

## Studies on Ruminant Production Research Core in Graduate School of Agricultural Science, Tohoku University

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Domestic cattle have been selected and bred as milking cow and beef cattle from an ancestral species, auroch *Bos primigenius*. Cattle are ruminant animals that mainly feed grass, and their habitats are the grassland. Domestic cattle have been kept in the mountainous area in many countries. Recent production systems of cattle are being separated from the grassland to achieve the high efficiency of the production. As a result, outbreaks of BSE and environmental issues of animal waste occurred. One of these causes is imported feed. Now we should re-construct the grassland animal production system using domestic feed products in Japan.

Our research core will study ruminant animals, ruminant production systems, grassland, animal production environment and animal health mainly in the mountainous area. I will mention research topics performed and future research of our research core.

### ***1. Nutritional and physiological studies on the ruminant***

We have clarified the crucial role of volatile fatty acids (VFAs), which produced by bacterial fermentation from plant fibers in the reticulo-rumen, as an important energy source for the synthesis of dairy products as well as for essential body maintenance. In addition, we found the importance of nitrogen recycling in this species by the dilution method with  $^{15}\text{N}$  stable isotopes. The physiological characteristics in the ruminant are inevitably related with the function of the reticulo-rumen. We found that post-prandial decreases in  $\text{HCO}_3^-$ -rich saliva secretion and feed intake are caused by the acidosis induced by an excess transport of alkaline reserve from blood to the intestinal lumen in sheep. Post-prandial decrease in plasma GH is reproduced by VFA injection into venous blood or the reticulo-rumen, or treatment of somatotrophs with VFAs, indicating that VFAs show an inhibitory action on GH secretion. Lactogenic actions of GH

have been studied by the isotope dilution method with  $6,6\text{-}^2\text{H}_2$ -glucose and by the euglycemic insulin-clamp method in dairy cows. Although the function of the reticulo-rumen is undeveloped in pre-weaning animals, it rapidly develops at 4 – 6 weeks of age and becomes mature at 13 weeks of age. The concentration of salivary  $\text{HCO}_3^-$  is increased, but that of  $\text{Cl}^-$  is reciprocally decreased, with the development of the reticulo-rumen, suggesting an age-dependent increase in buffering action of saliva on VFAs produced in the forestomachs in calves. Finally, we found a significant relationship between salivary  $\text{HCO}_3^-$  concentrations and carbonic anhydrase activity in the parotid gland.

### ***2. Grassland utilization and animal production***

Various aspects of land ecosystem have been studied, which especially focused on grassland being about 40% of the land area which exist in border areas between arable land and woodland and between desert and woodland, and on which many herbivores are living. Relationships within and among constituent elements such as soil and/or microorganism, plants and animals are investigated of matter dynamics, the style of living and behavior from the viewpoints of plant production, animal production and environmental remediation. Following themes are studied; 1) relationships among soil/microorganism, plant and animal in land ecosystem, 2) plant physiological and ecological studies of grassland productivity, 3) behavior and welfare of herbivores.

### ***3. Animal Breeding and Genetics***

For the genetic improvement of reproduction, growth rate, feed efficiency, disease resistance, quality and amount of products, the following subjects are studied with various approaches of statistical, molecular, physiological and

immunogenetics. 1) The methods for the genetic improvement of the production traits such as milk yield, meat productivity supported by the reproduction, growth and disease resistance traits of animals. 2) Practical breeding plan for each livestock species and its application. 3) Theoretical prediction of long-term selection response. Beef and dairy cattle, sheep and swine are mainly considered in these studies. Laboratory animals are also used for the basic studies as the pilot of the domestic animals.

We have obtained followings. 1) Crossbreeds, such as Japanese black (cow) x Brahman (bull) and Japanese Shorthorn (cow) x Brahman (bull), showed higher fitness and productivity than indigenous breeds on the pasture. 2) Packed red blood cell volume was proposed as a selection criterion for higher resistance to *Thileria orientalis sergenti* infection in Japanese Shorthorn and Japanese Black. 3) For the genetic improvement of the dairy and beef cow herd in the University Farm, most adequate semen for A. I. or bulls for natural mating were selected and the performances of the cow herd are improved.

#### **4. Animal Health and Management**

We performed epidemiological survey for *Cryptosporidium*, which is the pathogen of a zoonotic protozoan parasitic disease. We identified an isolate from beef cattle as a new strain by experimental infection and DNA analysis, and referred to it as *C. andersoni* Kawatabi strain. We also have been isolating functional microbes removing malodorous materials generated from animal waste and their treatment processes, and clarified the distribution and function of microbes degrading indole or skatole and microbes assimilating ammonia in wastewater treatment processes and composting processes.

#### **5. Future study**

In the field for nutrition and physiology of the ruminant, we are to investigate 1) transport mechanisms for prion proteins in the calf intestinal epithelium, 2) changes in physiological and endocrine functions of weaning calves, 3) usage of nucleic acid-related compounds and lactoferrin as feed additives for growth promoters, and 4) usefulness of myostatin-gene-mutated calves as meat and gene resources. We are to investigate 1) genetic resistance to bovine mastitis, 2) genetic

resistance to piroplasmosis of pasturing cattle, 3) genetic improvement of general performance of Holstein, Japanese Black, and Japanese Shorthorn in the field for animal breeding. In the field of animal health and management, we will perform 1) molecular epidemiology of *Cryptosporidium*, 2) development of eradication of pathogenic *E. coli* O157 in the environment of the animal production, 3) analysis of structures of the microbial community in animal waste treatment processes and composting to develop novel treatment systems.

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