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Review Article

Effect of heat stress on rumen microbial population and milk production in lactating dairy cattle - Review

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Abstract

Milk production of dairy cattle is significantly influenced by ruminal microbial populations, which also have a negative impact on the health and milk production of dairy cows under heat stress. Studies examining modifications in the rumen microbiota of lactating dairy cow brought on by heat stress are not yet available. One of the key organs of dairy cows, the rumen, has a direct impact on the host's health and milk output. Dairy cows rely on rumen bacteria to transform fodder that is indigestible to humans into products that are edible to humans by supplying volatile fatty acids (VFAs) and microbial proteins. A deeper comprehension of the relationship between heat stress and the ruminal microbiome may help researchers devise methods for reducing the impact of heat stress on ruminants by modifying the composition of the ruminal microbiome.

Key words: dairy cattle, heat stress, milk production, rumen microbiome

Introduction

Heat stress can alter the host's metabolism, which can alter the ruminal microbiota and affect how nutrients are absorbed (Bergman, 1990). High temperatures are typically a year-round characteristic of the tropical and subtropical climates. Heat stress is a physiological condition brought on by an imbalance between the amount of thermal energy produced by an animal and the net amount of energy that flows from it to its surroundings (ST-Pierre *et al.*, 2003). The key factor influencing rumen microbial fermentation is thought to be diet (Henderson *et al.*, 2015).

Heat stress on lactating dairy cattle

Heat stress has the potential to impair dairy cows' tissues and organs' ability to function as well as inhibit the synthesis of some proteins and hormones. This can result in decreased fertility by interfering with the synthesis of proteins and hormones linked to the reproductive system (Putney *et al*., 1988). Since dairy cows are among the most vulnerable domestic animals to HS, the dairy industry faces a global dilemma (Tian *et al.*,). Roughage digestion generates a significant quantity of metabolic heat, which raises cows' body temperatures. Cows reduce their feed intake to reduce heat stress as ambient temperature rises in the summer and as body temperature rises concurrently (Ammer *et al*., 2018). Animals exhibit a variety of physiological, endocrine and behavioural defense systems to deal with heat stress (HS). HS is typically regarded as a major factor contributing to decreased feed intake, which in turn causes a negative energy balance and lower milk output (Sammad *et al*., 2020).

Heat stress and rumen microbial population

Regarding rumen fermentation activities, blood parameters and metabolites and changes in metabolic pathways, heat stress has an impact on a variety of metabolic processes in ruminants, particularly in dairy cows. Cattle under HS have decreased ruminal pH due to the elevated lactic acid concentrations (Yadav *et al*., 2013). However, it should be emphasized that HS might also have an indirect impact on the gut flora and metabolism. This is due to the fact that HS can produce changes in a number of aspects that affect the gut flora and metabolism, including lower intake of dry matter, sorting of favored feed pieces, shorter bolus chewing time and salivary bicarbonate infusion into the rumen. Last but not least, HS has the ability to alter the abundance of other microorganisms, including anaerobic fungi, archaea and protozoa, which calls for additional research (Zhao et al., 2019).

Additionally, less feed is consumed during heat stress conditions, which leads to less rumination, which lowers the quantity of buffers that enter the rumen and may account for the drop in ruminal pH. (Sammad *et al*., 2020). Recent studies have revealed that an animal's microbiome has an enormous impact on practically every element of its physiology and is essential to maintaining good health. Highly numerous and diverse microorganisms play a vital impact in the host's metabolism and health in dairy cows (Kim *et al*., 2020).

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Rumen microbial population and milk production

The VFAs produced by rumen bacteria has direct effect on milk production (Hurtaud *et al*., 1995). The potential modification of rumen bacteria may also cause a drop in ruminal pH. In relation to this, Holstein heifers' rumen pH fell when kept in environments with temperatures between 20 and 33 °C (Tajima *et al*., 2007). Importantly, ruminal microorganisms convert plant polysaccharides into VFAs including butyrate, acetate, and propionate, which are the primary source of energy for cows (Flint *et al*., 2008). Recent research has demonstrated that the rumen microbiome changes dramatically and clearly from gestation through lactation (Lima *et al*., 2015).

Recent research found that lactating dairy cows and yaks with varied feed intakes had diverse rumen microbiota compositions (Li *et al*., 2020 and Shi *et al*., 2020).

Conclusion

An important process used by ruminants to meet daily energy needs is the fermentation of food components in the GI tract. The GI microbiota, particularly in lactating dairy cows, is essential for the breakdown of indigestible plant polysaccharides and for supplying the majority of AAs, fatty acids, and gluconeogenic precursors needed for milk production. As a result, it's possible that characteristics of milk production are more closely tied to gut microbial populations.

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