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Solutions limiting the use of antibiotics in poultry production in Poland and other European Union countries

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SUMMARY

The widespread occurrence of drug resistance among bacteria around the world poses a serious threat to the health and life of humans and animals. One of the global strategies adopted is the jointly developed 'One Health – from farm to fork' concept, within which measures are implemented to completely eliminate the use of antibiotics in animal production.

The aim of this review article is to present the latest statistical data on the use of antibiotics in farm animals, with special focus on poultry, in particular in Poland in comparison to other European countries, on the basis of EVSAC (European Surveillance of Veterinary Antimicrobial Consumption) reports. The article also presents measures making it possible to reduce the use of antibiotics in poultry farming, including biosecurity schemes proposed by European public health associations, as well as other solutions involving diet modification, prevention programmes, and other programmes for managing poultry flocks, including the results of our own research, mainly in Poland.

The final conclusions indicate the need to introduce obligatory reporting of the use of antibiotics in animal production by all countries in the world, not only in Europe. In addition, there is a need to implement monitoring procedures, effective biosecurity, changes in management, and educational activities associated with multiple areas of the economy for various social groups, such as food producers and breeders, to raise awareness of the threats arising from the use of antibiotics.

KEY WORDS: Antibiotic resistance, AMR, Biosecurity, Poultry production, Legislation, Reports

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INTRODUCTION

The global problem of drug resistance among bacteria around the world and the rapid spread of drug resistance genes among different species of bacteria, including environmental bacteria, point to a progressive threat to the health and life of humans and animals. For this reason, the One Health concept, introduced all over the world, involves measures affecting multiple areas of the economy, implemented at the global, national, regional, and local level. Its overriding goal is to achieve optimal health outcomes in populations of humans, animals and plants functioning in a common environment and forming diverse ecosystems. The concept itself recognizes the need to connect the health of humans and animals and the environment, which is possible owing to increased cooperation between multiple sectors of production representing various scientific fields and disciplines (Koopman et al. 2021). One such measure undertaken on a global scale involves preventing the occurrence of antibiotic residues and limiting the spread of drug resistance among bacteria. For this purpose, legislative processes were initiated in European Union countries in 2009, leading to a substantial reduction or complete elimination of the use of selected groups of antibiotics in animal production, especially in the poultry sector.

DISCUSSION

According to the latest reports from the European Public Health Alliance (EPHA, 2022), Poland remains one of the largest users of antibiotics in agriculture in Europe and one of the few European countries in which sales of active antibiotic substances in recent years (2020–2022) have been very high (Table 1).

In the years 2011–2020, the use of antibiotics in Poland increased steadily from 472.9 tonnes of active substances in 2011 to 856.7 tonnes in 2020. This was due in part to a lack of effective systemic solutions and the continual growth of intensive animal production, especially poultry. Production of poultry meat in European countries is second only to pork production. Poultry production in 2020 amounted to 13.6 million tonnes, and one of the leading producers was Poland (19.8% of total production), in which the level increased by 4.0% (EPHA, 2022).

Reports presented by individual European countries show that the use of antibiotics for poultry has decreased significantly in many countries. Only three countries – Poland, Germany and Spain – noted an increase in or stabilization of consumption of antibiotics in the last three reporting years (2020–2022). It should also be stressed that statistics from 2021 indicate a reduction in the use of antimicrobials in poultry production in all European countries, which was linked to the COVID-19 pandemic (Fig. 1). The renewed increase in the use of antibiotics in poultry production in 2022 in six countries, including Poland, raises concern. At present, the report for 2023 is not yet available. One of the most important and most recent legal acts concerning the use of antibiotics is Regulation (EU) 2019/6 of the European Parliament and of the Council of 11 December 2018 on veterinary medicinal products and repealing Directive 2001/82/EC (Text with European Environment Agency (EEA) relevance; PE/45/2018/REV/1, OJ L 4, 7.1.2019, p. 43–167). According to the regulation, member states are required to collect data on antimicrobial medicinal products used in animals. New regulations in force since January 2022 also limit the use of antibiotics in animals for metaphylaxis (2019/6).

Table 1.
Sales of antibiotics in the veterinary sector in Poland and other European countries according to reports in 2020–2022, in mg/PCU (EPHA, 2022; EVSAC reports 2021, 2022)

Total sales of antibiotics (mg/PCU)	**European Countries**		
	2020	**2021**	**2022**
≤254.7	Cyprus, Bulgaria, Hungary, Italy, **Poland,** Portugal	Cyprus, Hungary, Italy, Malta, **Poland,** Portugal, Spain	Cyprus, Italy, Malta, **Poland**
≤170	Spain	Belgium, Bulgaria, Greece	Bulgaria, Hungary, Spain
≤150	Malta, Belgium		
≤100	Greece, Germany	Estonia, Germany, France, Ireland	Greece, Portugal
≤86	Croatia, Romania	Austria, Croatia, Czech Republic, Denmark, Netherlands Romania, Slovakia, Switzerland	Belgium, Czech Republic, Estonia, France, Germany, Romania, Slovakia, Slovenia
≤50	Czech Republic, France, Slovakia, Netherlands, Estonia, Ireland, Austria, Denmark, Switzerland, Slovenia, Latvia, United Kingdom, Luxemburg, Lithuania		Austria, Croatia, Denmark, Netherlands, United Kingdom, Lithuania, Ireland
>2.1<10	Finland, Iceland, Norway, Sweden	Finland, Iceland, Latvia, Lithuania, Luxemburg, Norway, Sweden, United Kingdom	Finland, Iceland, Latvia, Luxemburg, Norway, Sweden, Switzerland

According to Regulation (UE) 2021/578, the obligation to collect data on the use of antibiotics in individual European countries is to be gradually introduced according to defined species of animals:

– From 2024 reporting of data on the use of antibiotics in beef cattle, dairy cattle, pigs, broiler chickens, layer hens, and turkeys,
– From 2027 reporting of the use of antibiotics in other animals used for consumption (e.g. sheep, goats, fish, rabbits, and horses),

– From 2030 reporting of the use of antibiotics in companion animals – cats and dogs – and animals raised for fur (e.g. mink).

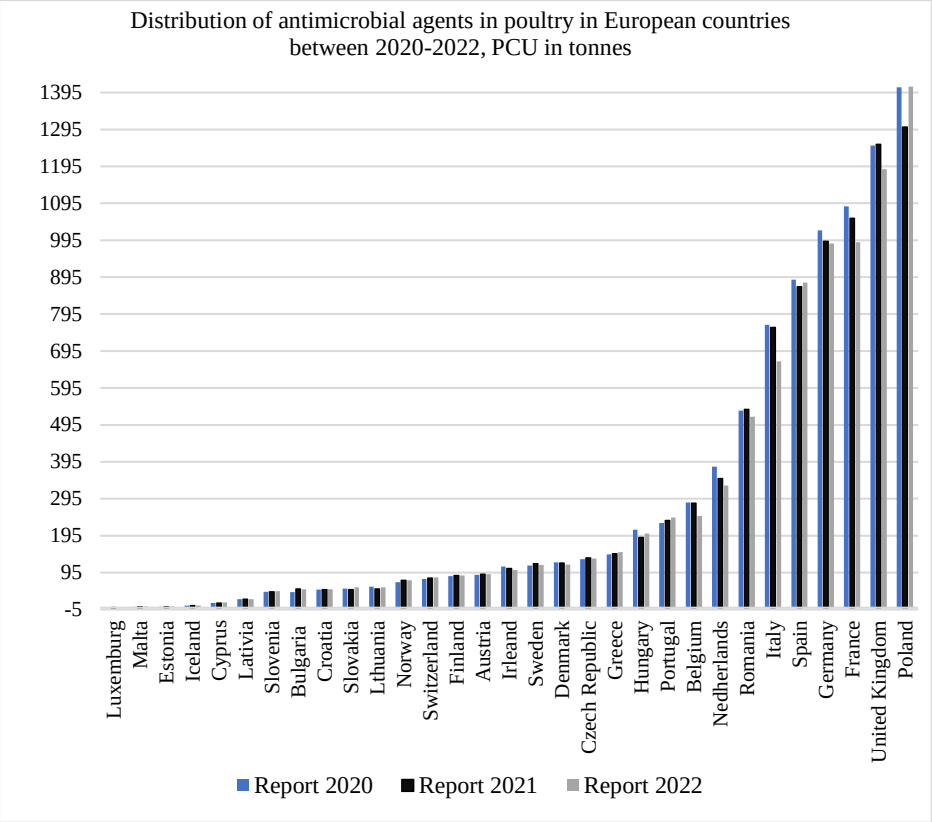

Figure 1**.** ESVAC reports from 2020, 2021, 2022 on the distribution of antimicrobial agents in poultry production in 32 European countries, calculated as PCU in tonne.

Reports of this type have been prepared in European countries, particularly in those belonging to the EU, for a few years. These were not obligatory, but were a response to the need to demonstrate a given country's policy on reducing the use of antibiotics, especially in farm animals. Statistics on sales of antibacterial substances (tonnes of active substances) in farm animals in Poland and in 31 European countries, including the United Kingdom, indicate that Poland has a significant share in the use of selected groups of antibiotics, e.g. penicillin and tetracycline, amounting to 21.4% and 13.5%, respectively, on a global scale (Fig. 2) (ESVAC report, 2022).

Increasing public awareness and understanding is crucial to reducing the use of antibiotics. For this reason it is essential to obtain the support of all sectors of production and fields of science, including human and veterinary medicine, producers of food of animal and plant origin, farmers and animal breeders, and pharmaceutical companies (Manzanilla, 2019).

The cooperation of animal breeders and veterinarians, based on mutual trust, is also of great importance in reducing the use of antimicrobials in animal production. Knowledge must be effectively passed on to poultry farmers by competent individuals such as veterinarians, animal husbandry and feeding specialists, and other specialists in production and welfare technology in areas in which training is required, such as biosecurity, feeding, immunoprophylaxis, or genetics (Amato et al., 2021).

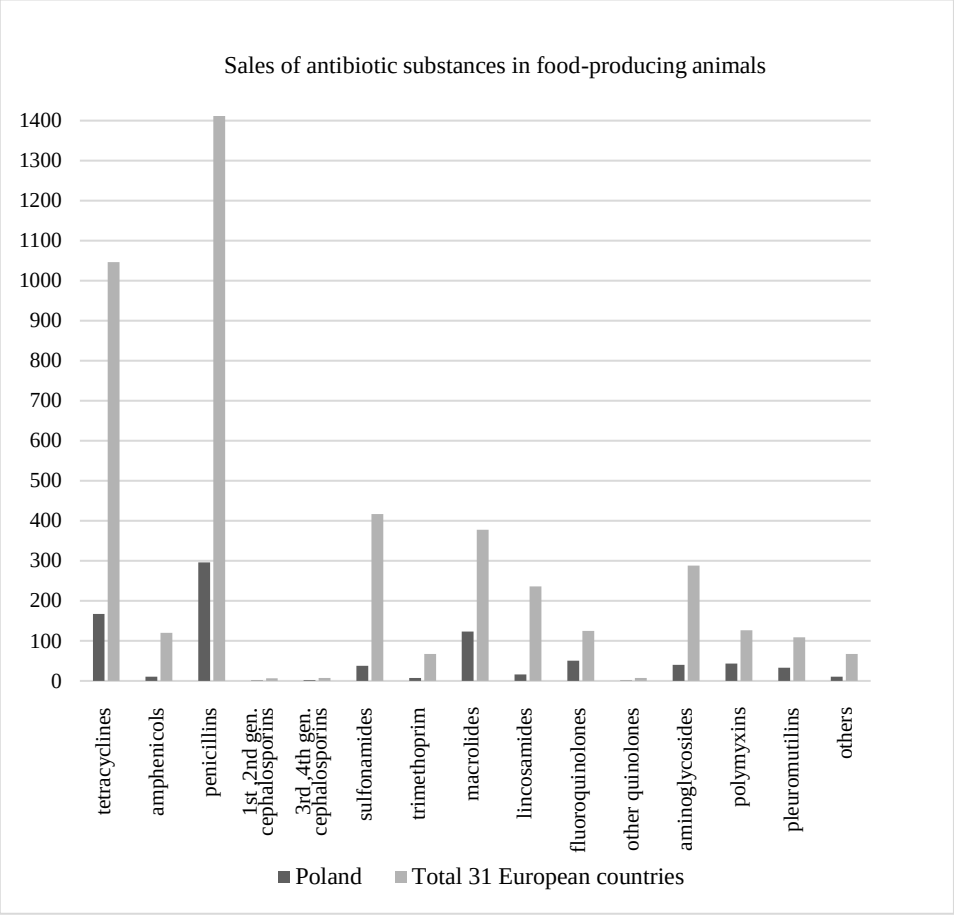

Figure 2. The 31 European countries included were Iceland, Malta, Luxemburg, Latvia, Norway, Slovenia, Estonia, Finland, Sweden, Slovakia, Lithuania, Croatia, Switzerland, the Czech Republic, Austria, Cyprus, Bulgaria, Ireland, Denmark, Portugal, Hungary, Greece, the Netherlands, Belgium, the United Kingdom, Romania, France, Germany, Italy and Spain.

The veterinarian carrying out educational activities for livestock farmers should impart information on the procedures used, taking into account risk analysis in assessment of the breeding

environment, the epidemiology of infections, the causes of diseases, and basic biosecurity principles. It should be stressed that antibiotics should be used in antimicrobial treatment only when necessary and in accordance with a prior diagnosis. The choice of drug should be based on the results of laboratory tests, including evaluation of the drug susceptibility of the bacteria. Broad-spectrum antimicrobials and those used in human medicine should not be used. Breeders should be made aware that antibiotics do not work on viruses, and in the case of bacterial infections, antibiotics should not be the first choice (Amato et al., 2021).

According to The European Innovation Partnership for Agricultural productivity and Sustainability (EIP-AGRI) Focus Group report (2021), in the biosecurity system, especially in areas with a high concentration of poultry farms, particular attention should be paid to the following:

- Locating and arranging livestock buildings in such a way as to prevent the transmission of infectious bacteria to the farm from outside, between poultry production sectors on the same farm, and through vectors such as rodents, wild birds, equipment, people, and other factors.
- Proper flock management procedures and feed programmes adapted to the species, type, and age of bird and to the production level.
- A high level of hygiene, at the farm level and in individual flocks, by ensuring proper ventilation, available sources of clean water, dry litter, and parasite control.
- The implementation of effective biosecurity procedures, i.e. hygiene barriers, visitor control, pest control, a ban on feeding poultry outdoors, familiarizing employees with the fundamentals of the epidemiology of infectious diseases, and implementation of standard operating procedure (SOP) documentation on all poultry farms.
- Regular monitoring of the health of the flock and permanent implementation of screening tests, especially in breeding flocks.
- The development of strategic vaccination programmes for every flock in order to reduce and eliminate the occurrence of disease in a given area, especially in areas with a high concentration of farms. Vaccination programmes and the choice of vaccine should be adjusted to the local situation in a given area and depend on the prevalence of specific serotypes of pathogens.
- Fast and accurate diagnosis of diseases and education of poultry farmers and farm employees regarding recognition of the general symptoms of a disease at the early stages and the basic principles of disease prevention, especially on outdoor poultry farms.
- Knowledge about the use of antimicrobials and the threats arising from the occurrence of drug-resistant bacteria, as well as about prudent use of these drugs in order to avoid increasing drug resistance, should be widely shared among poultry farmers and others associated with the poultry production sector (including scientists). Educational activities should also take into account the principles of animal welfare.

The main goal of the global poultry industry is to produce safe food for consumers in an economically sustainable environment with prudent use of antibiotics. This can be achieved through consistent implementation of the principles of biosecurity, comprehensive vaccination programmes for poultry flocks, fast and efficient diagnosis of diseases, and the development of modern methods of diagnosis of pathogens. An important role is also played by the development and implementation of suitable feeding strategies, e.g. through supplementation with substances which stimulate natural immune mechanisms in birds and thereby reduce the need for antimicrobials. It is almost mandatory

to develop, implement and understand SOP on every farm, including widespread exchange of knowledge, e.g. on online platforms, as well as the use of specific genetic selection of birds, taking into account genotypes which are slower-growing and thus more resistant to infection (Manzanilla, 2019).

The poultry industry

The possibility of following all procedures from farm to fork in the poultry sector is one of the most visible examples of good veterinary and breeding practices (Manzanilla, 2019). A list of recommended breeding practices in poultry production, which can help to reduce the use of antimicrobials in poultry, was presented by a special Focus Group in the EIP-AGRI Report in 2021.

The general concepts of good and best practices aimed at limiting the use of antimicrobials are common to various animal species. Good practices include specific alternatives in the fight against problems with disease, mainly through changes in feeding, vaccination, and to some extent breeding. Good practices also include a non-specific approach, such as changes in human habits and behaviour and overall improvement in animal health (e.g. biosecurity) and welfare (e.g. management). Within these criteria, supervision of the following is carried out:

Biosecurity

Biosecurity plans and standards, including SOP documentation, should be reviewed and evaluated on the basis of scientific criteria, and the results should be made available to all users. The use of SOPs which are easily available and comprehensible to farm personnel is essential to avoid injustices in animal farming. SOP has become more available and taken on greater importance in recent years. Cleaning, disinfection and drying of poultry houses are key components of biosecurity implementing the basic elements of biocontainment and bioexclusion. A very important element of the biosecurity programme is periodic monitoring of the effectiveness of the measures applied, which should also be detailed in SOP documentation. Most poultry producers, irrespective of the form of production, allow periods of downtime, which should be strictly adhered to. Protocols for cleaning and disinfection of indoor spaces and equipment used in poultry production should be individually adapted to each farm and strictly adhered to. It is also extremely important to educate and increase the awareness of farm workers on the importance of cleaning and disinfection and applicable internal biosecurity rules. Control of rodents and other pests, as potential vectors of transmission of pathogens, should be the basis of biosecurity principles. To this end it is worth using the services of specialized sanitation companies. In the context of environmental protection, the interactions between the preparations used and the external environment and ecosystems should also be taken into account, leaning towards more ecological preparations (EIP-AGRI Report, 2021).

Data collection and sharing

Examples of data sharing include the exchange of information between countries on the use of antimicrobials, slow-growing genetic lines, the epidemiology of diseases, genetic variation, and the effects of implementation of good breeding practices. Coordinated efforts between countries, including those with fewer resources, would increase progress throughout the EU. Access to documentation confirming the absence of specific diseases, health certificates (import control), and monitoring programmes, particularly when birds are moved, will make it possible to avoid the spread of infectious diseases onto farms which are free of given diseases (EIP-AGRI Report, 2021).

Diagnostics

As part of diagnostic procedures, tools are implemented for testing and monitoring farms in terms of flock health, characterization of pathogens, and profiling of pathogen resistance. Diagnostics including identification of bacteria and their pathogenicity and drug resistance profiles will make it possible to initiate fast and effective treatment. Rapid diagnosis on the farm, supported by precise information about production and disease history, can accelerate the treatment process by at least 1–2 days, reducing the need to wait for the results of tests of samples sent to the laboratory (EIP-AGRI Report, 2021).

Treatment

To be effective, treatment should be initiated only following diagnosis, particularly in the case of treatment with antimicrobials. To this end, appropriate diagnostics (clinical and laboratory) should be performed in accordance with regulations and good practice, as well as an antibiogram in the case of bacteria. It is also essential to assess the effectiveness of the treatment after it has been implemented, by analysing health parameters such as mortality, weight gain, or the behaviour of birds. This information can be helpful in future treatment and can be the basis for effective disease prevention.

Vaccinations

Implementation of comprehensive and universal vaccination programmes, with particular focus on viral poultry diseases (Newcastle disease, infectious bronchitis, infectious bursal disease, Marek's disease, avian paramyxovirus 3 infection, infectious laryngotracheitis, reovirus infections, turkey rhinotracheitis, swollen head syndrome, chicken anaemia, egg drop syndrome, haemorrhagic enteritis, avian encephalomyelitis, avian poxvirus infection, and Derzsy's Disease), should be the basis of any prevention programme in the flock. Examples of vaccination programmes for the prevention of viral diseases in individual poultry flocks are presented in Tables 2 and 3 (Koncicki, 2006). The individually developed programme for the flock/farm should be based on analysis of parameters such as the level of maternal immunity, the current immune status of the flock and entire farm, and the epidemiological status of infectious disease factors in a given region. Actions associated with transport, handling of vaccines on the farm, or administration of the vaccine itself play a key role in effective immunoprophylaxis of poultry diseases. It should be emphasized that every preparation used in vaccination has clear instructions for use and storage conditions, an expiration date, means of application, and dosage, which should be strictly adhered to.

Ideally, coordinated vaccination programmes and monitoring of their effectiveness would be introduced as well. Vaccines are no longer used exclusively at the level of the individual farm. Vaccinations which animals receive at previous stages should be well known, and the effectiveness of vaccinations on farms should be monitored so that adverse side effects can be responded to quickly and in a coordinated manner (EIP-AGRI Report, 2021).

Table 2.
Examples of vaccination programmes against viral diseases in chicken and turkey flocks.

Age	Breeding flocks of laying hens	Breeding flocks of meat chickens	Commercial flocks of laying hens (layers of table eggs)	Flocks of chicken broilers	Turkey breeding flocks	Flocks of turkey broilers
1 day	MD; ND; IB	MD; ND; IB	MD; ND; IB	ND; IB	TRT	TRT
6-10 days	REO	REO	-	-	-	-
10-14 days	-	IB	IBD	IBD	ND	ND
14-18 days	IBD	IBD	-		-	-
19-21 days	-	-	IBD	IBD	TRT	TRT
24-28 days	IBD	IBD			-	HE
4 weeks	ND; IB	ND; IB	ND ; IB	ND	-	-
5-6 weeks	REO	REO	-	-	ND	-
7-8 weeks	IB; ND	IB; ND	ND ; IB	-		TRT
9-10 weeks	REO; CA	REO; CA	SHS	-	TRT	ND
11 weeks	IBD	IBD	-	-	ND	-
12-13 weeks	SHS	SHS	AE	-		-
14-15 weeks	AE	AE	-	-	AE	-
16 weeks	SHS	SHS	ND; IB; EDS; SHS	-	-	-
18-19 weeks	IBD; ND; IB; REO; EDS	IBD; ND; IB; REO; EDS	-	-	ND; TRT; PMV 3	-
27-28 weeks	-	-	-	-	ND; TRT; PMV 3	-

ND – Newcastle disease, IB – infectious bronchitis, IBD – infectious bursal disease, MD – Marek's disease, APM-3 – avian paramyxovirus 3 infection, ILT – infectious laryngotracheitis, REO – reovirus infections, TRT – turkey rhinotracheitis, SHS – swollen head syndrome, CA – chicken anaemia, EDS – egg drop syndrome, HE – haemorrhagic enteritis, AE - avian encephalomyelitis, POX – avian poxvirus infection

Table 3.
Examples of vaccination programmes against Derzsy's Disease in flocks of geese and Muscovy ducks

Age	Flocks of geese and Muscovy ducks	Flocks of slaughter geese and Muscovy ducks
1 day*	Specific serum	Specific serum
14–21 days	Live vaccine	Live vaccine
6–7 weeks before laying	Live vaccine	
4 weeks before laying	Live vaccine	

*Specific serum exclusively in chicks from non-vaccinated flocks or those with a low level of antibodies

Precision breeding and genetics

Precision breeding in the case of poultry is especially well developed, including through the use of outdoor systems and treatment of poultry flocks as a whole rather than as individual animals.

A very important role in safe and effective poultry farming is played by genetics, appropriately adapted to the specific conditions and systems of maintenance and use. The quality of the birds' environment is crucial in poultry production. Attention to detail is important, especially in the initial stages of production. For example, litter quality and monitoring of feeding in the first week of rearing of broiler chicks has a major impact on the animal's development. Continuous monitoring of the environment in terms of basic microclimate parameters in buildings (temperature, humidity, and lighting) is another important factor determining the normal growth of chicks, which can also be controlled owing to precision breeding (EIP-AGRI Report, 2021).

In the case of genetic selection, despite the lack of a clear correlation with disease resistance, it is widely believed that slow-growing flocks have determinants associated with increased resistance to certain environmental factors. The use of appropriate genetic selection and the provision of suitable living conditions and management for birds from highly productive genetic lines can help to reduce the occurrence of diseases and thus the use of antimicrobials (EIP-AGRI Report, 2021).

Control of antimicrobial resistance (AMR)

An important role is played by constant monitoring and supervision of all poultry production chains. All data on the use of antimicrobials should be clear, whether in the private or public sector**.**

Another important step is for member countries to create systems for comparison and reference values which would define directions of action and responsibilities for poultry producers (EIP-AGRI Report, 2021).

AMR control also seems to require periodic assessment of the effects of the use of antimicrobials on the environment on farms and measures taken to minimize antibiotic residues on the farm. Alternative methods to antibiotics for controlling bacteria must be developed, e.g. using bacteriophages and feed additives.

Water quality

Water is even more important in poultry production than in the case of other species, because it is regularly used as a carrier for drugs and vaccines, especially in large-scale poultry production systems. Measures must be taken to use modern products aimed at improving water quality (microbiological and chemical). Efforts should also be made to standardize the physical properties

of water, such as temperature, hardness, and flow rate, which can affect drinking behaviour as well as the availability of vaccines and drugs for birds.

Nutrition

Feed quality has a major impact on the development of birds – not only the content of nutrients, but also the quality of the raw feedstuffs, the content of potential contaminants, the structure of the feed, and the use of feed additives. For this reason, feed management on and off the farm and the possession of appropriate logistics and hygiene equipment will be crucial for reducing the use of antimicrobials. Poultry feeding can also include supplements which modulate the intestinal microbiota and help to improve intestinal health, as well as the immune response and productivity of birds. This type of effect can result from a direct reduction of pathogens by specific diet supplements; the stimulation or introduction of useful bacteria, e.g. through the use of pro- and prebiotics; improvement of nutrient utilization by birds; and stimulation or modulation of the bird's immune system.

The favourable results of this type of solution are also confirmed by the findings of our own research (Pyzik et al., 2021) using 20% rye and xylanase as feed supplements in the diet of chicken broilers, which showed a significant effect in part by reducing *Staphylococcus* spp., *Clostridium* and *Campylobacter* spp. bacteria (about 2 or 3 $\log^{10}$ CFU) and by improving production indicators in comparison to the control groups receiving diets without supplements. The study confirmed that the use of varied feed supplements of plant origin, vitamins, or feed enzymes can help to increase the resistance of birds to colonization by infectious agents by modifying the intestinal environment and improving the status of local immunity associated with mucous membranes. The proposed dietary solutions using products based on phytomolecules have proven highly effective in programmes excluding the use of antibiotics in the rearing of chicken broilers. According to Yadav and Iha (2019), the use of phytobiotics, including xylanase, as supplements in broiler chickens modulates the gut microbiota by increasing the total content of *Lactobacillus* bacteria in the duodenum, ileum, and caecum, and also stimulates immune system activity in poultry. This results in higher growth performance and makes it possible to reduce or even eliminate the use of antibiotics in poultry production. Another study (Yang et al. 2008) confirmed that the addition of xylanase to the diet of chickens influences the mucosal morphology of the small intestine and causes a reduction in crypt depth in the jejunum.

However, the mechanism of action and effectiveness of feed additives added to water, such as phytobiotics, immunomodulators and acidifiers, require further research and standardization (Chodkowska et al. 2022). Transparency and documented effects are essential criteria of the registration of feed products for poultry. The legislature decides on the introduction of preparations into widespread practice. For example, the use of certain phytobiotics in domestic poultry production has been regulated by an applicable EU regulation (2022/1470).

Chick development

Early feeding and care for chicks unquestionably has the greatest impact on the normal development of birds. There is a need for continual improvement of hatching and feeding methods, as well as testing of hatching eggs.

Host (animal)-microbiome relationship

Continual expansion of knowledge about the microbiota of animals and its effect on the development of immunity should be the basis for the development of modern flock management technologies. The expansion of knowledge among entities involved in the poultry production sector regarding the possibility of modifying the structure of the microbiota in order to control populations of pathogens plays an important role.

CONCLUSIONS

To sum up, it should be stressed that there are enormous differences between individual European countries in terms of procedures for managing poultry production, the choice and availability of specific antimicrobials, vaccine availability, and the individual approach of veterinarians and poultry farmers, as well as the availability of laboratories and quality control tests.

A major success resulting from the collection and analysis of data on the use of antibiotics in individual European countries was the demonstration of the fact that despite the implementation of individual stages of legislative restrictions to reduce antibiotics, there are still enormous differences in their use in animal production, especially in the case of poultry, even though antibiotic growth promoters have been banned since 2008.

The collected reports confirm that countries with a total ban on the use of antibiotics for prevention in poultry flocks have the lowest level of antibiotic use in animal production. Examples include Denmark, Finland, Iceland, the Netherlands, Norway and Sweden.

The most important element is unquestionably the adoption of strategies involving the reorganization of management procedures towards improvement of breeding, the development and implementation of biosecurity principles, and improvement of animal welfare conditions.

Independently of global policy, each country should systemically develop its own coherent policy aimed at transitioning to more sustainable agricultural and breeding practices which will prioritize human and animal health and protection of the natural environment.

There is a need for further research assessing the practical aspects of biosecurity and management, especially testing of bioexclusion and biosecurity procedures in poultry flocks, as well as in other livestock species.

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