Chapter 21

Summary of Common Intestinal Diseases in Pigeons and Related Pharmacological Prevention

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ABSTRACT

Pigeons are relatively easy and profitable to raise compared to other exotic birds. However, the large-scale development of the pigeon breeding industry has led to the emergence of various diseases. The intestine plays a crucial role in the digestion and absorption of nutrients in animals. The specific methods employed in pigeon rearing make them particularly susceptible to intestinal diseases such as colibacillosis, salmonella, and Newcastle disease. These diseases pose a threat not only to the pigeon industry but also to human health. While feed additives have been utilized in animal nutrition, the use of antibiotics as feed additives raises concerns regarding antimicrobial resistance, making the search for suitable alternatives essential for pigeon farming. Therefore, this article aims to summarize the intestinal-related diseases affecting pigeons, enhance the understanding of the occurrence and development of their intestinal functions, explore natural and novel antibiotic alternatives, and provide recommendations for the prevention and treatment of pigeon diseases.

KEYWORDS
Pigeons; Intestinal diseases; Intestinal function and microorganisms; Drug prevention

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INTRODUCTION

As one of the earliest birds to be domesticated, pigeons not only possess ornamental and competitive value but also hold significant economic importance, making them a crucial type of commercial poultry (Wang et al., 2023). In many countries, pigeons have emerged as an important economic poultry species due to their nutritional value and meat quality, which are comparable to those of broiler chickens. Furthermore, they exhibit faster growth rates with minimal inputs, rendering their breeding profitable (Xu et al., 2020; Rani et al., 2021). Reports indicate that racing pigeons have become the fourth largest poultry product in my country, following chickens, ducks, and geese (Feng et al., 2022). According to relevant data, in 2021, China produced over 1.11 million pairs of pigeons, with approximately 1.6 billion pigeons slaughtered for food (Gao, 2022). However, unlike other poultry, the growth of young pigeons relies on exclusive feeding with milk secreted from the parental pigeon's crop. Following this initial phase, their diet gradually incorporates cereals and is eventually replaced by fodder, suggesting that this unique rearing method contributes to a faster growth rate (Xu et al., 2020a; Peng et al., 2023; Jin et al., 2023).Thus, the development of the pigeon industry has become a vital sector for maintaining the quality of life for the population and supporting economic growth.

Pigeon farming is a profitable business with low investment and labour, however there are challenges to the development of the pigeon industry, one of the major threats is the impact of intestinal diseases (Kim et al., 2010). The gut plays a crucial role in the digestion and absorption of nutrients, so gut health has a significant impact on poultry productivity (Yang et al., 2022). The pigeon's specific feeding regime also results in a significant impact on the nutrient and microflora in the gut at different stages (Guzman et al., 2013; Wang et al., 2023). Studies have shown that pigeon diarrhoea poses a major health risk at all ages, with a prevalence of up to 50%, and is accompanied by symptoms that lead to weight loss, crop stagnation, vomiting, anorexia and, in severe cases, death (Wang et al., 2024). Pigeons can also transmit these diseases (such as colibacillosis and salmonellosis) to humans and other mammals, and can also become a reservoir for certain infectious diseases in poultry, seriously affecting the safety of pigeon breeding and other animal industries (Grande et al., 2016; Ranjbar et al., 2020).Therefore an understanding of pigeon intestinal diseases and their functional development is essential for the prevention and control of this type of disease.

With the rapid advancement of poultry farming, animal food safety has emerged as a significant concern. The misuse of feed additives and the rise of antimicrobial drug resistance pose critical threats to animal health. Studies reveal that 80% of animals used in food production have received drug treatments at some point in their lives, and products derived from these animals (e.g., meat, milk, and eggs) may contain drug residues, contributing to the development of resistance (Chiesa et al., 2020; Silveira et al., 2021). Therefore more and more feed additives and supplements such as probiotics, prebiotics, organic acids and exogenous enzymes are being used as alternatives to antibiotics to regulate the gut microbiota in order to maintain normal life activities in poultry (Yadav et al., 2019).

Etiology

The intestinal tract is not only the centre of nutrient digestion and absorption, but also an important place for immune function (Xu et al., 2020; Li et al., 2020). Bacteria, viruses and parasites can cause intestinal diseases, and in severe cases, can cause the death of the animal, so understanding the causes of intestinal diseases is of great significance to the prevention and control of this type of disease.

Bacteria

Among the bacterial causes of pigeon diarrhea, *Escherichia coli* (*E. coli*), *Salmonella enterica*, *Campylobacter jejuni* in the phylum Aspergillus and *Clostridium difficile* in the phylum Thick-walled Bacteria are the main common pathogens (Wang et al., 2024). Research by Rosa Capita et al. shows that pigeon meat is an important reservoir of *E. coli* with genes for antibiotic resistance and virulence having the potential to cause disease in humans (Capita et al., 2019). Studies have shown that human infection with VT2f-producing *E. coli* is a zoonotic disease transmitted from pigeons. Pigeons can directly transmit VTEC strains that cause diarrhea, and can also indirectly release VT2f phages in the environment, thereby infecting humans(Grande et al., 2016). *E. coli,* as an opportunistic pathogen, can be widely present in the pigeon's intestinal tract, causing diarrhoea, enteritis and other diseases (Wang et al., 2022) (Fig. 1). Salmonellosis is a serious problem for all birds and is an important cause of high mortality from bacterial diseases in pigeons, mainly caused by *Salmonella enterica* subsp. enterica serovar Typhimurium (*S. Typhimurium*) and *Salmonella enterica* serovar *Enteritidis* (*S. Enteritidis*) (Ranjbar et al., 2020). Pigeons are common carriers of Salmonella and infection can be intestinal, parenteral (abscesses, pneumonia, osteomyelitis, septic arthritis, endocarditis and meningitis) and systemic (bacteremia), manifesting as Symptoms include enteritis, diarrhea and sepsis, and the bacteria can multiply in contaminated feces and remain viable for more than a month to continue to infect pigeons(Badr et al., 2022). At present, bacterial diarrhea in pigeons is mainly treated through standard microbiological examination and antibiotics. Ampicillin, streptomycin and tetracycline are classified as antibacterial in veterinary medicine (Stetsko et al., 2018).

Fig. 1: Pigeons infected with *E. coli.* A) Symptoms of mental depression in pigeons; B) Symptoms of pigeon diarrhea ; C) *Escherichia coli* isolated from sick pigeons.

Virus

Viral diseases are common in both humans and animals and most viral infections severe enough to kill birds .In a study on pigeon diseases, the percentage of viral diseases in pigeons was found to be as high as 66.06%, with a high prevalence of Newcastle Disease and pigeon pox (Islam, 2020). Newcastle Disease in pigeons is a serious infectious disease caused by the Newcastle Disease Virus or Paramyxovirus type 1 in pigeons (Fig. 2; Liu et al., 2015). It infects young pigeons and adult pigeons and causes severe neurological and digestive symptoms such as bilateral or unilateral wing or leg movement disorders, diarrhoea and greenish loose stools (Zhang et al., 2022; Qian et al., 2022). Other viruses such as Pigeon Circovirus PiCV) and Pigeon Rotavirus can also cause digestive disorders in pigeons. Pigeons of all ages may develop the disease affecting meat and racing pigeons. PiCV-infected pigeons exhibit symptoms such as ruffled feathers, depression, anorexia, weight loss, regurgitation, poor racing performance, diarrhea, and polydipsia.,while those infected with rotavirus show severe vomiting and diarrhea (McCowan et al., 2018; Abdulrasool et al., 2022). For this type of disease virus isolation and diagnosis of pigeons using PCR and immunofluorescence are crucial.The prevention and treatment of viral diseases is mainly achieved by vaccination, but it is more important to do a good job of pigeon husbandry management to reduce contact with all kinds of wild birds, free range poultry and contaminated environments, so as to avoid the infection of the disease (Abolnik, 2014; Liu et al., 2015).

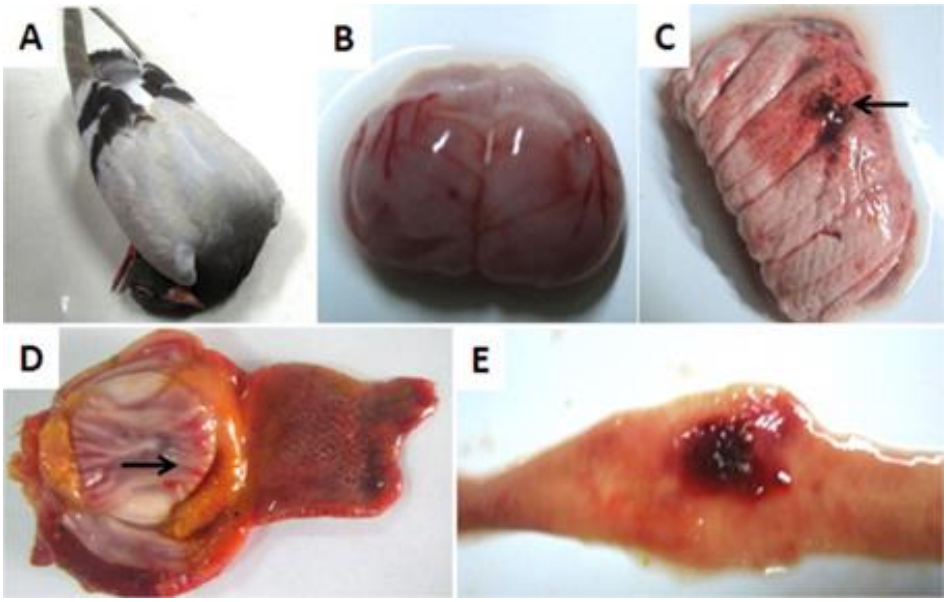

Fig. 2: Photos of pigeons infected with Newcastle Disease (Liu et al., 2015).

A) Pigeons infected exhibited severe nervous signs; B) Brain hyperemia and hemorrhage; C) Severe hemorrhage in the lung; D) Multifocal hemorrhages in the mucosa of muscular stomach; E) Multifocal hemorrhages in the mucosa of small intestine.

Parasites

Parasites is recognised as a major impediment to animal health and product performance, and the presence of internal and external parasites affects the growth, development and productivity of poultry, and in severe cases can lead to death (Mtd et al., 2020). It has been shown that coccidia (El-Seify et al., 2018), roundworms (Mtd et al., 2020) and trichinella (Cai et al., 2024) are the main parasites that infect pigeons with intestinal diseases.In the study of Gadelhaq et al. it was shown that globally the number of pigeons infected with coccidiosis is about 50-100% and the mortality rate reaches 70% (Gadelhaq et al., 2019). Pigeons infected with coccidia suffer from loss of weight and appetite, low immunity and wet feces, and bloody diarrhea in severe infections (Raś-Noryńska et al., 2011; Santos et al., 2020) and oocysts discharged in the fecal matter are non-pathogenic, but in the loft with appropriate temperature and humidity, they tend to grow and develop, thus, ultimately become invasive and able to infect pigeons (Balicka-Ramisz et al., 2014; Santos et al., 2020). Several studies have shown that the infection of pigeons with Trichinella is widespread in pigeons worldwide (Santos et al., 2020; Cai et al., 2024).Trichinella, as a parasite present in the respiratory (pharynx, oesophagus) and upper gastrointestinal (mouth) tracts, is mainly transmitted by feeding on the crop milk of infected pigeons, and the infected pigeons show clinical signs such as anorexia, weight loss, dyspnoea, dysphagia and diarrhoea, which in severe cases can lead to oesophageal luminal obstruction and death due to severe starvation. In severe cases, the oesophagus may be blocked and the pigeons may die due to severe starvation (Feng et al., 2020; Santos et al., 2020; Brunthaler et al., 2022). Heavy infections with roundworms can cause mild catarrhal enteritis, obstruction, dilatation and mild to necrotising ulceration of the small intestine in pigeons (Mtd et al., 2020). For this type of disease diagnosis is still mainly through clinical symptoms, microscopy to carry out, its treatment is still through the use of antiparasitic drugs plus symptomatic treatment of drugs, but also need to pay attention to the impact of drug resistance, the most fundamental is still the standardization of animal husbandry and management and maintain a clean environment in order to minimize the incidence of the disease and its spread.

Association between Intestinal Function and Intestinal Microorganisms in Pigeons

The intestinal tract, as a digestive organ, is responsible for the digestion and absorption of essential nutrients from poultry feed, and it also serves as a critical immune site with physical, chemical, immune, and microbial barriers that work synergistically against external stimuli (Liu et al., 2023). Pigeons are one of the few birds that can regurgitate pigeon milk to nourish their brood, and the feeding process is shown in Fig. 3 (Jin et al., 2023). Due to their delayed maturity, these pigeons cannot feed independently like other poultry and are entirely dependent on the milk secreted by the parental pigeon crop for a period following hatching. This milk, which is similar in composition to mammalian milk, is rich in microorganisms that facilitate microbiota establishment and metabolism, as well as promote the development of the immune system in the offspring (Dong et al., 2012; Ding et al., 2020; Jin et al., 2023).Intestinal function is usually reflected by intestinal morphology and structure, such as villus height, villus area, and crypt depth (Li et al., 2019). Studies have demonstrated that early weaning impairs intestinal development and health in pigeon squabs during artificial rearing periods (Wen et al., 2022).When pigeons are weaned at 7 days of age, their gastrointestinal tracts are often too immature to handle the physiological and environmental stresses associated with the transition from parental to captive feeding. This immaturity predisposes them to intestinal disorders and adversely affects their survival and disease resistance after weaning (Wen and Zhao et al., 2022).

Gut colonization by microbial communities is one of the most critical events in an animal's life, and the gut microbiota promotes poultry health by maintaining intestinal homeostasis, enhancing mucosal maturation, fostering immune system development, and inhibiting colonization by intestinal pathogens (Maynard et al., 2012; Wen et al., 2022). The gut microbiota can be categorised into probiotics, opportunistic pathogens and pathogens, where probiotics are beneficial to the host animal by inhibiting pathogens and balancing the gut microbiota, whereas opportunistic pathogens can be transformed into pathogens under specific conditions, which may threaten the health of the animal (Wang et al., 2014).The digestive system of newly hatched pigeons is sterile, immature, and highly susceptible to infection, with various microorganisms from the pigeon's milk and the environment briefly colonizing the gut (Wen et al., 2022). As the pigeon grows older its intestinal flora is gradually replaced from the Ascomycetes to the Thick-walled phylum due to the presence in the pigeon's milk of a rich microflora dominated by the representatives of the Thick-walled phylum, which are able to spread to the scales and participate in the process of bacterial colonization of the intestinal tract (Xi et al., 2019; Ding et al., 2020a). Many members of the Thick-walled phylum are associated with digestion and fermentation during starch metabolism, playing a crucial role in energy production, and eventually becoming the dominant flora in the intestinal tract (Ding et al., 2020a). Studies have shown that squab milk is rich in Lactobacillus and Bifidobacterium, with Lactobacillus being particularly beneficial to health due to its ability to inhibit the growth of pathogens through lactic acid production. Certain strains of Lactobacillus have been demonstrated to alleviate diarrhea in mammals by modulating the microbial community and enhancing immune system function in the small intestine, suggesting that Lactobacillus may play an important role in protecting the intestinal health of pigeon squabs (Bian et al., 2016; Ding et al., 2020a; Xu et al., 2022).

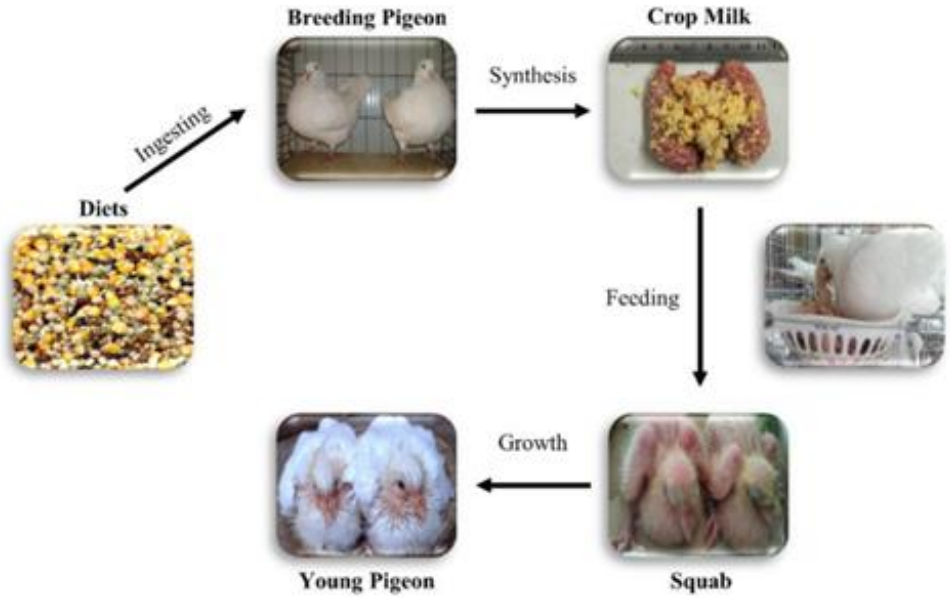

Fig. 3: Squab growth process (Jin et al., 2023).

Animal Feed Additive Alternatives for Intestinal Protection in Pigeons

Various feed ingredients and additives have been reported to modulate the gut microbiota and immune system of the host (Wang et al., 2023). However, with the rapid development of animal husbandry, issues related to bacterial resistance and drug residues resulting from antibiotic use have become increasingly prominent. Consequently, many countries and regions are gradually banning the addition of antibiotics to animal feed, prompting a heightened interest in the search for new medicinal drugs and alternative substances to antibiotics in animal feed (Cheng et al., 2014; Silveira et al., 2021; Hernando-Amado et al., 2020; Kim et al., 2022).Tea polyphenols, derived from tea, have antioxidant properties and promote the production of beneficial intestinal bacteria such as bifidobacteria and short-chain fatty acids (Su et al., 2019; Shao et al., 2022). Tea polyphenol supplementation in pigeon feed has been shown to improve growth performance, serum biochemicals, antioxidants and immunity, as well as enhance intestinal function to maintain intestinal health and improve the ability to digest and absorb nutrients (Chen et al., 2024). Astragalus, Epimedium, and Ligustrum lucidum (AEF) can enhance host immunity and improve animal growth performance. Supplementation of 0.1g/mL AEF in water enhances the pigeon's stress resistance, improves pigeon productivity (laying rate, egg quality, fertilization rate, weight gain, etc.), and strengthens pigeon's intestinal health and growth performance (Zhang et al., 2023).

Studies have shown that herbs and probiotics function extremely well as an alternative to antibiotics (Attia et al., 2023; Alagawany et al., 2023). Antibacterial peptide (ABP) is a broad-spectrum antibacterial and biologically active small molecule peptide, which exists in all kinds of animals, plants, bacteria, viruses and human beings, and can effectively kill bacteria, and not easy to produce drug resistance, which can enhance the immune function of the animal and improve the composition of the intestinal microflora, to maintain the health of the intestine, and to improve the production performance of the animal (Gadde et al., 2017; Mookherjee et al., 2020; Patyra et al., 2023). It has been demonstrated in the literature that supplementation of feed with ABP MccJ25 improves the serum antioxidant capacity of pigeons, enhances the intestinal barrier function and antioxidant capacity of pigeons, and promotes intestinal health (Cao et al.,

2024). ABP 200 increased the abundance of beneficial bacteria and decreased the abundance of harmful bacteria in the pigeon's intestine, improved intestinal morphology, facilitated digestion and assimilation of nutrients, and promoted the growth and development of pigeon squabs(H et al., 2024).It has been found that supplementing the diet of pigeon mothers with appropriate amounts of linoleic acid (LA), is essential for poultry, and that deficiencies in LA can lead to a reduction in inflammation in the offspring and promote the growth of beneficial bacteria to strengthen the intestinal immune and luminal microbiological environment (Xu et al., 2020).The progress of animal production is also accompanied by the abuse of various drugs and the side effects of antibiotic resistance, so the use of natural feed ingredients and plant extracts has become an optimistic and strong candidate for the replacement of traditional drugs, and such a measure provides assistance in the growth and development of animals and the prevention of diseases, and also makes an important contribution to the sustainable development of the livestock and poultry industry.

Conclusion

With the expansion of pigeon breeding scale and the improvement of production level, people have also begun to pay attention to the occurrence and development of pigeon-related diseases. Understanding pigeon intestinal-related diseases and selecting appropriate intestinal protective agents play an important role in the production and development of pigeons.

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