

主論文の要約

Heat tolerance and productivity of dairy cattle under tropical climate in suburb area of Cambodia

(カンボジア都市近郊の熱帯性気候下における乳牛の暑熱耐性と生産性)

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With increase in world population, demand for food derived from livestock increases rapidly in both developed and developing countries. Therefore, global improvement of the domestic animal productivity is necessary. Recently, in Cambodia, the increase in consumption of fresh milk and dairy products enlarges year by year, however the domestic production of fresh milk has not been well developed. As a result, almost all dairy products that are available in Cambodia depend on imports from other countries. Historically, dairy farming in Cambodia was carried out at a relatively early date from the 1960s within the Southeast Asian countries, and there is a record that dairy products were exported to the neighboring countries, such as Thailand and Vietnam in those days. However, through the civil war that began in the 1970s and horrible genocide under the Pol Pot regime, the dairy husbandry in Cambodia has been crushed and most knowledge about dairy production has disappeared. The reconstruction of the dairy farming is considered as one of the big issues to meet the increasing demand for dairy products in Cambodia.

For the modern milking cows, which produce large amount of milk yields after genetic improvement like Holstein-Friesian cows, the cool environment is preferable to raise them. Therefore, raising of dairy cows is full of difficulty under the subtropical and tropical climate in Southeast Asian countries including Cambodia. Indeed, high environmental temperature, also known as “heat stress”, decreases in the productivity of milk or reproductive performance in cattle. Crossbred cows (local cows × Holstein-Friesian cattle) were normally used for dairy farming in tropical and subtropical areas, because the local animals have resistance to heat stress. Thus, it is important to develop breeds of dairy cows with resistance to hot environment, and also to understand the mechanism affecting physiological functions like reproduction by heat

stress in dairy cattle. The present dissertation aims to understand the situation of dairy farming in Cambodia to accumulate the basic knowledge on factors affecting the dairy production, which in turn reconstruct the dairy industry in Cambodia. In addition, the study investigated heat tolerance in dairy cows in newly developed dairy farm in suburb area of Cambodia using a physiological method to contribute to the breeding of high-performance dairy cows that can adapt to tropical climates.

In Chapter 2, I reported the establishment of the first experimental dairy farm in Nagoya University Asian Satellite Campus in the Royal University of Agriculture (RUA) in the suburbs of Phnom Penh city for the purposes of education and research activities. In Cambodia, there has been no dairy farm as the model of dairy management and practice as well as for experimental use. The newly established farm consists of two cow houses to provide a good living condition for animals in the farm. The farm was installed with a milking parlor system with pipelines for the capacity of 10 milking cows at the same time. The farm enables us to raise milking cows on a stable condition with feeding of cultivated forages and enough supplementation of nutrient in cow shelters. In addition, the new farm has been established to follow the international standards of the farm and its facilities, because the international markets for livestock product will be important targets in developing countries like Cambodia for their economic growth.

In Chapter 3, I examined the effect of tropical temperatures on the autonomic nervous activities in crossbred Cambodian dairy cattle by analyzing heart rate variability (HRV). Holter-type electrocardiograms were recorded in five adult crossbred cows (Cambodian native \times Holstein-Friesian) either in a sheltered area or under direct sunlight in the established experimental dairy farm in the RUA campus. Rectal

temperatures and heart rates increased in all animals under direct sunlight as compared to those in the shelter. The power spectral analysis of HRV revealed that three out of the five cows studied showed a decrease in their parasympathetic nervous activity and a tendency of increase in sympathetic nervous activity under direct sunlight, showing that those three cows are likely to be more heat stressed. The other two cows did not show such tendency of increase in sympathetic nervous activity under sunlight exposure by the frequency domain parameters of HRV. The present result suggests that the latter two cows are likely to have higher heat tolerance. Results from the present Chapter, therefore, demonstrate that the power spectral analysis of the HRV would prove to be a useful tool to evaluate heat tolerance in individual dairy cows. The data from the HRV analysis would guide researchers and livestock farmers to breed high-performance dairy cows adapted to the tropical climate.

In Chapter 4, I examined the difference of heat stress response between Cambodian local cattle and crossbred dairy cows based on the HRV analysis. The result revealed that the frequency domain parameters of HRV in Cambodian local cows under the direct sunlight showed the uniform fluctuations. On the other hand, crossbred dairy cows showed the different response to heat stress in each individuals, and a couple of dairy cattle seemed to respond similarly with Cambodian local cows in response to exposure to direct sunlight, as far as the fluctuation of the frequency domain parameters of HRV. The present result in Chapter 4 indicates that there is the possibility of difference in response to heat stress between Cambodian local and crossbred dairy cows. The results suggest that the potential to be able to establish the novel breed of dairy cattle in future using the selection method of the individual cows with heat tolerance by the power spectral analysis of the HRV.

In Chapter 5, I examined the current situation of milk production in Cambodia where there has no official data of milk yields, and whether the decrease in milk yields is associated with housing and feeding management. To achieve the goal, I compared with the newly established systematic dairy farm in the RUA, and the local dairy farms located in the suburb area of Phnom Penh city. Four primiparous dairy cows fed at the RUA farm and four primiparous cows fed at three suburb local farms were used in the study. The average milk yields per day of RUA cows tended to be higher compared with those of local farm cows. Further, milk yields in RUA cows with high milk production tended to decrease in the dry season with high ambient temperature. In the present Chapter, I first reported current situations of dairy milk production in smallholder farms and the modern farm in the suburb area of Cambodia. Moreover, a difference in milk production between the RUA and local farms was seemed to depend on the feeding and management condition. Thus, more dairy production would be achieved by improving feeding technique of dairy cows in Cambodia.

In conclusion, in the present dissertation, I indicate the importance of dairy management and the correlation between heat stress and HRV indices in domestic native crossbred dairy cattle in the tropical climate in Southeast Asia. The results help to improve dairy cattle breeding which objects the increase in milk yields based on heat-tolerant characteristics in the region with tropical and subtropical climate. Moreover, the dairy cattle selection based on heat tolerance with HRV analysis could produce efficient and sustainable development of dairy industry in Cambodia as well as countries in tropical climate region.