

Comparison of Resistance to *Theileria sergenti* Infection between Holstein and Japanese Black Cattle under Grazing Conditions

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Abstract

To analyze the resistance against *Theileria sergenti* infection in Holstein and Japanese Black cattle under field conditions, clinical, hematological and parasitological findings in these breeds of cattle that were grazed in the same pasture were examined during the grazing period. Holstein cattle showed a higher level of parasitemia than Japanese Black. With the progression of parasitemia, packed cell volume (PCV) decreased in both breeds and the minimum value of PCV recorded in Japanese Black was higher than in Holstein. The daily gain rate was higher for Japanese Black cattle than Holstein. These results suggest that the Japanese Black cattle display a higher resistance to *T. sergenti* infection than the Holstein under field conditions, based on a previous infection test carried out under experimental conditions without external factors.

Discipline: Animal health

Additional key words: daily gain (DG), ELISA, packed cell volume (PCV), piroplasm

Introduction

Genetic resistance to infectious diseases is currently emphasized in livestock development programs. It was reported that some of the introduced breeds of cattle were resistant to certain hemoprotozoan parasites^{1,2,5-7}. For example, N'Dama cattle display a genetic resistance to trypanosomiasis, and are more trypanotolerant than Zebu cattle^{1,5,6}. Owing to this characteristic, N'Dama cattle are grazed in tsetse-infested areas in Africa. Thus, the use of trypanotolerant N'Dama cattle is considered to be an important strategy for the control of African animal trypanosomiasis.

For grazing cattle in Japan, economically the most serious disease is bovine theileriosis caused by the

tick-transmitted protozoan parasite *Theileria sergenti*⁴. *T. sergenti* infection by itself causes mild anemia, but it often leads to further problems when it is accompanied by other infectious diseases, stress, transportation and delivery⁹. For *T. sergenti* infection, it is generally recognized that the resistance varies among the cattle breeds. We previously reported that Japanese Black cattle were more resistant to *T. sergenti* infection than Holstein cattle under controlled conditions in artificial environmental chambers¹⁰. However, there are only a few reports on the difference in the resistance to *T. sergenti* infection between the 2 breeds under grazing conditions³. In these reports, the parasitemia and some blood constituents in *T. sergenti* infection were compared between both breeds without distinguishing cattle with a previous history of *T. sergenti*

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infection and use of anti-theilerial drugs, which may prevent an accurate comparison of the resistance to *T. sergenti* infection between both breeds. Therefore, in the present study, we recorded the clinical, hematological and parasitological changes, as well as body weight changes in grazing cattle belonging to both breeds that were infected with *T. sergenti* in considering a previous history of *T. sergenti* infection without the use of anti-theilerial drugs.

Materials and methods

Six male Holstein (H1-H6) and Japanese Black (B1-B6) cattle aged 5-6 months were used in this experiment. However, it was observed that 4 head in each breed showed a positive reaction to *T. sergenti* infection based on the detection of piroplasms in the erythrocytes and confirmation of antibody response using an enzyme-linked immunosorbent assay (ELISA)⁸⁾ before grazing. Therefore, all the cattle in this experiment were divided into 2 groups, not infected and infected cattle. They were grazed for the first time in the same pasture from April to October. Before and during the grazing period,

clinical signs and body weight were recorded every week, and serial blood samples were taken from the cattle every 2 or 3 weeks to examine the presence of *T. sergenti* parasitemia as well as determine the packed cell volume (PCV) and antibody response against *T. sergenti* piroplasms. Parasitemia was checked by light microscopy using Giemsa-stained blood smears. PCV was determined by the capillary tube method. Specific antibody response against *T. sergenti* piroplasms was evaluated by ELISA⁸⁾. Daily gain rate (DG) of each cattle was calculated based on body weight data.

Results and discussion

1) Cattle not infected before grazing

No apparent changes in the clinical signs were observed in both breeds. Fig. 1 shows the parasitemia, ELISA value and PCV in both breeds of cattle which were infected with *T. sergenti* during the grazing period. While few ticks were detected on the pasture and cattle, piroplasms began to be detected in the erythrocytes 16, 7, 2 and 17 weeks after grazing in H1, H2, B1 and B2, respectively. The

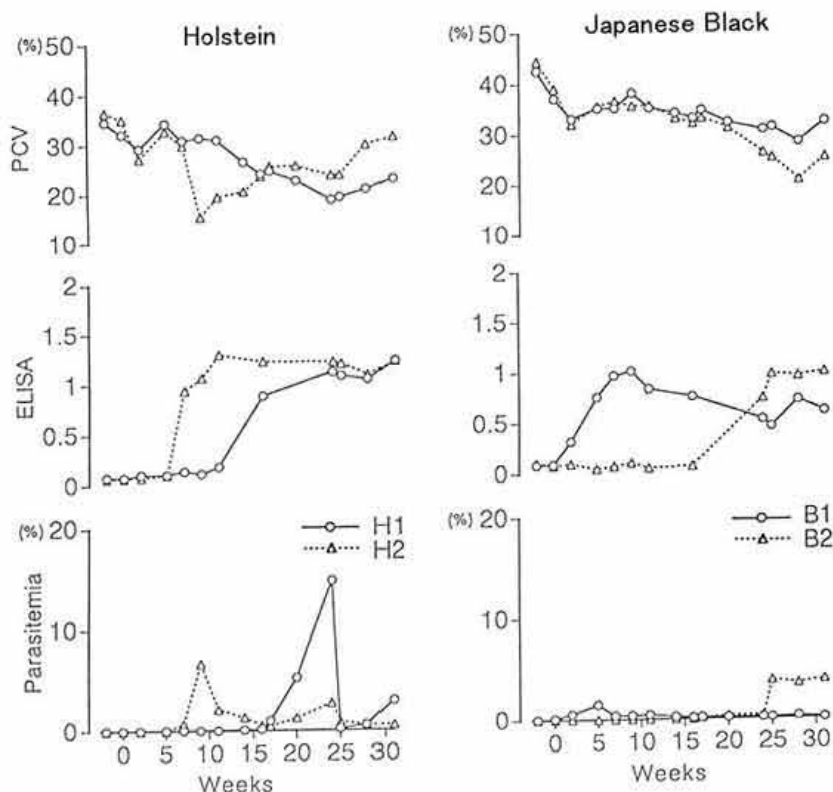


Fig. 1. Changes in parasitemia, ELISA value and PCV. The cattle were infected with *T. sergenti* during the grazing period.

maximal level of parasitemia was clearly higher in the Holstein than in the Japanese Black, with a value of 7, 15% for the former and 2, 4% for the latter. PCV showed a phasic decrease in the early grazing period when cattle had not been infected with *T. sergenti* in both breeds. Following the progression of parasitemia, both breeds of cattle showed a decrease in PCV. The minimal value of PCV was 15, 18% in the Holstein and 28, 20% in the Japanese Black.

As the PCV was higher before the start of grazing in the Japanese Black, there were no apparent differences in the reduction of PCV between the 2 breeds. A similar tendency was observed in our previous experiment carried out under artificial conditions¹⁰⁾, suggesting that there may be a difference in the erythrocyte clearance mechanism between Holstein and Japanese Black under *T. sergenti* infection.

In both breeds, ELISA value began to rise when the piroplasms appeared in the erythrocytes. No apparent differences in the antibody response were observed between the 2 breeds (Fig. 1).

The daily gain rate (DG) is shown in Table 1. The DG of Holstein was higher than that of Japanese Black. Watanabe et al.¹¹⁾ reported that the standard DG of Holstein and Japanese Black that were grazed in the same pasture was 0.65 and 0.45 kg, respectively. In this experiment, the DG of Holstein (H1, H2) was lower than the standard DG in Holstein¹¹⁾, but the DG of Japanese Black (B1, B2) was higher than the standard DG in Japanese Black¹¹⁾.

Although only 2 head in each breed were observed in this experiment, it is suggested that the

Holstein are more susceptible to *T. sergenti* infection than Japanese Black based on the DG values.

2) Cattle infected before grazing

No apparent changes in the clinical signs were observed in the Holstein, while 2 Japanese Black (B5, B6) suffered from pneumonia and diarrhea from the middle of September to the middle of October and they required treatment. Fig. 2 shows the parasitemia, ELISA value and PCV of both breeds of cattle which had been infected with *T. sergenti* before grazing. Parasitemia level increased above 2% around the 5 and 28 weeks after grazing in 3 Holstein cattle (H3, H4, H6), the highest value being about 14%. In contrast, the level of parasitemia was lower than 2% in all the Japanese Black during the grazing period.

Although there are few reports about the immunological reaction in *T. sergenti* infection, it is well known that infected cattle are resistant to re-infection. However, these 3 Holstein cattle showed a diphasic increase of parasitemia in spite of having already been infected with *T. sergenti*. For the first increase of parasitemia, as the parasitemia increased immediately after the beginning of grazing, some external factors such as change of climatic conditions and feeding conditions may have induced the increase of parasitemia. The second increase of parasitemia, with a lower peak than the first one, may be due to the reduction in the immunity response caused by some external factors. On the other hand, since all the Japanese Black showed a low parasitemia during the grazing period, it appears that Holstein may be more affected by external factors than Japanese Black in relation to parasitemia.

In Holstein, PCV changed slightly during the grazing period, while parasitemia changed substantially from 2 to 14% in the same period. On the contrary, PCV decreased until around 25% during the grazing period with slight changes in the parasitemia in Japanese Black (Fig. 2). It appears that PCV in Holstein does not change in case of re-infection with *T. sergenti*. Since it was considered that in the Japanese Black breed the PCV tended to change easily under grazing conditions, the decrease of PCV may not be caused by the parasite proliferation.

Both breeds of cattle showed a high ELISA value which indicated a positive reaction for *T. sergenti* infection before grazing, and then they showed a diphasic increase of ELISA value in the grazing period (Fig. 2).

As indicated in Table 1, the DG of the H3-H6

Table 1. Daily gain (kg/day) in both breeds of cattle

Holstein		Japanese Black	
No.	Daily gain	No.	Daily gain
H1	0.62 (0.95) ^{a)}	B1	0.60 (1.33)
H2	0.54 (0.83)	B2	0.45 (1.00)
H3	0.93 (1.43)	B3	0.69 (1.53)
H4	0.96 (1.48)	B4	0.67 (1.49)
H5	0.93 (1.43)	B5	0.41 (0.91)
H6	0.87 (1.34)	B6	0.32 (0.71)

a): The numbers in the parentheses for Holstein indicate the rate to the standard daily gain rate of 0.65 kg in Holstein¹¹⁾ and those of Japanese Black indicate the rate to the standard daily gain rate of 0.45 kg in Japanese Black¹¹⁾.

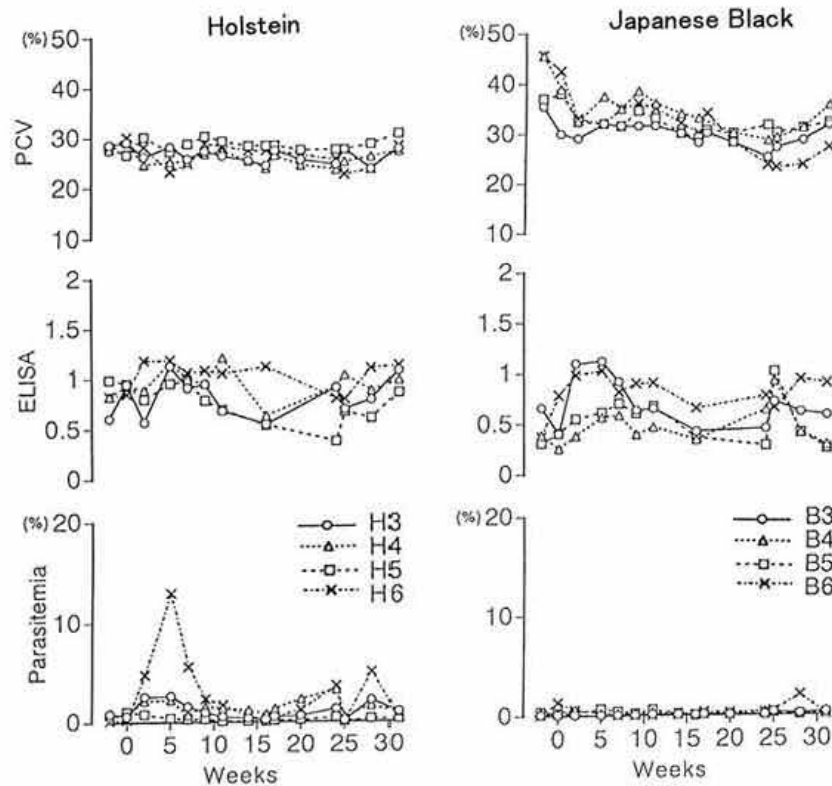


Fig. 2. Changes in parasitemia, ELISA value and PCV
The cattle had already been infected with *T. sergenti* before grazing.

Holstein and B3, B4 Japanese Black exceeded the standard DG in both breeds¹¹⁾. Since the body weight gain was stationary when B5 and B6 suffered from pneumonia and diarrhea, the DG was lower than the standard DG¹¹⁾ in the Japanese Black. Therefore, the DG may not be different between the 2 breeds of cattle which had been infected with *T. sergenti* before grazing.

Conclusion

In this field experiment we confirmed that Japanese Black showed a higher resistance to *T. sergenti* infection than Holstein based on the level of parasitemia as reported in our previous study¹⁰⁾. Thus, it is necessary to clarify the mechanism underlying these phenomena in order to develop a method of control of bovine theileriosis.

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