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A Review on Ruminant's Meat-Born Helminth Zoonoses

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Abstract

Helminths found in ruminant animals are intricate, multicellular parasites capable of infecting both animals and humans, leading to zoonotic diseases. This review focuses specifically on zoonotic helminth infections linked to meat from ruminant animals, such as Taenia saginata, Fasciola spp, and Trichinella spiralis. Consuming contaminated meat from infected ruminants can pose significant health risks to humans. These parasites can spread through various means, including ingestion of eggs and larvae in contaminated environments, as well as the consumption of raw or undercooked meat. Infections with these parasites may manifest in symptoms like weight loss, dizziness, abdominal pain, diarrhea, headaches, nausea, constipation, chronic indigestion, and loss of appetite. The paper provides valuable insights into the epidemiology and public health consequences of zoonotic helminth infections originating from ruminant meat and contributes to existing knowledge in this field.

Introduction

The consumption of ruminant meat plays a significant role in many cultures and economies worldwide. However, the presence of zoonotic helminths in such meat presents a considerable public health concern. Zoonotic helminths are parasites that can be transmitted from animals to humans, posing risks to human health through the consumption of contaminated meat [1]. The incidence of helminth zoonotic parasite infections transmitted through meat is underestimated and neglected, so they become more common in many parts of the world mainly because of inadequate procedures used for routine diagnosis, monitoring, and reporting for many of the zoonotic parasites [2].

Ruminant animals, including cattle, sheep, and goats, are known hosts for a variety of helminth parasites such as Tania saginata, Fasciola spp and Trichinella spp. These parasites have complex life cycles that involve different stages of development within the host animal and may result in the contamination of meat with infective stages, such as eggs, larvae, or cysts [3].

Several studies have highlighted the prevalence and distribution of these helminth zoonoses in ruminant populations across different geographical regions. For example, research conducted by fesseha and asefa (2023) investigated the prevalence of Taenia saginata in cattle herds in various parts of the world, highlighting variations in infection rates and associated risk factors [4].

The transmission of helminth zoonoses to humans primarily occurs through the consumption of raw or undercooked meat contaminated with infective stages of parasites. Inadequate processing and hygiene practices during meat production, distribution, and consumption further contribute to the transmission cycle. As a result, ruminant meat-borne helminth zoonoses pose significant challenges to food safety and public health systems globally [5].

Furthermore, the clinical manifestations of helminth infections in humans can vary widely, ranging from mild gastrointes-

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tinal symptoms to severe complications. These infections not only impose a substantial burden on healthcare systems but also have socio-economic implications for affected individuals and communities [6]. In conclusion, understanding the dynamics of ruminant meat-borne helminth zoonoses is crucial for devising effective control strategies and interventions to minimize the risk of transmission to humans [7].

This comprehensive review aims to provide an in-depth understanding of the various helminth zoonoses associated with ruminant meat consumption, drawing upon findings from a multitude of scholarly sources.

Ruminant's meat-born helminth zoonosis

Taenia saginata

Taenia saginata, also known as the beef tapeworm, is a zoonotic parasite belonging to the order Cyclophyllidea and genus Taenia. This intestinal worm causes taeniasis in humans and cysticercosis in cattle [8]. Cattle act as intermediate hosts for the tapeworm, where larvae develop, while humans serve as definitive hosts for the adult worms [9].

The disease is widespread in various regions, including Africa, parts of Eastern Europe, the Philippines, Latin America, as well as East, Southeast, and South Asia where beef consumption is common [10]. However, its highest prevalence is in Sub-Saharan Africa and the Middle East [11].

Cattle get infected with embryonated eggs, called oncospheres, when they consume contaminated food [12]. In the duodenum, the front part of the small intestine, oncospheres hatch due to gastric juices. The larvae with six hooks attach to the intestinal wall, penetrate the mucosa into blood vessels, and circulate through the body before settling in skeletal muscles within about 70 days [13]. In muscle tissue, they become fluid-filled cysticerci by shedding their hooks and forming a protective cuticular shell [14]. Cysticerci can also develop in the lungs and liver [12].

Humans can acquire infective cysticerci by consuming raw or undercooked meat containing larvae[15]. In the jejunum, the inverted scolex of the tapeworm becomes evaginated outward due to digestive enzymes. Using the scolex, it attaches to the intestinal wall and matures into adult worms within 5 to 12 weeks. Adult worms can live in the host for up to 25 years, usually with only one worm present but occasionally multiple worms reported [16]. Self-fertilization in mature proglottids leads to zygote production that develops into embryonated eggs called oncospheres [17].

As thousands of oncospheres accumulate, older gravid proglottids detach from the tapeworm. Gravid proglottids are shed individually, some rupturing inside the intestine and releasing eggs [18]. Peristalsis expels free proglottids and eggs into the environment where motile proglottids shed eggs as they move on the ground [19]. These oncospheres in the external environment can remain viable for several days to weeks in environments like sewage, rivers, and pastures [13].

Infections caused by Taenia saginata are often asymptomatic, but in more severe cases, symptoms such as weight loss, dizziness, abdominal pain, diarrhea, headaches, nausea, constipation, chronic indigestion, and loss of appetite may occur [20]. In rare instances, individuals may develop intestinal obstruction that might require surgical intervention. The tapeworm can also produce antigens that trigger allergic reactions in the host and has been associated with uncommon conditions like ileus, pancreatitis, cholecystitis, and cholangitis [12]. If left untreated, Taenia saginata has been known to cause gallbladder perforation in certain cases. Adult Taenia saginata worms can live in the human body for up to 25 years, with most infections lasting 2 to 3 years if not treated [21].

Unlike other parasites that cause cysticercosis by infecting human tissues such as the brain and muscles, Taenia saginata does not form cysticerci in humans [22]. Therefore, cysticercosis does not occur in human hosts due to this parasite. Instead, Taenia saginata causes taeniasis, an infection characterized by symptoms like weight loss, intestinal pain, and potential blockages that can be life-threatening [23].

Effective preventive measures against Taenia saginata include thoroughly cooking beef viscera at 56 °C (133 °F) for 5 minutes to eliminate cysticerci [21]. Other methods such as refrigeration, freezing at -10 °C (14 °F) for 9 days, or extended periods of salting are also effective in killing cysticerci [24]. Proper inspection of beef products and appropriate disposal of human waste are crucial steps in preventing infections. Treatment for taeniasis typically involves medications like praziquantel or niclosamide, while albendazole is highly effective in treating infections in cattle [25].

Trichinosis

The Trichinella genus comprises nine species and three genotypes found in various animals, including birds, reptiles, and more than 150 domestic and wild mammalian species. Some species within this genus can lead to trichinellosis, a foodborne illness causing around 5751 cases and five deaths annually [26].

Trichinellosis is caused by the ingestion of undercooked meat containing encysted larvae of Trichinella species. After exposure to gastric acid and pepsin, the larvae are released from the cysts and invade the small bowel mucosa where they develop into adult worms. Females are 2.2 mm in length; males 1.2 mm. The life span in the small bowel is about four weeks. After 1 week, the females release larvae that migrate to striated muscles where they encyst [27].

While Trichinella spiralis from domestic pigs or wild boars has traditionally been the primary source of human trichinellosis, other animals such as omnivores, carnivores, herbivorous livestock, and horses have also been implicated [28]. In 1977, T. spiralis was detected in camels in India, and an outbreak of trichinellosis in Germany linked to spiced camel meat prompted further investigations [29].

Although the exact source of the camel meat causing the outbreak was inconclusive, experimental infections demonstrated that camels could harbor high levels of Trichinella in their muscles. This is particularly crucial as the consumption of raw camel meat is prevalent among camel nomads in specific regions and has previously resulted in severe foodborne illness outbreaks [30].

Abdominal symptoms can occur 1-2 days after infection. Further symptoms usually start 2-8 weeks after eating contaminated meat. Symptoms may range from very mild to severe and relate to the number of infectious worms consumed in meat [31].

The signs, symptoms, severity and duration of trichinellosis vary. Nausea, diarrhea, vomiting, fatigue, fever, and abdominal discomfort are often the first symptoms of trichinellosis [32]. Headaches, fevers, chills, cough, swelling of the face and eyes,

aching joints and muscle pains, itchy skin, diarrhea, or constipation may follow the first symptoms. If the infection is heavy, patients may experience difficulty coordinating movements, and have heart and breathing problems. In severe cases, death can occur [11].

The most effective way to prevent trichinosis is by thoroughly cooking meat. Using a food thermometer can confirm that the meat has reached a sufficiently high temperature [33]. Regulations and guidelines for food producers can enhance food safety for consumers, as seen in the European Commission's standards for inspections, rodent management, and improved sanitation [34]. Raising awareness about the risks associated with consuming raw or undercooked meat, could help lower infection rates. Hunters, who often come into contact with and consume wild game like bear, are considered a high-risk group [35].

Fasciolosis

Human and animal fasciolosis occurs worldwide. While animal fasciolosis is distributed in countries with high cattle and sheep production, human fasciolosis occurs, excepting Western Europe, in developing countries. Fasciolosis occurs only in areas where suitable conditions for intermediate hosts exist [36].

The incidence of human cases has been increasing in 51 countries of the five continents. A global analysis shows that the expected correlation between animal and human fasciolosis only appears at a basic level. High prevalences in humans are not necessarily found in areas where fasciolosis is a great veterinary problem [37].

Human infection with F. hepatica is influenced by various factors such as the presence of intermediate snail hosts, domestic herbivorous animals, climatic conditions, and dietary habits. Sheep, goats, and cattle are the main reservoirs for this parasite, while other animals play a lesser role in transmitting the disease to humans [38].

Immature eggs are discharged in the biliary ducts and in the stool. The eggs release miracidia, which invade a suitable snail intermediate host. In the snail the parasites develop into cercariae, which are released from the snail and encyst as metacercariae on aquatic vegetation or other surfaces [39]. Mammals become infected by eating contaminated vegetation. Humans become infected by ingesting contaminated freshwater plants, especially watercress. After ingestion, the metacercariae encyst in the duodenum and migrate through the intestinal wall, the peritoneal cavity, and the liver parenchyma into the biliary ducts, where they develop into adults [40]. The adult flukes live in the large biliary ducts of the mammalian host. Human infection by consumption of raw liver from infected sheep, goats, and cows has also been reported [41].

Fascioliasis may cause early symptoms such as: Fever, Nausea, Vomiting, Diarrhea, and A swollen liver, liver function abnormalities, Skin rashes, Shortness of breath, abdominal pain or tenderness [42]. In the chronic phase, there is inflammation and thickening of the bile ducts and gall bladder. This can lead to biliary lithiasis or obstruction. These symptoms are due to a blockage in the biliary tract and inflammation in the gall bladder. Inflammation of the liver, gallbladder, and pancreas may also occur [43].

Conclusion and recommendations

In conclusion, this review sheds light on the significant public health implications associated with zoonotic helminth infections originating from ruminant meat consumption. Through a comprehensive analysis of various scholarly articles and research findings, it becomes evident that helminth parasites found in ruminant animals pose a substantial threat to human health, leading to a range of debilitating symptoms and potentially fatal outcomes if left untreated.

Furthermore, the review highlights the diverse range of helminth species, including Taenia saginata, Fasciola spp., and Trichinella spiralis, which can contaminate ruminant meat and subsequently infect humans through consumption. These findings underscore the importance of implementing stringent measures to ensure the safety and quality of meat products derived from ruminant animals.

Based on the insights gleaned from this review, several recommendations can be made to mitigate the risk of zoonotic helminth infections associated with ruminant meat consumption:

It is imperative to establish robust surveillance systems to monitor the prevalence of helminth parasites in ruminant populations.

Educational campaigns should emphasize proper cooking techniques and hygiene practices to minimize the risk of infection.

Government agencies and regulatory bodies should enforce strict regulations governing the production, processing, and sale of ruminant meat products.

Collaborative efforts between researchers, policymakers, and healthcare professionals are needed to address this multifaceted public health challenge.

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