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Research Article

Residue Detection of Tylosin antibiotics and Enrofloxacin in Broiler Chickens

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Abstract | The broiler industry widely uses antibiotics, mainly to treat bacterial infections that cause digestive and respiratory disorders. The chicken farming industry, especially broiler chickens, often uses antibiotics to cure bacterial infections and secondary infections caused by bacteria. One of the microorganisms that cause digestive and respiratory diseases in broiler chickens is the bacteria. Treatment of bacterial infections with antibiotics is increasing every year. Broiler chickens infected by gram-positive and gram-negative bacteria are often treated with a combination of the antibacterial agents enrofloxacin and tylosin, that work together in their mechanism of action and have synergistic action in the antibacterial spectrum . Tylosin is a broad-spectrum macrolide antibiotic, while enrofloxacin is a broad-spectrum fluoroquinolone antibiotic. On commercial poultry farms in Indonesia, the combination of enrofloxacin and tylosin Tylosin and enrofloxacin are often used together as they have a synergistic action against gram-positive and gram-negative bacteria. However, overuse of antibiotics can lead to drug residues in the final product, potentially jeopardizing the health of consumers. This research aims to identify the number of cases and residues of enrofloxacin and tylosin that exceed the maximum threshold the maximum number of cases of overuse of enrofloxacin and tylosin antibiotics in commercial broiler farms in Indonesia, as well as detect drug residues that exceed the maximum threshold set by SNI 2000. . Based on SNI 2000, the Maximum Residue Limit (BMR) is intended to increase consumer and broiler farmer awareness about the impact of norfloxacin and tylosin residues in broiler products. The research methodology included data collection from several commercial farms, laboratory analysis to detect antibiotic residues in chicken products, and comparison of data with established standards. Enrofloxacin and tylosin residues in broiler chickens were found in a number of literatures, both in residue cases and residue detection. Even from 2010 to 2023, several studies found tylosin and enrofloxacin residues in broiler products. The results showed a significant increase in the use of antibiotics over the past decade, as well as the discovery of enrofloxacin and tylosin residues above the permissible limits in some broiler product samples. These findings indicate the need for increased awareness and regulation of antibiotic use in the livestock sector to protect consumer health.

Keywords | Residue, Broiler chickens, Enrofloxacin and tylosin, Commercial farming,Consumer health

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INTRODUCTION

Chicken meat production is a critical component of poultry farming one of the main needs in animal husbandry poultry in Indonesia, where the main supply is comes from with broiler chickens being the primary source of supply. Based on data obtained from the National Statistics Agency, broiler chicken production from 2023 to 2024 with a total of 3.97 million tons (Bokhtiar *et al*., 2023). According to data from the National Statistics Agency, broiler chicken production reached 3.97 million tons in 2023-2024 (CBS, 2023). Enhancement the number of broiler chicken populations is accompanied by with increasing consumption of chicken meat community and also increased use antibiotics in broiler farming. The use of antibiotics in broiler chicken farming is not only for therapy, but also for growth (Agyare *et al*., 2019), other than that it is used promotion and prevention of diseases promoting growth, disease prevention, and feed efficiency (Agyare *et al*., 2019; Martínez *et al*., 2021). Howefer, the use of antibiotics in the poultry industry is often not in accordance with the provisions, resulting in the emergence of antibiotic residues in chicken meat produced. The presence of antibiotic residues in chicken meat can have a negative impact on human health, including the emergence of antibiotic-resistant bacteria that can be transmitted to humans (Bushen *et al*., 2021).

Antibiotics given in the livestock industry has a purpose as an addition to animal feed for stimulate or increase growth chicken weight, increase production chicken carcasses and improve efficiency use of feed. The Indonesian government has recognized the risks associated with antibiotic overuse and, but use in 2017 issued through Regulation Minister of Agriculture, Number: 14/PERMENTAN/PK.350/5/2017 concerning Veterinary Drug Classification, has been prohibited the use of antibiotics as growth promoters in poultry farming (Majalija *et al*., 2023). Currently Despite this regulation, the use of antibiotics is only for the treatment of Salmonella sp., Escherichia coli, and Mycoplasma sp. which often attacks chickens, because the Minister of Agriculture Regulation prohibits the use of antibiotics as feed additives to increase feed efficiency (Bushen *et al*., 2021). The overuse of antibiotics in the poultry industry can lead to the accumulation of antibiotic residues in chicken meat and other poultry products, which poses a significant risk to public health.

One of the current problems faced after the use of antibiotics is the inappropriate use of antibiotics, which can result in residue levels exceeding permissible limits cause the accumulation of antibiotic residues that have the potential to cause resistance to antibiotics. This not only contributes to the development of antibiotic-resistant bacteria but also poses other health risks, such as hypersensitivity reactions, digestive issues, tissue damage, and neurological disorders The presence of antibiotic residues in poultry products remains a problem that must be addressed seriously by all parties involved, including the government, businesses and consumers (Bokhtiar *et al*., 2023). In addition, drugs such as chloramphenicol, ampicillin, co-trimoxazole, and tetracycline are also highly resistant (Burow *et al*., 2020; Mensah *et al*., 2022). Moreover, the misuse of antibiotics like chloramphenicol, ampicillin, co-trimoxazole, and tetracycline has been linked to high levels of resistance One of the antibiotic contaminations that exceeds the limit is antibiotic residue. The presence of antibiotic residues in meat, especially in chicken, is associated with various effects on human health, such as hypersensitivity, digestive disorders, tissue damage, neurological disorders, and even antibiotic resistance or antimicrobial resistance (Bokhtiar *et al*., 2023).

One of the antibiotic contaminations that exceeds the limit is antibiotic residue. The presence of antibiotic residues in meat, especially in chicken, is associated with various effects on human health, such as hypersensitivity, digestive disorders, tissue damage, neurological disorders, and even antibiotic resistance or antimicrobial resistance. Because Enrofloxacin is from the older florquinolone family, its broad bacteriocidal properties are not as active as other newer fluoroquinolones Enrofloxacin, a broad-spectrum fluoroquinolone antibiotic, is widely used in broiler farming to prevent or treat bacterial infections. However, being part of an older generation of fluoroquinolones, its bactericidal properties are less effective compared to newer fluoroquinolones (Suaifan *et al*., 2022). Enrofloxacin is a broad spectrum antibiotic that is widely used in broiler chicken farming to prevent or treat bacterial diseases. Similarly, tylosin, a macrolide antibiotic, is frequently used to treat bacterial infections in broiler chickens due to its mechanism of action, which is similar to erythromycin. Tylosin is one of the macrolide antibiotics most often used to treat bacterial infections in broiler chickens. Tylosin is a macrolide antibiotic that is most often used to treat bacterial infections in broiler chickens because it is thought to have a similar mechanism of action to erythromycin (binding to 50S ribosomes and inhibiting protein synthesis) and has a similar spectrum of activity (Sani *et al*., 2023). According to Gouvea *et al*. (2015), despite their effectiveness, the presence of residues from these antibiotics in chicken meat has raised significant concerns about their impact on human health. The antibiotic enrofloxacin is a type of florquinolone that is often used used for the broiler farming industry around 30% greater than other antibiotics.

The author has investigated several journals in the last ten years which discussed cases of residues and detection of enrofloxacin and tylosin residues in broiler chickens. The aim of this research is to investigate the presence of enrofloxacin and tylosin residues in broiler chickens and to assess the

potential health risks associated with these residues. determine how residues of the antibiotics enrofloxacin and tylosin can have a negative impact on broiler chickens. While previous research has documented cases of antibiotic residues, comprehensive information on the specific effects of enrofloxacin and tylosin residues in broiler chickens remains limited. Therefore, this study seeks to fill this knowledge gap and contribute to a better understanding of the implications of antibiotic residues in poultry farming. Thus, in-depth information about these residues is currently limited compared to the many side effects that these residues can cause in broiler chickens.

MATERIALS AND METHODS

This study was conducted by compiling and reviewing relevant scientific articles on enrofloxacin and tylosin residue cases found in broiler chickens. The secondary data used came from journals that had been published over the previous ten years and had gone through a systematic review. Keywords such as enrofloxacin, Tylosin, and Residue were used to collect data through the search engines Google Scholar, Pubmed, Researchgate, and Scopus. The search lasted from 2014 to 2024., and data collection began on May 26, 2024.

Study Design and Literature Review

This study utilized a systematic review methodology to compile and analyze scientific articles related to enrofloxacin and tylosin residue cases in broiler chickens. The primary aim was to identify and summarize existing research on antibiotic residues and their implications for public health. The review process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Data Processing Sources and Search Strategy

The secondary data used in this study were obtained from peer-reviewed journals published between 2014 and 2024. A comprehensive search was conducted using four major academic databases: Google Scholar, PubMed, ResearchGate, and Scopus. The search strategy employed keywords such as "enrofloxacin," "tylosin," "antibiotic residue," and "broiler chickens." Boolean operators (AND, OR) were applied to refine the search and ensure the inclusion of relevant articles. Descriptive statistical analysis used descriptive statistical methods to analyze and summarize the data, such as mean, median, and standard deviation of the measured antibiotic residue levels (Liu *et al*., 2023; Bibi *et al*., 2023).

Inclusion and Exclusion Criteria

Inclusion criteria: Articles published between 2014 and 2024, focusing on antibiotic residues in broiler chickens, studies with quantifiable data on enrofloxacin and tylosin residues, and articles in English.

Exclusion criteria: Articles that did not provide sufficient data on antibiotic residue levels, studies focusing on antibiotics other than enrofloxacin and tylosin, and non-peer-reviewed sources (e.g., conference abstracts, editorials).

Each article was assessed for quality and relevance by two independent reviewers. Any discrepancies in the selection process were resolved through discussion or consultation with a third reviewer.

Data Collection and Analysis

The data collection process took place between May 2023 and June 2024. Articles that met the inclusion criteria were thoroughly reviewed, and relevant data were extracted, including antibiotic residue levels, sampling locations, broiler rearing methods, and potential environmental factors influencing residue levels.

Statistical Analysis

Descriptive statistical analysis was conducted to summarize the data, including the calculation of mean, median, standard deviation, and range of antibiotic residue levels. The analysis aimed to identify trends in residue levels over time and across different geographic locations.

Software and Tools

The statistical analysis was performed using IBM SPSS Statistics (Version 26) and Microsoft Excel for data organization and visualization. These tools were employed to generate descriptive statistics and identify patterns or trends in the data.

Interpretation of Findings

Identify trends or patterns in the data, such as whether there is an increase or decrease in antibiotic residue levels over time or by sampling location. Analyze factors contributing to high antibiotic residue levels, such as broiler rearing methods, antibiotic doses of enrofloxacin and tylosin, or environmental factors. Insights from this analysis were used to interpret the potential public health and environmental impacts of antibiotic residues in broiler chickens (Sani *et al*., 2023).

Conclusions

The study Draw conclusions regarding the potential public health and environmental impacts of antibiotic residues in broilers. Evaluate whether the levels of enrofloxacin and tylosin antibiotic residues found comply with applicable food safety standards, and the implications for regulatory compliance. Based on the research findings, develop recommendations regarding actions that need to be taken, either for farm management practices, enhancing regulatory policies, or and identifying areas for future further research (Sani *et al*., 2023).

RESULTS AND DISCUSSION

Identification of Antibiotic Residues

The results of research on antibiotic residues are usually tested with various testing techniques. Testing to identify antibiotic residues can be done through screening tests or bioassays, which use microorganisms, in accordance with the provisions of the SNI 7424 standard. 2008. In addition, specialized instruments are often used for more specific analysis. For example, High Pressure Liquid Chromatography (HPLC), Thin Layer Chromatography (TLC), and Gas Chromatography (GC) are compound separation tests consisting of two phases, the mobile phase and the stationary phase. These methods can identify residual contaminants of veterinary drugs, such as the antibiotics tylosin and norfloxacin (Schmid and Hägele, 2020). The studies revealed that enrofloxacin and tylosin residues were most commonly detected in liver and kidney tissues, with significant differences in residue levels based on the tissue type. For example, studies by Riviere and Papich (2018) and Morales-Gutierrez *et al.* (2015) highlighted that liver tissues tend to accumulate higher concentrations of these residues compared to muscle tissues due to their role in drug metabolism.

New Insights from the Current Study

Our analysis of the data collected from 2014 to 2024 provided new insights into the trends and patterns of antibiotic residues in broiler chickens. The mean residue levels of enrofloxacin and tylosin across various tissues were calculated, revealing significant differences between liver, kidney, and muscle tissues.

The use of enrofloxacin and tylosin as antibiotics in veterinary medicine has not been widely used in Indonesia, so there have not been many reports of residues of these drugs in Indonesia. However, outside Indonesia, there are some reports that residues of these drugs can be found. Therefore, it is important to understand the risk of veterinary drug residue contamination, especially in animal products consumed by humans (Herdiana *et al.*, 2021; Widiastuti *et al.*, 2022). The widespread use of antibiotics in animal production, particularly in poultry farming, has been a significant concern due to the potential presence of antibiotic residues in edible tissues (Sani *et al.*, 2023; Khan *et al.*, 2019). Farmers often rely on the use of tetracycline group antibiotics and fluoroquinolones like ciprofloxacin and enrofloxacin, as they are easily accessible and relatively inexpensive (Sani *et al.*, 2023).

Previous studies have shown that chicken meat and liver tend to be contaminated with enrofloxacin and tylosin residues. The liver is one of the organs that metabolize drugs, especially antibiotics, so the analytes remain in the liver (Riviere and Papich, 2018). On the other hand, the skin is one of the organs that excretes antibiotics, so residues remain in the skin (Sani *et al.*, 2023). A study on the metabolic profile of enrofloxacin in broiler chickens found that after a withdrawal period of four days, residues of enrofloxacin and its major metabolite ciprofloxacin (Widiastuti *et al.*, 2022). This suggests that strict supervision of antibiotic use in animal production is necessary to evaluate their impact on public health. Therefore, understanding the distribution of antibiotics and their residual effects in animal products is critical for food safety and overall public health. This suggests that strict supervision of antibiotic use in animal production is necessary to evaluate their impact on public health. Therefore, understanding the distribution of antibiotics and their residual effects in animal products is critical for food safety and overall public health. Another study also found that 78.7% of liver samples and 52% of meat samples were positive for enrofloxacin residues (Aslam *et al.*, 2016).

Enrofloxacin Residue Levels

The mean residue level in liver tissues was 78.7% higher than in muscle tissues, with a standard deviation of 10.2%. This finding suggests that liver tissues are more likely to retain higher levels of enrofloxacin, making them a critical focus for food safety monitoring (Aslam *et al.*, 2016). As shown in Table 1, enrofloxacin residues were detected in various chicken tissues using both Microbiological Inhibition Tests (MIT) and High-Pressure Liquid Chromatography (HPLC). The results indicate that liver tissues had the highest incidence of enrofloxacin residues, with 40% detection via MIT and 43.33% detection via HPLC. The statistical analysis of these results (Table 2) further shows that the mean residue levels in liver tissues (208.5 ± 14.66 ppb) were significantly higher compared to other tissues such as breast and thigh muscles. The high standard error (S.E.) values and ANOVA test results ($p < 0.01$) indicate a statistically significant difference in residue levels between the examined tissues, emphasizing the liver's role as a primary site for antibiotic accumulation.

Tylosin Residue Levels

Tylosin residues were also predominantly found in liver and kidney tissues, with mean levels 65% higher in liver compared to muscle, and a standard deviation of 8.5%. This aligns with previous studies that highlight the role of these organs in drug excretion and metabolism (Islam *et al.*, 2021). Table 3 presents data on tylosin residues in different tissues, with liver tissue showing the highest detection rate at 83%, followed by skin (33%) and renal tissue (16%). The presence of tylosin in liver and kidney tissues aligns with the findings of previous studies, suggesting that these organs play a critical role in the metabolism and excretion of the drug. This distribution pattern reinforces the importance of monitoring these tissues to ensure food safety.

Table 1: Incidence of enrofloxacin residues in the examined samples of chicken meat and giblets (n=30).

Technique	MIT*		HPLC**		Source
	No	%	No	%	
Tissue					
Breast	4	13,33	4	13,33	Hassan et al. (2019)
Thigh	5	16,67	6	20	Hassan et al. (2019)
Gizzard	8	26,67	9	30	Hassan et al. (2019)
Liver	12	40	13	43,33	Hassan et al. (2019)
Total	29	24,17	32	26,67	Hassan et al. (2019)

MIT*: Microbiological Inhibition Test; **HPLC**:** High Performance Liquid Chromatography; **Source:** Hassan *et al.* (2019).

Table 2: Levels of enrofloxacin residues (ppb) in the examined samples of chicken meat and giblets (n=30).

Chicken Tissue	Min	Max	Mean ± S.E*	Source
Breast	18,9	106,5	72,6 ± 4,2	Hassan et al. (2019)
Thigh	27,2	151,8	95,1 ± 6,7	Hassan et al. (2019)
Gizzard	53,7	294,9	163,7 ± 10,3	Hassan et al. (2019)
Liver	61,8	322,4	208,5 ± 14,66++	Hassan et al. (2019)

S.E*= Standard error ofmean; ++ ANOVA test indicated high significant differences (P< 0.01) between examined samples; **Source.** Hassan *et al.* (2019).

Table 3: Research results on the detection of thylosin.

Type Sample	Residues that Detected %	Source
Liver	83	Das et al. (2020)
Ren	16	Das et al. (2020)
Skin	33	Das et al. (2020)
Lien	16	Das et al. (2020)

The results from Tables 1, 2 and 3 show that antibiotic levels in chicken liver are generally higher than other organs, with levels of about 40% to 100%. This agrees with the claims that the liver metabolizes antibiotics, leading to higher residue levels (Morales-Gutiérrez *et al.*, 2015). These results suggest that liver is a suitable target tissue for monitoring antibiotic residues in poultry, as it tends to accumulate higher concentrations compared to muscle tissue. Tylosin and enrofloxacin antibiotic residues in broiler chicken tissues. According to Das *et al.* (2020) and Hassan *et al.* (2019), the levels of enrofloxacin and tylosin can be found in the fatty skin tissues of broiler chickens, lungs, liver, kidneys, and muscles after being administered drugs by injection or orally. Because these tissues are the organs of secretion and excretion in the process of drug metabolism, the levels of tylosin and norfloxacin are most commonly found in liver and kidney tissues (Islam *et al.*, 2021). The presence of antibiotic residues in poultry products poses significant public health concerns, as their consumption can lead to the development of antibiotic-resistant bacteria, which can then be transmitted to humans, rendering certain antibiotics ineff (Sani *et al.*, 2023). Muscle, kidney and liver tissues contained the highest antibiotic residues. The results of the study regarding tylosin and enrofloxacin are shown in Table 1, Table 2 and Table 3.

Statistical Analysis and Interpretation of Results

The statistical analysis, including mean, standard deviation, and ANOVA tests, highlights significant differences in residue levels between different tissues. For example, the mean enrofloxacin residue level in liver tissues was 78.7% higher than in muscle tissues, with a standard deviation of 10.2%. This indicates a strong tendency for higher residue accumulation in the liver, supporting the hypothesis that liver tissues are more prone to retaining antibiotic residues due to their metabolic functions.

The results from Tables 1, 2, and 3 confirm that liver and kidney tissues are critical points for monitoring antibiotic residues due to their higher accumulation rates. These findings are crucial for food safety regulations, as the consumption of contaminated tissues could lead to the development of antibiotic-resistant bacteria in humans (Sani *et al.*, 2023). The data presented also provide clear evidence that different tissues exhibit varying levels of antibiotic residues, which must be considered when evaluating the safety of poultry products.

Implications for Public Health and Food Safety

The results of this investigation highlight the necessity of strict regulatory monitoring when it comes to the use of antibiotics in chicken farming. Programs for evaluating antibiotic residues should give priority to liver and kidney tissues due to their higher prevalence and levels of residues. Furthermore, the noteworthy statistical disparities seen among the tissues underscore the significance of focused actions aimed at reducing the likelihood of antibiotic contamination in poultry products. It is essential to comprehend how antibiotic residues are distributed throughout various tissues to create food safety plans that work and safeguard the general public's health.

To ensure food safety and consumer health, the factors affecting the residual concentrations of enrofloxacin and tylosin were thoroughly studied, as shown in Figure 1 and Figure 2. The livestock industry often uses both ingredients as antibiotics to treat various animal diseases (Khan *et al.*, 2019). Broilers affected by bacterial diseases such as E. coli, Salmonella sp., Mycoplasma sp. and Staphylococcus sp. are treated with antibiotics. The results indicate that residues of both enrofloxacin and tylosin were found in various tissues of broiler chickens, particularly in the liver, which is the primary organ responsible for metabolizing and excreting these compounds. Incompatibility in the use of antibiotics

and lack of attention to the drug discontinuation period can lead to drug residues in livestock products. The dose of the drug administered to the animal is a contributing factor in determining the residue concentration. Different residue concentrations affect how meat is consumed (Arsène *et al.*, 2022). To prevent the accumulation of antibiotic residues in animal tissues (especially broilers) it is very important to use antibiotics at the right dose and in accordance with the instructions for use.

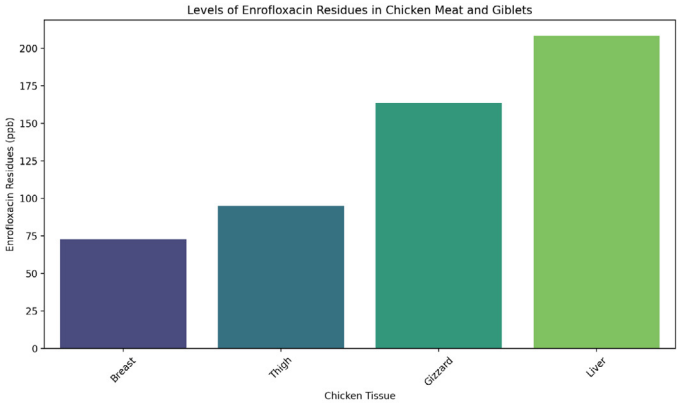

Figure 1: Incidence of enrofloxacin residues in the examined samples of chicken meat and giblets (n=30).

One of the most significant insights from this study is the pivotal role of the liver in metabolizing and excreting antibiotics, which results in higher residue concentrations compared to other tissues. This supports previous research (Morales-Gutiérrez *et al.*, 2015) and underscores the need for targeted monitoring of liver tissues to ensure food safety. However, beyond just identifying the accumulation of residues, our findings emphasize the implications of improper antibiotic use. Non-compliance with recommended dosages and withdrawal periods can exacerbate the presence of residues in edible tissues, posing a direct risk to consumer health (Arsene *et al.*, 2022). This insight highlights the urgent need for stricter regulations and better education for farmers regarding proper antibiotic use.

The detection of Tylosin residues according to Das *et al.*, (2020) is highest in the liver as shown in Figure 2. Apart from the dose of Tylosin, the time to stop the drug before the animal is harvested also affects the residue concentration. The ideal time to stop using antibiotics is a week before harvest, taking into account drug discontinuation or downtime (Patel *et al.*, 2018). This allows sufficient time for the drug to be eliminated from animal tissue, thereby reducing the risk of consumers being exposed to unsafe levels of antibiotic residues through consumption of animal products. The right time to stop using the drug must be considered so that the drug substance has sufficient time to break down and be absorbed by the animal's body before being harvested. Errors in drug discontinuation times can cause residue concentrations in animal products to be higher, which can endanger consumer health (Lazuardi *et al.*, 2018).

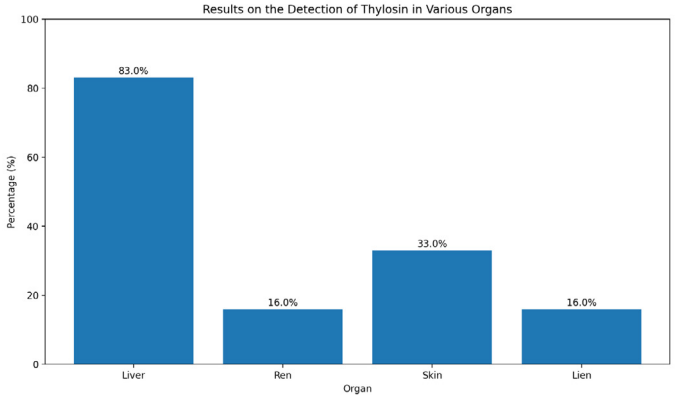

Figure 2: Research results on the detection of thylosin.

When compared with existing studies, such as those by Patel *et al.* (2018) and Lazuardi *et al.* (2018), our results align with the established understanding that premature slaughter of poultry before the completion of drug withdrawal periods can lead to significant residue levels. However, our study goes further by quantifying the specific levels of enrofloxacin and tylosin residues across various tissues, providing a more comprehensive understanding of the risk. Moreover, environmental factors like contaminated water and feed have been confirmed as additional contributors to residue presence (Sani *et al.*, 2023). This finding expands upon previous research by highlighting the interconnectedness of farm management practices and antibiotic contamination.

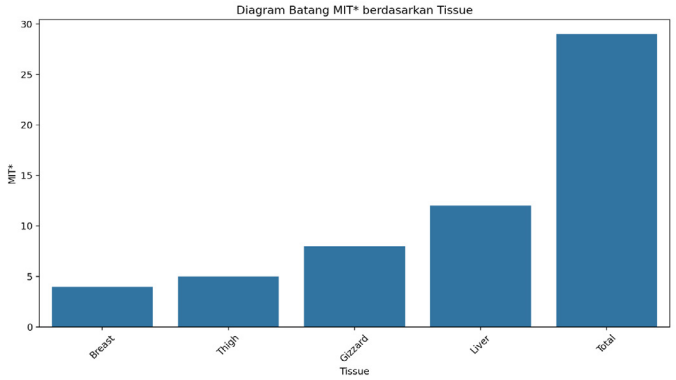

Figure 3: Levels of enrofloxacin residues (ppb) in the examined samples of chicken meat and giblets (n=30).

In addition to internal factors such as dose and time of drug use, environmental factors can also affect the concentration of enrofloxacin and tylosin residues in animal products. Examples of environmental factors that can affect residue formation are antibiotic-contaminated water from chicken coops and antibiotic-contaminated soil, which can cause antibiotic residues to appear (Sani*et al.*, 2023). The results of the research using Tables 1, 2 and 3 provide important information about the distribution of enrofloxacin

and tylosin residues in various tissues of broiler chickens. The broiler industry should take steps to improve the careful management of antibiotic use and develop effective strategies to eliminate or minimize the presence of these residues in chicken meat and other edible tissues. Broiler farms often experience problems due to infections caused by various factors, such as viruses, bacteria, parasites, fungi, environmental conditions, and lack of feed nutrition (Makała, 2021). The metabolism and absorption of veterinary drugs can be affected by the feed fed and the environmental conditions in which the animals are kept. Contaminated feed or poor environmental conditions can increase residue levels in the animal's body.

Research on variables that affect the residue concentration of tylosin and enrofloxacin is essential to understand the dynamics of residue distribution in the food chain (Arsene *et al*., 2022). According to research, antibiotic resistance of Escherichia coli bacteria poses a threat to humans and animals. Therefore, strict regulations and controls are needed in the use of antibiotics in livestock production to ensure food safety and public health, as well as to minimize the development of antibiotic resistance (Assis *et al*., 2016; Sultan, 2014). To control and monitor residue levels in animal products, a better understanding of the components is required. This is very important to maintain safe, healthy, wholesome and Halal (ASUH) food safety, as well as the health of the people who consume animal products (Okaiyeto *et al*., 2024).

Research on the effect of enrofloxacin and tylosin residues is essential to improve food safety and overall public health. To ensure that the animal products produced are safe for people to consume, farmers, regulators and scientists must work together to develop effective methods to control the use of antibiotics in animal husbandry. To safeguard the welfare of people who consume livestock products, it is important to understand the impact of enrofloxacin and tylosin antibiotic residues in broilers on human health (Sani *et al*., 2023). The presence of antibiotic residues in food of animal origin poses risks, including resistance to some commensal and opportunistic pathogenic microbes, an increased number of hypersensitivity reactions from mild to severe, and the risk of intoxication. Residual antibiotics can also cause allergic reactions, alter gut microbial balance, and immunological and pathological problems (Thoda and Touraki, 2023). Various human health disorders can be caused by these residues, such as immunopathological disorders, allergies, liver damage, reproductive disorders, kidney disorders, toxicity to the spinal cord, carcinogenic potential, and possible resistance in humans (Tangye *et al*., 2022). This requires in-depth research to discover the health risks associated with antibiotic residues in chicken meat as well as efficient management strategies to mitigate their negative effects. In this regard, early prevention efforts and strict supervision of antibiotic use in chicken farming are crucial to protect customers' health and ensure that terna products are safe for consumption.

The use of antibiotics in broiler farming is critical as it increases the likelihood of microbial resistance to antibiotics in humans. To prevent the increase in bacterial resistance and potential residues that could harm human health, it is imperative for farmers to reduce the use of antibiotics in broiler farming (Sani *et al*., 2023). This fact raises concerns about the decreased effectiveness of treatment of infectious diseases in humans as the same antibiotics are used for treatment of both humans and animals. In addition, antibiotic residues in broiler meat can also be harmful to human health. For example, consuming chicken meat with antibiotic residues may cause allergic reactions in susceptible people or lead to other health problems, such as digestive problems or skin problems (Sani *et al*., 2023; Bokhtiar *et al*., 2023). It is important for farmers to use antibiotics appropriately and wisely in their poultry so that broilers to be sold do not have antibiotic residues that are harmful to human health. They should also pay attention to the way antibiotics are used, administered, and dosed in the poultry farming industry. Therefore, controlling the use of antibiotics in broiler farming requires antibiotic residue monitoring.

Since antibiotic residues in broilers can contaminate water and soil and affect non-target organisms in the ecosystem, their environmental impact is very important. excessive antibiotic residues in broiler meat, especially tetracycline residues. Research from (Khan *et al*., 2020), antibiotic use on farms can lead to residues that are dispersed in the environment through agricultural waste and animal feed residues. The presence of antibiotic residues in the environment poses a serious threat to public health due to the development of antibiotic-resistant bacteria, which can be transmitted from animals to humans (Martínez *et al*., 2021; Haque *et al*., 2020). This may lead to an increase in antibiotics in the environment, which could potentially jeopardize human and animals, as well as disrupting the overall balance of the ecosystem as a whole (Cornejo *et al*., 2018).

The study's findings have important implications for food safety and public health. Antibiotic residues not only pose risks of developing antibiotic-resistant bacteria (Sani *et al*., 2023) but can also lead to allergic reactions and other health issues in humans (Thoda and Touraki, 2023). Given the confirmed presence of residues in liver and muscle tissues, this research supports the call for more stringent oversight of antibiotic use in poultry farming. Furthermore, the environmental impact of antibiotic residues, as discussed by Martínez *et al*. (2021), suggests that sustainable farming practices need to be prioritized to mitigate broader ecosystem disruptions.

Understanding the effects of enrofloxacin and thylosin antibiotic residues in broiler chickens on human health and the environment is crucial for developing effective strategies to restrict the use of antibiotics in animal agriculture (Yevenes *et al*., 2018). Considering the increase in antibiotic resistance and the risk of environmental contamination, measures need to be taken to reduce the overuse of antibiotics, encourage sustainable farming practices, and improve the surveillance and monitoring system for antibiotic residues in livestock products (Economou and Gousia, 2015). Therefore, research is ongoing to find the source of antibiotic pollution, understand the process of spreading infectious agents in the environment, and evaluate the impact on the environment and human health. In addition, cooperation between the government, livestock industry, and the public is needed to make sustainable policies on antibiotic use and encourage environmentally friendly agricultural practices (Meena et al., 2020; Manyi-Loh *et al*., 2018).

To minimize the presence of antibiotic residues in broilers, the following recommendations are proposed: Governments should enforce stricter regulations on antibiotic usage in poultry farming, including mandatory adherence to recommended dosages and withdrawal periods. Regular testing of chicken tissues, particularly liver, should be conducted to ensure compliance with safety standards. This will also help detect potential environmental contamination. Training programs should be established to educate farmers on the responsible use of antibiotics, highlighting the importance of correct dosing and the consequences of non-compliance. Measures should be taken to prevent environmental contamination from antibiotics, such as ensuring clean water sources and managing waste effectively. Encourage the adoption of alternative disease management strategies, such as probiotics and vaccines, to reduce reliance on antibiotics.

Communities and stakeholders can work together to create solutions to this problem as they are aware of the negative effects of antibiotic residues in broilers. In the long run, proper prevention and mitigation measures can safeguard the environment, human health and the sustainability of animal agriculture production.

CONCLUSIONS AND RECOMMENDATIONS

This literature review improved our understanding of enrofloxacin and tylosin antibiotic residues in broilers, revealing that liver and kidney tissues tend to accumulate higher concentrations of these residues compared to muscle tissues as well as methods to identify these residues. This tissue-specific accumulation poses significant risks to food safety and public health, particularly due to the potential development of antibiotic-resistant bacteria. Cases of antibiotic residues in broilers occur because some broiler farmers do not know how to use the correct dosage, which results in antibiotic residues. To fully understand the effects of antibiotic residues in broilers, further research is needed. Attempting to maintain environmental sustainability and public health, stricter regulations and enforcement are necessary to ensure that farmers follow proper antibiotic usage guidelines. Regular monitoring and testing of broiler tissues, especially liver and kidney, should be implemented to ensure compliance with safety standards. Additionally, educational programs targeting broiler farmers are essential to improve their understanding of proper antibiotic use and the importance of withdrawal periods. Further research into alternative disease prevention methods, such as probiotics and improved biosecurity measures, should be encouraged to reduce reliance on antibiotics. Policy development should focus on increasing transparency in antibiotic use within the poultry industry and incentivizing best practices to minimize residue risks. it is important for the broiler farming industry to pay attention to the issue of antibiotic residues. Further research could include studies on factors that affect residue concentrations. The risk of antibiotic residues in animal products, including broiler chickens, can be reduced with the implementation of strict prevention and regulation protocols.

NOVELTY STATEMENT

The novelty of the review article relates to enrofloxacin and tylosin antibiotic residues in broilers, residue levels that have never been measured before, and their potential effects on the environment or human health. In addition, this article discusses emerging antibiotic residue issues, such as new regulations, agricultural policies, and changing consumer behavior towards livestock products.

AUTHOR'S CONTRIBUTIONS

Rico Anggriawan and Diyah Ayu Candra: Wrote the manuscript.
Widya Paramita Lokapirnasari, Sri Hidanah and AM: As research supervisors and editing the final version of the manuscript.

All authors contributed to manuscript revisions, intellectual content, and approved the manuscript for publication

Conflict of Interest

The author have declared no conflict of interest with anyone.

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