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DISTRIBUTION OF HYDATID CYSTS IN SHEEP AND ITS INFLUENCE ON THE SAFETY AND NUTRITIONAL CHARACTERISTICS OF MUTTON

Annotation: *Echinococcosis is one of the most widespread zoonotic diseases affecting sheep husbandry in Kazakhstan and poses significant veterinary, public health, and economic challenges. The aim of this study was to determine the localization of echinococcal cysts in sheep and to assess the impact of echinococcosis on the physicochemical and nutritional properties of mutton.*

The research was conducted in 2024 in Abay region and included 269 slaughtered sheep. Postmortem examination and laboratory analyses were performed in accordance with GOST standards to determine the chemical composition of meat, as well as mineral and vitamin levels. Statistical evaluation was carried out using ANOVA with a significance level of $p<0.05$.

The results showed that 64.8% of cysts were localized only in the liver, while 31.5% were detected in both the liver and lungs. Histopathological changes, particularly in the liver and lungs, included fibrosis, inflammatory infiltrates, and tissue atrophy. Infected sheep exhibited higher tissue moisture and reduced levels of protein, fat, essential minerals, and vitamins A, E, B1, B2, and PP, indicating significant metabolic disturbances and reduced nutritional and technological quality of the meat.

Echinococcosis markedly reduces the quality of mutton and causes economic losses in sheep production. Strengthening veterinary control, ensuring regular deworming of dogs, and implementing integrated measures within the "One Health" framework are essential to reducing disease prevalence.

Keywords: *echinococcosis, mutton, hydatid cysts, parasitic disease, nutritional value, pathomorphology changes*

Inrtoduction

Echinococcosis, particularly cystic echinococcosis, is a significant zoonotic disease caused by the larval stage of the tapeworm Echinococcus granulosus, which predominantly affects sheep as intermediate hosts. In Kazakhstan, the prevalence of echinococcosis in sheep is notably high, with studies indicating infection rates ranging from 30% to 50% in certain regions [1, 2]. This high prevalence is attributed to the close interactions between domestic animals, particularly sheep, and definitive hosts such as dogs, which play a crucial role in the transmission cycle of the parasite [3]. The disease not only poses a threat to animal health but also has substantial implications for public health and economic stability in rural communities that rely heavily on sheep husbandry.

The epidemiological landscape of echinococcosis in sheep in Kazakhstan has been influenced by various factors, including environmental conditions, livestock management practices, and the presence of stray and domestic dogs [4]. Seasonal variations also affect the prevalence of hydatid cysts in sheep, with lower infection rates observed during summer and autumn [5]. The economic impact of echinococcosis is significant, as infected sheep can lead to reduced meat quality and yield, further exacerbating the challenges faced by farmers in endemic regions [3, 5].

Moreover, the genetic diversity of Echinococcus granulosus strains found in sheep in Kazakhstan has been a subject of research, indicating the presence of multiple genotypes that may influence the epidemiology of the disease [6]. Understanding these genetic variations is crucial for developing targeted control measures and improving the management of echinococcosis in livestock. The integration of molecular techniques, such as polymerase chain reaction (PCR), has enhanced the ability to identify and characterize Echinococcus strains, facilitating better epidemiological studies [7].

A comprehensive understanding of the parasite's prevalence, transmission dynamics, and genetic diversity will contribute significantly to the formulation of effective disease control strategies and the improvement of livestock productivity in the region.

Materials and methods

The experiment was conducted in accordance with national and international laws based on the European Convention for the Protection of Vertebrate Animals used for Experimental and Other Scientific Purposes guidelines [8].

The study was conducted from January to December 2024 in Abay region (Figure 1). A total of 269 slaughtered sheep aged 2 to 5 years were examined. The work was carried out at the Institute of Veterinary Medicine and Animal Husbandry. The object of the study was sheep infected with echinococcosis.

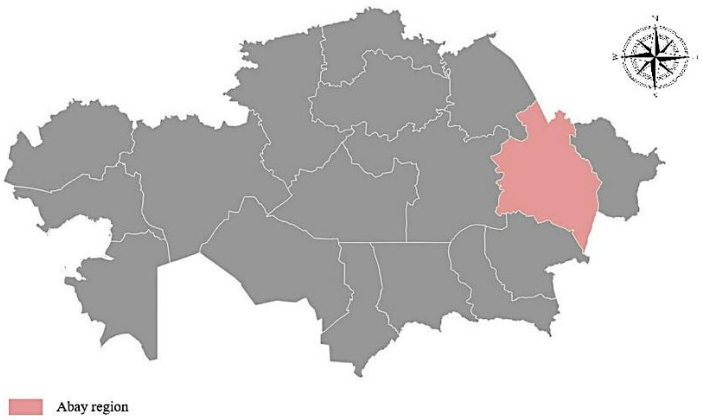

Figure 1 - Map of the Abay region, Republic of Kazakhstan

Determination of nutritional value according to GOST 9793-2016 [9], GOST 25011-81 [10], GOST 23042-2015 [11], GOST 31727-2012 (ISO 936:1998) [12] and GOST 32605-2013 [13].

Determination of mineral content was determined in accordance with the following standards: GOST R 55573-2013 [14], GOST 32009-2013 (ISO 13730:1996), spectrophotometric method (trilonometric method) for determining the mass fraction of total phosphorus [15], GOST R 55484-2013 [16] and GOST 26928-86 [17].

Vitamin content was determined in accordance with the “Guidelines for methods of quality control and safety of biologically active food additives” (R 4.1.1672-2003, Chapter 2, Section 1) [18].

Data analysis. Basic data entry and processing were performed using MS Excel. Significance of differences in each sample was determined by analysis of variance (ANOVA). Differences were considered significant at the $p<0.05$ level.

Results

Figure 2 shows the distribution of echinococcal cysts by organs in infected sheep. Of the 54 animals in the table, 64.8% (35 sheep) had only liver lesions, which is the most common site of cyst localization. In 31.5% of sheep (17 animals) echinococcus affected both liver and lungs, which is also quite a frequent combination. In rare cases (1 animal, which is 1.85% for each) there was a lesion of three organs: kidneys, liver and lungs, or a combination of spleen, liver and lungs.

At postmortem examination of diseased sheep there were signs of emaciation, enlargement and lumpiness of affected organs, presence of blisters of different sizes filled with transparent slightly opalescent liquid, in which barely visible scolexes (heads) of the parasite were floating.

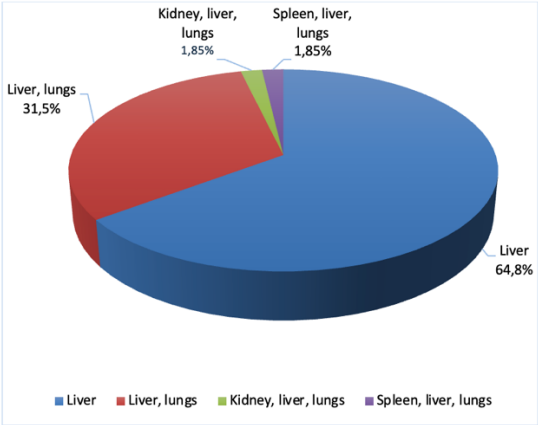

Figure 2 - Distribution of echinococcal cysts by organs of infected sheep

Examination of internal organs revealed that echinococci are most often localized in the liver and lungs, but in some cases other organs are affected. In the affected organs, the echinococcus is represented by a one-chamber bubble filled with fluid and surrounded by a bilayer shell, reaching significant size.

The bubble consists of three layers and is filled with clear opalescent fluid. The inner layer is sprouting, and outside it is located chitinous shell. The vesicle is surrounded by a dense connective tissue capsule, the fibrous capsule, which is a product of the host tissue trying to confine the parasite. The parasite grows by squeezing surrounding tissues, feeding on substances from the host's tissue fluid and blood. As it grows, secondary daughter vesicles and scolexes bud off from the growth zone of the bladder and float as sand in the echinococcal fluid of the mother bladder.

Macroscopic changes associated with the pathogenesis of the disease were most pronounced in the liver and lungs.

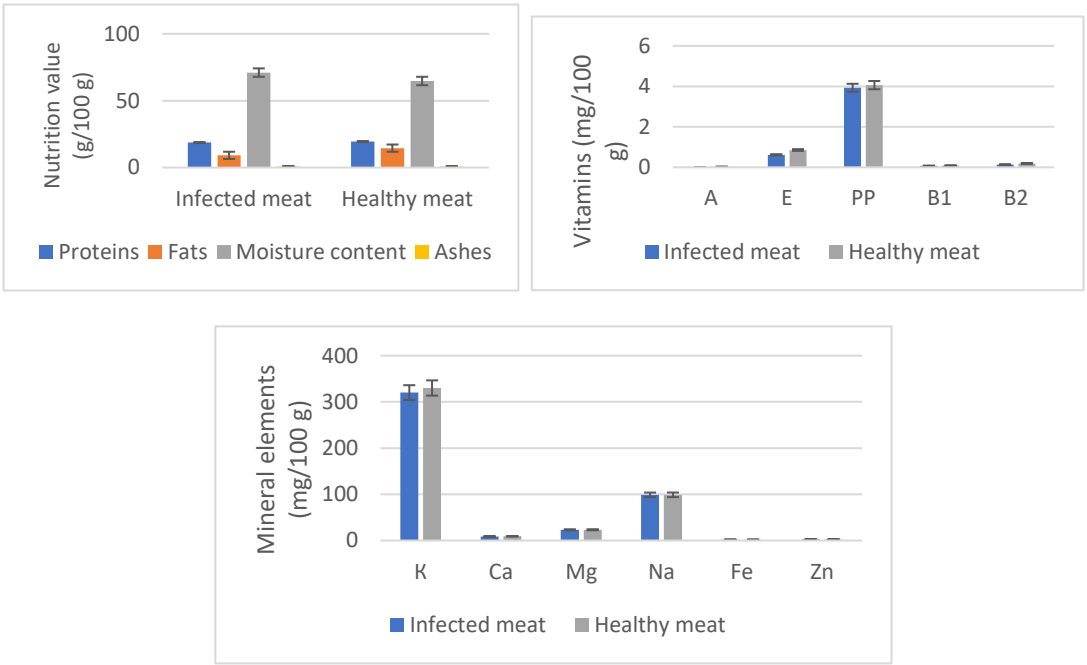

Figure 3 - Nutritional value of mutton

In Figure 3 nutritional value of mutton is given. As a result of the study of chemical composition of meat of sheep infected with echinococcosis, it was found that the hydration of tissue in infected animals is significantly higher compared to clinically healthy animals. Thus, the moisture content in muscles of infected sheep is 71.05±0.30 g/100 g, which is 9.5% higher than in healthy animals - 64.75±0.13 g/100 g. This indicates increased tissue hydration in infected animals.

As for the protein content, in the meat of healthy sheep this index is 19.48±0.05 g/100 g, and in infected animals it is somewhat lower and is 18.72±0.20 g/100 g, which confirms the decrease in

the protein level in the muscles of infected animals. In turn, the fat content in the meat of infected sheep was 37% lower than in healthy individuals, where the index is 14.55±0.09 g/100 g, and in infected animals it is 9.15±0.42 g/100 g.

These studies show that in echinococcosis-infected sheep there is also a change in the concentration of minerals. Thus, calcium content in meat of infected animals was 8.8±0.08 mg/100 g, which is 5.1% less than in healthy sheep (9.20±0.06 mg/100 g). Magnesium was 23.2±0.13 mg/100 g, which was 11.7% less compared to 23.25±0.11 mg/100 g in meat from healthy sheep. Potassium and sodium concentrations were also slightly lower in infected animals: potassium was 320.2±0.31 mg/100 g (3% less than in healthy sheep - 330.1±0.35 mg/100 g), and sodium was 98.85±0.20 mg/100 g (0.05% less than in healthy meat, where it was 98.9±0.28 mg/100 g).

Concentrations of trace elements iron and zinc in the meat of infected animals had small differences from those of healthy sheep, amounting to 1.95±0.13 mg/100 g and 2.68±0.22 mg/100 g, respectively. The difference in their concentration was 2.1% for iron and 5.1% for zinc.

As for vitamins, in the meat of infected animals, the content of vitamin A was 0.012±0.01 mg/100 g, which was 57.1% lower than in healthy sheep (0.028±0.01 mg/100 g). Vitamin E content was also lower, 0.617±0.02 mg/100 g, which was 27.9% lower than in the meat of healthy animals (0.855±0.04 mg/100 g). Vitamin B1 in meat of infected animals was 0.077±0.01 mg/100 g, which was 9.4% lower compared to 0.085±0.01 mg/100 g in healthy sheep. Vitamin B2 was reduced by 29.1% at 0.135±0.01 mg/100 g compared to 0.190±0.01 mg/100 g in meat of healthy sheep. Vitamin PP in the meat of infected sheep was 3.930±0.04 mg/100 g, which was 3.2% less than in healthy animals (4.060±0.02 mg/100 g).

Thus, the studies confirmed the presence of significant changes in the chemical composition of meat of sheep infected with echinococcosis, with a decrease in the concentration of most nutrients and minerals.

In echinococcosis, the liver is enlarged, thickened in places, with a color from brown-gray to clay. In multiple lesions, the organ has a honeycomb appearance. In the case of portal cirrhosis, the liver is reduced, with a finely bumpy surface. Echinococcal cysts are more often localized in the right lobe, closer to the surface, and can cause tissue atrophy. The cysts are surrounded by a fibrous capsule, which becomes thicker when suppuration occurs and deforms the organ. Histologic examination reveals inflammatory reactions with eosinophils, macrophages and giant cells, as well as changes in vessels and formation of new bile ducts (Figure 4).

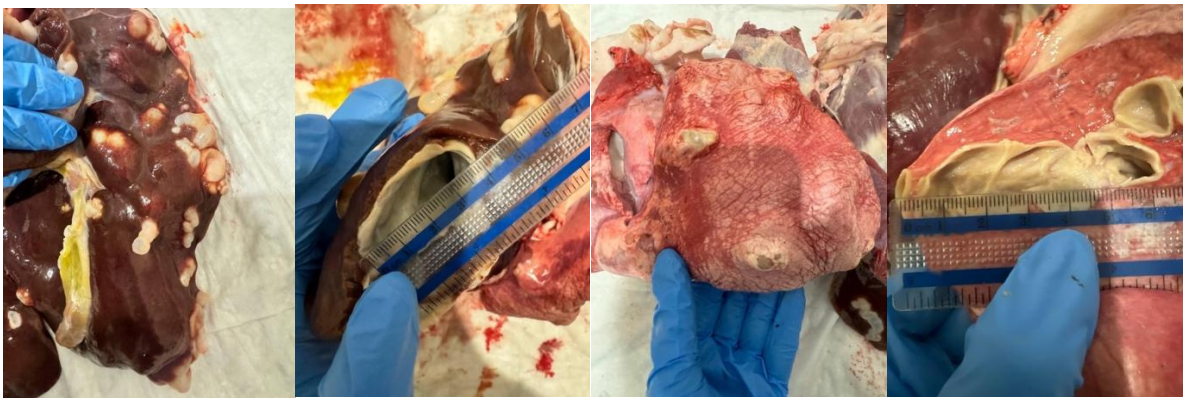

Figure 4 - Infected liver and lungs

Lung echinococcosis revealed single and multiple cysts located both on the surface and deep in the lung parenchyma, ranging in size from 0.5 to 8 cm. The right lung was more frequently affected, mostly by single-chamber cysts. The cysts are surrounded by a double-walled shell and a fibrous capsule formed from pressure on surrounding tissues. Large cysts may cause atelectasis. Chronic or subacute eosinophilic pneumonia develops in the lungs with vascular hemorrhage, hemorrhages, bronchial spasms, and lymphocytic infiltrates. Around cysts there is a zone of necrotic detritus and granulation tissue with eosinophils, macrophages and plasma cells (Figure 4).

Discussion

The findings of the present study demonstrate that echinococcosis significantly affects both the physicochemical and nutritional properties of mutton, which is consistent with previously reported observations. The alterations identified in pH, moisture content, protein level, and fat composition

indicate that infection by *Echinococcus granulosus* can severely compromise meat quality and consumer acceptability. Similar shifts in fundamental physicochemical parameters, including increased ultimate pH and changes in meat texture and coloration, have been documented in parasitic and chronic infectious conditions affecting livestock [19, 20]. Elevated pH values in particular are known to promote darker meat color (the “dark, firm, dry” phenomenon), reduce tenderness, and accelerate microbial spoilage, ultimately decreasing shelf life and raising safety concerns [21]. These changes may be attributed to metabolic stress and impaired muscle energy reserves in infected animals, which disrupt postmortem glycolysis and modify biochemical processes in muscle tissue.

Lipid oxidation is another critical factor negatively influenced by echinococcosis. Evidence from earlier studies indicates that oxidative degradation of lipids intensifies in animals suffering from chronic parasitic infections, promoting the formation of rancid flavors and reducing sensory quality [22]. Our results corroborate this: infected sheep displayed significantly lower fat content (by 37% compared to healthy animals), which may be explained by altered lipid metabolism, increased energy expenditure due to chronic immune stimulation, and tissue degeneration associated with hydatid cyst development. Reduced fat reserves contribute to poorer organoleptic properties, diminished juiciness, and decreased caloric value of the meat.

Nutritional analysis confirms that echinococcosis adversely influences the chemical composition of mutton. The lower protein content observed in infected animals (18.72±0.20 g/100 g vs. 19.48±0.05 g/100 g in healthy sheep) aligns with the notion that chronic parasitic infection leads to protein catabolism, reduced muscle development, and impaired nutrient assimilation [23]. A similar trend is seen in mineral composition: reductions in calcium, magnesium, sodium, and potassium indicate systemic metabolic disturbances and potential impairment of mineral homeostasis in infected sheep. These findings are consistent with studies reporting that parasitic infections interfere with nutrient absorption, hepatic metabolism, and overall biochemical balance in ruminants [24].

Vitamin content also decreased significantly in infected animals, especially vitamins A, E, B2, and PP. This decline may reflect not only diminished dietary intake but also increased oxidative stress, liver dysfunction, and reduced metabolic conversion of precursors into active vitamin forms. Since the liver is a major storage site for fat-soluble vitamins, pathological lesions caused by hydatid cysts—such as tissue fibrosis, necrosis, and inflammation—can directly impair vitamin retention and utilization [25]. The observed histopathological alterations in hepatic and pulmonary tissues in the current study reinforce this connection: enlarged fibrous capsules, necrotic zones, and eosinophilic infiltration indicate chronic inflammatory processes that substantially alter organ function [26].

The organ distribution of hydatid cysts recorded in this study also provides important epidemiological insights. The predominance of liver infections (64.8%) followed by combined liver and lung involvement (31.5%) is in line with the typical route of parasitic oncosphere migration through the portal bloodstream, where the liver acts as the primary filtration organ [25, 27]. Rare but documented cases of multiorgan involvement (kidney–liver–lung and spleen–liver–lung combinations) highlight the potential for systemic dissemination when primary barriers fail. Macroscopic and microscopic observations confirm classical signs of hydatid disease, including multilayered cyst walls, chitinous membranes, hydatid fluid with brood capsules and scolices, and host-generated fibrous capsules. These structural features, described extensively in earlier pathological studies [27], contribute to progressive tissue compression, organ dysfunction, and metabolic disturbances that ultimately influence meat quality.

The increased moisture content in muscle tissue of infected sheep (71.05±0.30 g/100 g vs. 64.75±0.13 g/100 g in healthy animals) may be due to edematous changes and impaired osmotic regulation resulting from chronic inflammation. Edema, a hallmark of parasitic infestation, often reflects capillary damage and altered fluid homeostasis. In the context of meat processing, excessive moisture is undesirable because it reduces water-holding capacity, negatively affects texture, and can accelerate spoilage.

Collectively, these findings underscore that echinococcosis is not merely a pathological condition affecting internal organs but a significant factor influencing the economic and nutritional value of sheep meat. Quality deterioration—manifested through altered physicochemical properties, reduced nutrient density, and compromised organoleptic characteristics—presents challenges for producers and raises concerns for public health and consumer safety. Considering the high prevalence of echinococcosis in many pastoral regions, including Kazakhstan, the results of this study highlight the need for improved control measures, including effective dog deworming, enhanced slaughterhouse diagnostics, and strengthened veterinary surveillance systems.

Conclusion

The results of this study show that cystic echinococcosis remains a significant problem for sheep husbandry in Kazakhstan, causing marked pathological changes in the liver and lungs and negatively affecting overall animal condition. The high frequency of cyst localization in the liver and combined liver–lung involvement reflects the typical pathogenesis of *Echinococcus granulosus* and confirms the persistent circulation of the parasite in livestock.

Analysis of mutton quality demonstrated that infection leads to substantial deterioration in its physicochemical and nutritional properties. Infected animals showed increased tissue moisture, reduced protein and fat content, and lower levels of essential minerals and vitamins. These changes indicate metabolic disturbances and result in decreased nutritional value and technological quality of the meat.

Echinococcosis significantly impacts both animal health and the economic value of sheep products. The findings highlight the importance of strengthening control measures, including systematic deworming of dogs, improved veterinary surveillance, and enhanced slaughterhouse inspection procedures. Implementing these measures will help reduce the prevalence of the disease and improve the safety and quality of mutton in endemic regions.

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РАСПРЕДЕЛЕНИЕ ЭХИНОКОККОВЫХ КИСТ У ОВЕЦ И ИХ ВЛИЯНИЕ НА ПОКАЗАТЕЛИ БЕЗОПАСНОСТИ И ПИЩЕВОЙ ЦЕННОСТИ БАРАНИНЫ

Эхинококкоз мелкого рогатого скота является одной из наиболее распространённых зоонозных инвазий в Казахстане и представляет серьёзную ветеринарную, санитарную и экономическую проблему. Целью данного исследования было изучение локализации эхинококковых кист у овец, а также оценка влияния эхинококкоза на физико-химические и пищевые свойства баранины.

Исследование проведено в 2024 году в области Абай на выборке из 269 овец. Патологоанатомический осмотр и лабораторный анализ включали определение химического состава мяса, содержания минералов и витаминов согласно государственным стандартам. Статистическая обработка данных проводилась методом ANOVA при уровне значимости $p<0.05$.

Результаты показали, что у 64.8% животных кисты локализовались только в печени, у 31.5% в печени и лёгких, что соответствует типичному пути миграции онкосфер. Гистопатологические изменения наиболее выражены в печени и лёгких и включали фиброз, воспалительные инфильтраты и атрофию тканей. У заражённых овец наблюдалось увеличение влажности мышечной ткани, снижение содержания белка, жира, основных макро- и микроэлементов, а также существенное уменьшение концентраций витаминов A, E, B1, B2 и PP. Эти изменения указывают на выраженные метаболические нарушения и снижение пищевой и технологической ценности мяса.

Эхинококкоз приводит к значительному ухудшению качества баранины, снижению её биологической ценности и экономических потерь в мясном производстве. Полученные данные подчёркивают необходимость усиления ветеринарного контроля, регулярной дегельминтизации собак и внедрения комплексных мер в рамках концепции «Единое здоровье» для снижения распространённости заболевания.

Ключевые слова: эхинококкоз, баранина, эхинококковые кисты, паразитарные заболевания, пищевая ценность, патоморфологические изменения

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ҚОЙЛАРДАҒЫ ЭХИНОКОКК КИСТАЛАРЫНЫҢ ТАРАЛУЫ ЖӘНЕ ОЛАРДЫҢ ҚОЙ ЕТІ ҚАУІПСІЗДІГІ МЕН ТАҒАМДЫҚ ҚҰНДЫЛЫҚ КӨРСЕТКІШТЕРІНЕ ӘСЕРІ

Эхинококкоз Қазақстандағы қой шаруашылығында кең таралған зооноздық аурулардың бірі болып табылады және айтарлықтай ветеринарлық, санитарлық және экономикалық қауіп төндіреді. Зерттеудің мақсаты – қойларда эхинококк кисталарының орналасуын анықтау және эхинококкоздың қой етінің физика-химиялық және азықтық қасиеттеріне әсерін бағалау.

Зерттеу 2024 жылы Абай облысында 269 қойға жүргізілді. Патологоанатомиялық тексеру және зертханалық талдау мемлекеттік стандарттарға сәйкес еттің химиялық құрамы, минералдар мен витаминдердің деңгейін анықтауды қамтыды. Статистикалық өңдеу ANOVA әдісімен жүргізіліп, мәнділік деңгейі $p<0.05$ деп алынды.

Нәтижелер бойынша эхинококк кисталарының 64,8%-ы тек бауырда, 31,5%-ы бауыр мен өкпеде орналасқаны анықталды. Гистопатологиялық өзгерістер, әсіресе бауыр мен өкпеде, фиброз, қабыну инфильтраттары және тіндердің атрофиясымен сипатталды. Зақымданған қойлардың етінде ылғалдылықтың жоғарылауы, ақуыз бен май мөлшерінің, макро- және микроэлементтердің, сондай-ақ A, E, B1, B2 және PP витаминдерінің мөлшерінің төмендеуі байқалды. Бұл өзгерістер еттің тағамдық және технологиялық сапасының төмендегенін көрсетеді.

Эхинококкоз қой етінің сапасын айтарлықтай төмендетіп, мал шаруашылығында экономикалық шығындарға әкеледі. Аурудың таралуын азайту үшін ветеринарлық бақылауды күшейту, иттерді жүйелі дегельминтизациялау және «Бір денсаулық» тұжырымдамасы аясында кешенді шараларды енгізу қажет.

Түйінді сөздер: *эхинококкоз, қой еті, кисталар, паразиттік ауру, тағамдық құндылық, патоморфологиялық өзгерістер*

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