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Risky diseases affecting rabbit health and meat productivity

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Review Article

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Abstract

There are many of benefits for consuming rabbit meat, which characterized by its low in fat compared to beef, but it is still a good source of protein like many other animal products. Numerous respiratory diseases are common in rabbits. Pasteurellosis is caused by *P. multocida* and is considered a highly severe disease. It causes significant mortality and high losses in rabbit farming. It is characterized by either sudden and less severe bronchopneumonia or long-lasting mucopurulent respiratory issues (snuffles). Pasteurellosis has also been connected to neurological and reproductive problems, ear infections, localized infections, and blood poisoning. *P. multocida* is a worldwide disease that mainly affects 4–8-week-old rabbits. *P. multocida* is usually spread by direct or indirect contact, mainly through aerosol. Moreover, additional stressors may exacerbate the infection's severity. When the diagnosis be sure, conventional isolation and identification techniques are regarded as the gold standard, *P. multocida* and its virulence factors can now be quickly identified by molecular techniques. Vaccinations, treatment with various antimicrobial agents, and the application of hygienic practices are all share in prevention techniques.

Rabbits are highly susceptible to the common protozoal illness known as coccidiosis. Rabbits that are rescued frequently go on to become carriers. *.Eimeria stiedae, E .magna, E .irresidua, E. media, E. flavescens,* and *E. intestinalis* are responsible for the hepatic form of coccidiosis, whereas all Eimeria spp. cause the intestinal form. The intestinal and hepatic forms are both transmitted through consuming the sporulated oocysts found in contaminated food or water.

This review article includes information on incidence, susceptibility, symptoms, signs, laboratory diagnosis, preventive, control measures and an overview of benefit of rabbit meat, most important diseases (pasteurellosis, coccidiosis) in rabbits.

Keywords: *P. multocida; rabbits; incidence; Eimeria, coccidiosis*

1- Health benefits of rabbit meat:

The need for raising rabbits is growing more and more, particularly in low-income countries. It offers animal-based protein. Rabbits are particularly susceptible to different infections that leading to considerable economic losses **Umaraw *et al.* (2024)**.

Slovenia is still seeing an increase in the breeding and consumption of rabbit meat, similar to other European nations, particularly those in the Mediterranean region. It has currently reached a value of 0.3 kg per person. One of the main sources of fat in the diet is meat, particularly saturated fatty acids, which are generally thought to pose a risk for the diseases linked to modern living, particularly in developed nations. These include a rate of cancers

prevalence with coronary heart disease being the most common **Wood *et al.* (2003**).
According to World Health Organization guidelines, daily fat consumption should be limited to 30% of total energy intake, with saturated fatty acids (SFA) making up only 10% of total energy intake **WHO (1990**). Simultaneously, it is advised that the polyunsaturated to saturated fatty acid ratio (P/S) be greater than 0.4 **Wood *et al.* (2003**). It is advised that the ratio of n-6/n-3 PUFA (polyunsaturated fatty acid) be less than 4 since it is thought to be a risk factor for cancer and coronary heart disease **Enser *et al.* (2001**).
It is commonly known that the chemical makeup of rabbit meat, particularly the amount of fat and the profile of fatty acids, is greatly influenced by a number of factors, such as the animals' age, breed, sex, diet, physical activity, and/or genotype. From a nutritional perspective, rabbit meat is valued for its advantageous qualities: it is low in cholesterol, rich in unsaturated fatty acids (which make up 60% of its fatty acid contents), and lean. The sensory aspects of meat, in addition to its nutritional value, are important in influencing consumer choice. Customers believe that rabbit meat has good sensory qualities because it is flavorful (wild taste), lean, and tender. The primary reason for a possible rejection is the usual flavor of wild game meat that some customers may find objectionable **Dalle Zotte (2002**).

1. Rabbit meat physico-chemical composition and sensory profile:

1.1. pH level:

The pH values of rabbit meat varied significantly based on their age at slaughter and genotype. The meat from male and hybrid rabbits had higher pH values than female SIKA rabbits. Researches have indicated that breed and diet have a minor impact on the pH of meat 24 hours after slaughtering; this pH value is most likely influenced by the equilibrium of muscle energy metabolism **Barron *et al.* (2004**).

1.2. Moisture, protein and ash content:

Rabbit meat typically contains 72.7% moisture, 22.1 % proteins, and 1.31% ash. Males had a higher moisture content than females, and the SIKA group had a significantly lower moisture content than the Hybrid group. The moisture content did not significantly differ between animals of different ages at slaughter. water content decreasing as age increased as long as there was a significant difference (7 weeks) between age groups. Significant variations in ash content were found in relation to genotype, age, and sex; in the SIKA, ash content was higher than in the hybrid breed, and it was higher in male than in female samples. However, as age increased, ash content decreased **Pascual *et al.* (2004**). Additionally high in proteins (20.0–21.9%), high in biologically valuable amino acids, and relatively high in energy.

1.3. Fat contents:

The range of fat content in rabbit meat is 0.6% to 14.4% **El madfa *et al.* (2001**). The amount of fat in rabbit meat varied depending on the sex and genotype. The SIKA had a considerably lower fat content than the hybrid breed, and the males had a significantly lower fat content than the females.

1.4. Cholesterol content:

The range of the cholesterol content in rabbit meat is 45 to 85 mg/100g, according to **Souci *et al.* (2000).** The average cholesterol content of fresh boneless rabbit meat (LL + abdominal wall + hind leg) is 76.6 mg/100g. No experimental fixed effect was found to have an impact on this content. As per **Dalle Zotte's (2002)** assertion, rabbit meat has the lowest cholesterol content among the commonly consumed meats.

1.5. Sensitivity traits:

The primary characteristics of rabbit meat, such as color, tenderness, juiciness, and mouth feel, are unaffected by genotype; however, the aftertaste of rabbit meat is greatly influenced. Compared to the Hybrid group, SIKA had a noticeably stronger aftertaste of rabbit meat. The SIKA genotype received lower flavor scores as a result. Thus, it can be inferred that the SIKA genotype exhibits some unwanted scent traits that may not sit well with customers **Lefevre *et al.* (2004**).

2. Pasteurellosis in rabbit:

Among the most devastating infectious agents

is pasteurellosis, a highly contagious bacterial disease that causes severe epidemics and adverse significant economic losses in rabbit production worldwide **El-Jakee *et al.* (2020)**. In rabbit fields, pasteurellosis is thought to be the most common cause of death. *P. multocida* is the causative agent of the illness. It is characterized by either acute or subacute bronchopneumonia, which can have a significant mortality rate in the animal, or chronic mucopurulent respiratory affection (snuffles). However, in cases of rabbit pasteurellosis, acute fatal pneumonia from both epizootics and enzootics has been documented **Tinelli *et al.* (2020)**.

2.1. Clinical form of pasterurellosis:

Septicaemia, rhinitis with purulent nasal discharge (snuffles), pneumonia, abscesses, otitis media, meningitis, pyometra, and orchitis are among the various clinical manifestations of pasteurellosis in rabbits. Pasteurellosis in rabbits has occasionally been reported without any symptoms. Pasteurellosis has been reported to be the cause of death or culling for over 50% of adult rabbits **Premalatha *et al.* (2009)**.

Lesions and indications:

P. multocida has been demonstrated to exhibit a broad spectrum of pathogenicity , ranging from lethal acute septicemia to chronic forms (snuffles). Additionally, there are differences in the pathogenicity of *P. multocida* isolates; some are essentially connected with fiery problems of the upper respiratory tract, while others might bring about septicemia and pneumonia. Violent invasive strains of *P. multocida* can quickly penetrate the respiratory mucosa, causing acute or pernicious diseases **Al-Haddawi *et al.* (2001)**.

P. multocida infections in rabbits were characterized by fever and respiratory distress, which finally led to respiratory failure. Pasteurellosis caused morbidity and mortality rates of 23% and 35–40%, respectively. When rabbits were auscultated, mucous exudate increase in their lungs and trachea, causing them to make snuffling sounds. Significant fibrinopurulent pleuropneumonia and highly fibrinous adhesions on the lung surfaces **El-Hendy *et al.* (2020)**.

2.2. Laboratory diagnosis of *P.multocida*:

P. multocida isolates are small, white colonies on tryptic soy agar and as 1 mm-diameter, non-haemolytic, dewdrop-shaped colonies on 5% sheep blood agar **Ehsan (2019).** A member of the Pasteurellacae family is *P. multocida*. Facultative anaerobic, Gram-negative, capsulated, non-motile, or spore-framing coccobacilli **kuhnert and Christensen (2008).** After staining blood smears, a unique bi-polar bacterium in the acute stage of infection can be seen under the microscope. Biochemical reactions of *P. multocida* (urea hydrolysis test, oxidase, catalase, and indole test). **Tinelli *et al.* (2020)** reported that ,Although culture is the most reliable method for identifying *P. multocida*, it is unreliable for screening purposes due to the possibility that up to 30% of infected rabbits will not be detected.

Using the latex agglutination test, the bacterium could be divided into five capsular serogroups (A, B, D, E, and F) and sixteen somatic serotypes (1-6). In contrast, *P. multocida* strains with capsular types (A, D, and, to a lesser extent, type F) are the most common cause of pasteurellosis in rabbits. Some examples include the superoxide dismutase (sodA), (sodC), (pfhA), (tbpA), hemoglobin binding protein (hgbA), hemoglobin binding proteins (hgbB). Serotypes 1, 3 and 12 were the most common capsular type A strains in Egyptian rabbit flocks **Mahrous *et al.* (2022)**.

Serotypes A:3,5, A:12, B:2, and D:6 represent the majority of *P. multocida* isolated from rabbits in Egypt, while serotypes D:12 and A:4 made up a smaller percentage. The *P. multocida* serotyped A:3,5, and A:3 might interface with each other. Because most serological monitoring tests use uncharacterized antigen mixtures that may not detect all serotypes that colonize rabbits, this method may not be able to identify isolates of *P. multocida* **Youssef (2011)**.

Variables that affect virulence Polysaccharide capsules and endotoxins, also known as lipopolysaccharides, are believed to be the main factors influencing the virulence of *P. multocida.* Fimbriae, or pili, have demonstrated the bacterium's ability to adhere to the rabbit nasopharyngeal epithelium. As a result, the pathogen's virulence and pathogenicity may be

influenced by adhesion and colonization factors, fimbriae, iron storage, regulatory proteins, exotoxins, plasmids, and extracellular enzymes **Katoch *et al.* (2014)**. Several studies have shown that rabbits harbor *P. multocida* virulence-associated genes, including filamentous haemagglutinin (flgA), neuraminidase (nanH), neuraminidase (nanB), dermonecrotoxin production (toxA), and fimbriae adhesions (ptfA). Consuming and frequently fall short because certain transport media don't keep the organism viable at room temperature for longer than a day. By detecting *P. multocida* directly from samples and small amounts of cultures, nucleic acid-based assays improve sensitivity and shorten the time needed for bacterial identification **Dutta *et al.* (2005)**. The DNA-based *P. multocida* identification method has been acknowledged as an efficient characterization approach due to its high discriminatory power. As a result, polymerase chain reaction (PCR), a molecular identification technique for *P. multocida* isolates, is currently recognized as a fundamental technique for infection detection. **Stahel *et al.* (2009)** PCR-typing methods were used to show genetic heterogeneity between various *P. multocida* clones. The pathogen's molecular fingerprinting will be useful in identifying the origins and reservoirs of infections in rabbits. To obtain a pure culture of *P. multocida* needed for serotyping, extensive subculturing is needed. Various serological tests for the identification of serum antibodies to *P. multocida*, including the enzyme-linked immunosorbent assay, gel diffusion precipitin test, and haemagglutination test **Asway *et al.* (2008)**.

2.3. Prevention and treatment of pasteurellosis:

Finding the virulence characteristics and antibiotic resistance to *P. multocida* isolates would help with the creation of efficient preventative measures.

Vaccination:

Immunization Rabbits' capacity to fight off *P. multocida* infection is contingent upon the state of the exposed mucosa and the speed at which mucosal immunoglobulins (IgA) are produced, which impede the growth of bacteria. Elevated levels of IgG in the blood are linked to a long-term process rather than the removal of infection. Pasteurellosis has not been successfully prevented over time by inducing immunity and protection against *P. multocida* using bacterins, potassium thiocyanate extracts, or attenuated live bacteria. To prevent issues related to variations in the antigenic structure of prepared vaccines and those antigens circulating in the field, autovaccines against rabbit pasteurellosis are advised **Peshev and Christova (2003)**. additionally advised developing a pasteurellosis vaccine using the strains of the disease that are most frequently isolated and immunogenic. showed that rabbits immunized intravenously with vaccines containing *P. multocida* or a cross-protective core lipopolysaccharide mutant of *Escherichia coli* developed kidney lesions and severe purulent bronchopneumonia and pleuropneumonia, while animals immunized mucosally (aerosol, conjunctival) did not exhibit any lesions. **Youssef (2011)** showed that when rabbits were challenged with homologous serotypes instead of heterologous ones, subcutaneous double vaccination with a monovalent formalized inactivated *P. multocida* vaccine (at 2-week interval) produced good protection. One term for this could be "lack of crossprotection" between the serotypes of *P. multocida*. In order to vaccinate infected rabbits, **Ruzauskas (2005)** prepared an oil-in-water adjuvant inactived *P. multocida* vaccine containing serotypes A and D. The vaccine was found to be safe, highly protective (100% survival rate), immunogenic, and to lessen the severity of respiratory symptoms when given subcutaneously twice to infected rabbits. After recovering, some animals continued to be carriers, which was expected given the pathogen's ability to survive in macrophages and their resistance to neutrophil phagocytosis. Inactivated formalised *P. multocida* vaccine has been commercially used for the vaccination of rabbits **Ismail *et al.* (2018)**. **El-Jakee *et al.* (2020)** assessed the effectiveness of a bivalent inactivated vaccine in protecting rabbits against the rabbit haemorrhagic disease virus (RHDV) and pasteurellosis.

The treatment of *P. multocida*:

Infected animals does not eradicate the infec-

tion; rather, it reduces the severity of the symptoms and slows the disease's progression.Treatment could only be said to be effective for a short while. There are regional differences in *P. multocida*'s resistance to different antimicrobials **Awad and Abd El-Hamid, (2019**).
For instance, a recent study conducted by **Mahrous *et al.* (2022**) found that Italian isolates of *P. multocida* were tolerant of tetracycline, whereas Egyptian rabbit isolates exhibited predominant resistance to erythromycin, oxytetracycline, and kanamycin. The study conducted in **Cucco *et al.* (2017**) who found different results. Extra examination revealed that *P. multocida* were more impervious to antibiotic medication, ampicillin, amoxicillin, and neomycin **Awad and Abd El-Hamid, (2019). El Sayed *et al.* (2018)** found that every Egyptian *P. multocida* isolate from pasteurized rabbits was resistant to neomycin, ampicillin, and penicillin.

Rabbit pasteurellosis affects large rabbit farms all over the world. Thus, it is thought that using autogenous *P. multocida* bacterin and putting strict hygienic guidelines in place are suitable precautions against the disease.

3. Coccidiosis:
It is considered the most prevalent and serious disease that affects domestic rabbits . Not only does this disease cause a large number of deaths overall, but it also causes growth retardation that survive the acute form of the illness. While it primarily affects young rabbits, adults, particularly those who have never experienced the illness before, can also suffer greatly from coccidiosis **Al-Quraishy, (2012**).
Coccidiosis is a curious parasite to a serious illness. The tiny single-cell organisms called coccidia are invisible without a microscope. Fortunately, most coccidi are specific to their host. Coccidi come in a variety of forms. In other words, according to **Abakar *et al.* (2005**), rabbits coccidia cannot infect chickens or other animals, and chicken or other animals coccidia cannot infect rabbits. No other animal has been shown to be susceptible to rabbit coccidia infection. Comprehending the life cycle of coccidia is imperative for both understanding and effectively managing the disease. Because the intestinal and liver coccidia have the same life cycle, The current review describe the details about the liver coccidia.
Begining with the oocyst, a form that is found in recently excreted materials. This has a large center body that resembles the size and shape of an egg yolk, and a small body that is shaped like an egg and flattened at one end. It is not contagious and will not spread the illness if given to an susceptible animal. If kept warm and moist, this oocyst will sporulate in 24 to 72 hours, mostly depending on temperature. The term "sporulation" refers to the division of the main body into four smaller bodies, or "sporocysts." Each of these sporocysts then divides into two smaller bodies. The original oocyst now has eight bodies, or sporozoites, as a result. This is the infective stage, which released when the body consumes tainted food or water, rupturing the oocyst and sporocyst shells. Following that, these ascend the common bile duct until they reach the liver, where they pierce the epithelial cells of the small bile duct. After entering the cell, they mature **González-Redondo *et al.,* (2008**).

3.1. Rabbit hepatic coccidiosis:
The quantity of oocysts consumed determines the disease's severity. Youthful bunnies are most in danger. It is possible for affected rabbits to exhibit anorexia and have rough coats. Even though hepatic coccidiosis is typically subclinical, growing rabbits may not gain weight normally. Death occasionally has a brief course. A month typically passes following a severe experimental exposure in rabbits. Upon necropsy, minuscule, yellowish-white knobs are found all through the hepatic parenchyma. They might not be the same at first, but over time, they might combine to form one mass. Early injuries contain a smooth substance, though more established sores might have a consistency more like cheddar. Under a microscope, the nodules are made up of gallbladder or hypertrophied bile ducts **Pakandl (2009**).

3.1.1. Diagnosis of hepatic coccidiosis:
Diagnosis is made using the oocysts inner the bile ducts as well as microscopic and macro-

scopic changes. When a liver lesion impression smear is examined under light microscopy, oocysts are often visible. An additional technique for displaying the oocysts is fecal flotation. It's imperative to clearly identify the oocysts from Cyniclomyces guttulatus, the common fecal examination yeast.

3.1.2. Treatment of hepatic coccidiosis:
Sulfaquinoxaline, when added consistently in the drinking water (0.04% for 30 days) forestalls the advancement of clinical indications of hepatic coccidiosis in rabbits that are vigorously presented to *E. stiedae*. However, the lesions might not stop there. In addition, 0.025 sulfaquinoxaline can be administered intravenously twice per week for a total of 20 days. A solitary oral portion of 50 mg/kg of sulfadimethoxine, trailed by its expansion to drinking water at 1 g/4 L for nine days, was found be essentially to bring down the waste oocyst count. As the liquid sulfaquinoxaline is utilized more frequently .Rabbits raised for food have a ten-day withdrawal period. Other coccidiostats, for example, amprolium (9.6% in water or 0.5 mL/500 mL), salinomycin, toltrazuril/ ponazuril, diclazuril, and others could likewise be viable. In addition, a single oral dose of toltrazuril at 2.5 mg or 5 mg/kg has been shown to significantly lower oocyst counts. Yet again it is exhorted that treatment be controlled for at least five days. Bunnies that get the right consideration become invulnerable to new diseases **Kvicerova *et al.* (2008**).
A sanitation program must be implemented in tandem with treatment to ensure its success. To break up the protozoa's life cycle, the bottoms of wire cages need to be brushed daily with a wire brush. Because it kills oocysts, a solution containing 10% ammonia is the best option for cleaning cages or other equipment that comes into contact with excrement **Pakandl (2005**).

3.2. Rabbits with intestinal coccidiosis:
Both cleanly raised and properly cared-for rabbits can be affected by this particular form of coccidiosis. The majority of infections are not severe, and there are rarely any symptoms. Early contaminations seldom cause injuries; later, the digestive tract might thicken and turn pale**.** Good sanitation practices seem to only be able to eradicate hepatic coccidiosis; intestinal coccidiosis appears to be impossible to eradicate **Yun *et al.* (2000**).

3.2.1. Diagnosis of intestinal coccidiosis :
The most widely used techniques for identifying the species of intestinal coccidiosis are microscopic oocyst identification and fecal flotation. It is essential to distinguish coccidian oocysts from Cyniclomyces guttulatus, a widely distributed nonpathogenic yeast.

3.2.2. Treatment of intestinal coccidiosis:
As in hepatic coccidiosis, with the exception of giving sulfaquinoxaline for seven days, followed by another seven days.

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