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Exploring Rumen Microbial Circadian Biology to Improve Food Safety and Security

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Summary

This perspective article introduces an innovative roadmap for research and farm application based on optimizing rumen microbial circadian biology to help minimize metabolic disorders and food-producing ruminant health and efficiency. Suitable feedstuffs must be fed at optimal times of the circadian phase in optimal relation to milking and housing management. Certain microbial populations may be negatively sensitive to given combinations of sugars, starches, proteins and fats. Discovering optimal harmonies amongst circadian rhythms of ruminant, rumen, and their environmental management is key towards improving food safety and security for humans in the new era.

Keywords: Microbial ecology; Rumen; Physiology; Circadian rhythm

Philosophy for Practice

Ruminants have evolved to graze mostly during day, especially at the beginning and end of the light phase. As such, they have evolved to ruminate predominantly overnight when little grazing/easting occurs [1-5]. Rumination stimulates chewing and insalivation to effectively neutralize rumen acids and help maintain stable and healthy rumen conditions [2-4]. It thus seems that ruminants experience more stable or more tolerant rumen environment during evening and night times [2,3,5]. Should that be the case, rumen microbial populations must have circadian properties in fermenting ruminated ingesta. In so doing, rumen should possess differential capacities for bioprocessing of different substrates. In modern ruminant farming with no grazing, however, such natural patterns of rumen ecology are in ways interrupted or altered [6-10]. For instance, feed delivery could well be exercised during evening and night hours. Milking does essentially occur overnight and early morning. Thus, it is critical to discover optimal combinations of feeding, milking, housing and health management [11-16].

Recent findings suggest that nocturnal vs. morning feeding can improve feed intake and milk fat and energy production in dairy cows [5,6,7,10-12]. Data, also, suggest that rumen encounters more periprandial fluctuations in feed intake and rumen conditions rhythms when ruminants are fed at night vs. morning [10-12]. These discoveries would question the conventional belief that higher fluctuations in rumen conditions are rather harmful to healthy rumen physiology and ruminant production [13,14]. Instead, it appears that rumen can develop tolerance against those conditions that are considered risky under practical scenarios [15-18]. Rumen, thus, possesses specialized circadian rhythm in its microbial properties that must be matched optimally with nutritional characteristics of feeds and patterns of environmental cues.

It is time to formulate strategies that optimize rumen microbiology based on circadian rhythms of rumen fermentation and microbial metabolism [19]. Advanced rumen microbiology must take initiatives to embrace circadian microbial properties towards more specialized feeding management and reduced risks of subacute rumen acidosis and related metabolic abnormalities [18-20]. Specific microbial populations and activities must be uncovered to enable optimal utilization of risky feed components at optimal circadian times under competitive feeding and housing environments.

Implication

The evolutionary trends of ruminant physiology and metabolism provide evidence to uncover specialized circadian rhythms in rumen microbial properties. This is to improve rumen health and microbial interactions towards greater fibre digestion and lower risks of subacute rumen acidosis and related metabolic and immune problem. Prospects are vast and vivid in harmonizing feeding and housing management with circadian rumen microbial characteristics. The goal is reducing waste and increasing microbial efficiency and health.

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