ETIOLOGY, DISTRIBUTION AND PATHOGENESIS OF ANTIBIOTIC RESISTANCE IN MODERN FARMING CONDITIONS (review article)

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Antibiotics remain one of the most widely used medicines. Its inappropriate use becomes main cause of increasing pathogen resistance to one or more antimicrobials. Antibiotic resistance hamper the efficacy of antimicrobial drags in human medicine, lowers the quality of products meant for human consumption and the economic efficacy of animal husbandry enterprises.

The main purpose of our work was to highlight the distribution, etiology and pathogenesis of antibiotic resistance in modern farming condition.

The analysis of the given date allowed to draw the following conclusions: the resistance to antibiotics is an important problem of the modern productive veterinary medicine constitute a serious risk to public health; today increasing antimicrobial resistance has become a serious concern worldwide and antimicrobial use in productive animal husbandry is currently in the need of revising; nor the heard-level management practice or the antibiotic regimen usage has always close association with the prevalence and resistance properties of the pathogens; identification of the causative pathogen and sensitivity testing may be helpful in developing the treatment protocols and could decrease the antibiotic resistant patterns.

The increased load of antibiotic usage in animal husbandry poses more questions as to efficacy, safety and economy issues. The actual development of antibiotic resistance in the farming conditions is not still fully understood and it has to be the subject of further research.

Keywords: *antibiotic resistance, distribution, etiology, pathogenesis, veterinary medicine, farms.*

Antibiotics remain one of the most widely used medicines [1-3]. Inappropriate use of antibiotics becomes main cause of increasing pathogen resistance to one or more antimicrobials. It is becoming one of the most important problem in the modern veterinary medicine [5, 10, 27].

Antibiotic resistance hamper the efficacy of antimicrobial drags in human medicine, lowers the quality of products meant for human consumption and the economic efficacy of animal husbandry enterprises. Pinto Ferreira J. [5] also emphasized that antimicrobial resistance is currently recognized as one of the most significant threats to public health worldwide. In an authors opinion this phenomenon highlights the interconnectivity between human and animal health since any use of antibiotics in humans can eventually lead to resistance in the microbial populations colonizing animals and vice versa.

Rosengren A. et al. [10] studied the fresh and short-time ripened cheeses to investigate the occurrence and levels of S. aureus, Listeria monocytogenes and Escherichia coli with special emphasis on enterotoxin genes, antibiotic resistance, bio-typing and genetic variation. Of all isolates, 39 % showed decreased susceptibility to penicillin. The proportion of resistant isolates from cows' cheese (66 %) compared to isolates from goats' cheese (27 %) was significantly higher. Others authors [27] showed that resistance to penicillin was found in a quarter of S. aureus isolates, but in virtually no Streptococcus isolates. They concluded that microbial identification and sensitivity testing would be beneficial when assessing treatment options.

The study done by G. Dotto et al. [4] describes a multidrug-resistant Enterococcus faecium isolated from a case of feline urinary tract infection. The authors proved that the combination of the found resistance features, together with its virulence traits, makes this strain an example of a potentially dangerous pathogen that could easily spread in veterinary hospitals and perhaps to the environment and to humans, seriously compromising patient outcomes.

So, the mentioned dates allow us to conclude that antibiotic resistance is the worldwide problem the need to be addressed. Important questions that need to be answered are the influence of antibiotic resistance on the human and animal health.

The main purpose of our work was to highlight the distribution, etiology and pathogenesis of antibiotic resistance in modern farming condition.

Awad A. et. al. [12] pointed on the presence of multidrug resistant and toxin producing S. aureus in dairy farms. The authors emphasized that this may pose a major risk to public health and that it is important to lower the transmission of multidrug resistant strains of S. aureus to humans.

At the same time Anderson K. L. et. al. [15] showed that the antimicrobial resistance was uncommon among the mastitis-causing S. aureus isolates identified in the milk samples. The authors found that a limited number of genotypes were associated with mastitis cases. Mostly, the antimicrobial resistance phenotypes were associated with particular S. aureus PFGE types.

The study done by Melchior M. B. et al. [18, 21] indicated that mastitis is one of the important diseases in dairy cattle and Staphylococcus aureus is one of its major pathogen. The authors found that despite an apparently good antimicrobial susceptibility in vitro, the cure of diseased animals from this bacteriological infection is often ineffective. They suggested that recurrent and chronic Staphylococcus infections can be attributed to the resistance acquired due to ability to form biofilm.

While studying dysentery pathogens in swine J. Joerling et al. [1] found that the proportion of strains that showed resistance to both tiantimictobial usagelin und valnemulin (39.1 %) varied considerably among the most frequent STs ranging from 0 % (0/14 isolates resistant) in ST8 isolates to 46.7 % (14/30), 52.1 % (25/48), and 85.7 % (6/7) in isolates belonging to ST112, ST52, and ST114, respectively.

Some associations between organic management and

antimicrobial susceptibility of gram-positive mastitis pathogens have been noted, but overall, few mastitis pathogens from both conventional and organic dairy herds demonstrate resistance to antibiotics commonly used for mastitis control [38].

Ombarak R. A. [2] stressed antimicrobial-resistant E. coli are widely distributed in the milk production and processing environment in Egypt and may play a role in dissemination of antimicrobial resistance to other pathogenic and commensal bacteria.

Due to the fact that the issue of mastitis is compromised, it is very important to conduct an analysis relationships between usage of antimicrobial drugs on dairy farms and results of antimicrobial susceptibility testing of mastitis pathogens. Pol M. and P. L. Ruegg [31] have noticed that the most isolates were inhibited at the lowest dilution tested of most antimicrobial drugs. Survival curves for S. aureus and coagulase-negative staphylococci demonstrated heterogeneity in minimum inhibitory concentration based on the amount of exposure to penicillin and pirlimycin. For coagulase-negative staphylococci, farm type was associated with the minimum inhibitory concentration of ampicillin and tetracycline. For Streptococcus spp., farm type was associated with minimum inhibitory concentration of pirlimycin and tetracycline. For all mastitis pathogens studied, the minimum inhibitory concentration of pirlimycin increased with increasing exposure to defined daily doses of pirlimycin. The level of exposure to most other antimicrobial drugs was not associated with minimum inhibitory concentration of mastitis pathogens. A dose-response effect between antimicrobial exposure and susceptibility was observed for some pathogen-antimicrobial combinations, but exposure to other antimicrobial drugs commonly used for prevention and treatment of mastitis was not associated with resistance [31].

In addition, special attention is paid to treatment Staphylococcus aureus infections. It is an important cause of udder problems in dairy herds. Barkema H. W. et al. [32] while studying this question stressed that the probability of cure depends on cow, pathogen, and treatment factors. Cure rates decrease with increasing age of the cow, increasing somatic cell count, increasing duration of infection, increasing bacterial colony counts in milk before treatment, and increasing number of quarters infected. On an authors opinion the treatment of young animals with penicillin-sensitive S. aureus infections is often justified based on bacteriological cure and economic outcome, whereas treatment of older animals, chronic infections, or penicillin-resistant isolates should be discouraged.

Barlow J. W. et al. [35] demonstrated positive direct effects of lactation therapy. Their study provides evidence that treatment of subclinical S. aureus mastitis during lactation can have indirect effects including preventing new mastitis and reducing incidence of clinical mastitis within dairy herds.

Rajala-Schultz P. J. et al. [34] have noticed what also minimum inhibitory concentration for penicillin was higher among isolates from older cows. On the other hand, resistance to tetracycline was more common and minimum inhibitory concentration was higher among isolates from first lactation cows than from older cows. Differences in the proportions of resistant isolates between first lactation and older cows were not statistically significant, though. The resistance patterns of the coagulase-negative staphylococci isolated during the study are concordant with antimicrobial usage in the study herd. The authors stated that that was in agreement with the generally accepted notion that selection pressure from the use of antibiotics is a main factor in development of antibiotic resistance.

So the inappropriate use of antibiotics poses a danger not only in livestock production, but also for human consumption, therefore this issue should be given special attention.

Today increasing antimicrobial resistance has become a serious concern worldwide and antimicrobial use in productive animal husbandry is currently in the need of revising.

Jagielski T. et. al. [9] highlighted what the Staphylococcus aureus is the predominant causative agent of bovine mastitis, a disease that remains a major economic burden for the dairy industry worldwide.In their study, the antimicrobial resistance patterns and the genetic composition of 80 S. aureus mastitis isolates collected from 14 dairy farms in Eastern Poland were determined. Of the 10 antimicrobial agents evaluated, only testing for penicillin G produced drug resistance.

In the similar study H. M. Nam et. al. [11] found out that during 2003-2009 in Korea there were collected a total of 402 Staphylococcus aureus isolates from bovine mastitis milk and all of them were tested for susceptibility to 20 antimicrobial agents. All S. aureus isolates were susceptible to 11 of 20 antimicrobials tested; no resistance was observed against pirlimycin, telithromycin, novobiocin, penicillin/novobiocin, quinupristin / dalfopristin, clindamycin, rifampin, ciprofloxacin, trimethoprim / sulfamethoxazol, vancomycin, and linezolid. Over 66 % of the S. aureus isolates were resistant to penicillin. Resistance was also seen for gentamicin (11.9 %), erythromycin (7.7 %), methicillin (oxacillin and cefoxitin, 6.2 %), and tetracycline (4.2 %). No noticeable change was observed in penicillin, gentamicin, and erythromycin resistance over the 7-year period. The authors also noticed that tetracycline resistance have a tendency to decrease consistently, whereas methicillin resistance increases from as far as 2005. Also about 2.7 % (11/402) of isolates were resistant to three or more antimicrobials.

The increase of antimicrobial use and resistance leads to the necessity to monitor antimicrobial resistance in bacteria. Saini V. [13] studied the herd-level use of certain antimicrobials administered for mastitis treatment and control. There were studied intramammary applied penicillin and pirlimycin and systemically administered penicillin and florfenicol. There was found positive association with antimicrobial resistance in bovine mastitis pathogens in the field conditions. The authors also observed the differences in antimicrobial resistance outcomes across 4 regions of Canada.

Mastitis is an important disease for the dairy industry worldwide, causing economic losses and reducing milk quality and production. Staphylococcus aureus is a worldwide agent of this intramammary infection, which also causes foodborne diseases. Silva N. C. and Guimarães F. F. [14] have noticed what was to determine the frequency of methicillin-susceptible Staphylococcus aureus isolates in milk of mastitis cows in Brazil and to analyze the genetic lineages and the content of antimicrobial resistance genes and virulence factors among these isolates.

Staphylococcus aureus is a major foodborne pathogen due to its capability to produce a wide range of heat-stable enterotoxins. Peles F. et al. [19] while studying this question stressed was to characterize S. aureus isolates recovered from

mammary quarter milk of mastitic cows and from bulk tank milk produced on Hungarian dairy farms of different sizes.

Gentilini E. et al. [20] demonstrated high resistance to penicillin most of the isolated pathogens in Argentina. A total of 206 strains of Staphylococcus aureus isolated from bovine clinical and subclinical mastitis in Argentina during 1996 to 1998 were investigated for their in vitro susceptibility to several antimicrobial agents. Resistance was detected in 83 (40.3 %), 24 (11.6 %), 16 (7.7 %) and 7 3.4 %) S. aureus isolates for penicillin, erythromycin, pirlimycin and gentamicin, respectively. No resistance was detected for oxacillin, cephalothin and ampicillin-sulbactam.

In Turkey, research was carried out to determine antimicrobial resistance patterns of Staphylococcus aureus strains isolated from bovine clinical mastitis cases and to subtype the strains by polymerase chain reaction technique based on coagulase gene polymorphism [22]. It was noticed that a few coagulase gene types of S. aureus are responsible for the majority of bovine clinical mastitis cases in one province of Central Anatolia region, Turkey. The highest resistance was observed in 63.3 % of the strains against beta-lactam antibiotics, penicillin and ampicillin. Oxytetracycline resistance was observed in 27.9 % of the strains, either alone or in combination with beta-lactams. No resistance was detected for amoxicillin-clavulanate, oxacillin, enrofloxacin and kanamycin-cephalexin. Beta-Lactamase production and resistance to beta-lactam antibiotics were usually correlated. The authors also stressed that resistance against beta-lactams increased from 43.5 %, 58 and to 77 % in 1995, 1999 and 2004 respectively.

Others researchers [25, 28] emphasized a herd-level association between antimictobial usage and antimictobial resistance in Escherichia coli (n=394) and Klebsiella species (n=139) isolated from bovine intramammary infections and mastitis cases on 89 dairy farms in 4 regions of Canada (Alberta, Ontario, Québec, and Maritime Provinces (Prince Edward Island, Nova Scotia, and New Brunswick)). In the mentioned studies there was determined prevalence of antimictobial resistance in common mastitis pathogens such as Staphylococcus aureus, including methicillin-resistant S. aureus (n=1,810), Escherichia coli (n=394), and Klebsiella species (n=139), including extended-spectrum β-lactamase (ESBL)-producing E. coli and Klebsiella species, isolated from milk samples on 89 dairy farms in 6 Canadian provinces.

Antimicrobial use data are critical for formulating policies for containing antimicrobial resistance. There was determined the extant of antimictobial usage on Canadian dairy farms and its variations based on herd-level factors such as milk production, somatic cell count, herd size, geographic region and housing type. Among antimicrobials of very high importance in human medicine, the use of fluoroquinolones was rare, whereas third-generation cephalosporins and penicillin combinations containing colistin were used very frequently on Canadian dairy farms [26].

Persson Y. et. al. [33] showed that the nationwide survey on the microbial etiology of subclinical mastitis cases in dairy cows was carried out on dairy farms in Sweden. The aim was to investigate the microbial panorama and the occurrence of antimicrobial resistance. Differences between newly infected cows and chronically infected cows were investigated as well. They found that the most common isolates of 590 bacteriological diagnoses were Staphylococcus aureus (19 %) and coagulase-negative staphylococci(coagulase-negative staphylococci; 16 %) followed by Streptococcus dysgalactiae (9 %), Str. uberis (8 %), Escherichia coli (2.9 %), and Streptococcus spp. (1.9 %). Samples with no growth or contamination constituted 22 % and 18 % of the diagnoses, respectively. The distribution of the most commonly isolated bacteria considering only bacteriological positive samples were: S. aureus – 31 %, coagulase-negative staphylococci – 27 %, Str. dysgalactiae – 15 %, Str. uberis – 14 %, E. coli – 4.8 %, and Streptococcus spp. − 3.1 %. Four percent of the S. aureus isolates and 35 % of the coagulase-negative staphylococci isolates were resistant to penicillin G. Overall, resistance to other antimicrobials than penicillin G was uncommon.

Minimum inhibitory concentrations were determined for 811 strains of Staphylococcus aureus isolated from cases of bovine mastitis in 11 European countries. The antimicrobial agents tested were penicillin, ampicillin, oxacillin, cephalothin, ceftiofur, amoxicillin + clavulanate, penicillin + novobiocin, enrofloxacin, premafloxacin, erythromycin, clindamycin, lincomycin, pirlimycin, neomycin, lincomycin +neomycin and sulfamethazine. It was found out that the overall level of resistance was generally low for all antimicrobial agents tested regardless of country [17].

The study done by Ruegg P. L et al. [23] indicate the importance of the determining phenotypic susceptibility and presence of selected antimicrobial resistance genes in staphylococci, streptococci, and streptococcal-like organisms recovered from cases of clinical mastitis in cows on large Wisconsin farms. The authors noticed that in the United States, few intramammary antimicrobials approved for treatment of bovine mastitis and this ensure their responsible usage.

Botrel M. A. et. al. [36] analyzed the survey on the use of antibiotics in mastitis cases on dairy farms by veterinarians in France. They stated that the risk of transmission of resistant bacteria from milk or milk products to human is very limited, even in case of consumption of raw milk. However, it also stressed the fact that attention must be maintained to avoid any emergence of such resistant bacteria.

The antibiotic resistance is the important issue that medical sciences is being dealt with. It pertains to human health, animal husbandry and important issues to mankind. To resolve the problem it is important to know the causes that give rise to resistance development in microbial organism. The opinion arise that for the most extant the antibiotic resistance is due to the non-rational use of antibiotics in a human and veterinary medicine, animal husbandry and food-processing industry.

The research on antibiotic resistance often accompanies a study on antibiotics use in the treatment of various infections in animals. Yousefi A. and Torkan S. [3] were studying the prevalence rate and antimicrobial resistance properties of uropathogenic Escherichia coli strains isolated from dogs affected urinary tract infections. Four-hundred and fifty urine samples were collected and cultured. E. coli-positive strains were subjected to disk diffusion and PCR methods. Two-hundred out of 450 urine samples (44.4 %) were positive for E. coli. Prevalence of E. coli in healthy and infected dogs was 28 and 65 %, respectively. Female had the higher prevalence of E. coli (P=0.039). Uropathogenic Escherichia coli strains had the highest levels of resistance against gentamicin (95 %), ampicillin (85 %), amikacin (70 %), amoxicillin (65 %), and

sulfamethoxazole-trimethoprim (65 %). The others authors [8] found that urine containing ceftiofur metabolites provides a advantage to resistant E. coli populations, resulting in significantly prolonged persistence of these bacteria in the soil and that resistant strains readily colonize calves by contact with contaminated bedding.

The other authors [6] found out an increase in prevalence of commensal Escherichia coli carrying blaCTX-M genes among dairy cattle. They also emphasize that: infections caused by extended spectrum β-lactamase producing E. coli occur globally and present treatment challenges because of their resistance to multiple antimicrobial drugs; cattle are potential reservoirs of extended spectrum β-lactamase producing Enterobacteriaceae, so understanding the causes of successful dissemination of blaCTX-M genes in commensal bacteria may have a clue to the future approaches to prevention of antibiotic resistant pathogen emergence.

Nair S. at al. [7] conducted a clinical trial to assess the effectiveness of in-feed flavophospholipol in reducing Salmonella shedding and antimicrobial resistance associated with Salmonella and generic Escherichia coli in naturally infected grower-finisher pigs. Pigs were obtained from a farm with a history of salmonellosis and were housed at a research facility. Over the span of 10 weeks the pigs received either a feed containing 4 ppm of flavophospholipol (treatment, 25) or a non-medicated feed (control, n=20). There was found that the prevalence of Salmonella shedding ($p>0.05$) and antimictobial resistance in Salmonella ($p>0.01$) and E. coli ($p>0.005$) isolates was not different between the treatment and control groups. In spite of this it was noted [8] that the U. S. Food and Drug Administration recently issued new rules for using ceftiofur in food animals. This was the way they react to an increasing prevalence of enteric bacteria that are resistant to 3rd-generation cephalosporins.

Moser A. et al. [16] emphasized that the dairy industry suffers massive economic losses due to staphylococcal mastitis in cattle. The Staphaureux latex agglutination test (Oxoid, Basel, Switzerland) was reported to lead to negative results in 54 % of bovine Staphylococcus aureus strains, and latex-negative strains are thought to be less virulent comparing to Staphaurex latex-positive strains. The authors suggest that latex-negative isolates represent a group of closely related strains with specific resistance and virulence gene patterns that need to be studied more closely.

When designing mastitis-prevention and control programs R. G. Olde Riekerink et al. [29] took into account the herd-level prevalence of contagious mastitis pathogens. The objectives of their study were to estimate herd-level prevalence of contagious mastitis pathogens and associations of certain management practices with the isolation of Staphylococcus aureus from the bulk tank milk from Canadian dairy farms. They found that most of Canadian dairy farms adopted modern mastitis-prevention practices, such as post-milking teat disinfection and drying off all cows with antibiotics. A few of the practices were associated with the prevalence of *S. aureus* in bulk tank milk, such as dry-cow treatment and barn type for the lactating cows.

Taponen S. et al. [24] compared the combined parenteral and intramammary treatment of mastitis caused by Staphylococcus aureus with parenteral treatment only. Cows with clinical mastitis (166 mastitic quarters) caused by *S. aureus* treated by veterinarians of the ambulatory clinic of the faculty of veterinary medicine during routine farm calls were included. Treatment was based on in vitro susceptibility testing of the bacterial isolate. Procaine penicillin G (86 cases due to beta-lactamase negative strains) or amoxycillin-clavulanic acid (24 cases due to beta-lactamase positive strains) was administered parenterally and intramammarily for 5 days. Efficacy of treatments was assessed 2 and 4 weeks later by physical examination, bacteriological culture, determination of CMT, somatic cell count and NAGase activity in milk. Quarters with growth of *S. aureus* in at least one post-treatment sample were classified as non-cured. As controls we used 41 clinical mastitis cases caused by penicillin-susceptible *S. aureus* isolates treated with procaine penicillin G parenterally for 5 days and 15 cases due to penicillin-resistant isolates treated with spiramycin parenterally for 5 days from the same practice area. Bacteriological cure rate after the combination treatment was 75.6 % for quarters infected with penicillin-susceptible S. aureus isolates, and 29.2 % for quarters infected with penicillin-resistant isolates. Cure rate for quarters treated only parenterally with procaine penicillin G was 56.1 % and that for quarters treated with spiramycin 33.3 %. The difference in cure rates between mastitis due to penicillin-susceptible and penicillin-resistant *S. aureus* was highly significant. Combined treatment was superior over systemic treatment only in the beta-lactamase negative group.

Tenhagen B. A. et al. [30] studied the prevalence of mastitis pathogens in dairy cows and their resistance to selected antimicrobial agents. Cephalosporins were the drug of first choice for treatment of clinical mastitis cases followed by fixed combinations of antimicrobial agents, beta-lactamase-resistant penicillins, and penicillin. The drugs were used mostly 3-4 times per case. The most often used for dry-cow therapy were cloxacillin, alone or in combination, and penicillin. The authors found that antimicrobial resistance of the pathogens was within the range of other reports; Resistance of Staph. aureus to ampicillin increased significantly during the first lactation. They conclude that the further research is required to determine the factors that lead to the appearance of *S. aureus* strains that are resistant to ampicillin during the first lactation.

Pol M. and Ruegg P. L. [37] investigated the differences in prevalence and management of selected diseases between conventional and organic farms. The overall estimated prevalence of selected diseases was greater for conventional compared with organic farms. Organic farmers reported use of a variety of nonantimicrobial compounds for treatment and prevention of disease as soon as the conventional farmers reported that the compound most commonly used for dry cow therapy was penicillin and the one most commonly used for treatment of clinical mastitis – cephapirin.

The analysis of the given date allowed drawing the following **conclusions**.

1. The resistance to antibiotics is an important problem of the modern productive veterinary medicine constitutes a serious risk to public health.

2. Today increasing antimicrobial resistance has become a serious concern worldwide and antimicrobial use in productive animal husbandry is currently in the need of revising.

3. Nor the heard-level management practice or the antibiotic regimen usage has always close association with the prevalence and resistance properties of the pathogens.

4. Identification of the causative pathogen and sensitivity testing may be helpful in developing the treatment protocols and could decrease the antibiotic resistant patterns.

The increased load of antibiotic usage in animal husbandry poses more questions as to efficacy, safety and economy issues. The actual development of antibiotic resistance in the farming conditions is not still fully understood and it has to be the subject of further research.

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Козий Н. В., Стильнык О. В., Соколова А. Е., Козий В. И., Краевский А. Й. Этиология, распространение и патогенез антибиотикорезистентности в условиях современного животноводства.

Антибиотики остаются одними из самых распространенных лекарственных средств. Их ненадлежащее использование является основной причиной повышения устойчивости патогенов к одному или нескольким антимикробным препаратам. Резистентность к антибиотикам снижает эффективность антимикробных средств в медицине, негативно влияет на качество продуктов питания и экономическую эффективность животноводства.

Главной целью нашей работы было осветить распространение, этиологию и патогенез антибиотикорезистентности в современном животноводстве.

Анализ результатов научных исследований позволил сделать следующие выводы: устойчивость к антибиотикам является важной проблемой современного животноводства и представляет угрозу для здоровья населения; методы и показания к применению антимикробных средств в продуктивном животноводстве требуют усовершенствования; распространенность и наличие резистентности патогенных микроорганизмов не всегда можно связать с практикой управления на фермах или протоколами использования антибиотиков; идентификация возбудителя болезни и тестирования его чувствительности к антимикробным препаратам могут быть полезными для разработки протоколов лечения и уменьшения уровня устойчивости к антибиотикам.

Развитие резистентности при использовании антибиотиков в животноводстве ставит дополнительные вопросы по их эффективности, безопасности и экономической целесообразности. Патогенез развития резистентности к антибиотикам в условиях продуктивного животноводства еще не полностью понятен что должно быть предметом дальнейших исследований.

Ключевые слова: *устойчивость к антибиотикам, распространение, этиология, патогенез, ветеринарная медицина, фермы.*

Козій Н. В., СтільникО. В., Соколова А. Є., Козій В. І., Краєвський А. Й. Етіологія, поширення та патогенез антибіотикорезистентності в умовах сучасного тваринництва.

Антибіотики залишаються одними з найбільш поширених лікарських засобів. Їх неналежне використання є основною причиною підвищення стійкості патогенів до одного або декількох антимікробних препаратів. Резистентність до антибіотиків знижує ефективність антимікробних засобів у медицині, негативно впливає на якість продуктів, призначених для споживання людиною та економічну ефективність тваринництва.

Головною метою нашої роботи було висвітлити поширення, етіологію та патогенез антибіотикорезистентності в сучасному тваринництві.

Аналіз результатів наукових досліджень дозволив зробити наступні висновки: стійкість до антибіотиків є важливою проблемою сучасної продуктивної ветеринарної медицини і становить загрозу для здоров'я населення; застосування антимікробних засобів у продуктивному тваринництві потребує перегляду; поширеність та резистентність патогенних мікроорганізмів не завжди можна пов'язати з практикою управління на фермах чи протоколами використання антибіотиків; ідентифікація збудника хвороби та тестування його чутливості до антимікробних препаратів може бути корисним для розробки протоколів лікування та зменшення стійкості до антибіотиків.

Розвиток резистентності за використання антибіотиків у тваринництві ставить додаткові питання щодо питань їх ефективності, безпеки та економіки. Патогенез розвитку резистентності до антибіотиків в умовах продуктивного тваринництва ще не повністю зрозумілий і має бути предметом подальших досліджень.

Ключові слова*: стійкість до антибіотиків, поширення, етіологія, патогенез, ветеринарна медицина, ферми.*