LIÈGE université
Gembloux
Agro-Bio Tech

Le Corps professoral de

Gembloux Agro-Bio Tech - Université de Liège vous prie

de lui faire l'honneur d'assister à la défense publique de la dissertation originale que

Madame Xiaohua PAN,

Titulaire d'un *master's degree of agriculture,*

présentera en vue de l'obtention du grade et du diplôme de

DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,

le 3 juillet 2017, à 14 heures précises (personne ne sera admis après cette heure),

en l'auditorium ZT1 (Zootechnie, bât. 1),

Passage des Déportés, 2 à 5030 GEMBLOUX.

Cette dissertation originale a pour titre :

« Characterizing Thiamine Status and Mechanisms of Thiamine Supplementation on Subacute Ruminal Acidosis Attenuation in Dairy Cows ».

Le jury est composé comme suit :

Président : Prof. L. WILLEMS, Vice-Président du Département AGROBIOCHEM,
Membres : Prof. Y. BECKERS (Promoteur), Prof. B. XIONG (Copromoteur, CAAS – Chine), Prof. J. BINDELLE, Prof. N. EVERAERT, Dr E. FROIDMONT (CRA-W).

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Summary

Dairy cows are often fed high grain diets to maximize milk production in today's intensive management farms. However, overfeeding high grain diets increases the risk of subacute ruminal acidosis (SARA), which is characterized by prolonged decrease of rumen pH and high levels of lipopolysaccharide (LPS). SARA challenge has been confirmed to severely impair animal health, production performance and farm profitability, and more and more attentions have been paid to prevent the occurrence of SARA in dairy industry worldwide. Our teams' previous research found that thiamine supplementation could help to relieve SARA in dairy cows, but the modes of action of thiamine in SARA attenuation are still unclear. In this context, this thesis was conduct to increase our understanding of relationships between SARA induction and thiamine, and to explore the mechanisms of thiamine supplementation on SARA attenuation by determining its effects on rumen fermentation, microbiome composition and anti-inflammatory response.

Firstly, the first experiment in Chapter 3 demonstrated that thiamine status in rumen and blood were altered by SARA induction and thiamine deficiency occurred during SARA challenge. Regression analysis proved the ruminal thiamine content was positively related to pH and the concentrations of acetate in the rumen, and negatively correlated to the lactate contents, indicating the altered rumen fermentation would affect thiamine status.

Secondly, the mRNA expression of thiamine transporters (Chapter 4) and bacteria compositions (Chapter 5) in SARA and control cows were measured. We found that thiamine concentration was positively correlated with *Bacteroides*, *Ruminococcus 1*, *Ruminobacter*, *Pyramidobacter* and *Fibrobacter*, and the decrease of genera above implied SARA challenge alters ruminal thiamine status by inhibiting the growth of thiamine synthesis related bacteria; The positive correlation between ruminal and blood thiamine, and the down-regulation of thiamine transporters' expression in rumen epithelium indicating that the decreasing ruminal thiamine synthesis and suppressed thiamine transport by SARA challenge resulted in low blood thiamine content of SARA cows.

Thirdly, the effects of thiamine on rumen fermentation (Chapter 3), anti-inflammatory response (Chapter 4) and microbiome composition (Chapter 4) were evaluated to reveal its mechanisms on SARA attenuation. We found that thiamine supplementation promoted acetate-producing bacteria including *Ruminococcus 1*, *Pyramidobacter*, *Succinivibrio* and *Bacteroides*, and decreased bacteria positively related to ruminal lactate (*Succiniclasticum* and *Ruminococcaceae NK4A214*). Consequently, rumen fermentation was improved by reducing the accumulation of lactate and increasing ruminal pH. In addition, thiamine supplementation alleviated inflammatory response in rumen epithelium by inhibiting the release of LPS and phosphorylation of NFκB protein, which is conducive to SARA attenuation.

In summary, this thesis had increased our understanding of thiamine nutrition in dairy cows, and provided a new control strategy for subacute ruminal acidosis in dairy cows. However, further investigations are needed to deeply understand the relationship between thiamine and SARA induction, such as the isolation and validation of thiamine synthesis bacteria affected by SARA challenge, as well as to figure out metabolic pathways through which SARA induction affects thiamine synthesis in the rumen. Moreover, the impacts of overfeeding high grain diets on intestinal thiamine absorption are still unclear and need to be illuminated in dairy cows.