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CURRENT ASPECTS OF THE PROBLEM OF TRICHINELLOSIS IN UKRAINE AND THE WORLD: OVERVIEW

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The article provides an analysis of modern literary sources on the problem of animal and human trichinellosis in Ukraine and the world. Trichinella infestation is a serious problem, the relevance of which does not decrease even with existing preventive, diagnostic and veterinary sanitary measures. Improvement of diagnostic approaches, medical and preventive measures, sanitary assessment is possible only with a clear understanding of the pathogen's life cycle, its sensitivity, as well as epizootological features. Gastronomic habits of the population play a significant role in the spread of infestation. The study of the effect of trichinellosis on the immune response of animals and humans, which is the basis for the development of specific prevention of the disease, remains relevant.

Key words: *trichinellosis, spread, zooanthroponosis, trichineloscopy, pigs.*

Formulation of the problem. The problem of trichinellosis in Ukraine and the world has been extremely relevant for many years [1].

The highest incidence of trichinellosis is registered in the countries of North and South America (USA, Argentina, Mexico), in Europe (Spain, Poland, CIS countries). In the countries of Asia and Africa, there are isolated cases of diseases [20]. A significant problem is the problem of trichinellosis in China [5].

Trichinellosis can affect not only animals, but also humans. Wolves and foxes are the main reservoir of this nematode in natural habitats. According to literature data, more than 1,500 cases of human trichinellosis have been recorded in Ukraine over the past 30 years [1]. According to other literature data, the largest number of cases of trichinosis infestation among pigs was registered in Ukraine in 1997 (421 cases) [31].

The situation with human trichinellosis in Ukraine in 1990-1999 was the most tense [2]. Most often, trichinellosis in Ukraine is registered in Zakarpattia, Odesa, Volyn, Zhytomyr, Kyiv regions [1].

Trichinellosis causes complications, often with fatal consequences in humans. In terms of malignancy, trichinellosis is unmatched. Food products made from trichinella carcasses using various technological processes are dangerous [14].

Trichinellosis can be accompanied by neurological and cardiac complications in humans and can be fatal. In 2017, 15 EU countries reported 224 cases of trichinellosis, of which 168 cases were confirmed [6].

To date, the situation with trichinellosis in Ukraine remains unstable. Thus, according to scientific data, helminthiasis can occur even in prosperous regions due to the import of meat products affected by trichinella, which were not subject to mandatory veterinary and sanitary control [8]. At the same time, it is necessary to remember that veterinary safety is a component of biological safety, which in turn is a component of environmental safety as an institution of environmental law [13].

The trichinellosis prevention system does not provide reliable prevention of human infection due to the difficulty of controlling backyard slaughter of pigs, consumption of wild animal meat, etc [26].

So, based on the above, it can be concluded that the problem of studying the characteristics of trichinellosis in Ukraine and the world remains relevant and is a component of the "One Health" concept.

The goal of the work. The aim of the work was to get acquainted with the available literary sources for the last 10 years, which reflect the current situation with trichinellosis in Ukraine and the world.

Materials and methods. In order to study the current state of animal and human trichinellosis in Ukraine and the world, domestic and foreign literary sources (a total of 37 sources) were studied.

The main research methods used were analytical, statistical and comparative.

Results and discussion. Trichinellosis is a serious public health problem in the world. The complex of measures for the prevention and elimination of trichinellosis in animals should include preventive actions regarding the formation and maintenance of endemic foci of invasion. The disease causes losses to livestock farms, which include the organization of anti-epidemic measures, disposal of infested carcasses affected by trichinella larvae, human diseases, reduction of their working capacity, disability, etc [4]. Trichinellosis mainly affects adults (average age 33.1 years) and approximately equally men (51%) and women [24].

In the European Union, the estimated annual costs of inspecting the meat of 167 million pigs range from 25 to 400 million euros. Even in countries without mandatory meat inspection (such as the United States), the economic costs of selling pork on international and domestic markets are significant [24]. Trichinella infection was one of the most common parasitic diseases in Italy until 1959, when mandatory screening for these parasites in slaughtered pigs was introduced [34]. Veterinary control of the slaughter of animals for food, in particular the inspection of meat, was introduced in Germany in 1866 specifically to prevent trichinosis in pork infected with the muscle larvae of *Trichinella spiralis* [24].

In Southeast Asia, in pork-consuming communities, several cultural factors play an important role in the transmission of Trichinella to humans. In some villages in Laos and Vietnam, the seroprevalence of trichinellosis infection in humans is known to be 0–10.5%. In addition, Cambodia, Laos, Malaysia, Thailand and Vietnam have reported relatively few human outbreaks (13) and cases (1,604) over the past 21 years. The mortality associated with them was low (0,75%) [36].

To date, more than 40 million people in China are at risk of infection with trichinellosis. The spread of trichinellosis in the country is facilitated by the wide spread of trichinella, eating habits, lack of meat safety standards, lack of developed methods of detection and treatment. New strategies combining sustainable domestic animal breeding with vaccines may represent a viable alternative to block Trichinella transmission and ensure meat safety. In China, 12 reference laboratories and 3 cooperation centers on food parasites have been established [5]. According to literature data, swine trichinellosis in China is transmitted mainly through garbage. Pig husbandry practices should be improved and mandatory pork inspection further strengthened in rural and mountainous areas of western China to control the disease [9].

Overall, Zhang X. Z. et al. (2022) believe that a "One Health" approach involving governments, health officials, physicians and veterinarians is vital to control foodborne zoonotic trichinellosis [37].

The northern regions of Vietnam are endemic areas for Trichinella infections in domestic pigs and humans [35].

Of all foodborne parasitic diseases, trichinellosis has the most pronounced negative impact on human health in Bulgaria, and the country is still one of the European Union member states with a high incidence of human trichinellosis [28]. Sadkowska-Todys, M. and Gołab, E. (2013) report outbreaks of trichinellosis in Poland. Moreover, the foci of trichinellosis are associated with pork, which is obtained from private farms for own consumption [30].

Consumption of horse and wild boar meat by the population played a significant role during outbreaks in Europe over the past three decades. Human infection is possible not only through pork, but also through the meat of wild animals - bears, wild boars, badgers, dogs, as well as nutria [4, 27]. Horses can become infected through feed to which flour of animal origin is added (which may be infested); in the case of a distorted appetite in case of metabolic disorders, eating corpses of rats, carnivorous insects, grass [15].

Today, China is one of the few countries with the largest number of trichinellosis outbreaks in the world. For diagnosis, a method based on PCR, the LAMP method, duplex PCR based on the liquid gene chip method, and ELISA are used. Among these tests, ELISA is the most common method for detecting infection. China is actively researching the development of a vaccine against trichinellosis [20].

The available literature suggests that only hygienic procedures when preparing wild game meat and cooking game meat to the recommended internal temperatures can prevent transmission of trichinellosis to humans [10].

According to Murrel K. D. (2016), important elements in the prevention of human trichinellosis are the improvement of animal husbandry practices, meat inspection, educational work among the population, medical care. However, domestic pork is still the cause of many outbreaks, mainly in Eastern Europe and Argentina, where traditional small-scale, "backyard" pig farming for domestic and local consumption often involves high-risk farming practices, especially feeding on food waste [23]. Troiano G. and Nante N. (2019) believe that strict supervision is appropriate for the prevention of trichinellosis, especially for meat products from endemic countries or from wild animals to significantly reduce the risk of infection [34].

To reduce the risk of trichinellosis in humans, the endemic and epizootic situation is monitored annually in Ukraine using modern diagnostic methods: ELISA, IChA, pepsinization [25]. According to V. A. Shelevytska and O. G. Partoeva (2016), the presence of natural and synanthropic foci of trichinellosis, the development of private farms that do not follow the sanitary rules for keeping pigs, reducing the volume of deratization measures, the presence of spontaneous markets, trade in food products that have not passed veterinary examination do not give reason to consider the prognosis of trichinellosis in Ukraine to be favorable [31].

It is considered that an unfavorable point, farm, district is considered healthy if there has been no case of trichinellosis within 3 years, as well as the presence of antibodies to trichinellosis in the blood sera of animals during monitoring for the determination of the ELISA reaction [16].

This disease in natural conditions is registered in more than 120 species of mammals, animals, birds, as well as humans, which is of great economic and social importance. Until now, low-cost, but at the same time highly effective control and prevention measures that will reliably protect both people and animals from trichinellosis have not yet been developed [18].

Diagnosis of trichinellosis is focused on three main criteria: clinical results, laboratory results (non-specific laboratory parameters, detection of larvae in muscles and / or detection of antibodies), as well as epidemiological research (detection of the source and origin of infection) [20].

The compressorium method was developed in the 60s of the 20th century. Nowadays, in most countries of the world, this method is used very rarely, but it is still used in some countries of Europe and Latin America. So, in Italy and Switzerland trichineloscopy is performed only on the muscles of carcasses and meat products imported from other countries, and in Great Britain, the USA, Canada, and some other countries, compressor trichineloscopy is practically not used. The method of compression trichinoscopy of muscle sections practically reveals only intense or moderate damage by trichinella larvae. With a weak lesion (1–2 larvae per 1 g of muscle), the effectiveness of this method is about 50%, and with a weaker one, the detection of Trichinella larvae is accidental [8].

In many countries of the world, the main method of detecting trichinella is the digestion of meat in artificial gastric juice [21]. The method of pepsinization in 2-2.5 times more reliable than the compressor trichinoscopy method [2]. The pepsinization method has a high diagnostic efficiency. It is implemented in Ukraine in accordance with the Regulation of the Commission (EU). The pepsinization method makes it possible to detect weak, medium and intense lesions of trichinellosis pig carcasses. Food products made from trichinellosis carcasses remain dangerous under various technological processes, so the extent of their damage must be investigated by the pepsinization method [14]. Enzyme immunoassay (ELISA) is also used to diagnose trichinellosis. A method of immunodiagnostics using a PPR biosensor has been developed [18].

In recent years, an express method of diagnosing trichinellosis has been put into practice in Ukraine - immunochromatographic analysis (IChA), which allows detecting the presence of antibodies against trichinella in biological fluids: blood, serum and blood plasma, intermuscular fluid. Studies are conducted in accordance with the instructions for the use of diagnostic kits of IChA [25].

Muscle biopsy is the gold standard for diagnosing trichinellosis in human medicine, but this technique is invasive and does not detect the early stage of infection. Although immunodiagnosis is also available, antibody detection usually occurs after 3 weeks and persists for up to 19 years after the acute phase. Therefore, to improve the diagnosis of trichinellosis, it is necessary to identify additional diagnostic biomarkers [33].

According to O. A. Karpenko (2012), the main methods of trichinellosis research in Ukraine are prenatal and postmortem diagnostics. Enzyme immunoassay (ELISA) method for the detection of antibodies is included in intravital diagnostics [20].

The biology of the causative agent of trichinellosis is fully adapted to obligate parasitism inside the animal organism. This means that the same animal is the definitive host (intestinal trichinellae) as well as the intermediate host (muscular trichinellae) [1].

There are natural and synanthropic foci of trichinellosis infestation in Ukraine. Red foxes, badgers, rodents, and wolves play an important role in the circulation of trichinellosis in natural habitats. Cases of human disease indicate a close relationship between natural and synanthropic foci of trichinellosis infestation, which causes the occurrence of trichinellosis disease [3]. In synanthropic cells, the main parasite circulation is the chain "pig - pig slaughter products - pig". The relationship between natural and synanthropic centers is caused by hunters, leaving the carcasses of killed wild animals on the territory of settlements or feeding them to domestic animals [25].

According to A. P. Artemenko and co-authors (2010), among wild carnivores, the red fox is the most affected by Trichinella larvae. Moreover, it is a powerful source of trichinella infestation in both natural and synanthropic centers [2].

The genus Trichinella currently includes 8 taxa with species status and 3 genotypes without species status. Identification of trichinella species is based not only on morphological features, some of which are essential, but also on biological, molecular and biochemical features. The main biological features are the number of hosts, resistance to temperature factors, the number of larvae born, which are reproduced by females in the body of different hosts. Such an important morphological feature as the formation of a connective tissue capsule around the muscular larvae has 5 of the 8 species: *Trichinella spiralis*, *Trichinella nativa*, *Trichinella Britovi*, *Trichinella nelsoni* and *Trichinella murrelli*. They do not form capsules: *Trichinella pseudospiralis*, *Trichinella papuae* and *Trichinella zimbabvensis* [25]. Research shows that 3 types of trichinella are widespread in Ukraine: *T. spiralis*, *T. brutovi*, *T. nativa*. All species are highly pathogenic to humans, but *T. nativa* is the most aggressive [1].

Studies have shown that *T. spiralis* differs from other helminths by manipulating the host's immune response not only through the well-known characteristics of its life cycle, but also by modulating inflammation. How the parasite achieves the modulation of inflammation is not fully understood. This review will summarize the mechanism and focus on ES immunomodulatory molecules of *T. spiralis* that may be important for the development of new therapeutics for inflammatory diseases [12].

The bulk of the larvae reaches sexual maturity on the 23rd day after infection. Males impregnate females and die. Females give birth to 1,500 to 10,000 larvae after 4-8 days, and then also die. After 16-17 days after birth, the larvae acquire an S-shaped shape, after 21 days - a spiral shape. After 30-36 days after infection, the larvae have capsules. After 3-4 months, the double layer of the capsule is clearly visible. After encapsulation, the development of trichinella larvae stops. Calcification of the capsules begins, which can continue from 3 to 16 months or more. Viability of muscular trichinella is preserved in animals for many years, and in humans up to 25 years [29]. Thus, sexually mature helminths parasitize in the intestines of people and animals, and the larval stage - in the striated muscles. The disease can cause complications that can lead to fatal consequences [31].

The intestinal phase is critical for trichinellosis, because it determines both the process and the consequences of the disease. During the intestinal phase, the number of eosinophils, goblet cells, mucosal mast cells, and dendritic cells increases [11].

The pathogenic effect of trichinella on the body of the host is associated with the harmful effect of metabolic products, symbionts, accompanying microflora [1].

In people affected by trichinella, the main clinical signs are fever, muscle pain, edema (face, eyelids, limbs), conjunctivitis, headache, eosinophilia, biochemical changes in the blood [31].

Literary sources report that people affected by trichinella can be treated. However, treatment is effective only in the early stages. At the same time, high doses of anthelmintics are used in combination with steroid hormones. This treatment scheme often leads to complications. Animals affected by trichinella are not treated [1].

There are reports of the use of trichinella for the treatment of tumors. Many studies prove that *T. spiralis* has an antitumor effect. The mechanisms underlying the inhibitory effects are still unclear. Convincing evidence of a link between T. spiralis and the prevention or treatment of tumors in clinical trials is lacking [22]. This is because Trichinella byproducts can successfully modulate parasite-specific immune responses as well as responses to unrelated antigens, providing an anti-inflammatory environment and maintaining homeostasis [32].

Knowledge of the immune response against Trichinella is fundamental to understanding how the parasite can evade such mechanisms [7]. Trichinella invasion can induce an increase in the immune cells of the mucous membrane of the small intestine [11]. Trematodes exert an immunomodulatory effect on the host's immune response through excretory-secretory products released from encysted muscle larvae [17]. Modulation of the immune system by parasites is partially carried out by dendritic cells [19].

Conclusion. Analysis of literature data in recent years allows us to conclude that trichinella infestation is widespread not only in Ukraine. Yes, this helminthiasis causes concern among specialists in European and Asian countries. Existing preventive measures do not provide a 100% guarantee of preventing outbreaks of the disease, because it can affect a large number of animals, as well as humans. The problem of trichinellosis is also an important issue in achieving the goal of the "One Health" concept. To date, trichinoscopy remains the main diagnostic method in Ukraine. Most European countries use the pepsinization method for diagnosis. The most accurate diagnostic methods are immunodiagnostics, the ELISA method. Muscle biopsy has not become widespread due to its invasiveness. There are reports of the possibility of using trichinella for the treatment of tumors, but the data are quite controversial. The body's immune response to trichinella can be used to develop specific disease prevention (vaccine development).

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СУЧАСНІ АСПЕКТИ ПРОБЛЕМИ ТРИХІНЕЛЬОЗУ В УКРАЇНІ ТА СВІТІ: ОГЛЯД

О. Півень

У статті наведено аналіз сучасних літературних джерел з проблеми трихінельозу тварин та людей в Україні та світі. Трихінельозна інвазія є серйозною проблемою, актуальність якої не знижується навіть за наявних заходів профілактики, діагностики та ветеринарно-санітарних заходів. Удосконалення діагностичних підходів, лікувально профілактичних заходів, санітарної оцінки можливе лише за чіткого розуміння життевого циклу збудника, його чутливості, а також епізоотологічних особливостей. Значне місце у поширенні інвазії відіграють гастрономічні звички населення. Актуальним лишається також вивчення впливу трихінельозного ураження на імунну відповідь тварин та людини, що покладено в основу розробки специфічної профілактики захворювання.

Ключові слова: *трихінельоз, поширення, зооантропоноз, трихінелоскопія, свині.*