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Analysis of Factors Affecting Tetracycline Antibiotic Residue in Broiler Chickens Meat in Asahan District, Sumatera Utara Province

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ABSTRACT
Antibiotics are commonly used in poultry production to prevent and treat bacterial infections, enhance growth, and improve feed efficiency. To ensure food safety and prevent antibiotic resistance, only registered antibiotics are permitted, with maximum residue limits established in food products. This study aims to identify and analyze factors influencing tetracycline antibiotic residues in broiler chickens, compare residue levels across different rearing systems, and evaluate the relationships between rearing management, antibiotic usage, and environmental conditions in the barn in Asahan Regency. The research was conducted in Asahan Regency, North Sumatra Province, and at the Animal Production Science Laboratory, Faculty of Agriculture, Universitas Sumatera Utara. Data collection through surveys across several farming areas in Asahan Regency was carried out over three months, from September to November 2025. Sampling was performed on chickens at harvest ages of 21 and 35 days. Residue test results from five markets Kartini Market, Bakti Market, Air Joman Market, Dipo Market, and Simpang 4 Market revealed high tetracycline levels in broiler chickens, detected in 100% of 21day old chicken meat samples and still present in 60% of 35day old samples across various markets. Logistic regression analysis indicated that the withdrawal period significantly influenced residue risk reduction P-value = 0.044, ($P < 0.05$), while farming experience exceeding five years significantly increased the likelihood of residues P-value = 0.049, ($P < 0.05$). Other variables, such as harvest age, dosage, and duration of antibiotic administration, showed no significant partial effects.

Keywords: Antibiotic residue, Tetracycline, Broiler chicken, Withdrawal period, Food safety.

1. Introduction

Tetracycline is a broad-spectrum bacteriostatic antibiotic that is widely used to inhibit the growth of various Gram-positive and Gram-negative bacteria. Rather than directly killing bacteria, tetracycline suppresses bacterial proliferation, allowing the host immune system to eliminate the pathogens. It is commonly used in both medical and veterinary applications to treat respiratory, gastrointestinal, and intracellular bacterial infections [1].

In broiler production, antibiotics especially tetracycline are commonly applied for disease prevention, treatment, and growth promotion, contributing to improved feed efficiency and productivity. In contrast, probiotics are increasingly used as safer alternatives to enhance gut microbiota balance, nutrient absorption, and immune function [2]. However, the extensive and often uncontrolled use of antibiotics in intensive livestock systems raises serious concerns regarding antibiotic residues in animal products and the emergence of antimicrobial resistance [3]. To ensure food safety, regulatory frameworks such as EU/37/2010 establish maximum residue limits (MRLs), requiring accurate monitoring through reliable analytical methods. In practice, improper handling and

storage of antibiotics particularly in reconstituted forms can affect their stability and efficacy, while inadequate adherence to withdrawal periods may lead to residue accumulation in edible tissues[4].

This issue is evident in broiler farms in Asahan Regency, where the use of tetracycline is prevalent for disease prevention and growth promotion. Reports indicate that residue levels in meat and liver frequently exceed the permitted MRL (0.1 mg/kg), primarily due to overdosing and insufficient withdrawal periods[5]. These conditions highlight the need for further investigation into the factors influencing tetracycline residues in broiler chickens to support safer and more sustainable poultry production and safety product from broiler meat.

2. Materials and Methods

2.1.Research Design and Sampling

This research was conducted in Asahan Regency, North Sumatra Province, and at the Animal Production Science Laboratory, Faculty of Agriculture, University of North Sumatra. Research activities and data collection through surveys in several livestock areas in Asahan Regency were conducted over a three-month period, from September to November 2025.

This study used a cross-sectional design to evaluate the prevalence of antibiotic residues in broiler chickens. The minimum sample size was 50 per group based on the central limit theorem, with power analysis (α=0.05, power=0.80) using GPower for optimization. Sample stratification was based on: (1) rearing system (closed house), (2) antibiotic treatment, and (3) type of broiler chickens at 21 and 35 days of harvest. Sampling was conducted purposively to ensure the representativeness of both rearing systems in Asahan Regency.

2.2. Experimental procedure

2.2.1. Sampling Process

Broiler chickens raised by partner companies in Asahan Regency were randomly sampled at traditional markets in Asahan Regency using a one-season rearing method. Sampling was carried out at 21 and 35 days of harvest. The test materials used were meat and small intestine. The antibiotics used were (Tetracycline, Chlortetracycline, Oxitetracycline). Rapid Test (Lateral Flow Immunoassay) for Detecting Antibiotic Residues.

2.2.2 Rapid Test Procedure

This study used the Tetracycline Rapid Test Kit to detect tetracycline antibiotic residues in broiler chicken meat samples. The test began by preparing a test tube or using the glass test bottle provided in the kit. Approximately 10 grams of blended solid samples were placed into the test tube, while 1–2 ml of liquid samples were used as test material. Next, add 2 drops of Reagent A and 1.5 ml of Reagent B to the test tube or bottle. If the sample contains tetracycline, the mixture will develop a reddish-purple color within approximately 2 minutes. After 5 minutes, add 2–3 ml of distilled water; if the test is positive for tetracycline, the solution will turn yellow.

2.2.3 Observed Variables

The variable observed in this study was the presence of tetracycline antibiotic residues in broiler chicken meat samples tested using the Tetracycline Rapid Test Kit. Observations were made based on the color change of the test solution as an indicator of chemical reactions. Samples were declared positive if the color change to reddish purple occurred within ±2 minutes and turned yellow after the addition of distilled water. Samples were declared negative if no color change occurred according to the indicator. Thus, the measured variables were categorical (positive and negative) based on the color reaction results in the test.

2.3. Observation of the Antibiotic Administration Program

This study employed a descriptive method using a questionnaire to describe the farmer profile and antibiotic administration program in detail, based on data collected through a series of questions

formulated in a questionnaire addressed to broiler chicken farmers in Asahan Regency, North Sumatra.

2.3.1. Observed Variables

This study used a questionnaire with an interview method with broiler chicken farmers to obtain information on farmer profiles (age, experience, education), health management (antibiotic administration, treatment, and productivity), as outlined in the questionnaire in the appendix to this study.

2.3.2.Wald Test (Partial t-Test)

According to (Ghozali, 2018), the Wald (t-test) essentially indicates the extent to which the independent variable partially explains the dependent variable. To determine the Wald (t-test) value, a significance level of 5% was used. The decision-making criteria are as follows:

1. If t-count < t-table and P-value > 0.05, then H0 is accepted, meaning one of the independent variables does not affect the dependent variable.
2. If t-count > t-table and P-value < 0.05, then H0 is rejected, meaning one of the independent variables affects the dependent variable.

2.3.3. Data Analysis

The statistical analysis of the data used in this study was logistic regression analysis. According to Ghozali (2018), logistic regression analysis is a regression that tests whether the probability of a dependent variable occurring can be predicted by the independent variables. Logistic regression analysis does not require a normal distribution in the variables.

3. Results and Discussion

3.1 Tetracycline residue test results in chicken meat collected from several markets.

Tetracycline residue test results in chicken meat collected in this study were taken from five markets: Kartini Market, Bakti Market, Air Joman Market, Dipo Market, and Simpang 4 Market at 21 and 35 days of harvest shown in Table 1 and 2.

Table 1. Results of tetracycline residue tests on chicken meat taken from several markets (21D)

No	Markets	Sample	Code	Results
1	Kartini	5	U21 A	Positive (+)
			U21 B	Positive (+)
			U21 C	Positive (+)
			U21 D	Positive (+)
			U21 E	Positive (+)
2	Bakti	5	U21 A	Positive (+)
			U21 B	Positive (+)
			U21 C	Positive (+)
			U21 D	Positive (+)
			U21 E	Positive (+)
3	Air Joman	5	U21 A	Positive (+)
			U21 B	Positive (+)
			U21 C	Positive (+)
			U21 D	Positive (+)
			U21 E	Positive (+)
4	Dipo	5	U21 A	Positive (+)
			U21 B	Positive (+)
			U21 C	Positive (+)
			U21 D	Positive (+)
			U21 E	Positive (+)

5	Simpang 4	5	U21 A	Positive (+)
			U21 B	Positive (+)
			U21 C	Positive (+)
			U21 D	Positive (+)
			U21 E	Positive (+)

Table 2. Results of tetracycline residue tests on chicken meat taken from several markets (35D)

No	Markets	Sample	Code	Results
1	Kartini	5	U35 A	Negative (-)
			U35 B	Negative (-)
			U35 C	Positive (+)
			U35 D	Positive (+)
			U35 E	Negative (-)
2	Bakti	5	U35 A	Positive (+)
			U35 B	Positive (+)
			U35 C	Positive (+)
			U35 D	Negative (-)
			U35 E	Negative (-)
3	Air Joman	5	U35 A	Negative (-)
			U35 B	Positive (+)
			U35 C	Negative (-)
			U35 D	Positive (+)
			U35 E	Negative (-)
4	Dipo	5	U35 A	Positive (+)
			U35 B	Positive (+)
			U35 C	Negative (-)
			U35 D	Negative (-)
			U35 E	Negative (-)
5	Simpang 4	5	U35 A	Positive (+)
			U35 B	Positive (+)
			U35 C	Positive (+)
			U35 D	Negative (-)
			U35 E	Negative (-)

The analysis of tetracycline residues in broiler chicken meat collected from several markets in Asahan Regency revealed a high prevalence of contamination. Tetracycline residues were detected in 100% of samples at 21 days of age and remained detectable in 60% of samples at 35 days, indicating that antibiotic exposure is widespread and persists even at typical market age. These findings suggest that current antibiotic use practices in broiler production are not adequately controlled, particularly regarding drug withdrawal compliance[6]. One of the main causes of residues is the inappropriate use of antibiotics, both in terms of dosage and failure to adhere to the withdrawal period[7], resulting in antibiotic residues remaining in the meat tissue when the chicken is slaughtered [8]. The presence of antibiotic residues in animal food products has serious implications for public health[9]. Continuous consumption of tetracycline residues can trigger allergies, disrupt the gut microbiota, and most worryingly, trigger the development of antibiotic resistance in humans [10].

The persistence of residues at 35 days highlights a critical food safety concern, as residue levels should decline below the maximum residue limit (MRL) before slaughter. The continued detection of residues at this stage indicates that either the withdrawal period is not properly implemented or antibiotics are administered too close to the harvesting time. First, the withdrawal period is typically longer at the final harvest than at 21 days of age, allowing for tetracycline degradation via cytochrome enzymes in the liver and active excretion via urine and feces, reaching 60-70% of the dose within the first 48 hours. Second, residual concentration dilution occurs due to

exponential body weight gain from 1.0-1.2 kg (21 days) to 2.2-2.5 kg (35 days), resulting in a proportional decrease in tetracycline levels per kg of tissue despite continued accumulation of metabolites in the liver and kidneys [11]. Furthermore, physiological factors such as increased rates in adult chickens contribute significantly to drug clearance. This result is consistent with previous studies showing that intensive poultry production systems often prioritize productivity over strict adherence to antibiotic usage guidelines.

3.2. Observation of Human Resources to Support Tetracycline Antibiotic Residue Reduction in Asahan Regency.

The questionnaire results indicate that broiler farmers in Asahan Regency are predominantly of productive age, with most having low to moderate educational backgrounds and more than five years of farming experience. According to [12] shows that livestock farmers of productive age (young adults) tend to outperform older farmers in terms of adopting innovations, accepting new technologies, and participating in training or extension services. Younger age groups generally have higher levels of work energy, are more open to change, and have a faster ability to grasp modern technical information, making them more responsive to the implementation of efficient, technology based livestock management systems.

In terms of management practices, antibiotic use is generally routine, while the implementation of appropriate dosage, frequency, and withdrawal period varies among farmers. Despite a relatively adequate level of awareness regarding antibiotic use, the findings suggest that proper practices are not consistently applied. According to [13], routine antibiotic administration to broiler chickens can improve growth and feed efficiency, but it can trigger antimicrobial resistance, harmful residues in meat, and environmental pollution. To ensure food safety and prevent antibiotic resistance, only registered antibiotics are permitted and maximum residue limits (MRL) are met in food products[14].

The majority of farmers reported using antibiotics for preventive purposes, which reflects a reliance on routine administration rather than targeted therapeutic use. In addition, variability in withdrawal period compliance indicates that many farmers do not fully adhere to recommended guidelines before harvesting. Participation in training programs related to animal health and antibiotic management was limited, which may contribute to inconsistent implementation of best practices[15]. Although some farmers possess basic knowledge of antibiotics, this knowledge does not necessarily translate into proper application in the field. This condition reflects a gap between knowledge and practice, commonly observed in livestock production systems.

3.3 Logistic Regression Analysis of Factors Affecting Antibiotic Residues in Asahan Regency

Logistic regression analysis was conducted to identify factors influencing the occurrence of tetracycline residues. Among the 10 variables examined, only withdrawal period (X4) and farming experience >5 years (X7) showed statistically significant effects ($P < 0.05$). The withdrawal period variable had a negative coefficient ($\beta = -2.881$; OR = 0.056)**,** indicating that proper implementation significantly reduces the likelihood of residue occurrence. This finding confirms that withdrawal period adherence is the most critical factor in minimizing antibiotic residues, as it allows sufficient time for drug metabolism and elimination from animal tissues [16].This aligns with the principle of veterinary pharmacology, which states that the withdrawal period is the time between antibiotic administration and harvest to allow drug residues to be eliminated from the livestock's body[17].

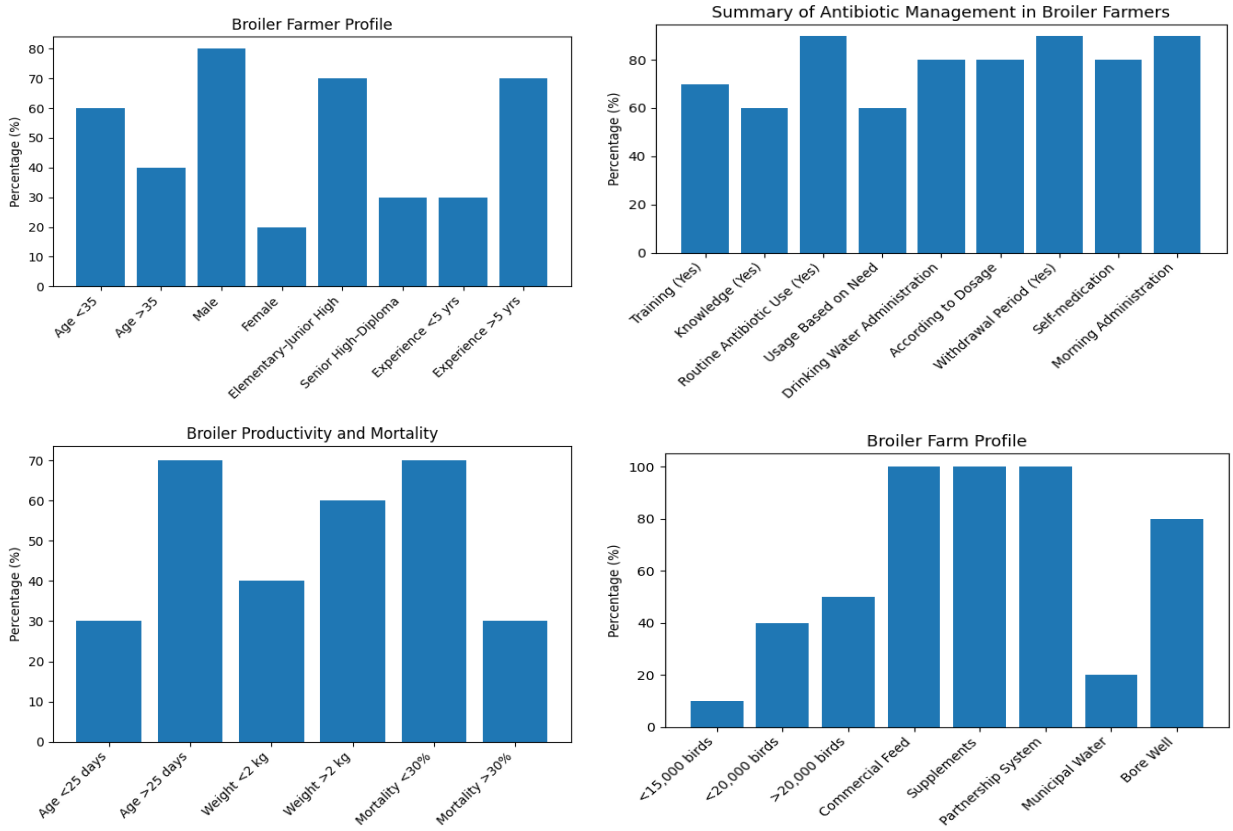

Figure1. Human resources to support tetracycline residue in Asahan regency

Table 3. Logistic Regression Analysis of Factors Affecting Antibiotic Residues

No	Variable	Code	β	Wald	P-value	Odds Ratio (Exp β)	Interpretation
1	Routine antibiotic administration	X1	-2.221	1.926	0.165	0.109	Not significant
2	Appropriate antibiotic frequency	X2	1.603	2.141	0.143	4.968	Not significant
3	Appropriate antibiotic dosage	X3	-0.725	0.381	0.537	0.484	Not significant
4	Withdrawal period	X4	-2.881	4.057	0.044*	0.056	Significant
5	Knowledge of antibiotics	X5	1.339	1.375	0.241	3.814	Not significant
6	Management/health training	X6	-0.504	0.107	0.744	0.604	Not significant
7	Farming experience > 5 years	X7	2.919	3.879	0.049*	18.531	Significant
8	Farmer age	X8	1.402	1.499	0.221	4.063	Not significant
9	Farmer education	X9	1.585	1.903	0.168	4.878	Not significant
10	Broiler harvest age	X10	0.350	0.079	0.779	1.419	Not significant
	Constant	β_0	-1.887	0.339	0.560	0.152	Not significant

Note: * $P < 0.05$ indicates statistical significance (Wald test).

If the withdrawal period is not adhered to, the antibiotic has not fully degraded, resulting in detectable residues in the chicken meat at harvest. Therefore, adherence to the withdrawal period is a key factor in controlling antibiotic residues. According to [18] proper implementation of the

withdrawal period not only prevents antibiotic residues in livestock products but also reflects sound livestock health management, ultimately contributing to optimal production performance.

In contrast, farming experience greater than five years showed a positive and significant effect (β = 2.919; OR = 18.531)**,** suggesting that more experienced farmers are more likely to produce broilers with antibiotic residues. [19] stated that knowledge is a fundamental factor influencing a person's attitudes and actions. Farmers who have a good understanding of the function, dosage, and risks of antibiotic use tend to implement more rational and responsible husbandry practices, thus increasing livestock productivity. This unexpected result may reflect a reliance on habitual antibiotic use practices without strict adherence to updated regulations. Experienced farmers may adopt routine or preventive antibiotic use strategies, which can increase the risk of residue accumulation if not properly managed. This phenomenon highlights that experience alone does not guarantee better management practices, especially in the absence of continuous training and regulatory oversight.

Other variables, including routine antibiotic administration, frequency of use, dosage accuracy, farmer knowledge, training, age, education level, and harvest age, were not statistically significant ($P > 0.05$). Although these factors are theoretically important, their lack of significance suggests limited variability among respondents or a general pattern of similar practices across farms. Notably, the non-significant effect of farmer knowledge and training indicates a gap between awareness and actual implementation in the field. Farmers may understand proper antibiotic use but fail to apply it consistently due to economic pressures, limited supervision, or inadequate enforcement of regulations. The absence of a significant effect from dosage and frequency variables suggests that misuse of antibiotics may occur systematically rather than variably across farms. Similarly, the non-significant effect of harvest age implies that age alone is insufficient to ensure residue reduction without proper withdrawal management. According to [20] tetracycline has a high affinity for binding to calcium ions in bone tissue and magnesium ions in muscle tissue, forming a stable complex that is difficult to eliminate. The relatively long elimination half-life of tetracycline (ranging from 6-12 hours in chickens, but accumulation in tissues can last longer) means that residues can be detected even several days after discontinuation of administration. This explains why tetracycline is often detected as residue in chicken meat compared to other types of antibiotics that have shorter half-lives.

From a public health perspective, the high prevalence of antibiotic residues observed in this study is concerning. Residues in animal products can contribute to antimicrobial resistance, allergic reactions, and disruption of human microbiota. These findings underscore the urgent need for improved antibiotic stewardship in poultry production systems. A study by [21] provides comprehensive evidence that antibiotic use in the livestock sector is a major contributor to the global burden of antimicrobial resistance, particularly in Asian countries with high livestock production intensity. They identified that antibiotic consumption in the global livestock sector increased by 65% between 2000 and 2015, with a projected increase of an additional 67% by 2030. Indonesia, as one of the largest poultry producers in Asia, faces high risk in this context [22]. Resistance gene transfer can occur horizontally between bacteria through various mechanisms such as conjugation, transformation, and transduction, allowing the rapid spread of resistance determinants not only between strains of the same bacteria but also across bacterial species[23,24]. Resistance genes that develop in commensal livestock bacteria or bacteria in the livestock environment can be transferred to human pathogens, creating a significant health threat [25]. Overall, this study demonstrates that withdrawal period compliance is the primary determinant of antibiotic residue occurrence**,** while behavioral factors particularly among experienced farmers may contribute to persistent misuse. Strengthening farmer education, improving regulatory enforcement, and promoting alternative strategies such as probiotics are essential steps toward reducing antibiotic residues and ensuring food safety.

4. Conclusion

Tetracycline antibiotic residues were still detected in all 21-day-old chicken meat samples (100%) and in 60% of 35-day-old samples in various markets. This indicates that: (a) short harvest times (<30 days: 40%, 30-35 days: 40%) do not provide sufficient elimination time, and (b) there is a gap

between farmer knowledge and the implementation of safe practices. Variables that significantly influenced tetracycline antibiotic residues were withdrawal period (X4) and farming experience >5 years (X7) ($P < 0.05$). Withdrawal period had a negative effect ($\beta = -2.881$; OR = 0.056), meaning that compliance with drug withdrawal periods reduced the risk of residues. Conversely, farming experience >5 years had a positive effect ($\beta = 2.919$; OR = 18.531), indicating an increased chance of antibiotic residues.

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References

[1] Adeola S. A., Folorunso O. S., & Amisu K. O. (2012). Antimicrobial Activity of *Ocimum basilicum* and its Inhibition on the Characterized and Partially Purified Extracellular Protease of *Salmonella typhimurium*. *Research Journal of Biology*, 2(5), 138-144.

[2] Antriyandarti, E., Supriyadi, S., & Putro, H. N. (2020). Residu Antibiotik pada Daging Ayam dan Dampaknya terhadap Kesehatan Masyarakat: Tinjauan Sistematis. *Jurnal Ekonomi Kesehatan Indonesia*, 5(1), 25-35.

[3] Aulia, F., Sari, M. P., & Rahman, H. (2023). Deteksi Residu Tetrasiklin pada Daging Ayam Broiler di Pasar Tradisional Indonesia. Jurnal Veteriner Indonesia, 12(1), 45-54.

[4] Aust, M.O., F. Godlinski, G.R. Travis, X. Hao, T.A. McAllister, and P. Leinweber. 2008. Distribution of sulfamethazine, chlortetracycline and tylosin in manure and soil of Canadian feedlots after subtherapeutic use in cattle. Environ. Pollut., 156:1243–1251

[5] Baynes, R. E., Dedonder, K., Kissell, L., Mzyk, D., Marmulak, T., Smith, G., & Riviere, J. E. (2016). Health concerns and management of select veterinary drug residues. Food and Chemical Toxicology, 88, 112-122.

[6] Beyene, T. (2016). Veterinary drug residues in food-animal products: Its risk factors and potential effects on public health. Journal of Veterinary Science & Technology, 7(1).

[7] Riyanti, A., Nandhirabrata, R., & Adyatama, A. (2025). Organoleptic test of cassava leaf silage with different molasses levels. *Innovative: Journal of Social Science Research*, 5(4), 1–8.

[8] Chopra, I., & Roberts, M. (2001). "Tetracycline antibiotics: mode of action, applications, molecular biology, and epidemiology of bacterial resistance." Microbiology and Molecular Biology Reviews, 65(2), 232-260.

[9] Codex Alimentarius Commission. (2018). Maximum Residue Limits (MRLs) and Risk Management Recommendations (RMRs) for Residues of Veterinary Drugs in Foods. CAC/MRL 2-2018. FAO/WHO.

[10] Das, S. C., Chowdhury, S. D., Khatun, M. A., Nishibori, M., Isobe, N., & Yoshimura, Y. (2014). Tetracycline Residues in Broiler Chickens: A Public Health Concern. Bangladesh Journal of Veterinary Medicine, 12(1), 29-34.

[11] Dewi, N. P. S., Sumiarto, B., & Widiastuti, R. (2021). Faktor-faktor yang mempengaruhi kepatuhan waktu henti antibiotik pada peternakan ayam broiler. *Jurnal Sain Veteriner, 39*(2), 169–178.

[12] Elshaafi, A. M., Mohammed, A. S., & Ibrahim, M. T. (2020). Detection of Antibiotic Residues in Poultry Meat: Implications for Food Safety. International Journal of Food Science and Technology, 55(3), 1234-1242.

[13] FAO & WHO. (2017). Responsible Use of Antimicrobials in Food and Agriculture. Joint FAO/WHO Expert Meeting Report. Rome: Food and Agriculture Organization of the United Nations.

[14] Gaspar, A., Almeida, A., & Cardoso, L. (2019). Antimicrobial Use in Livestock: Impact on Productivity and Public Health. Veterinary World, 12(6), 852-860.

[15] Kinsella, B., O'Mahony, J., Malone, E., Moloney, M., Cantwell, H., Furey, A., & Danaher, M. (2020). Current Trends in Sample Preparation for Growth Promoter and Veterinary Drug Residue Analysis. Journal of Chromatography A, 1216(46), 7977-8015.

[16] Manyi-Loh, C., Mamphweli, S., Meyer, E., & Okoh, A. (2018). Antibiotic use in agriculture and its consequential resistance in environmental sources: Potential public health implications. Molecules, 23(4), 795.

[17] Mitchell, J. M., Griffiths, M. W., McEwen, S. A., McNab, W. B., & Yee, A. J. (2017). Antimicrobial Drug Residue Detection Methods: Current Status and Future Prospects. Journal of Food Protection, 80(7), 1188-1202.

[18] Sajid, A., Kashif, N., & Ahmad, M. (2016). Antibiotic Residues in Poultry Products: Detection and Public Health Implications. Poultry Science, 95(11), 2543-2553.

[19] Tasho, R. P., & Cho, J. Y. (2016). "Veterinary antibiotics in animal waste, its distribution in soil and uptake by plants: A review." Science of The Total Environment, 563-564, 366-376

[20] Zhao, P. Y., & Kim, I. H. (2015). Effect of Direct-Fed Microbial On Growth Performance, Nutrient Digestibility, Fecal Noxious Gas Emission, Fecal Microbial Flora And Diarrhea Score In Weanling Pigs. Anim. Feed Sci. Technol., 200, 86-92. Doi:10.1038/S41598-017-07420-4

[21] Webster, J. (1992). The biochemistry of silage (Book review). *Experimental Agriculture*, 28(1), 125–125.

[22] Zhang, J., Wang, Q., Yu, H., Lin, L., Zhang, Z., & Song, Y. (2024). Metagenomic insights into protein degradation mechanisms in natural fermentation of cassava leaves. *Bioresource Technology*, 396, 130433.

[23] Purba, M. A., Trisna, A., Hua, L. G., Sepriadi, S., & Aswa, D. A. (2023, December). Evaluation the effect of antibiotics and probiotics supplementation in feed on broilers chicken immunity status. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1286, No. 1, p. 012009). IOP Publishing.

[24] Purba, M. A., Syahputra, R., Pandiangan, A., Trisna, A., Hasan, F., Tampubolon, Y. K., Budi, U., Guohuo, L., Ginting, N. (2026, February). Supplementation of ketepeng cina powder (Senna alata) as a biobiotic in feed for improving growth and slaughter performance on broiler chicken infected by Salmonella typhimurium. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1583, No. 1, p. 012061). IOP Publishing.

[25] Purba, M. A., Pirzado, S. A., Cai, H., Haile, T. H., Zheng, A., Liu, J., Chen, J., Liu, G., Ginting, N., Yunilas, Y. (2020). A study about protective effect of Brevibacillus laterosporus texasporus culture on broiler chickens infected with Salmonella pullorum. *International Journal of Science, Technology & Management*, *1*(2), 68-78.