

Doctoral Thesis

Studies on Glucagon-like Peptides in Dairy Calves

(Summary)

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## **Studies on the Glucagon-like Peptides in Dairy Calves**

(哺乳子牛のグルカゴン様ペプチドに関する研究)

Dairy calves are at high risk of morbidity and mortality, with recorded rates as high as 50% and 11%, respectively, thus protecting calves from disease is one of the urgent global issues for dairy calf management. Glucagon-like peptide 1 (GLP-1) and 2 (GLP-2), secreted from intestinal L-cells, have important roles in growth and maintenance of health via glucose homeostasis and gastrointestinal tract (GIT) development in dairy calves. Thus, GLP-1 and GLP-2 have been a target of investigation in dairy science, and it should be beneficial to maximize the secretion of GLP-1 and GLP-2. However, there is little information about the effects of different nutrient strategy on the circulating levels of GLP-1 and GLP-2 in calves. Therefore, primary objective of this study was to determine the effect of nutrients and feeding method on plasma concentrations of GLP-1 and GLP-2 at several life stages, including fetal, neonatal, pre- and post-weaning periods in dairy heifer calves.

### **Relationship between feeding strategy at close-up diet (last 28 d of gestation) to dam on GLP-1 in female offspring**

The previous studies reported that altered status pre-partum is associated with a change in glucose and insulin concentrations of the cows, which can cause alteration in blood glucose concentration of offspring. In this chapter, we evaluated the effect of feeding moderate- or high-starch close-up diet to dam on response of calves to milk replacer (MR) feeding and intravenous (i.v.) injection of GLP-1. As a result, this study indicates that feeding a high-starch close-up diet to cows affects glucose status in their female offspring via suppression of postprandial plasma concentrations of GLP-1 and insulin as well as the alteration in the glucose-lowering action of GLP-1 after feeding.

### **Effect of feeding strategy of colostrum on plasma GLP-1 and GLP-2 concentrations in newborn calves**

In the previous studies, amount, timing, and frequency of colostrum intake affected circulating levels of hormones, such as insulin and insulin-like growth factor-1, and GIT development in calves. In this chapter, we evaluated the effect of different feeding method of colostrum on plasma GLP-1 and GLP-2 concentrations in neonatal calves. As a result, we showed that delaying first colostrum feeding for 12 h decreased plasma GLP-1 and insulin concentrations without affecting plasma GLP-2 concentration. Furthermore, it was shown that extended duration of colostrum feeding increased plasma GLP-1 concentration on 3 d after birth. Thus, it is presumed that different method of colostrum feeding affects glucose

metabolism via the alteration of circulating level of GLP-1 and insulin in newborn calves.

### **Effect of tributyrin supplementation in MR on plasma GLP-2 concentration in pre-weaning calves**

To establish the feeding strategy that increases GLP-2 secretion, we focused on butyrate, which has been shown to stimulate GLP-2 secretion in ruminants, including dairy calves, as well as non-ruminants. Tributyrin (TB) is liquid at normal temperature and does not have butyrate-distinctive offensive odor, thus can be a more practical supplement to the MR compared to sodium butyrate. To evaluate the effect of TB supplementation in MR on plasma GLP-2 concentration in calves, calves were fed MR containing either palm oil as control (CON) or TB (TB) until weaning at 49 d after birth. Starter dry matter intake and metabolizable energy (ME) intake were lower in TB calves at 46, 47, from 49 to 55 d after birth compared with the CON calves. However, any growth parameters were not affected by TB treatment, indicating that nutrient absorption was enhanced by TB ingestion, which might result in difference in growth parameters between treatments. Further, GLP-2 concentration was higher for TB than for CON, which could partly contribute to no difference in growth parameters despite the decreased ME intake.

### **Conclusion**

Obtained results indicate that it is possible to control plasma GLP-1 concentration via the change of feeding strategy of close-up diet to dam and colostrum in dairy calves. Although treatment effect of feeding method of colostrum was not observed for plasma GLP-2, we succeeded in increasing plasma GLP-2 concentration by TB supplementation to MR. Therefore, feeding TB presumably improves GIT development directly and indirectly through an increase in plasma GLP-2 concentration. These findings extend our understanding of the effects of different feeding strategy on plasma concentrations of GLP-1 and GLP-2 and may have implications for the improvement of calf performance.