 3. MR of the two groups during the first six weeks of life

Groups	MR Results					
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
NVG	1.36±0.49	0.41±0.21	1.82±0.16	2.14±0.2	1.32±0.7	0.7±0.17
VG	1.9±0.4	0.5±0.13	0.29±0.01	0.49±0.25	0.3±0.12	0.39±0

VG: Vaccinated group; NVG: Non-vaccinated group.

Across the six-week period, mortality in the VG diverged markedly from the NVG from week three onward. In week one and two, VG exhibited slightly higher mortality (1.9±0.4% vs 1.36±0.49% in week one; 0.5±0.13% vs 0.41±0.21% in week two). However, beginning in week three, VG birds showed a dramatic reduction—0.29±0.01% compared to 1.82±0.16% in NVG—and similarly in week four (0.49±0.25% vs 2.14±0.20%), week five (0.3±0.12% vs 1.32±0.7%), and week six (0.39±0% vs 0.7±0.17%) (Table 3). When pooled across all weeks, the overall reduction in mortality in the VG was highly significant ($P<0.01$), underscoring the protective effect of the HVT vaccine on flock survival.

The economic analysis of MDV vaccination in broiler chickens revealed a clear financial advantage. The total cost of vaccination, including vaccine procurement (72 EUR), administration (146.66 EUR), and anti-stress supplements (0 EUR), amounted to 218.66 EUR (32,800 DZD). The benefits of vaccination were estimated through increased average weight gain, reduced mortality (3.73% difference), and decreased feed consumption, collectively valued at 5,708.74 EUR (856,312.695 DZD). The significant weight gain in vaccinated birds, combined with lower mortality and feed costs, underscored the economic viability of MDV vaccination, yielding a substantial net benefit of 5489.74 EUR (823,512.695 DZD) per flock. This cost-benefit dynamic

demonstrates the critical role of MDV vaccination in enhancing both production efficiency and profitability in broiler farming.

4. Discussion

This study highlights the multifaceted benefits of HVT vaccination in broilers, emphasizing its role in enhancing growth performance, reducing mortality, and ensuring economic efficiency. Previous studies corroborate the modest yet consistent weight gain in vaccinated flocks, coupled with improved feed conversion trends. The dramatic reduction in mortality and associated CBA further establishes the financial and production advantages of vaccination [8-14]. These findings underline the importance of integrating HVT vaccination into poultry health management strategies to optimize productivity and profitability.

The modest but consistent gain in BW observed in HVTvaccinated broilers from week four onward aligns with previous findings that HVTbased vaccines can subtly enhance growth performance. Pan et al. (2023) [15] reported that broilers receiving an HVTvected hemagglutinin vaccine (HVTH9) showed a slight increase in weight gain under field conditions, even in the absence of H9N2 challenge (mean weight gain ~+50 g by market age). This is in line with other studies [16]. Earlier work by Lemiere (2013) [17] similarly documented a statis-

tically significant increase in average daily gain (+1.13 g) among broilers vaccinated with an HVT-IBD vector compared to unvaccinated controls, suggesting that HVT vectors may exert growth-promoting effects beyond their immunological role. The same was observed by Wegner et al. (2023) [18].

FCR in our study remained comparable between VG and NVG, with a nonsignificant trend toward improvement in the VG. Lemiere (2013) [17] observed a modest FCR reduction (-0.05) in HVT-IBD-vaccinated broilers ($P > 0.05$), and this finding echoes the HVTH9 trial in which vaccinated broilers exhibited a lower FCR in the absence of viral challenge [16]. Together, these data indicate that HVT vaccination does not impair and may slightly enhance nutrient utilization efficiency.

The dramatic reduction in mortality from week three onward in VG (overall $P < 0.01$) underscores the strong protective effect of HVT vaccination. This finding is consistent with longstanding field experience: Witter and Offenbecker (1978) [19] reported mortality drops from 6.0% in unvaccinated flocks to 0.9% in HVT-vaccinated birds ($\approx 85\%$ reduction) [20]. Moreover, the HVTH9 study demonstrated that HVT vaccination significantly lowered MR during concurrent AIV challenge, further evidencing the vaccine's role in bolstering flock survival under field conditions [16]. Collectively, these results confirm that HVT vaccination offers robust protection against disease-related losses without detriment to performance metrics.

Islam et al. (2002) showed that vaccination with HVT provided good protection against most of the immunosuppressive effects of MDV [9]. This immunosuppression caused by MDV is frequently associated with stunted growth and reduced production performance in poultry. This condition is linked to the degeneration of lymphoid organs and impairment of both humoral and cellular immune responses [10].

It has been demonstrated that vv MDV and vv+ MDV strains can induce a range of non-neoplastic syndromes that differ from those typically seen in the classical form of the disease [12-14]. Research on MD indicates that early cytolytic infection with a hypervirulent strain of MDV can lead to marked immunosuppression, making affected birds more vulnerable to secondary infections, including those caused by *Escherichia coli* and coccidia [11]. This immunosuppression could well explain the statistically significant difference in MR between the two groups — vaccinated and non-vaccinated one. The economic analysis of MDV vaccination in broiler chick-

ens underscores its substantial financial benefits. With a total vaccination cost of 218.66 EUR (32,800 DZD) per flock—including vaccine procurement, administration, and anti-stress supplements—the investment yields significant returns. Benefits arise from increased average weight gain, reduced mortality (a 3.73% difference), and decreased feed consumption, collectively valued at 5,708.74 EUR (856,312.70 DZD), resulting in a net benefit of 5,489.74 EUR (823,512.70 DZD) per flock. This translates to a benefit-to-cost ratio of approximately 26-to-1, highlighting the economic viability of MDV vaccination.

These findings align with global studies emphasizing the cost-effectiveness of MDV vaccination. For instance, in the United States, the benefit-to-cost ratio for MD control has been estimated at 22-to-1, reflecting substantial economic gains from vaccination programs. Similarly, a study in Thailand reported total economic losses of 295,823 USD due to MD outbreaks in layer farms, emphasizing the financial impact of the disease and the importance of preventive measures [21].

In Algeria, despite widespread vaccination efforts, outbreaks have occurred in vaccinated broiler breeder flocks, suggesting potential challenges in vaccine efficacy or implementation. These instances underscore the necessity for continuous evaluation of vaccination strategies and the potential need for updated or more effective vaccines [22].

Overall, the economic analysis supports the implementation of routine MDV vaccination in broiler chickens, not only for its direct financial benefits but also for enhancing production efficiency and flock health. Continued research and monitoring are essential to optimize vaccination protocols and address emerging challenges in MDV control.

The study on HVT vaccination against MD in broiler chickens demonstrates significant zootechnical, economic, and scientific benefits. It improves growth from the fourth week and maintains a stable FCR. A marked reduction in mortality is observed from the third week. Economically, the low vaccination cost is largely offset, with a cost-benefit ratio of 26-to-1. Scientifically, the results confirm the vaccine's protective and indirect effects on performance. The study supports the value of HVT vaccines in an integrated approach. Systematic use is recommended to optimize profitability. Further research is needed to refine vaccination protocols.

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Compliance with ethical guidelines

The present study was approved by the Institutional Animal Care Committee of the National Administration of Algerian Higher Education and Scientific Research (CODE: 98-11, Law of August 22, 1998).

Data availability

All data of this study are available upon request from the corresponding author.

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Authors' contributions

Investigation and formal analysis: Samia Ameziane and Omar Salhi; Writing the original draft: Samia Ameziane, Omar Salhi, Salim Zaidi, Amina Amraoui, and Aya Bensalem; Review and editing: Sana Hireche, Nadjet Amina Khelifi Touhami, Nassim Ouchene, and Amir Agabou.

Conflict of interest

The authors declared no conflict of interest.

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