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Monitoring of antibiotic use in broiler turkey flocks in the Warmia and Mazury province in 2019–2021

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Abstract

Introduction: The increasing resistance of bacteria to antibiotics has obliged the EU Member States to reduce by 50% the use of antibiotics in animal production by 2030. This study was undertaken with the aim to analyse the use of antibiotics in flocks of broiler turkeys reared in the Warmia and Mazury province in a two-year period. **Material and Methods:** From data from 238 production records of turkey flocks provided by the County Veterinary Inspectorates, the use of antibiotics (mg/kg) was analysed in turkey flocks reared in 2019–2021. The data provided the year of rearing, turkey sex and immunoprophylactic measures. **Results:** A significant decrease in antimicrobial use was reported in the male turkey flocks in 2021 (157 mg/kg body weight) in comparison to 2020 (241 mg) and 2019 (299 mg). In both male and female turkeys, the use of antimicrobials gradually decreased from 2019 to 2021. Significantly lower antibiotic use was reported in turkey flocks using autogenous vaccines. **Conclusion:** The positive trend shown in this study proves the possibility of meeting the EU recommendations for 50% reduction in the use of antibiotics in animal production by 2030. More emphasis should be placed on minimising the risk of infectious diseases requiring antibiotic therapy with welfare, biosecurity, immunomodulation and specific prophylaxis measures.

Keywords: broiler turkeys, antimicrobial use, monitoring.

Introduction

For many decades, poultry production has been the fastest growing branch of animal production, important from the perspective of both the global balance of animal protein and the economies of many countries. A ban on the use of antibiotic growth promoters in the poultry production sector was imposed in the EU Member States in 2006 (9). The current challenge faced by this sector is the need to reduce the use of antibiotics, and this need is one justified for many reasons. Because the misuse of antibiotics poses a threat to public health, this problem has become a focus of interest for the World Organisation for Animal Health (OIE), the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), and the European Parliament (8, 12, 25). As a consequence, the European Parliament has obliged the Member States to radically reduce the use of antibiotics in animal production by 2030 (8).

The major reasons for the need to reduce the amount of antibiotics used in animal production are the constantly increasing resistance of bacteria to antibiotics used in human and veterinary medicine and the need to ensure the safety of food of animal origin. The therapeutic difficulties related to the drug resistance of microorganisms are one of the most important challenges faced by both human and animal medicine (3, 6, 8, 12, 20, 21, 23, 25).

Excessive use of antibiotics in animal production also poses other risks, such as the possibility of residues of active substances being left in animal products intended for human consumption (4, 22). For this reason, maximum residue limits (MRL) for all drugs in use in the European Union Member States and beyond and limits for the breakdown products of those drugs have been stipulated for all food products of animal origin (7, 10). Among the antibiotic residues, the most dangerous found in food products are those of tetracycline, and unpublished data show that they may account for over

40% of antibiotics used in veterinary medicine in Poland. They may exert immunosuppressive and teratogenic effects and are particularly dangerous to foetuses and young children, as they may negatively affect bone mineralisation and possibly cause growth disorders (5). In addition, the use of antibiotics in animal production may also have an adverse indirect impact on human health through the transfer of antibiotic residues into the environment with animal faeces. These residues end up in surface waters and, consequently, in plants intended for human consumption that are not routinely tested for their presence (1).

Establishing and complying with MRLs for antibiotics in animal products does not always ensure public health safety, because of the high individual variability of consumers' bodies' responses to residues and the possibility of residues' interaction with other xenobiotics (13, 14). Therefore, products derived from animals reared without the use of antibiotics will become increasingly important on the food market.

Given the desirability of reduction and phasing-out of antibiotic use in livestock farming, a study was undertaken with the aim of analysing the use of antibiotics in flocks of broiler turkeys reared in the Warmia and Mazury Province in 2019–2021, investigating the variables of the sex of birds and the immunoprophylactic measures deployed.

Material and Methods

Study design. Data for this study was sourced from three County Veterinary Inspectorates (CVI) located in the Warmia and Mazury voivodeship. The inspectorates made available the production records of broiler turkey flocks fattened in 2019–2021 while ensuring compliance with the General Data Protection Regulation. Each CVI provided 41 or 42 records of male flocks and 38 of female flocks. In total, data from 238 flocks were analysed. With a low number of incomplete data sets making some few exceptions, the production records contained the following data: the poult insertion date; their sex; the number of poults inserted; the commercial name of the genetic hybrid; the vaccinations given; the clinical examinations conducted and veterinary diagnoses made; a list of administered drugs, including the commercial name of the drug, the name of the active substance and the period of administration; the date of issue of the official health certificate for the flock; the number of birds sent for slaughter and the cumulative mortality rate (%).

Based on the records, the amount of active substance used in the periods of individual treatments was calculated for each flock, assuming that the drug was administered in the maximum dose recommended by the manufacturer per 1 kg of turkey body weight. The body weights of the birds during the therapy were estimated based on data sheets of genetic hybrid meat-type turkeys of individual turkey hybrid producers. The total amount of active substances used in the whole rearing period and the weight of the livestock sold from a given flock was calculated, which finally made it possible to calculate the amount of active substances used in a given flock per 1 kg of bird weight (mg/kg). The respective data is presented with division into years of rearing (2019, 2020 and 2021) and separately for male and female turkeys. The results were also sorted according to the level of antibiotic use, allocated to one of the following ranges: 0, 0.10–5.00, 5.01–10.00, 10.01–50.00, 50.01–100.00, 100.01–150.00, 150.01–200.00, 200.01–250.00, and >250.01 mg/kg. In addition, the data for flocks of turkeys regarding the amount of the active substance used in separate therapies enabled the use of individual active substances in 2019–2021 to be calculated.

Antibiotic use per kilogram of bird weight was also calculated in the flocks separately for the different immunoprophylactic measures undertaken against infectious turkey rhinotracheitis (TRT). The flocks were divided into the six following groups: Poulvac TRT (Zoetis, Parsippany, NJ, USA) on the 1st day of life (d.o.l.), Poulvac TRT on the 1st d.o.l. with additional subsequent vaccination, Aviffa RTI (Boehringer-Ingelheim, Ingelheim, Germany) on the 1st d.o.l., Aviffa RTI on the 1st d.o.l. with additional subsequent vaccination, Aviffa RTI simultaneously with Poulvac TRT on the 1st d.o.l., and Aviffa RTI simultaneously with Poulvac TRT on the 1st d.o.l. with additional subsequent vaccination.

Besides the above division, a group of turkey flocks was identified which was administered an autogenous vaccine freely combined with each vaccination scheme.

Statistical analysis. Differences in the total use of antibiotics in the analysed flocks of turkey toms and hens in study years were determined with the use of the Kruskal–Wallis non-parametric test for independent samples. Statistical analysis was performed using Statistica 13.1 (TIBCO, Palo Alto, CA, USA). Differences were considered significant at a confidence level of 95% ($P < 0.05$).

Results

Characteristics of the analysed flocks. Table 1 presents basic data characterising the analysed flocks of turkeys. The numbers of males or females per flock were very inconstant and ranged from 1,050 to 34,995 and 4,250 to 29,942 respectively. The estimated minimum and maximum weight of livestock sold per flock is presented in Table 1.

Antibiotic use in the analysed turkey flocks. Table 2 presents the results of the conducted analysis without division into years. The data covers a total of 238 flocks, comprising 124 flocks of males and 114 flocks of females. When expressed per 1 kg of livestock produced, 227 mg of active substances were used in male flocks, and 173 mg in hen flocks. Without taking into consideration the sex of the birds, 209 mg of active substances were used per 1 kg of livestock produced.

Table 1. Overview of turkey flocks analysed in the study

	Minimum		Maximum	
	♂	♀	♂	♀
Number of poults	1,050	4,250	34,995	29,942
Weight of livestock sold (kg)	21,640	27,297	648,214	294,584

Table 2. Use of antibiotics in the analysed turkey flocks in the three-year period 2019–2021

	Males	Females	Total
Number of flocks	124	114	238
Number of birds (poults)	1,025,725	1,053,984	2,079,709
Weight of livestock sold, t	19,312	9,838	29,150
Amount of active substances used, kg	4,385.4	1,702.6	6,088
Use of active substances per livestock weight, mg/kg	227	173	209

Table 3. Use of antibiotics in the analysed turkey flocks in individual study years

	Year of study		
	2019	2020	2021
Number of flocks	76	81	81
Males	43	39	42
Females	33	42	39
Number of poults	604,656	696,058	778,999
Males	311,656	315,987	426,341
Females	293,000	380,071	352,654
Weight of livestock sold, t	8,446	9,474	11,230
Males	5,702	5,767	7,843
Females	2,744	3,707	3,387
Amount of active substances used, kg	2,256.8	2,085.0	1,746.0
Males	1,726.1	1,391.9	1,267.3
Females	530.7	693.1	478.7
Mean ± SD use (mg/kg) of antibiotics in a given year	258 ± 220.1[a]	204 ± 157.4[a]	149 ± 130.4[b]
Males	299 ± 215.9[a]	241 ± 154.6[b]	157 ± 134.2[b]
Females	206 ± 217.5[a]	178 ± 155.1[a]	140 ± 127.2[a]

a, b – Mean values in a line with different superscript letters differ significantly (Student's *t*-test, $P < 0.05$)

Table 4. Use of antibiotics per livestock weight in the analysed flocks of turkeys, considering antibiotic use intervals

Antibiotic use intervals (mg/kg)	Number of turkey flocks								Males and females
	Males				Females				
	2019	2020	2021	Total	2019	2020	2021	Total	
0	0	0	2	2	0	0	1	1	3
0.1–5	0	3	5	8	1	1	1	3	11
5.01–10.00	1	0	0	1	0	1	0	1	2
10.01–50.00	1	2	3	6	5	8	9	22	28
50.01–100.00	4	5	5	14	7	5	12	24	38
100.01–150.00	5	1	7	13	7	8	4	19	32
150.01–200.00	5	3	9	17	3	7	2	12	29
200.01–250.00	5	5	3	13	0	5	4	9	22
> 250.01	22	20	8	50	10	7	6	23	73

Table 5. The mean use (mg/kg) of different antibiotic classes in the analysed turkey flocks in individual study years

	Males			Females		
	2019	2020	2021	2019	2020	2021
Amoxicillin	73.6	32.3	43.3	46.6	46.2	59.4
Colistin	45.1	40.1	19.4	30.1	22.2	18.5
Doxycycline	99.6	83.2	52.5	72.1	42.1	35.8
Enrofloxacin	13.3	16.5	5.1	17.7	18.9	4.8
Florfenicol	0.4	0.0	0.0	0.5	0.0	1.0
Lincomycin	3.9	1.0	0.7	1.3	1.6	2.7
Neomycin	0.6	1.5	0.4	4.0	0.2	0.0
Phenoxymethylpenicillin	0.0	0.0	1.4	0.6	0.0	0.4
Oxytetracycline	1.7	0.9	0.0	0.0	0.6	2.0
Spectinomycin	2.5	0.6	0.3	0.5	2.9	0.4
Sulfamethoxazole	9.1	2.4	6.4	7.7	9.2	2.4
Sulfadimethoxine	0.0	31.1	6.3	0.0	0.0	4.8
Trimethoprim	1.9	7.1	2.9	2.5	1.8	1.6
Tilmicosin	2.1	2.3	0.1	0.0	0.0	0.0
Tylosin	45.3	7.3	9.0	22.4	32.1	6.3
Apramycin	0.0	2.1	9.2	0.0	0.0	0.0
Tiamulin	0.0	12.5	0.0	0.0	0.0	0.0
Total	299.0	241.0	157.0	206.0	178.0	140.0

Table 6. Use of antibiotics per livestock weight in flocks of turkeys administered autogenous vaccines

Males		Females		Total	
Number of flocks	Antibiotic use mg/kg	Number of flocks	Antibiotic use mg/kg	Number of flocks	Antibiotic use mg/kg
29	171	11	166	40	170

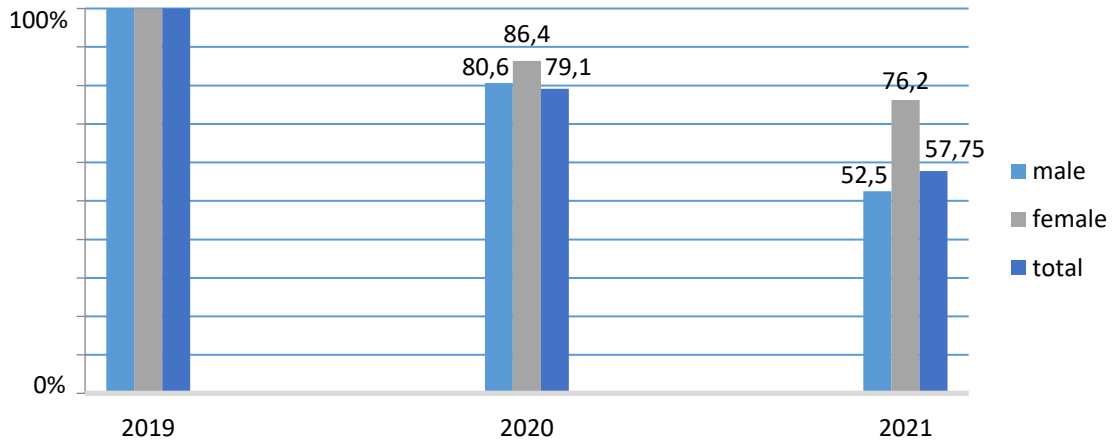

Fig. 1. Trends in the use of antimicrobials per livestock weight in flocks of male and female turkeys in individual study years

Table 3 presents data on the use of antibiotics in particular study years. Figure 1 depicts trends in the use of antibiotics per livestock weight in flocks of male turkeys and female turkeys in individual study years. The reference value (100%) was adopted based on data from 2019. As presented in Table 3, a statistically significant decrease in the antimicrobial use per livestock weight (mg/kg) was reported in the male turkey flocks in 2020 and 2021 in comparison to the data from 2019. Despite the fact that such differences were not reported for the female flocks, a significant decrease in antimicrobial use in 2021 was recorded in total compared to use in 2019 (Table 3).

As shown in Table 4, in 14 flocks of turkeys, *i.e.* in approximately 6% of the analysed flocks, the amount of active substances used did not exceed 5 mg/kg. Three of these flocks, *i.e.* approximately 1%, did not receive antibiotics at all. In 73 flocks (approximately 31%),

antibiotic use exceeded 250 mg/kg, with the number of such flocks of males being more than double that of females (50 *vs* 23). The highest use of antibiotics per livestock weight, amounting to 1,115 mg/kg, was found in a flock of male turkeys. The maximum use in the flocks of female turkeys was 996 mg/kg.

In Table 5, the consumption (mg/kg) of different antibiotic classes in male and female turkey flocks in different years of analysis is summarised. Between 2019 and 2021, colistin, doxycycline, enrofloxacin and tylosin were the antibiotics for which the greatest decrease in usage was recorded in flocks of male and female turkeys and amoxicillin was administered markedly less to the flocks of male turkeys over these years, although the differences between a year's use and the following year's were not statistically significant.

Use of antibiotics in turkey flocks broken down by TRT immunoprophylactic strategy. Analysing the impact of the type of immunoprophylactic strategy against TRT, no statistically significant differences were found in the use of antibiotics per livestock weight in turkey flocks. In the flocks vaccinated only on day 1 of life with the Poulvac TRT vaccine, it was 215 mg/kg, and in those administered Aviffa RTI vaccine it was 208 mg/kg. When both vaccines were combined, the use of antibiotics per livestock weight was 176 mg/kg. Additional vaccination of the turkeys at a later age caused no statistically significant change in the antibiotic use per livestock weight, regardless of vaccine type (data not shown). Thirty-four production records lacked information about the vaccination programme against TRT.

Use of antibiotics in flocks of turkeys treated with autogenous vaccines. Table 6 shows the use of active substances per livestock weight in 40 flocks of turkeys (29 of males and 11 of females) administered an autogenous vaccine. In these 40 flocks (17% of all analysed flocks), the use of antibiotics was 170 mg/kg, which was approximately 19 % lower than the average for all 238 flocks (209 mg/kg) and approximately 22% lower than in the flocks of turkeys not administered this vaccine (217 mg/kg). These differences were statistically significant (P = 0.032 and 0.011, respectively).

Discussion

Nearly 70% of antibiotics used in the EU Member States are administered in animal production. Since 2010, the European Medicines Agency (EMA) has been monitoring the amounts of active antimicrobial substances sold and has published them in the form of annual reports covering 31 European countries. According to the latest EMA report (8), over 5.5 thousand tonnes of active substances were used in animal husbandry in 2020 in the monitored countries, which translates to 89 mg per 1 kg of animal body weight (population correction unit – PCU). In the same year, 853 tonnes of these substances were used in Poland (which accounts for approximately 15.3% of the total use in the monitored countries), which gives 187.9 mg/PCU. In more than half of the monitored countries, the value of this indicator recorded in 2020 was below 50 mg/PCU.

The cited report (8) also documents changes in the use of antibiotics per livestock weight in the period since 2010 (for some countries this period is shorter). Poland belongs to a small group of countries where the value of this indicator in 2020 was higher than in 2010 or 2011 (8). It increased from 126.3 mg/PCU in 2011 to 187.9 mg/PCU in 2020. Pursuant to Regulation 6/2019/EU (22) and based on EMA monitoring data (7), the Member States are obliged to reduce the use of antibiotics by 50% by 2030. While antibiotic administration was noted to have risen in Poland in the period preceding Regulation 6/2019/EU's entry into force, thereafter, at least in turkey rearing, the use of these substances in the country appears to be falling as it should in view of Poland's member state obligation.

Although this manuscript presents only estimates of the calculated indicators, it may be concluded that the use of active substances per livestock weight decreased in both male and female turkey flocks in 2019–2021. In this period, the value of this indicator decreased from 299 mg/kg to 157 mg/kg in flocks of males (a significant decrease of approximately 47.5%) and from 206 mg/kg to 140 mg/kg (a decrease of approximately 33.8%) in flocks of females. Taking both turkey sexes together, the use of antibiotics per livestock weight decreased significantly in the analysed period, falling by approximately 42.25%. This should be considered a very positive trend, demonstrating the possibility of meeting the EU recommendations for a 50% reduction in the use of antibiotics in animal production by 2030. It is also worth noting that in approximately 6% of the analysed flocks, the amount of active substances used did not exceed 5 mg/kg, and over 1% did not receive antibiotics at all. Assuming 187.9 mg/PCU as the base value for estimating the scale of the continual reduction in antibiotic use, the result that Poland would have to achieve for turkeys by 2030 would be below 94 mg/PCU (8). Taking into account the trend observed in the present study, indicating a successive reduction in the use of antibiotics in flocks of turkey toms and hens for fattening, this goal seems to be achievable.

Numerous strategies aimed at reducing the need to use antibiotics in large-scale animal production are currently being considered and evaluated. Most of these strategies are based on actions aimed at minimising the risk of an infectious disease in livestock herds. Magnusson (19) concluded that the three main measures to prevent infectious disease on a poultry farm (and therefore to minimise the antibiotic use) are good animal husbandry (*e.g.* good quality of feed and water, good ventilation and efficient inspection of the animals); effective biosecurity (*e.g.* only buying chickens or pullets from disease-free suppliers and imposing strict hygienic demands when entering the turkey or hen houses); and vaccinations which can protect birds

against specific poultry diseases. In the present study, we had no information on rearing conditions or the biosecurity regime prevailing on turkey farms; therefore, we were unable to estimate the relationship between these parameters and the level of antibiotic use. The available data granted only the possibility of analysing the impact of modifications on turkey vaccination strategies on antibiotic use, with the immunoprophylaxis of TRT (the dominant viral disease of turkeys with a very high incidence in birds) and the use of autogenous vaccines as a model for the analysis.

Despite the great pressure currently posed by avian metapneumoviruses in turkey production of both toms and hens (17, 24), there were no significant differences in the use of antibiotics per livestock weight between flocks (of both sexes) receiving one specific TRT prophylaxis strategy and flocks receiving a different one. What is interesting, however, is the fact that in the flocks administered autogenous vaccines, a 19% lower use of antibiotics was recorded in the entire analysed period, regardless of the sex of the birds. It is worth noting that autogenous vaccines are preparations from inactivated bacteria, derived directly from the farm where they are ultimately used (15, 16); hence, the level of homology between the strains contained in the vaccine and field strains is very high. Vaccination with inactivated antibacterial preparations has previously been shown to be very effective in reducing bird morbidity and mortality, particularly if there is high homology between the bacterial strains contained in the vaccine and field strains (15, 16, 18), which may indirectly explain the relationships observed in the present study. It should also be borne in mind that the efficacy of antibiotic therapy is the result of two main elements: the sensitivity of the microorganism to a given antibiotic and the efficiency of the immune system (2). Considering that the construction of autogenous vaccines is mostly based on bacteria that previously caused relevant cases of clinical diseases in given flocks, it can be presumed that the stimulus of the immune system provided by these vaccines may directly and indirectly contribute to the limited need for antibiotics in poultry flocks.

The increasing antibiotic resistance of bacteria and the related threat to public health challenge poultry production in Poland to minimise the amount of antibiotics used. The EMA report (8) shows that in 2020 in 31 monitored EU countries, the average use of active antibiotic substances in animal production was 89 mg/PCU, and in more than half of the monitored countries it was below 50 mg/PCU. In Poland, the average use of antibiotics at that time was 187.9 mg/PCU. Data were lacking in this country on the use of antibiotics in individual areas of animal production, and therefore their use was analysed through a selection of such data as were available. Those selected were for flocks of meat-type turkeys reared in the years 2019–2021 in the Warmia and Mazury region. They show that in this period there was a significant decrease in the use of active antibiotic substances per livestock weight in broiler turkey production in this region. An average of 42.25% less was administered, *i.e.* a reduction from 299 to 157 mg/kg body weight (a significant decrease of 47.5%) in male turkeys and from 206 to 140 mg/kg body weight (a decrease of 33.8%) in female turkeys. The positive trend shown in our study proves the attainability of the EU-recommended 50% reduction in the use of antibiotics in animal production by 2030. A strong indication of the feasibility of this reduction coming from the present study is that in 6% of the analysed flocks, the use of antibiotics was at the level of 5 mg/kg or less or was zero. In order to achieve this goal, even more emphasis should be placed on measures minimising the risk of infectious diseases requiring antibiotic therapy, particularly welfare, biosecurity, immunomodulation and specific prophylaxis improvements.

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