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DETECTION OF ANTIBIOTIC RESIDUES IN THE LIVER AND KIDNEY OF INTENSIVE BROILERS AND KUB CHICKENS REARED ACCORDING TO ANIMAL WELFARE STANDARDS

Deteksi Residu Antibiotik Pada Hati dan Ginjal Ayam Broiler Intensif dan Ayam KUB yang Dipelihara Sesuai Standar *Animal welfare*

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Abstract

The increasing public demand for chicken meat has driven the intensification of broiler poultry farming, which risks increasing the use of antibiotics and the presence of residues in animal-derived food products. Uncontrolled antibiotic use can trigger the presence of residues that endanger consumer health. This study aimed to detect and compare the prevalence of antibiotic residues in the liver and kidney organs of intensively reared broiler chickens and Kampung Unggul Balitbangtan (KUB) chickens raised according to animal welfare standards. This research was an analytical observational study with a comparative cross-sectional design. A total of 20 liver and kidney samples were collected using purposive sampling and tested using the bioassay method at the Balai Besar Veteriner (BBVet) Denpasar to detect residues of penicillin, tetracycline, macrolide, and aminoglycoside. The results showed that the prevalence of antibiotic residues in intensive broiler chickens was 10% with findings of penicillin group residues, while all KUB chicken samples showed negative results. Statistical analysis using the Chi-Square test indicated that there was no significant difference between the two groups (p-value=0.305). The animal welfare-based rearing system in KUB chickens demonstrates better food safety potential compared to the intensive system due to the absence of antibiotic residues. The implementation of animal welfare standards plays an important role in maintaining livestock health and the quality of animal products naturally. It is recommended for farmers to begin implementing animal welfare standards to reduce dependence on antibiotic use and ensure food safety.

Keywords**:** Animal welfare, antibiotic residues, broiler, food safety, KUB chicken

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Abstrak

Kebutuhan masyarakat akan daging ayam yang terus meningkat mendorong intensifikasi peternakan ayam broiler yang berisiko meningkatkan penggunaan antibiotik dan keberadaan residu pada produk pangan asal hewan. Penggunaan antibiotik yang tidak terkontrol dapat memicu keberadaan residu yang membahayakan kesehatan konsumen. Penelitian ini bertujuan untuk mendeteksi dan membandingkan prevalensi residu antibiotik pada organ hati dan ginjal ayam broiler yang dipelihara secara intensif dengan ayam Kampung Unggul Balitbangtan (KUB) yang dipelihara sesuai standar *animal welfare*. Penelitian ini merupakan studi observasional analitik dengan desain *cross-sectional* komparatif. Sebanyak 20 sampel organ hati dan ginjal diambil secara *purposive sampling* dan diuji menggunakan metode bioassay di Balai Besar Veteriner (BBVet) Denpasar untuk mendeteksi residu golongan penisilin, tetrasiklin, makrolida, dan aminoglikosida. Hasil penelitian menunjukkan prevalensi residu antibiotik pada ayam broiler intensif sebesar 10% dengan temuan residu golongan penisilin, sementara seluruh sampel ayam KUB menunjukkan hasil negatif. Analisis statistik menggunakan uji *Chi-Square* menunjukkan tidak terdapat perbedaan yang signifikan antara kedua kelompok (*p-value*=0,305). Sistem pemeliharaan berbasis *animal welfare* pada ayam KUB menunjukkan potensi keamanan pangan yang lebih baik dibandingkan sistem intensif karena tidak ditemukannya residu antibiotik. Penerapan standar kesejahteraan hewan berperan penting dalam menjaga kesehatan ternak dan kualitas produk hewani secara alami. Disarankan bagi para peternak untuk mulai menerapkan standar kesejahteraan hewan guna menekan ketergantungan terhadap penggunaan antibiotik serta menjamin keamanan pangan.

Keywords**:** *Animal welfare*, ayam KUB, broiler, keamanan pangan, residu antibiotik

INTRODUCTION

The public demand for animal-derived food products, particularly chicken meat, continues to increase annually in line with population growth and rising purchasing power (Pusat Data dan Sistem Informasi Pertanian, 2024). This condition has prompted the broiler poultry industry to intensify production systems to meet market demand. Intensive farming systems with high stocking densities create environmental stress that predisposes chickens to various infectious diseases, thereby promoting the extensive use of antibiotics for both prevention and treatment purposes (Brassó *et al.*, 2025; Cuong *et al.*, 2021). The improper use of antibiotics, especially without adherence to the recommended withdrawal time, may result in drug residues remaining in body tissues, particularly in the liver and kidneys, which function as the primary organs for drug metabolism and excretion (Etikaningrum & Iwantoro, 2017; Abdel-Wahhab *et al.*, 2024).

Antibiotic residues in poultry products represent a serious food safety concern and continue to be reported in several regions of Indonesia (Bura *et al.*, 2024). A study conducted in Surakarta reported penicillin residue prevalence rates of 16.67% in broiler breast meat and 63.33% in thigh meat (Marsini *et al.*, 2024). Other studies have shown that antibiotic residues in poultry liver and kidneys can reach up to 20%, a level higher than those detected in muscle tissues (Abdel-Wahhab *et al.*, 2024). The presence of antibiotic residues may trigger allergic reactions, long-term toxic effects, and contribute to the development of antimicrobial resistance (AMR), which has become a major global public health threat (Enshaie *et al.*, 2025; Sana *et al.*, 2025). In response to this issue, the Indonesian Ministry of Agriculture Regulation No. 14 of 2017 prohibits the use of antibiotics as antibiotic growth promoters (AGPs) and mandates that antibiotics be administered only under veterinary prescription. Nevertheless, violations in the field still occur, particularly in intensive broiler farming systems that neglect animal welfare aspects (Hamza *et al.*, 2023).

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As an alternative, Kampung Unggul Balitbangtan (KUB) chickens raised under animal welfare principles offer promising potential for improved food safety. KUB chickens possess greater genetic resistance to diseases and better productivity compared to native village chickens, thereby reducing the need for antibiotic intervention (Rusdianto *et al.*, 2017; Sitindaon *et al.*, 2020). Animal welfare-based farming systems characterized by lower stocking densities and facilities that support natural behavior have been shown to reduce chronic stress, maintain immune function, and minimize antibiotic requirements (Hariono *et al.*, 2024). Therefore, this study aimed to detect and compare the prevalence of antibiotic residues in the liver and kidneys of intensively raised broiler chickens and KUB chickens reared according to animal welfare standards, in order to provide scientific evidence regarding the influence of farming systems on the food safety of poultry products.

RESEARCH METHODS

Ethical Clearance

Ethical clearance was not required because this study did not involve live experimental animals or any treatment/intervention procedures. The samples used consisted of liver and kidney organs collected post-mortem from broiler chickens and KUB chickens. Animal slaughter procedures were conducted at a Chicken Slaughterhouse facility in accordance with standard operational slaughtering procedures, without any intervention from the researchers while the animals were alive.

Research Objects

The research objects consisted of 20 liver and kidney organ samples collected from 10 intensively raised broiler chickens and 10 KUB chickens reared according to animal welfare standards. Samples were collected using a purposive sampling technique from farms implementing intensive broiler farming systems and welfare-based KUB chicken farming systems.

Research Design

This study employed an analytical observational design using a comparative cross-sectional study approach. The study was conducted by comparing the occurrence of antibiotic residues between two sample groups raised under different farming systems.

Research Variables

The independent variable in this study was the farming system, namely intensive farming and animal welfare-based farming. The dependent variables were the presence of antibiotic residues from the penicillin, tetracycline, macrolide, and aminoglycoside groups. Controlled variables included the type of organs examined and the laboratory testing methods used.

Data Collection Methods

Data were obtained through laboratory examination of the collected organ samples. Testing was conducted at the Disease Investigation Center Denpasar using the Bioassay Screening Test method. The test bacteria used were *Bacillus cereus*, *Geobacillus stearothermophilus*, *Kocuria rhizophila*, and *Bacillus subtilis* to detect bacterial growth inhibition zones.

Data Analysis

Laboratory test data were processed to calculate the prevalence percentage of antibiotic residues and to compare the occurrence of residues between broiler chicken and KUB chicken groups. Statistical analysis was performed using the Chi-square test in SPSS software with a significance level of $p < 0.05$.

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RESULTS AND DISCUSSION

Results

Characteristics of the Sample Farms

The characteristics of the sample farms are presented in Table 1 and Table 2. All five broiler farms implemented intensive farming systems using closed-house cages, 24-hour artificial lighting, stocking densities of 10–15 birds/m², without perching facilities, and sample birds aged 32–35 days. In contrast, all five KUB farms applied semi-open housing systems with natural lighting, stocking densities of < 5 birds/m², available perching facilities, and ground areas for scratching and dust bathing, with sample birds aged 3–4 months. These differences reflect better implementation of the Five Freedoms principles in KUB farms compared with intensive broiler farms (Phillips & Kluss, 2018).

Antibiotic Residue Detection Results

The results of antibiotic residue testing using the bioassay method for four antibiotic groups are presented in Table 3. Of the 20 samples examined, only one sample tested positive for antibiotic residues, namely Broiler 1B, which was positive for penicillin-group residues. The remaining nine broiler samples and all ten KUB chicken samples showed negative results for all tested antibiotic groups.

Prevalence and Statistical Analysis

The prevalence of antibiotic residues in intensively raised broiler chickens was 10%, whereas no residues were detected in KUB chickens (0%). Chi-square analysis showed no statistically significant difference between the two groups ($\chi^2 = 1.053$; df = 1; $p = 0.305$), as presented in Table 4. Although the difference was not statistically significant, likely due to the limited sample size, descriptively, residues were detected only in the intensive broiler group.

Discussion

The detection of penicillin residues in sample Broiler 1B indicates that uncontrolled antibiotic use still occurs in intensive broiler farms. This condition is associated with intensive farming practices in closed-house environments that create physiological stress in chickens. High stocking densities, the absence of perching facilities, and continuous 24-hour artificial lighting induce chronic stress characterized by elevated corticosterone hormone levels. At high concentrations, corticosterone suppresses T-lymphocyte activity and antibody production, thereby exerting immunosuppressive effects (Hariono *et al.*, 2024). Consequently, intensively raised broilers become more susceptible to infectious diseases, encouraging farmers to use antibiotics routinely for both therapeutic and prophylactic purposes (Cuong *et al.*, 2021; Hamza *et al.*, 2023).

The detected residue indicates that the antibiotic had not been completely eliminated from the liver and kidneys. These organs are known to accumulate the highest levels of residues because they play central roles in first-pass metabolism and drug excretion through urine (Abdel-Wahhab *et al.*, 2024). Differences in results among individuals from the same farm, where Broiler 1A tested negative while Broiler 1B tested positive, may be explained by individual pharmacokinetic variation, including differences in hepatic metabolism, renal excretion efficiency, and the amount of antibiotic consumed through drinking water (Aulia *et al.*, 2023). These findings are consistent with the study by Marsini *et al.* (2024) in Surakarta, which reported the presence of penicillin residues in poultry products, as well as the study by Bura *et al.* (2024), which confirmed that antibiotic residue problems in broiler chickens remain prevalent in Indonesia.

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The absence of tetracycline, aminoglycoside, and macrolide residues in all samples may reflect better compliance with withdrawal times for these antibiotic groups or residue concentrations below the detection limit of the bioassay method. It should be noted that the bioassay method is qualitative in nature, detecting only the presence or absence of inhibition zones and not the exact concentration of residues (Balouiri *et al.*, 2016; Sajid *et al.*, 2016). Therefore, negative results do not necessarily indicate the complete absence of residues, but rather that residue levels may be below the detection threshold of the method. The withdrawal time for tetracyclines is at least 5 days before slaughter (Aulia *et al.*, 2023), and this antibiotic group is among the most widely regulated and socialized, leading to better farmer compliance regarding withdrawal periods.

Negative results in all KUB chicken samples suggest that animal welfare-based farming systems are effective in reducing the need for antibiotic use. The KUB farming environment, characterized by low stocking density, natural lighting that allows approximately 8 hours of nighttime rest, and the availability of perching and scratching areas, creates low-stress conditions. Studies have shown that animals experiencing lower stress levels maintain normal corticosterone concentrations, allowing the immune system to function optimally and preserving resistance against infections (Hariono *et al.*, 2024). In addition, KUB chickens possess strong genetic resistance as a result of selective breeding from Indonesian local lines adapted to tropical climatic conditions (Rusdianto *et al.*, 2017; Sitindaon *et al.*, 2020). The combination of genetic resilience and welfare-oriented management practices synergistically reduces the need for antibiotic intervention. The study by Kamil *et al.* (2025) further supports these findings by demonstrating that a combination of herbal multivitamins and probiotics can replace antibiotics in KUB chicken production while improving performance outcomes.

Although the prevalence of residues in this study was relatively low, the presence of penicillin residues remains a concern from a food safety perspective. Under the ASUH standard (Safe, Healthy, Whole, and Halal) implemented in Indonesia, animal-derived food products must not contain chemical contaminants harmful to consumers, including antibiotic residues exceeding the Maximum Residue Limit (MRL) (Ariningsih *et al.*, 2023). Penicillin is among the most frequently reported causes of drug-related allergic reactions. Exposure through the consumption of poultry products containing residues may trigger hypersensitivity reactions ranging from urticaria to anaphylaxis in sensitive individuals (Marsini *et al.*, 2024). Repeated exposure to low-dose antibiotic residues through food also contributes to the selection and spread of resistant bacteria, thereby increasing the threat of antimicrobial resistance (AMR) (Sani *et al.*, 2024; Sana *et al.*, 2025). The absence of a statistically significant difference ($p = 0.305$) may have been influenced by low statistical power due to the limited sample size. Further studies with larger sample sizes and quantitative confirmation methods such as LC-MS/MS are required to accurately measure residue concentrations and strengthen the statistical conclusions (Delatour *et al.*, 2018).

CONCLUSION AND SUGGESTIONS

Conclusion

This study concluded that penicillin-group antibiotic residues were detected only in intensively raised broiler chickens, with a prevalence of 10%, whereas KUB chickens reared according to animal welfare standards were entirely free from antibiotic residues. Statistically, no significant difference was observed between the two farming systems; however, descriptively, animal welfare-based farming systems demonstrated better assurance of food safety.

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Suggestions

Farmers are encouraged to implement animal welfare principles in their farming management practices in order to maintain animal health naturally and minimize dependence on antibiotic use.

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Tables

Table 1. Characteristics of Intensive Broiler Chicken Farms

Code	Location	Housing Type	Floor/Litter	Lighting	Stocking Density	Natural Behavioral Facilities	Harvest Age
Broiler 1	Pering, Blahbatuh, Gianyar	Closed house	Soil and rice husk litter	24 hours	10–15 birds/m²	None	32 days
Broiler 2	Puhu, Payangan, Gianyar	Closed house	Soil and rice husk litter	24 hours	10–15 birds/m²	None	35 days
Broiler 3	Pering, Blahbatuh, Gianyar	Closed house	Soil and rice husk litter	24 hours	10–15 birds/m²	None	35 days
Broiler 4	Pering, Blahbatuh, Gianyar	Closed house	Soil and rice husk litter	24 hours	10–15 birds/m²	None	35 days
Broiler 5	Pering, Blahbatuh, Gianyar	Closed house	Soil and rice husk litter	24 hours	10–15 birds/m²	None	35 days

Note: Stocking density based on National Chicken Council (2022)

Table 2. Characteristics of KUB Chicken Farms Maintained According to Animal Welfare Standards

Code	Location	Housing Type	Floor/Litter	Lighting	Stocking Density	Natural Behavioral Facilities	Harvest Age
KUB 1	Kesimpar, Abang, Karangasem	Semi-open	Soil and rice husk litter	Natural (8 hours of nighttime rest)	< 5 birds/m²	Perches, soil floor	3 months
KUB 2	Pidpid, Abang, Karangasem	Semi-open	Soil and rice husk litter	Natural (8 hours of nighttime rest)	< 5 birds/m²	Perches, soil floor	3 months
KUB 3	Jehem, Tembuku, Bangli	Semi-open	Soil and rice husk litter	Natural (8 hours of nighttime rest)	< 5 birds/m²	Perches, soil floor	4 months

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KUB 4	Tumbu, Karangasem	Semi-open	Soil and rice husk litter	Natural (8 hours of nighttime rest)	< 5 birds/m²	Perches, soil floor	3 months
KUB 5	Tista, Abang, Karangasem	Semi-open	Soil and rice husk litter	Natural (8 hours of nighttime rest)	< 5 birds/m²	Perches, soil floor	3 months

Note: Stocking density based on Rusdianto *et al.* (2017).

Table 3. Results of Antibiotic Residue Testing in the Liver and Kidneys of Intensive Broiler Chickens and KUB Chickens

Sample Code	Penicillin	Tetracycline	Aminoglycoside	Macrolide	Residue Status
Broiler 1A	Negative	Negative	Negative	Negative	Negative
Broiler 1B	Positive	Negative	Negative	Negative	Positive
Broiler 2A	Negative	Negative	Negative	Negative	Negative
Broiler 2B	Negative	Negative	Negative	Negative	Negative
Broiler 3A	Negative	Negative	Negative	Negative	Negative
Broiler 3B	Negative	Negative	Negative	Negative	Negative
Broiler 4A	Negative	Negative	Negative	Negative	Negative
Broiler 4B	Negative	Negative	Negative	Negative	Negative
Broiler 5A	Negative	Negative	Negative	Negative	Negative
Broiler 5B	Negative	Negative	Negative	Negative	Negative
KUB 1A	Negative	Negative	Negative	Negative	Negative
KUB 1B	Negative	Negative	Negative	Negative	Negative
KUB 2A	Negative	Negative	Negative	Negative	Negative
KUB 2B	Negative	Negative	Negative	Negative	Negative
KUB 3A	Negative	Negative	Negative	Negative	Negative
KUB 3B	Negative	Negative	Negative	Negative	Negative
KUB 4A	Negative	Negative	Negative	Negative	Negative
KUB 4B	Negative	Negative	Negative	Negative	Negative
KUB 5A	Negative	Negative	Negative	Negative	Negative
KUB 5B	Negative	Negative	Negative	Negative	Negative

Note: Results based on bioassay testing conducted at the Disease Investigation Center Denpasar.

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Table 4. Prevalence of Antibiotic Residues and Chi-square Analysis Results

Group	Positive (n)	Negative (n)	Prevalence (%)	χ^2	df	Sig. (p)
Intensive Broiler Chickens	1	9	10	1.053	1	0.305
KUB Chickens (Animal Welfare)	0	10	0	–	–	–

Note: χ^2 = Chi-square value; df = degrees of freedom; Sig. = significance; $p < 0.05$ indicates a statistically significant difference.