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Lactose intolerance in dogs: Review

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Abstract

Dog lactose intolerance is a common condition caused by low levels of the lactase enzyme, which must digest the lactose in milk. While puppies possess sufficient lactase to digest the mother's milk, this decreases as the dogs grow up, leading to diarrhea, bloating, and vomiting after consuming dairy food. It can be treated by replacing ordinary milk with lactose-free products, which are nutritious without causing any gastrointestinal distress. Colostrum, which is the first milk produced after parturition, is vital to the survival of new puppies. It contains antibodies that help the immune system during the first few months of life. Puppies must consume the colostrum during the first 24-48 hours of life in order to gain these antibodies to reduce infections and mortality rates. Colostrum also contains vital nutrient components such as proteins, fats, and bioactive elements that are important to build the digestive and muscular systems. Dog milk has a rich fat (7.5%) and protein (8.5%) composition, which is appropriate for the rapid growth of puppies. Lactose may be difficult for adult dogs to digest since lactase secretion decreases after weaning. Lactose-free milk or commercial milk replacers can be used to provide normal nutrition to orphaned puppies or lactose-intolerant pups. Clinical signs such as pain and swelling and changes in milk appearance can be diagnostic in mastitis in female dogs. Laboratory tests such as pH analysis and cytology are important for correct diagnosis and treatment at an early stage.

Keywords: Lactose intolerance, colostrum, lactose-free milk, mastitis diagnosis, puppy nutrition

1. Introduction

Lactation in domestic carnivores, such as cats and dogs, has really received limited consideration. However, in recent years, study in this area has increased. The passive immune transfer plays a role in neonatal survival, especially in species like cats and dogs, and is critical in these species because low maternal immunoglobulins are transferred through the placenta^[5]. As a result, puppies and kittens depend on the ingestion of colostrum just after birth to obtain passive immunity. The colostrum intake was an increased focus on the neonates of dogs and cats and led to a deeper consideration of its effects on long-term health consequences^[27]. Dogs that produce insufficient amounts of the lactase enzyme are necessary for the digestion of lactose in milk; dogs that produce insufficient amounts of the lactase enzyme have developed lactose intolerance cases. Although dogs naturally produce enough lactase but some time decline in certain dogs that can result signs such bloating, vomiting, and diarrhea^[3]. The undigested lactose ferments in the colon, creating gases and producing gastrointestinal distress. Lactose intolerance differs between dogs depending on the breed. Some studies have shown that lactose-free milk can be an alternative for dogs in case of lactose intolerance, reducing gastrointestinal signs without adverse effects^[32].

Milk and colostrum are important for the development and growth of puppies. Colostrum released directly after birth is rich in immunoglobulins, proteins, and other compounds that are essential for animals' immunity and development in the gastrointestinal tract^[18, 28]. On the other hand, milk in dogs is composed of fat (7.5%) and protein (8.5%); these compositions of milk are changed during lactation, for example, colostrum containing higher concentrations of proteins and immunoglobulins^[1, 31].

The aim of this study is to investigate lactose intolerance in dogs, concentrating on the importance of colostrum in neonatal dogs and the compositions of dog milk and colostrum. Additionally, to review the milk replacer lactose-free alternatives for dog's health.

2. Colostrum in Dogs

2.1. Importance of Colostrum

Colostrum is the first milk produced by a mother dog directly after giving birth. It plays a serious role in the survival rate and health of neonatal puppies when providing them with essential immunoglobulins that support their immune systems through the first few weeks of life [6]. These immunoglobulins are absorbed through the intestines and protect puppies against infections. The period for absorbing colostrum from the intestine is limited to about the first 24-48 hours after birth when the intestines are still capable of absorbing these large immune molecules [18]. The transfer of passive immunity through colostrum is important, mostly because puppies do not obtain immunoglobulins during pregnancy due to the structure of the placenta of the bitch. Colostrum is necessary to protect newborns from bacterial and viral infections. Newborns must ingest colostrum within the first 24 hours of life [28].

2.2. Composition of Colostrum

Colostrum is vital for newborn survival rates; dogs are born without any systemic immunoglobulins and completely dependent on colostrum intake for passive immunity. The level of IgG in colostrum is variable; in the cat's colostrum was higher than in the dog's colostrum. Passive immunity, on the other hand, depends more on how much colostrum is eaten and when it is eaten than on IgG concentration [5, 7]. Canine colostrum is critical for neonatal survival rate because puppies are born with nearly no circulating antibodies and are therefore highly susceptible to infections [23]. The immunoglobulin level, about 20-37% in colostrum, is significantly higher than in the milk, particularly IgG, but there is a rapid decline in IgG level after the first 48 hours into 7 days, while the IgA level increases after 2 weeks [7, 16]. The colostrum contains essential nutrients as growth factors and enzymes that help gut maturation and energy production. The protein level in colostrum is nearly double that of regular milk [5]. Colostrum is a source of vital bioactive compounds, including enzymes and hormones that help gastrointestinal development and systemic growth. Alkaline phosphatase and gamma-glutamyl transferase are significant enzymes present in colostrum, higher than in the maternal bloodstream [4]. Additionally, colostrum contains somatic cells as polymorphonuclear neutrophils, exosomes, and a specific microbiota that plays a role in the immunity of the newborn's gut [37].

The lipids in colostrum are an essential source of energy for the rapidly growing neonates, while the proteins, such as casein, play a role with tissue growth. In addition, colostrum contains minerals and elements such as calcium, phosphorus, magnesium, sodium, potassium, zinc, iron, and copper, and vitamins such as A, D, K, C, and B complex [24, 26].

Colostrum composition is breed and lactation cycle specific. Fat content ranged from 6.5% in the German shepherd to 10.2% in the Golden Retriever, and protein content ranged from 3.7% in the West Highland Terrier to 8.1% in the German shepherd. The mean fat content was 8.42%, and the mean protein content was 5.97% [10].

3. Milk in dogs and mastitis

Milk production in carnivores is about three weeks after parturition and is influenced by factors such as stage of lactation and litter size. In dogs, daily milk production is ranging between 1.7% and 6.6% of body weight in female dogs. While, in cats, milk production per day under the first

week of lactation is ranged between 1% and 3.1% of the body weight and rises into 5.9% through the second to fourth week [12, 39].

3.1. Nutritional Composition of Dog Milk

The milk of domestic carnivores has an advanced dry matter content and energy value when compared to bovine, about twice the dry matter and energy of bovine milk, and the main protein type in dog milk is casein [1]. The composition of milk is affected by a feeding session and stages of lactation [20]. Dog milk is unique because of a higher fat and protein content than milk of bovine. On average, protein contains about 3.5% lactose, 7.5% fat, and 8.5% protein. The high fat content is important to the energy-essential growth of puppies, while the protein content supports immune function and the development of the muscle [31]. In addition, milk in dogs contains bioactive molecules like immunoglobulins and growth factors involved in immune protection and organogenesis of various organs. Nutritional composition of dog milk also during continuous lactation, fat and lactose concentrations increase, while immunoglobulins significantly decrease. These changes reflect the shifting nutritional needs of puppy growth and development. Understanding these shifts in milk constitution is important to breeders and veterinarians managing the initial diet of new puppies. The milk of a bitch's composition includes fat (8.92-14.31%), protein (6.62-17.34%), and ash (1.11-1.81%) [40]. The canine milk contains a protein that helps in growing muscles and tissue repair, and the fat provides immediate energy to the bodies of the puppies that are actively developing. The high fat content in dog milk plays a crucial role in the provision of energy to the puppies at their development phase. Dog milk has less lactose compared to bovine milk; hence, it is more digestible for the puppies. Additionally, their milk digestion system may alter, and that is when lactose intolerance may start to develop [31].

3.2. Mastitis in Bitches

Mastitis is inflammation of the mammary glands in bitches that can involve one or more glands. It is usually accompanied by a change in the appearance of milk, e.g., from white to yellow-green or brown, and in consistency. In others, milk might remain unchanged. Clinically, mastitis bitches exhibit localized signs such as swollen, warm, and tender mammary glands, and systemic signs such as anorexia, depression, and even sepsis [21].

Mastitis in bitches is classified into different types according to its presentation and severity. They are acute mastitis, gangrenous mastitis, mammary congestion, galactostasis, and subclinical mastitis. Galactostasis and mammary congestion must be detected and intervened at the initial stage because if not, these cases may finally stage into mastitis. In acute mastitis, the bitches can present with fever, pain, swelling of the glands and abnormal milk discharge. An immediate reaction is necessary. Subclinical mastitis, nonetheless, may not present any observable signs but may be identified using laboratory tests, especially milk cytology and microbial tests [33].

3.3. Laboratory examination tests

Laboratory examination tests are important for diagnosing and controlling mastitis, particularly in initial stages. Milk pH, cytology, chloride level, and bacteriological culture are the most tests used. Milk pH in healthy females should ideally be slightly acidic milk pH (~6.3), while alkaline milk (pH ~7) occurs in cases of mastitis. While, in severe cases, such as

mastitis gangrenosa, the milk pH can reach greater values up to 7 that indicate infection development^[34].

Microbiological analysis is required for the identification of pathogens in the milk of mastitis-infected bitches. Standard microbiological techniques are employed to cultivate commonly found pathogens such as *Staphylococcus*, *Streptococcus*, and *Enterobacteriaceae* from the milk sample. Milk samples plated on blood agar, for example, use mannitol salt agar to culture *Staphylococcus* spp., while MacConkey agar is used for *Enterobacteriaceae*. In others, more specific test techniques, such as the use of Vitek2 systems for the identification of bacteria, will be needed to determine the specific pathogens^[2, 19].

Cytology forms a critical component of mastitis diagnosis, particularly in subclinical mastitis, when there is no visible clinical sign. Milk cytology involves the examination of milk smears, which can show the presence of inflammatory cells such as neutrophils, macrophages, and epithelial cells. An increase in the somatic cell count (SCC) is suggestive of an active infection. At other times, milk from healthy bitches can divulge bacteria as contaminants, but the concurrent association between rising SCC and the presence of bacteria implies infection^[35].

4. Lactose Intolerance in dogs

Dog lactose intolerance is a common condition in animals caused by low levels of the lactase enzyme, lead to develop various lactose intolerance signs, about 50% of received milk powder of cow or goat, but not lactose free. When established lactose intolerance signs in dogs, feeding dogs lactose-free milk^[38].

4.1. Mechanism of Lactose Intolerance

Lactose intolerance in dogs is essentially because of the absence of the enzyme lactase, which is essential for the hydrolysis of the lactose to galactose and glucose. Puppies, during nursing, can produce sufficient amounts of lactase, but this production drops significantly as they grow older. This causes the accumulation of undigested lactose to be fermented in the colon of the dogs and causing diseases of the gastrointestinal tract such as diarrhea, bloating, vomiting, and discomfort. Lactose intolerance could strike many adult dogs and is likely to cause symptoms such as diarrhea, bloating, and abdominal pain^[38, 40].

Lactose, a disaccharide that converts into glucose and galactose, is the primary mammalian milk carbohydrate and serves a critical role in brain development and energy metabolism of the young^[14]. Lactose is split by lactase, a small intestine enzyme, to facilitate the absorption of its constituent monosaccharides^[36]. However, in the majority of mammals, lactase activity declines post-weaning, resulting in lactose maldigestion and potential intolerance^[9]. In dogs, lactose supplementation had an effect on faeces; faecal pH and ammonia concentrations remained unaffected. Microbial analysis in the faeces of the dogs revealed that the lactose did not have an effect on microbiotas. The Ca, Fe, K and Mn were influenced by the lactose supplement; Mg digestibility was decreased. Furthermore, protein, P, Mg and Zn digestibility were decreased^[15].

The lack of significant alterations in fecal pH levels and microbial numbers suggests lactose may not function as a prebiotic in dogs, unlike other animals such as pigs and humans^[30]. However, the calcium and magnesium did differ in the digestibility process that can reflect the role of lactose in enhancing nutrient digestion through enhanced intestinal

fermentation^[29]. The digestive system can adapt gradually to lactose consumption, possibly through enhanced enzyme activity or changes in intestinal microbiota^[36].

4.2. Management of Lactose Intolerance

Treatment of lactose intolerance is to remove dairy foods from the dog's diet or employing lactose-free alternatives. Such alternatives provide the nutritional advantages of milk without causing digestive irritation. Lactose-free formulas are available now and mimic the nutritional composition of canine milk so that the lactose-intolerant dogs get balanced nutrition^[40].

4.2.1. Alternatives to dog milk goat and commercial milk

Goat milk has been proposed as a replacement for lactose-intolerant dogs because it contains less lactose than cow's milk. Lactose-free milk, however, could be a better substitute for extremely lactose-intolerant dogs, and it suppresses gastrointestinal signs of lactose ingestion in intolerant canines^[38]. Commercial milk replacers are normally used in pups that cannot be suckled from the dam due to orphaning or maternal illnesses^[16]. Dog milk had higher concentrations of amino acids, including histidine and leucine, which are critical for growth and development, but milk replacer lacks in the proteins, fats, calcium, and long-chain fatty acid^[22]. The fat and protein levels were 18.3-37.5, and 24.4-33.2 g/100 g of dry matter, respectively, in commercial milk replacers in dogs. This is lower than bitch milk. While vitamin D in milk replacer was higher seven times from natural milk of dogs^[8]. Commercial milk replacer for puppies or kittens is recommended as cow's milk is not nutritious and causes diarrhea because of its high lactose content^[17]. Homemade milk replacers can be used in emergency situations but not in place of commercial milk replacers on a long-term basis. Proper feeding hygiene has to be followed to avoid introducing infections or gastrointestinal illness^[25].

4.2.2. lactose-free milk products

Recently, lactose-free milk has been introduced as suitable replacements for lactose-intolerant dogs, providing the same nutritional benefits without any digestive upset. For lactose intolerant dogs, lactose-free milk products are a healthy alternative. New studies have found that feeding dogs lactose-free milk really reduces gastrointestinal symptoms and still provides essential nutrients present in normal milk^[38]. Lactose-free milk is produced by adding lactase enzymes to regular milk, which breaks the lactose into simpler sugars^[11].

4.2.3. Fostering orphaned puppies

Fostered orphaned puppies and kittens are ideal when this is feasible. Not only can a lactating bitch or queen nourish but also stimulate and warm up the orphaned neonates. Successful fostering, however, depends on the behavior of the surrogate. Surrogate mothers will ignore, abuse, or even harm the new litter, hence the need to closely observe the first few interactions between the surrogate and orphans^[25].

4.2.4. Immune support for orphaned puppies

Orphaned neonates at birth will not get colostrum, the first milk rich in maternal antibodies. This intolerance in the consumption of colostrum leads to passive transfer failure, compromising the immune protection of the newborn^[23]. Veterinarians may supplement colostrum, serum or plasma from a healthy, vaccinated adult bitch when there has been failure in passive transfer^[25]. Ideally, this therapy should be

done within the first 24 hours as antibody uptake is poorer after this period ^[13].

Conclusion

In conclusion, knowledge of lactose intolerance, importance the colostrum, especially when they are young, the compositions of milk and colostrum in dogs. Early diagnosis of bitch mastitis. Understanding the lactose intolerance condition is very important for health of dogs, particularly at their early stage of the life. Also milk replacers, lactose-free alternatives and appropriate feeding methods can be used to minimize the effects of lactose intolerance.

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