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Original Scientific Paper

Raising broilers without antibiotics: challenges and alternatives

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ABSTRACT

Intensive poultry production has long relied on the use of antibiotics to improve animal health and yield. However, growing concerns about the emergence of antimicrobial resistance have led to restrictions and bans on the use of antibiotics as growth promoters in many countries. "Raised without antibiotics" production can be described as the production of broilers that have not come into contact with antibiotics during the production cycle, whether for prophylactic, therapeutic or growth-stimulating purposes.

The aim of this study was to demonstrate the opportunities and challenges in raised without antibiotics poultry production, focusing on the available alternative measures such as probiotics, phytobiotics, organic acids, improved biosecurity, hygiene and management. The data presented were obtained based on observational and survey-based methodologies. Test matrices were water, feed and litter. The technique used to determine the presence of antibiotics was ultra-high performance liquid-chromatography-mass spectrometry (UPLC-MS/MS).

From January 2020 to June 2025, antibiotic use on the studied farms steadily declined from 20.62 to 4.70 mg/kg of live weight. In the total of 3320 broiler production cycles examined on 200 farms, it was found that 62.14% of production runs met the requirements for antibiotic-free rearing. From such facilities, 59.36% of slaughtered broilers met the requirements for the Raised Without Antibiotics certificate.

The results indicate that it is possible to achieve satisfactory production indicators and maintain good animal health, but with strict adherence to preventive measures and precise management.

1. Introduction

"Raised without antibiotics" production means the production of broiler chickens that have not come into contact with antibiotics during the production cycle, whether for prophylactic, therapeutic or growth-stimulating purposes. In addition to this term, the term antibiotic-free is also often used. Unlike this production, traditional broiler chicken production allows the use of antibiotics for therapeutic purposes. For the avoidance of doubt, it should be noted that neither antibiotic-free nor traditional production allows the presence of antibiotics in the final product, i.e., in the meat and organs of the slaughtered chicken.

Poultry production is one of the most dynamic sectors of livestock production, with high produc-

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tion intensity and relatively fast return on investment. Traditionally, broiler farming has relied on the use of antibiotics not only for therapeutic purposes, but also as growth stimulants, thereby contributing to more efficient feed conversion, lower mortality and better economic profitability (*Castanon*, 2007). However, a growing body of evidence suggests a link between the use of antibiotics in animal production and the development of antimicrobial resistance in pathogens that can be transmitted to humans, which represents a serious global health challenge (*World Health Organization - WHO*, 2022). In response to these threats, the European Union banned the use of antibiotics for growth promotion in 2006 (*Regulation (EC) No. 1831/2003*, 2003). Similar measures have been introduced in the USA, China and Canada according to the Global Research on Antimicrobial Resistance (GRAM) report (*Murray et al*., 2022), while many other countries are implementing similar measures or planning a transition to a raised without antibiotics production model. All this should be integrated into the One Health concept, which implies the joint action by human and veterinary medicine to combat zoonoses, reduce antimicrobial resistance, and protect the environment and animal welfare (*Nedic et al.,* 2023). In this context, there is a need to develop effective and safe alternatives that will enable the preservation of animal health and meet technological and market requirements.

The use of antibiotics in poultry farming began in the mid-20th century, when it was discovered that certain subtherapeutic doses could significantly improve growth and feed efficiency in broilers. Antibiotics soon became an integral part of industrial poultry production, not only for therapeutic and prophylactic purposes, but also as so-called growth promoters (*Gadde et al*., 2017). However, the widespread and often uncontrolled use of antibiotics has led to the emergence of resistant strains of bacteria, both in animal and human populations. According to the *World Health Organization - WHO* (2022), antimicrobial resistance is among the ten greatest global threats to public health. In addition, antibiotic residues in meat and poultry products pose an added risk to consumer health. In the EU, around 33,000 human deaths due to antimicrobial resistance are recorded annually (*Cassini et al*., 2019), and estimates indicate that antimicrobial resistance could cause up to 10 million deaths per year by 2050 (*O'Neill*, 2016).

The use of antibiotics in poultry is regulated by a series of regulations with the aim of preventing the presence of residues in meat consumers. According to the European Union regulations and the Codex Alimentarius standard, it is prohibited to place on the market animal products that contain antibiotic residues above the prescribed maximum permitted levels (Maximum Residue Limits – MRLs) (Regulation (EC) No. 1831/2003). In order to avoid the presence of antibiotics in tissues, the implementation of a withdrawal period is crucial – this is the period that must elapse between the last application of antibiotics and the slaughter of the animal. Some antibiotics have a longer withdrawal period, especially those that accumulate in the liver or muscles. Failure to comply with the withdrawal period is a violation and directly threatens food safety.

In addition to antimicrobial resistance, antibiotic residues in food can cause other health problems in sensitive consumers. The most common consequence includes allergy reactions – especially to antibiotics such as penicillins and sulfonamides, even at very low concentrations (*Pawankar et al*., 2013). The presence of antibiotics can disrupt the microbiome and lead to digestive problems. Long-term exposure to residual amounts can lead to the development of hypersensitivity. Some trace amounts of antibiotics can affect the immune system response (immunosuppressive effects) (*Sharma et al*., 2018). The long-term effects in children and pregnant women are unknown because there is insufficient data on the effects of chronic exposure.

Studies show that improving animal welfare through ventilation, natural lighting, environmental enrichment and stress reduction leads to a lower incidence of disease and, therefore, a reduced need for antibiotics (*Broom*, 2010). Poultry production also encourages fair treatment of animals in accordance with the principles of the five freedoms, which can also influence consumer perception and increase the value of the product.

Reducing or eliminating the use of antibiotics in poultry production contributes to reduced contamination of soil, water and feed with drug residues. Antibiotics are often excreted unchanged from animals, entering ecosystems where they can disrupt the microbiological balance and promote the development of resistant bacteria in nature (*Kemper*, 2008).

Veterinary drug residues are tested using various screening (STAR protocol; PremiTest, four-plate, five-plate, and six-plate ELISA) and confirmatory methods such as LC-Orbitrap HRAM, UPLC-MS/MS, HPLC-FLD, and HPLC-UV. Certain studies

highlight the importance of simultaneous sampling of multiple matrices (feed, water, litter) in order to detect the possible presence of antibiotics on the farm (*Cortés et al*. 2025; *Davis et al*., 2021). Laboratory analyses involve several types of different analyses that are recommended in raised without antibiotics production (*Kemper*, 2008). The research objective of this study was to demonstrate the opportunities and challenges in raised without antibiotics poultry production, focusing on the available alternative measures such as probiotics, phytobiotics, and organic acids, along with improved biosecurity, hygiene, and management.

2. Materials and methods

The research was conducted in cooperation with a company from Bosnia and Herzegovina that markets chicken under the label Raised Without Antibiotics. They market chicken carcasses, fillets, wings and drumsticks, packaged on trays with plastic foil wrap and labelled as "Raised Without Antibiotics". Continuous education of farmers is carried out regularly, conditions and hygiene are improved, alternative means for improving immunity are given if necessary, quality food and water are used and the entire system is monitored. The same company previously produced and marketed chickens in bulk, without prior labeling.

The research was conducted in the period from January 2020 to June 2025 on a total of 3320 production cycles in 200 facilities. The certification body prepared a sampling plan based on the company's business volume, which included the type of samples, locations and sampling dynamics. Test matrices were water, feed and litter. Samples from these were selected because of the possible route of antibiotic administration, i.e., orally, as this is the only way to distribute the antibiotic to a large number of broilers. Unannounced sampling was carried out and 660 analyses were performed for 10 antibiotics most commonly used in poultry production. The sampling was unannounced for reasons of impartiality, i.e., the impossibility of any possible influence on the quality and integrity of the samples.

The technique used for the detection of antibiotics was ultra-high performance liquid chromatography-mass spectrometry (UPLC-MS/MS). The samples were analyzed for the presence of antibiotics identified as most commonly used in poultry farming, including those that are banned: amoxicillin (β-lactam), enrofloxacin (fluoroquinolone), doxycycline, oxytetracycline and tetracycline, sulfadiazine + trimethoprim (sulfonamides), flumequine (quinolone), florfenicol and chloramphenicol (amphenicol), nitrofurans and malachite green.

For water, animal feed and litter samples, the regulation does not prescribe the MRL. The detection limit of the method used was <0.1 µg/kg. A sample was considered positive if the presence of any of the target substances was detected above the detection limit of the method.

3. Results

No antibiotic residues were detected in any of the feed, water and litter samples. Of the total of 3,320 production cycles, it was found that 2,063 production cycles or 62.14% were raised without the use of antibiotics, and 1,257 or 37.86% were raised in the traditional way with the use of antibiotics for therapeutic purposes (Figure 1).

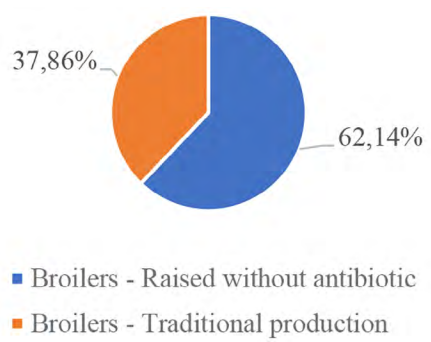

Figure 1. Proportion of broiler farming production cycles with (traditional production) and without the use of antibiotics

The share of slaughtered broilers raised without antibiotics was 59.36%, while 40.64% of the animals had experienced antibiotic use (Table 1).

Table 1. Overview of the number of slaughtered broilers raised without the use of antibiotics and traditional farming (using antibiotics)

Total number of slaughtered broilers	Traditional production (No)	Traditional production (%)	Raised without antibiotics (No)	Raised without antibiotics (%)
55,661,670	22,622,267	40.64	33,039,403	59.36

Table 2. Feed conversion ratio (FCR) and number of production cycles by broiler production types from 2020 to 2025

Type of production	Production cycles													
	2020		2021		2022		2023		2024		2025		Total	
	No.	FCR	No.	FCR	No.	FCR	No.	FCR	No.	FCR	No.	FCR	No.	FCR
Traditional production	30	1.83	278	1.82	269	1.82	262	1.80	300	1.79	118	1.79	1257	1.81
Raised without antibiotics	36	1.83	363	1.84	458	1.82	480	1.80	528	1.80	198	1.80	2063	1.81

Table 2 provides an overview of the number of breeding cycles and the average feed conversion ratio in the two types of broiler farming. No significant difference in feed conversion was found in the raised without antibiotics and traditional production systems.

Mortality and technological scrap of chickens is a very important parameter in broiler farming (Table 3). The measured percentage of mortality and technological scrap was higher in traditional farming than in the raised without antibiotics system because even with therapy, significant mortality of broilers occurs. This is also explained by the fact that antibiotics are used as a last resort, respecting the welfare of the animals. When therapy is applied at any stage of production, the entire batch cannot obtain the status of "Raised Without Antibiotics".

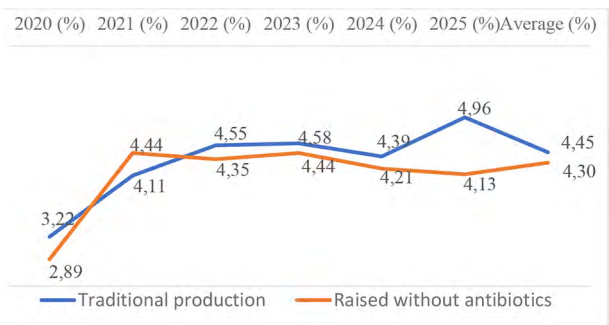

Figure 2. Percentage of mortality by batch in the studied facilities

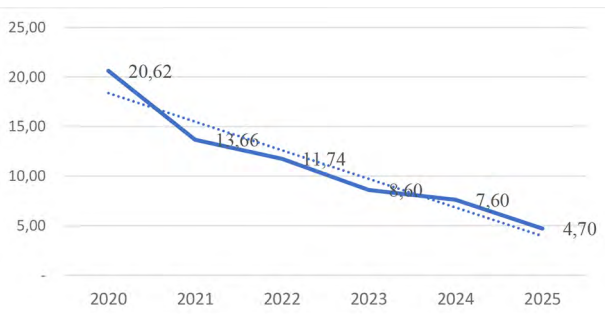

Figure 3. Antibiotic consumption on the 200 studied broiler farms (mg/kg of live weight)

On farms where broilers were not raised without antibiotics, the use of antibiotics was often necessary. In spite of that, however, Figure 3 shows that antibiotic consumption per kilogram of live weight in broiler farming has been in a constant decline over the last six years.

4. Discussion

The World Health Organization (WHO), the Food and Agriculture Organization (FAO) and the World Organization for Animal Health (WOAH) jointly recommend reducing the unreasonable use of antibiotics, respecting withdrawal periods and developing national residue monitoring programs in food of animal origin (*WHO*, 2022). Several countries have effective control systems, which include regular sampling of chicken meat in shops and slaughterhouses.

Transition to the raised without antibiotics broiler farming model directly affects animal welfare practices. Raised without antibiotics production requires better housing conditions, lower stocking density, adequate microclimate, ventilation, hygiene and general supervision, all in order to reduce the risk of disease (*Iannetti et al*., 2021). In such conditions, the need for the introduction of animal health monitoring programs is increased, with an emphasis on prevention rather than intervention.

Raised without antibiotics broiler production requires a multidisciplinary approach. Scientific research indicates the effectiveness of probiotics, prebiotics, phytobiotics and organic acids as alternatives to antibiotics. Probiotics stabilize the intestinal microbiota (*Mountzouris et al*., 2010), while phytobiotics such as oregano and thyme have antimicrobial effects (*Hashemi & Davoodi,* 2011). Organic acids lower pH and inhibit the growth of pathogens (*Dibner & Buttin*, 2002). In addition, biosecurity – disinfection, entry and vector control – plays a key

role. Genetic selection for resistance is also gaining importance (*Gogolin-Ewens et al*., 1990).

Raised without antibiotics, thus, is an important element in a sustainable poultry production strategy. This antibiotic-free production system requires more efficient waste management, better animal handling and adapted feeding systems that reduce nitrogen and phosphorus emissions to the environment (*Thanner et al*., 2016). This is particularly important in the context of climate change and biodiversity conservation.

Denmark and the Netherlands were among the first to reduce antibiotic use in farmed animals (*Aarestrup*, 2012; *Speksnijder et al*., 2015). The USA is developing raised without antibiotic production models, motivated by consumer demands. Antibiotic-free production conditions show a slight decrease in growth and increased mortality, but with good nutrition and hygiene, these effects are mitigated (*Hoelzer et al.*, 2018). Production costs are higher, but they are compensated by a higher product price and better market positioning (*Salois et al*., 2016).

In our study, the proportion of broiler production cycles from antibiotic-free rearing was 62.14%, while the proportion of broilers slaughtered from antibiotic-free rearing was 59.36%. No significant difference in FCR was observed between the two production systems over the years, indicating that it is possible to maintain productivity with a strong preventive approach. Raised without antibiotics production had 0.15% lower total mortality than the antibiotic-treated broilers from traditionally raised birds. In broiler farming, antibiotics are used only when preventive measures cannot prevent the spread of disease and bird deaths. By using antibiotics, that production cycle loses its "Raised Without Antibiotics" status. Treated broilers remain on the farm until the antibiotic is eliminated from the birds' bodies.

The observed decreasing trend in antibiotic consumption (mg/kg live weight) is consistent with European and American experiences in raised without antibiotics programs, where key effects are achieved through a combination of biosecurity, vaccination and nutritional strategies. For example, in Denmark, the share of antibiotics in broiler production was reduced by more than 50% between 2010 and 2020 (*DANMAP*, 2021). Monitoring of Antimicrobial Resistance and Antibiotic Usage in Animals in the Netherlands in 2022 (MARAN) has recorded a reduction of over 70% in total consumption of antibiotics in the raised without antibiotics production in the period 2011–2022 (MARAN, 2023). In the USA, according to *USDA* (2021), more than 60% of commercial broilers are raised in no antibiotics ever (NAE) systems. *Singer et al.* (2020) point out that the implementation of biosecurity measures and vaccination is crucial for maintaining performance in the raised without antibiotics system, while *Aarestrup* (2012) emphasizes the importance of an integrated approach in reducing antimicrobial resistance.

Our results show that it is possible to produce broilers without antibiotics by using alternatives with improved and controlled farm conditions. Alternatives, such as probiotics and phytobiotics, have the potential to replace antibiotics in maintaining health and improving productivity. The literature supports this approach, and the economic aspects can be positive under market support conditions (*Salois et al*., 2016).

5. Conclusion

The study confirms that a raised without antibiotics broiler production model is feasible with appropriate biosecurity measures and improved farm conditions. The results on a large sample of broiler production cycles confirm that raised without antibiotics broiler production is sustainable: we measured a stable feed conversion ratio (FCR) over time, higher shares of flocks and of slaughtered birds in raised without antibiotics systems than in traditional systems, lower mortality/technological scrap rates of the antibiotic-free flocks and a clear decrease in antibiotic consumption over time.

Consumer awareness, regulatory enforcement, and a developed market contribute to the expansion of antibiotic-free broiler production. The results presented are an encouragement and basis for the expansion of the program and its implementation in other companies in Bosnia and Herzegovina and in the region. Raising broilers without antibiotics has many benefits, but insufficient laboratories and expensive laboratory methods are a complicating factor. It is necessary to continuously educate farmers and raise consumer awareness about the benefits of rearing without antibiotics, specifically reducing antimicrobial resistance, strengthening animal welfare and protecting the environment (the One Health concept). Future research should contribute to a more precise assessment of the efficiency and cost-effectiveness of this type of farming.

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