Analysis of Production Performance and Medicine Cost Expenditure Before and After Avian Infectious Bronchitis in Commercial Broiler Farms

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Abstract

Avian infectious bronchitis is one of the diseases that can lead to losses in broiler farming. To investigate its impact, we conducted a recapitulation of plasma maintenance (RHPP) results data gathered from 5 clusters that tested positive for avian infectious bronchitis using PCR and ELISA tests. Subsequently, the RHPP data underwent quantitative analysis using paired sample t-test method. The results of this analysis revealed significant differences in the variables of performance index (PI), feed conversion ratio (FCR), and medicine costs within several clusters before and after being infected with avian infectious bronchitis. This study was important for the future to address zero hunger issues.

Keywords: broiler chickens, cost, infectious bronchitis, performance, zero hunger

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INTRODUCTION

Broiler chicken production is highly popular in Indonesia. According to data from the Central Statistics Agency (BPS) in 2022, broiler production in Indonesia reached 3,765,573 heads, whereas in 2021, it was 3,185,698 heads. This indicates a significant increase in production of 579,875 heads, representing an 18% growth from 2021 (Dirjen Peternakan dan Kesehatan Hewan, 2022). Broiler chicken cultivation offers advantages, such as a shorter production cycle. Chickens can be harvested within 4–6 weeks, achieving a body weight of 1.1–2.2 kg (Chu *et al*., 2020; Hanafi *et al*., 2021). Additionally, chicken prices tend to be more affordable (Prakoso, 2022).

However, broiler chickens are susceptible to various diseases (Nawab *et al*., 2018), one of which is avian infectious bronchitis (IB). The avian IB is a type of viral infection with a high prevalence of cases, commonly found in modern livestock systems (Guzmán and Hidalgo, 2020). Infected chickens experience respiratory, kidney, and reproductive tract disorders, leading to significant economic losses (Bande *et al*., 2016). These losses can result from 100% mortality (Bande *et al*., 2016), decreased egg production, weight loss, and meat rejection in slaughterhouses (Fernando *et al*., 2016). In Indonesia, study on IB has been conducted to identify and characterize the virus (Rahmahani and Wijaya, 2020; Dharmayanti and Indriani, 2017; Wibowo *et al*., 2019). However, there have been limited studies conducted to assess the losses caused by the impact of avian IB in Indonesia.

This study aimed to evaluate the impact of changes before and after being infected with IB on broiler farming in terms of performance and medicine expenditure. It is expected that this study will provide insights into mitigating the risk of losses caused IB in broiler farming industry.

MATERIALS AND METHODS

Ethical Approval

This study was approved by Universitas Airlangga Animal Care and Use Committee (ACUC) No 2.KE.021.12.2022.

Study Period and Location

This study was conducted for 6 months, from January to June 2023, a total of five clusters were confirmed to be infected with IB within a poultry farming facility located in Cirebon, West Java.

Sample Collection and Laboratory Test

The data collected pertained to clusters that had tested positive for IB following PCR and ELISA testing, conducted to confirm the presence of the infection. The PCR was a molecular technique employed to detect the presence of genetic material associated with the IB virus, distinguishing between positive and negative cases (Chandrasekar *et al*., 2015; Rahmahani *et al*., 2022). Meanwhile, ELISA testing was performed to assess antibody titers in chickens resulting from vaccinations or field infections (Safiul *et al*., 2021).

Data Analysis

A comprehensive recapitulation of plasma maintenance results (RHPP) data from these five clusters, both before and after infection, was meticulously collected. The collected data were then subjected to statistical analysis using the SPSS software, employing the paired sample t-test method.

The paired sample t-test method was utilized to compare data obtained from two or more groups assessed at two distinct time points (pre- and post-infection). This method allowed for the detection of differences and relationships within the data. It is worth noting that before applying this statistical test, the data underwent a normality assessment, a crucial step to ensure the validity of the statistical analysis (Ross and Willson, 2017). The dataset encompassed an array of performance variables, including harvest age, performance index (PI), feed conversion ratio (FCR), and mortality (Umam *et al*., 2014). Additionally, it included costs associated with managing IB cases (Fernando *et al*., 2016), such as expenses related to vitamins and medications.

RESULTS AND DISCUSSION

RT-PCR testing was conducted on several clusters suspected of being infected with the IB virus. The RT-PCR technique is utilized to detect the presence of viral or vaccine genetic material (Chandrasekar *et al*., 2015). RT-PCR results are qualitative, with positive and negative outcomes determined by examining the fluorescence line of the tested sample in comparison to the positive control fluorescence line (Rejali *et al*., 2020).

Figure 1 demonstrated the presence of genetic material associated with IB. This genetic material may originate from field viruses or vaccines with a documented vaccination history. In certain cases, the vaccination history of these clusters indicates that IB vaccination was administered using the Massachusetts strain at the age of 1 day (day-old chickens). Consequently, ELISA testing is essential to assess the antibody titer produced in alignment with the specific vaccine type used.

Based on data from Biocheck, antibody titers within the age range of 35–45 days typically fall between 300 and 1500 after a single administration of the Massachusetts-type vaccine. If the titer value surpasses 3000, it is indicative of a suspected field infection (Biocheck, 2017). However, in this particular case, serum samples were obtained at an average age of 28 days, considering the anticipated harvest time of 30 days with a tolerance of ± 1 day. As a result, any antibody titer exceeding 2500 at the age of 28 days is considered suggestive of a field infection.

Figure 2 indicated that all five clusters were suspected to be infected with IB, as evidenced by titer values exceeding 2500. This significantly surpasses the target titer range specified by Biocheck for a one-time vaccine, which is 300-1500 (Biocheck, 2017). Thus, in the context of case confirmation, it can be inferred that avian IB has indeed afflicted these clusters.

Subsequently, the RHPP data from the five clusters, both before and after infection, were collected and subsequently processed using the SPSS software, employing the paired sample t-test method. It's important to note that before conducting the data analysis, a normality test was conducted.

In Table 1, the results of the normality test revealed that each variable, both before and after the virus infection, yields a significance ($p > 0.05$). Therefore, it can be concluded that the data follows a normal distribution and is suitable for

Table 1. Normality test results

Variable	Infected Time	Shapiro-Wilk		
		Statistics	df	Sig.
Harvest age (days)	Before	0.929	5	0.587
	After	0.952	5	0.751
Performance index (PI)	Before	0.961	5	0.814
	After	0.945	5	0.704
Feed conversion ratio (FCR)	Before	0.943	5	0.685
	After	0.920	5	0.532
Mortality (%)	Before	0.891	5	0.364
	After	0.995	5	0.994
Medicine cost (Rp/head)	Before	0.932	5	0.608
	After	0.906	5	0.444

Table 2. Paired sample t-test results

Variable	Paired Sample t-test	
	Means ± Std. Deviation	Sig.
Harvest age (days)	2.06 ± 4.06	0.320
Performance index (PI)	77.25 ± 9.59	0.000*
Feed conversion ratio (FCR)	-0.09 ± 0.03	0.004*
Mortality (%)	-1.06 ± 1.08	0.093
Medicine cost (Rp/head)	-160.21 ± 41.81	0.001*

*Indicates a significant difference ($p < 0.05$).

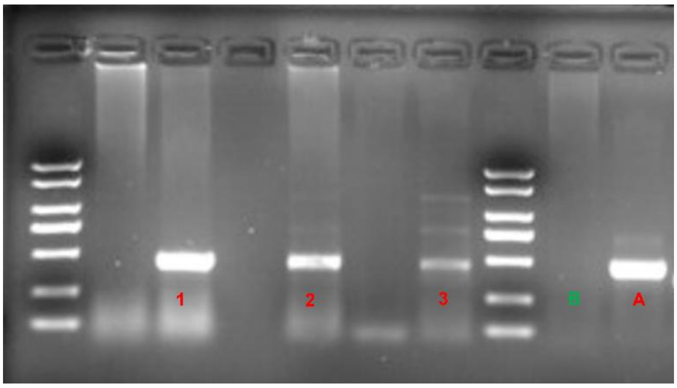

Figure 1. RT-PCR test results suspected of IB infection, (A) positive control, (B) negative control, (1,2,3) all samples fluoresced indicating that the samples were positive for IB.

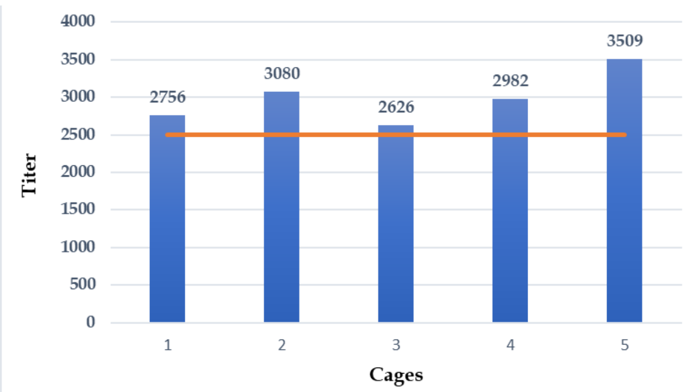

Figure 2. ELISA titers from five clusters suspected of being infected with IB.

paired sample t-tests. The normality test employed in this study was the Shapiro-Wilk test, chosen due to the sample size being less than 30 (Ross and Willson, 2017). Table 2 showed the results of paired sample t-test results.

Production Performance

The successful operation of a broiler farming business is contingent upon achieving good performance, which can be assessed through various metrics including harvest age, mortality, FCR, and PI (Umam *et al*., 2014). Harvest age, in the process of production cultivation, is not an absolute benchmark; however, faster harvesting can lead to quicker capital turnover and immediate profits for farmers (Hayati, 2019). Yet, it's important to note that harvest age is predominantly dictated by market prices, and the speed of harvesting does not inherently guarantee successful production (Maharatih *et al*., 2017). This variability can be attributed to factors such as the health of the chickens or the absence of a substantial increase in body weight, necessitating early harvesting to mitigate potential losses.

Mortality stands as a pivotal indicator that demands consideration – an increase in mortality rates is typically indicative of a decrease in production performance. High mortality levels are associated with lower performance, while good performance is often characterized by low mortality rates (Umam *et al*., 2014). The FCR denotes the ratio between the amount of feed consumed and the resulting broiler body weight (Suwarta, 2014). Lower FCR values are indicative of better performance, as they represent increased efficiency in achieving body weight with reduced feed consumption (Agustono *et al*., 2019). The PI, widely used in broiler cultivation, is positively correlated with performance achievement. A higher PI value reflects better performance on the part of the breeder. However, it's worth noting that the PI is strongly influenced by factors such as the percentage of live chickens, final body weight, FCR, and average harvest age (Pramudito *et al*., 2023).

In the context of IB, chickens typically encounter respiratory issues that result in reduced performance, manifesting as elevated mortality rates and diminished body weight. These factors contribute to economic losses (Bande *et al*., 2016; Fernando *et al*., 2016). Furthermore, the decrease in body weight and the surge in mortality lead to an increase in FCR and a decrease in PI (Megawati *et al*., 2020). The findings of this study revealed a general decline in average harvest age and PI. This was evident through the means ± standard deviation values in Table 2, which indicate a positive trend, signifying that after infection with IB, the average values for harvest age and PI have decreased compared to pre-infection levels. Conversely, the values for FCR and the percentage of mortality have shown a marked increase, as indicated by the negative means ± standard deviation values in Table 2, suggesting that after infection, both FCR and mortality rates increased significantly.

Regarding the significance of these changes, it was observed that only the PI and FCR exhibited significant differences ($p < 0.05$) before and after infection with IB. In contrast, harvest age and mortality percentage did not show significant alterations. This observation can be attributed to the fact that the average values for harvest age and mortality percentage are primarily influenced by decisions made by the company's management and market prices (Maharatih *et al*., 2017).

Medicine Cost

Avian IB in broiler chickens predominantly manifests as respiratory disorders but can also lead to renal and digestive system issues (Najimudeen *et al*., 2020). In cases followed by secondary infections, various literature sources indicate that Escherichia coli is commonly found as a consequential infection (Bande *et al*., 2016; Najimudeen *et al*., 2020; Nordin *et al*., 2021; Safiul *et al*., 2021). This necessitates the use of drugs and vitamin supplements in the field to manage these cases, resulting in increased costs related to drug and vitamin expenditures. Some literature suggests the use of antibiotics to address secondary respiratory infections, such as tylosin (Huang *et al*., 2021; Kamaruzaman *et al*., 2021), and tetracycline, even though they do not have a significant impact on viral infections (Gray *et al*., 2021). In the case of IB in young broilers, there is often a slow growth in body weight and heightened stress levels (Yohannes *et al*., 2012). Consequently, vitamins and amino acids are frequently administered to maintain the overall health of the chickens (Alagawany *et al*., 2020; Erol *et al*., 2017; Mohamed *et al*., 2019).

The results of this study suggest that there was a significant effect ($p < 0.05$) before and after infection with IB. This difference was evident in the means and standard deviation value of -160.21 ± 41.81, as shown in Table 2. The negative value indicates an increase in treatment costs after the chickens become infected (Rahmahani *et al*., 2021). These costs encompass expenses related to drugs, vitamins, and healthcare services provided to the chickens, all of which contribute to the total variable expenditure (Tandoğan and Çiçek, 2016). Therefore, it is crucial to make adjustments to enhance profits for business stakeholders. Greater expenditures will invariably reduce the net benefits obtained. The study's findings revealed that the variable costs associated with drugs and vitamins are among the factors that exhibit significant differences before and after infection with IB (Rahmahani *et al*., 2022). Consequently, it can be deduced that IB has the potential to inflate medicine costs and lead to economic losses for businesses. This aligns with the study conducted by Bande *et al*. and Fernando *et al*., which emphasizes the capacity of IB to incur economic losses (Bande *et al*., 2016; Fernando *et al*., 2016).

CONCLUSION

The results of this study suggested that significant differences exist in the variables of PI, FCR, and medicine costs within several clusters before and after infection with IB. However, the average age of harvest and the percentage of mortality before and after infection with IB showed no significant impact.

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AUTHORS' CONTRIBUTIONS

MV: Conceptualization and drafted the manuscript. MV, G, and HMR: Performed sample evaluation. HMR: Validation, supervision, and formal analysis. G: Performed the statistical analysis and the preparation of tables and figures. All authors have read, reviewed, and approved the final manuscript.

COMPETING INTERESTS

The authors declare that they have no competing interests.

REFERENCES

Agustono, B., Al Arif, M. A., Yunita, M. N., Purnama, M. T. E., & Ulkhaq, F. (2019). Bioactivity of digestive enzymes and histological descriptions of jejunum of broilers supplemented with sunflower seed flour (*Helianthus Annuus L*). *Indian Veterinary Journal*, 96(8), 12–15.

Alagawany, M., Elnesr, S. S., Farag, M. R., Tiwari, R., Yatoo, M. I., Karthik, K., Michalak, I., & Dhama, K. (2020). Nutritional significance of amino acids, vitamins and minerals as nutraceuticals in poultry production and health–a comprehensive review. *Veterinary Quarterly*, 11(2).

Bande, F., Arshad, S., Omar, A., Hair-Bejo, M., Abubakar, M.S., & Abba, Y. (2016). Pathogenesis and Diagnostic Approaches of Avian Infectious Bronchitis. Advance in Virology Article ID 4621659.

Biocheck. (2017). Interpretation and Application of Results Manual 2.

Chandrasekar, A., Raja, A., Dhinakar Raj, G., Thangavelu, A., & Kumanan, K. (2015). Rapid Detection of Avian Infectious Bronchitis Virus by Reverse Transcriptase-Loop Mediated Isothermal Amplification. *Proceedings of the National Academy of Sciences India Section B - Biological Sciences*, 85, 815–820.

Chu, T. T., Madsen, P., Norberg, E., Wang, L., Marois, D., Henshall, J., & Jensen, J. (2020). Genetic analysis on body weight at different ages in broiler chicken raised in commercial environment. *Journal of Animal Breeding and Genetics*, 137, 245–259.

Dharmayanti, N. L. P. I., & Indriani, R. (2017). Identification and Characterization of Infectious Bronchitis Virus (IBV) in Indonesia. *Jurnal Biologi Indonesia*, 13, 53–59.

Dirjen Peternakan dan Kesehatan Hewan, K. (2022). Produksi Daging Ayam Ras Pedaging menurut Provinsi (Ton) Tahun 2020–2022. Jakarta.

Erol, H. S., Imik, H., Gumus, R., & Halici, M. (2017). The effects of different amount of protein and vitamin E supplementation in rations on lipid and antioxidant metabolism of broilers exposed to heat stress. *Revista Brasileira de Ciencia Avicola*, 19, 289–296.

Fernando, F., Jr, M., Kasmanas, T., Schafer, G., Mazutti, A., Triques, G., & Lara, A. (2016). Economic impact of infectious bronchitis in a poultry complex in southern Brazil. In: 9th International Symposium on Avian Corona and Pneumoviruses. ovimex, Deventer, Netherlands, pp. 85–90.

Gray, P., Jenner, R., Norris, J., Page, S., & Browning, S. (2021). Antimicrobial prescribing guidelines for poultry. *Australian Veterinary Journal*, 99, 181–235.

Guzmán, M., & Hidalgo, H. (2020). Live attenuated infectious bronchitis virus vaccines in poultry: Modifying local viral populations dynamics. *Animals*, 11(2).

Hanafi, U. F., Dhamayanti, Y., Purnama, M. T. E., Soeharsono, S., Wibawati, P. A., & Prastiya, R. A. (2021). Hindlimb Osteometry of Lohmann Broiler on 7, 21 and 35 Days. *Jurnal Medik Veteriner*, 4(1), 23–36.

Hayati, H. N. (2019). Analisis Usaha Ternak Ayam Broiler Kemitraan Di Kabupaten Karanganyar. *SEPA: Jurnal Sosial Ekonomi Pertanian dan Agribisnis*, 15, 156.

Huang, A., Wang, S., Guo, J., Gu, Y., Li, J., Huang, L., Wang, X., Tao, Y., Liu, Z., Yuan, Z., & Hao, H. (2021). Prudent Use of Tylosin for Treatment of *Mycoplasma gallisepticum* Based on Its Clinical Breakpoint and Lung Microbiota Shift. *Frontiers in Microbiology*, 12.

Kamaruzaman, I. N. A., Ng, K. Y., Hamdan, R. H., Shaharulnizim, N., Zalati, C. W. S. C. W., Mohamed, M., Nordin, M. L., Rajdi, N. Z. I. M., Abu-Bakar, L., & Reduan, M. F. H. (2021). Complex chronic respiratory disease concurrent with coccidiosis in broiler chickens in Malaysia: A case report. *Journal of Advanced Veterinary and Animal Research*, 8, 576–580.

Maharatih, N., Sukanata, I. W., & Astawa, I. (2017). Analisis Performance Usaha Ternak Ayam Broiler Pada Model Kemitraan Dengan Sistem Open House. *Journal of Tropical Animal Science*, 5, 407–416.

Megawati, N. I., Dhamayanti, Y., Purnama, M. T. E., Soeharsono, S., Yudhana, A., & Yunita, M. N. (2020). The Growth Patterns of Broiler Lohmann Strains Based on Forelimb Bone Osteometry. *Jurnal Medik Veteriner*, 3(2), 216–223.

Mohamed, A. S. A., Lozovskiy, A. R., & Ali, A. M. A. (2019). Nutritional strategies to alleviate heat stress effects through feed restrictions and feed additives (vitamins and minerals) in broilers under summer conditions. *Journal of Animal Behaviour and Biometeorology*, 7, 123–131.

Najimudeen, S. M., Hassan, M. S. H., Cork, S. C., & Abdul-Careem, M. F. (2020). Infectious bronchitis coronavirus infection in chickens: Multiple system disease with immune suppression. *Pathogens*, 8(3).

Nawab, A., Nawab, Y., Tang, S., Wu, J., Liu, W., Li, G., Xiao, M., & An, L. (2018). A Pictorial Guidebook on Poultry Diseases; Diagnostic Techniques and their Effective Treatment. *Animal Review*, 5, 34–50.

Nordin, N., Sani, N. I. M., Kadir, A. A., Shaari, R., Mohamed, M., Reduan, M. F. H., & Nordin, M. L. (2021). Infectious bronchitis associated with *Escherichia coli* infection in commercial broiler chickens: a case report. *Journal of Advanced Veterinary and Animal Research*, 8, 101–104.

Prakoso, J. P. (2022). Penyebab Ayam Broiler Anjlok Hingga di Bawah HPP [WWW Document]. Bisnis Indonesia. URL https://bisnisindonesia.id/article/penyebab-ayam-broiler-anjlok-hingga-di-bawah-hpp (accessed 6.9.23).

Pramudito, O., Kusuma, R., Gando Hidayati, S., & Jefri, P. (2023). Analisis Indeks Performance dan Pendapatan Usaha ternak Ayam Broiler Kandang Semi Close House Gomin Farm di Desa Pagubugan Kabupaten Cilacap (Studi Kasus). *Jurnal Embrio*, 15, 23–25.

Rahmahani, J., & Wijaya, N. S. (2020). Seroprevalence of Infectious Bronchitis Using Indirect-ELISA on Duck (*Anas platyrhynchos domesticus*) and Native Chicken (*Gallus gallus domesticus*) Sold in Mojosari Traditional Market, Mojokerto. *Jurnal Medik Veteriner*, 3(2), 241–245.

Rahmahani, J., Pradhita, D. K. S., Widjaja, N. S., & Suwarno, S. (2021). Isolation and Identification of Protein Spike (Protein-S) in Field Isolates of Infectious Bronchitis Virus. *Jurnal Medik Veteriner*, 4(1), 104–109.

Rahmahani, J., Wudhu, R. Z. F. A. M., & Tacharina, M. R. (2022). Immunogenicity of Local and Massachusetts Strains Infectious Bronchitis Virus. *Jurnal Medik Veteriner*, 5(1), 98–102.

Rahmahani, J., Akbar, D. I., & Suwarno, S. (2022). Comparison of Antigenicity Between Local and Massachusetts Strains of Infectious Bronchitis Virus Using Indirect ELISA Test. *Jurnal Medik Veteriner*, 5(1), 28–33.

Rejali, N. A., Zuiter, A. M., Quackenbush, J. F., & Wittwer, C. T. (2020). Reverse transcriptase kinetics for one-step RT-PCR. *Analytical Biochemistry*, 601.

Ross, A., & Willson, V. L. (2017). Paired Samples T-Test. In: Ross, A., Willson, V.L. (Eds.), Basic and Advanced Statistical Tests: Writing Results Sections and Creating Tables and Figures. Sense Publishers, Rotterdam, pp: 17–19.

Safiul, M., Bhuiyan, A., Amin, Z., Muhammad, A., Abu Bakar, S., Saallah, S., Hydayaty, N., Yusuf, M., Shaarani, S. M., Siddiquee, S., My, N. H. M. Y., Perkhidmatan, J., Sabah, V., Kinabalu, K., & No, P. S. (2021). Veterinary sciences Review Factor Influences for Diagnosis and Vaccination of Avian Infectious Bronchitis Virus (Gammacoronavirus) in Chickens.

Suwarta. (2014). Feed Conversion Ratio (FCR) Usaha Ternak Ayam Brolier Di Kabupaten Sleman Feed Conversion Ratio (FCR)

Broiler Chickens Business In Sleman Regency. *Jurnal Ilmu-Ilmu Pertanian*, 130.

Tandoğan, M., & Çiçek, H. (2016). Technical performance and cost analysis of broiler production in Turkey. *Revista Brasileira de Ciencia Avicola*, 18, 169–174.

Umam, M. K., Prayogi, H. S., Nurgiartiningsih, V. M. A., Setyo Prayogi, H., & Nurgiartiningsih, D. V. M. A. (2014). The Performance Of Broiler Rearing In System Stage Floor And Double Floor Penampilan Produksi Ayam Pedaging Yang Dipelihara Pada Sistem Lantai Kandang Panggung Dan Kandang Bertingkat. *Ilmu-Ilmu Peternakan*, 24, 79–87.

Wibowo, M. H., Ginting, T. E., & Asmara, W. (2019). Molecular characterization of pathogenic 4/91-like and QX-like infectious bronchitis virus infecting commercial poultry farms in Indonesia. *Veterinary World*, 12, 277–287.

Yohannes, T., Sharma, A. K., Sumi, V., & Rout, S. S. (2012). Clinical manifestation and growth performance of broiler chickens fed with T-2 toxin and co-infected with infectious bronchitis virus. *Journal of Food and Agriculture Science*, 2, 30–35.

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