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研究課題名(和文)カンボジア在来種を利用したウシの暑熱ストレス耐性原因遺伝子の探索と機能解析

研究課題名(英文)Functional analysis of heat-stress resistance gene in Cambodian native cattle

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研究成果の概要(和文)：本研究では、暑熱ストレスによる乳牛の生産性低下の克服に資するため、ウシのストレス耐性を評価する手法の確立をめざした。カンボジア在来種とホルスタイン種の交雑牛を用いて、名古屋大学カンボジアサテライトキャンパス附属農場において実験を実施した。連続記録したウシの心電図の心拍変動解析を行ったところ、乳牛に負荷される暑熱ストレスに対する心拍変動の反応性の差により、ウシ個体の暑熱ストレス耐性を評価できる可能性を明らかにした。

研究成果の概要(英文)：Hot climate has negative effects on productivity in dairy cattle. The present study aims to measure heat stress by evaluating heart rate variability (HRV) in Cambodian dairy cattle under exposure to direct sunlight. 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 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 increase in sympathetic nervous activity under sunlight exposure. The present result suggests that the latter two cows are likely to have higher heat tolerance. Results from the present study demonstrate that the power spectral analysis of the HRV would prove to be a useful tool to evaluate heat tolerance in individual dairy cows.

研究分野：Reproductive physiology

キーワード：Heat stress Tropic climate Heart rate variability Dairy cattle Autonomic nerve

## 1. 研究開始当初の背景

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.

## 2. 研究の目的

The present study aims to investigate 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.

## 3. 研究の方法

In the present study, we 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 × Holstein-Friesian) either in a sheltered area or under direct sunlight. Rectal temperatures and heart rates increased in all animals under direct sunlight as compared to those in the shelter.

Heart rates were recorded using a Holter-type electrocardiograph with apex-base (A-B) leads. Animals were kept inside the shelter during the first 24-h period beginning from 18:00 (Day 1). On Day 2, all cows were kept in the shelter for 12 h, exposed to direct sunlight for 12 h as a heat-stress treatment and returned to the shelter during last 24-h period (Day 3). Rectal and ambient temperatures were recorded.

## 4. 研究成果

Ambient temperature and temperature-humidity index (THI) during experiments are shown in Fig. 1. The ambient temperature and THI appeared to decrease during nighttime and increase during daytime. Both the ambient temperature and THI tended to be higher when cows were present under the sunlight (heat stress) than inside the shelter. The rectal temperature tended to increase during daytime in cows kept under the sunlight, whereas it appeared relatively stable throughout the daytime on the day inside the shelter.

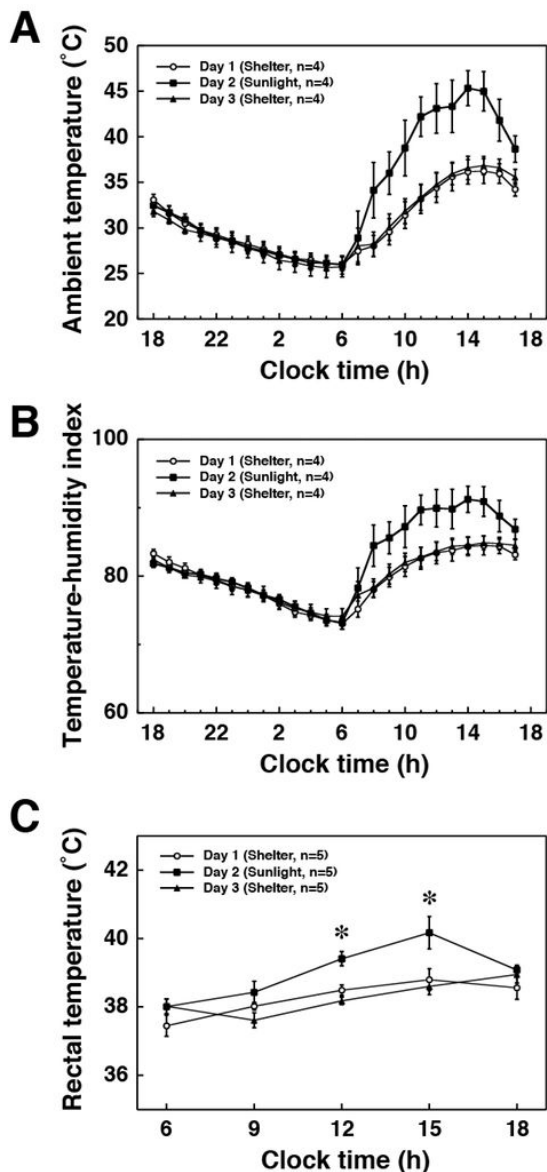


Fig. 1. (A and B) Changes in ambient temperature (A) and temperature-humidity index (B) during 3-day experimental period (n = 4). (C) Changes in rectal temperature of cows during daytime (06:00-18:00 hr) of 3-day experimental period (n = 5). Values are means  $\pm$  SEM.

\*on Day 2,  $P < 0.05$  vs Day 1 and Day 3.

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 experiment, 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.

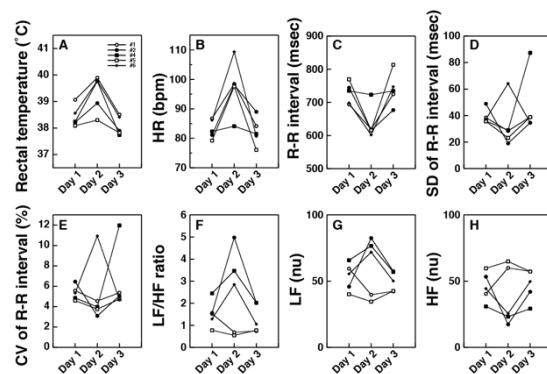


Fig. 2. Individual changes in rectal temperature (A), heart rate (B), R-R interval (C), SD (D) and CV (E) of R-R interval, LF/HF ratio (F), and normalized LF (G) and HF (H) powers in the five cows on pre- (Day 1), heat- (Day 2), and post- (Day 3) treatment days during daytime (09:00-15:00 hr). HR, heart rate; SD, standard deviation; CV, coefficient of variation; LF, low frequency; HF, high frequency; nu, normalized unit.

## 5. 主な発表論文等

(研究代表者、研究分担者及び連携研究者には下線)

[雑誌論文](計1件)

Bun, C., Watanabe, Y., Uenoyama, Y., Inoue, N., Ieda, N., Matsuda, F., Tsukamura, H., Kuwahara, M., Maeda, K.-I., Ohkura, S. and Pheng, V. (2018). Evaluation of heat stress response in crossbred dairy cows under tropical climate by analysis of heart rate variability. *The Journal of Veterinary Medical Science* 80, 181-185. 査読有  
DOI:10.1292/jvms.17-0368

〔学会発表〕(計2件)

Bun, C. Evaluation of heat stress responses by analysis of heart rate variability in crossbred dairy cows under the tropical climate. The 4th World Congress on Reproductive Biology, 2017年9月, Ginowan, Japan.

Bun, C. M Evaluation of heat stress responses by analysis of heart rate variability in dairy cows under the tropical climate. The 1st International Conference on Tropical Animal Science and Production, 2016年7月, Bangkok, Thailand.

〔図書〕(計0件)

〔産業財産権〕

出願状況(計0件)

取得状況(計0件)

〔その他〕

ホームページ等: 該当なし

6. 研究組織

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