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Hematological analysis of the Korean native cattle (Hanwoo) according to the period and method of grazing

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Abstract

Blood tests have been used to develop treatment plans, such as disease diagnosis, treatment effect, and prognosis determination in livestock. The present study examined changes in the blood count, including RBCs, WBCs, and platelets, before and after grazing among the Korean native cattle grazing from spring to autumn. The study compared the blood count of livestock group (A, n=34) that returned from the rangeland to cowshed every evening and livestock group (B, n=21) that were not returned from the rangeland to cowshed every evening during the grazing period. Hematological parameters such as RBC, hemoglobin, hematocrit, MCV, and WBC, neutrophil, eosinophil, monocyte, and lymphocyte were determined using a blood cell analyzer. Livestock group (A) showed significant differences in the values of RBC, MCV, MCHC, WBC, EOS, and LYM. Livestock group (B) showed significant differences in the values of RBC, Hb, HCT, MCV, MCH, PLT, NEU, and BAS. In particular, the RBC count decreased after grazing when compared with that before grazing. Compared with that before grazing, low RBC count was maintained from the first to fifth month of grazing. The WBC count increased from the fourth month of grazing, whereas the EOS count increased from the second month of grazing. These results suggest that the values of RBC and WBC vary before and after grazing, and also with the grazing period. Furthermore, it is necessary to develop a detailed feeding management based on these values of blood analysis for livestock that are raised continuously in the rangeland.

Key words : Blood test, Red blood cell, White blood cell, Grazing, Korean native cattle

INTRODUCTION

Blood cells are continuously produced and destroyed to maintain a healthy balance. However, under nutritional deficiency malfunction and during the entry of foreign material in the human body, there is a change in the normal balance of blood cells. Therefore, the blood components in the body and changes in its composition have been used as a guide to diagnose disease, determine treatment methods, and also determine prognosis. Not only in human medicine, but also in veterinary medicine, blood test are the most basic and universal clinical practice (Cheong, 1965). Hematological values of livestock change according to livestock species, breed, age, climate, genetic factor, pregnancy, birth, feeding management, environment, region, and parasitic infection (Fisher et al, 1980; Terada et al, 1995; Kim et al, 2014).

Red blood cells (RBCs) supply oxygen (O_2) to the cells in the body. The hemoglobin (Hb) in RBCs is a combination of heme and globin protein. Anemia is checked by measuring the level of Hb because the iron in heme combines with O_2 to supply O_2 to cells throughout the body and to transport carbon dioxide

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(CO_2). Hematocrit (HCT) is the volume percent of RBCs in the blood and is used to check anemia together with Hb. Mean corpuscular volume (MCV) is a measure of the size or the average volume of a single RBC. It is calculated by dividing the overall number of RBCs by HCT value. Mean corpuscular Hb concentration (MCHC) is the ratio of Hb in a RBC, and is calculated by dividing the total Hb concentration by HCT. The platelets (PLTs) coagulate blood by adhering to damaged blood vessel. The white blood cells (WBCs) are a part of immune system and can be divided into the following types: neutrophils (NEU) for phagocytosis, eosinophils (EOS) for phagocytizing allergens and inflammatory substances, basophils (BAS) to produce histamine, monocytes (MONs) for phagocytizing dead cells, and lymphocytes for cell-mediated and humoral immunity.

There is a need to increase mountain grazing because approximately 64% of land in South Korea is mountainous. Therefore, mountain grazing can reduce production cost of herbivorous livestock and form a foundation for eco-friendly animal husbandry. In addition, it will increase the competitiveness of livestock industry because the productivity can be improved by grazing herbivorous livestock, such as cattle and goats; it can reduce feed cost. As feeding of grazing livestock depends on grass forage land in the rangeland, feeding patterns, such as a lower amount of concentrate feeding, vary from confined livestock. Studies on changes in blood cells, such as RBC and WBC, among the Korean native cattle (*Bos taurus coreanae*, Hanwoo) before and after grazing are scarce. Therefore, the present study aimed to verify if the blood counts changed according to grazing by investigating the level of blood cells, such as RBC and WBC, in grazing cattle before and after grazing.

MATERIALS AND METHODS

Animals

The present study was conducted on the Korean native cattle grazed in the Animal Genetic Resources Research Center, National Institute of Animal Science (Namwon, 468 m above sea level) and the Hanwoo Research Institute (Pyeongchang, 768 m above sea level). Thirty-four heifers (Group A) in the Animal Genetic Resources Research Center that were born in 2016 without pregnancy history were tested. From May 22 to October 23, 2017 they were allowed to graze on the rangeland every morning and brought them back to the cowshed every evening and were provided concentrate feed. Twenty heifers (Group B) in the Hanwoo Research Institute that were born in the second half of 2015 without pregnancy history were also tested and were grazed from May 16 to November 19 in 2017. Unlike the heifers in the Animal Genetic Resources Research Center, these were raised without returning to the cowshed every evening during the grazing period. They were returned to the cowshed on November 19 at the end of the grazing period.

Blood tests

The blood for the tests was collected using a vacuum blood collection tube (BD Vacutainer®, UK) containing ethylenediaminetetraacetic acid (EDTA). The collected blood samples were immediately brought to the laboratory for mixing, and then the values of RBC, WBC, and PLT were determined using a blood cell analyzer (Procyte DM™, IDEXX, USA or Hemavet 950®, DREW, UK).

Statistical analysis

The significance of the analyzed values of RBC, WBC, and PLT was verified using SPSS version 18 software (one-way analysis if variance (ANOVA), $P<0.05$).

RESULTS

Values of RBC and WBC counts before and after grazing

Fig. 1 and Table 1 show the changes in the RBC and WBC counts among 55 heifers before and after grazing. The values of RBC (M/μL), Hb (g/dL), HCT (%), MCV (fL), MCHC (g/dL), and PLT (K/μL) changed

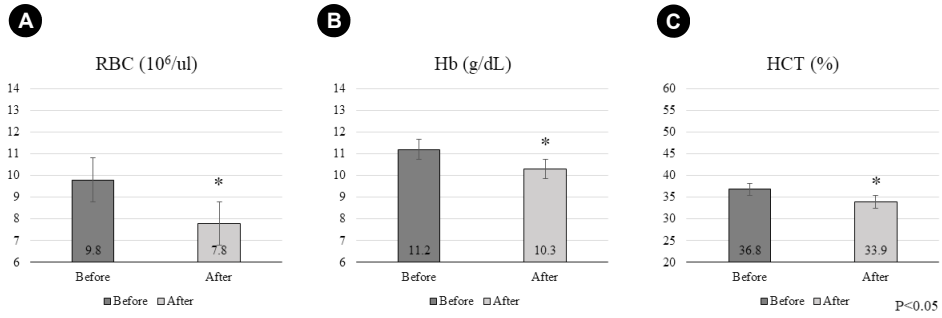

Fig. 1. Values of RBC (A), Hemoglobin (B), and Hematocrit (C) of the before and after grazing cattle (*$P<0.05$).

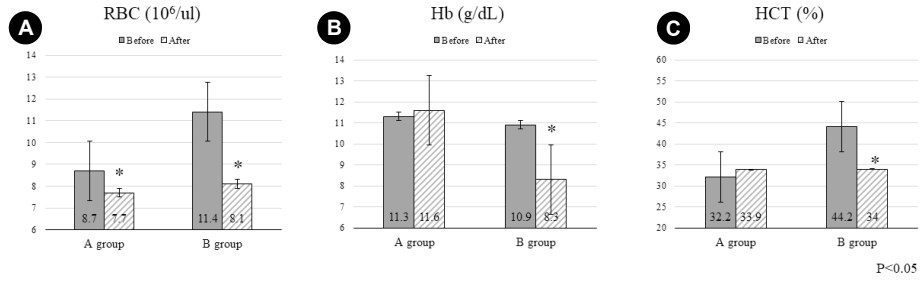

Fig. 2. Change of RBC (A), Hemoglobin (B), and Hematocrit (C) values of cattle grouped by different grazing method (*$P<0.05$).

Table 1. Changes in leukocyte count according to grazing among the Korean native cattle

Grazing	No. of animals	Leukocyte count					
		WBC (K/μL)	NEU (K/μL)	EOS (K/μL)	BAS (K/μL)	LYM (K/μL)	MON (K/μL)
Before	55	11.4±2.7	4.0±1.3	0.3±0.2[a]	0.03±0.03	6.6±2.0	0.6±0.3
After	55	12.1±3.4	3.7±1.2	0.6±0.5[b]	0.02±0.03	7.1±2.3	0.6±0.3

[a,b]Values with different superscripts differ significantly ($P<0.05$).

from 9.8±1.6, 11.2±1.0, 36.8±6.9, 37.7±3.2, 31.3±5.4, and 349.8±147.1, respectively, before grazing to 7.8±1.0, 10.3±2.0, 33.9±4.3, 43.4±4.0, 30.5±5.2, and 394.9±135.2, respectively, after grazing for 5～6 months. Compared with those before grazing, the values of RBC, Hb, and HCT decreased significantly ($P<0.05$) after grazing; however, the values of MCV and MCH increased. The values of MCHC and PLT did not exhibit significant changes. The values of WBC (K/μL), NEU (K/μL), EOS (K/μL), BAS (K/μL), LYM (K/μL), and MON (K/μL) changed from 11.4±2.7, 4.0±1.3, 0.3±0.2, 0.03±0.03, 6.6±2.0, and 0.6±0.3, respectively, before grazing to 12.1±3.4, 3.7±1.2, 0.6±0.5, 0.02±0.03, 7.1±2.3, and 0.6±0.3, respectively, after grazing for 5～6 months. The WBC count exhibited only a marginal change before and after grazing, except the EOS count that increased significantly ($P<0.05$).

Changes of blood count by the different grazing method

The results revealed changes in the blood cell values in the livestock groups subjected to different grazing methods (Fig. 2 and Table 2). The present study investigated changes in the blood count of cattle in livestock that returned to the cowshed every day (Group A) and livestock that were raised without returning during grazing (Group B).

The values of RBC (M/μL), Hb (g/dL), HCT (%), MCV (fL), MCHC (g/dL), and PLT (K/μL) in livestock group (A) changed from 8.7±1.0, 11.3±1.0, 32.2±3.7, 37.1±3.5, 35.3±1.8, and 405.8±100.5, respectively, before grazing to 7.7±1.0, 11.6±1.3, 33.9±4.8, 44.1±4.2, 34.3±1.6, and 395.6±89.3, respectively, after grazing for 5 months. Compared with those before grazing, the RBC count decreased ($P<0.05$) after grazing. In live-

Table 2. Changes in leukocyte count according to grazing method among the Korean native cattle

Farm	Grazing	No. of animals	Values of leukocyte					
			WBC (K/μL)	NEU (K/μL)	EOS (K/μL)	BAS (K/μL)	LYM (K/μL)	MON (K/μL)
Group A	Before	34	12.3±2.7[a]	3.8±1.5	0.3±0.3[a]	0.00±0.01	7.4±1.8[a]	0.8±0.3
	After	34	14.0±2.6[b]	4.0±1.2	0.9±0.5[b]	0.00±0.01	8.4±1.9[b]	0.7±0.3
Group B	Before	21	10.0±2.2	4.2±0.9[a]	0.1±0.1	0.06±0.03[a]	5.2±1.5	0.3±0.2
	After	21	8.9±1.8	3.2±1.0[b]	0.2±0.2	0.03±0.04[b]	5.1±1.1	0.3±0.1

[a,b]Values with different superscripts differ significantly ($P<0.05$).

Table 3. Change of erythrocyte, platelet, and leukocyte profile of group A cattle during the 5 month of grazing period

Grazing		Values of erythrocyte profile					
		RBC (M/μL)	Hb (g/dL)	HCT (%)	MCV (fL)	MCHC (g/dL)	PLT (K/μL)
Before		8.7±1.0[a]	11.3±1.0[a]	32.2±3.7[a]	37.1±3.5[a]	35.3±1.8[a]	400.5±100.5
After (Month)	1	8.2±1.0[b]	11.0±1.2[a]	30.7±3.9[a]	38.0±4.8[a]	36.1±1.9[a]	342.3±103.4[b]
	2	7.1±1.4[b]	10.3±1.7[b]	29.9±5.5[b]	43.0±6.2[b]	34.7±1.6[a]	343.0±111.5[b]
	3	6.4±1.3[b]	10.2±1.5[b]	29.7±3.8[b]	48.0±7.9[b]	34.2±1.8[b]	422.6±117.7[a]
	4	7.2±1.1[b]	11.0±1.3[a]	32.9±4.3[a]	46.4±5.8[b]	33.6±1.2[b]	378.0±104.4[a]
	5	7.7±1.0[b]	11.6±1.3[a]	33.9±4.8[a]	44.1±4.2[b]	34.3±1.6[b]	395.6±89.3[a]
Grazing		Values of Leukocyte profile					
		WBC (K/μL)	NEU (K/μL)	EOS (K/μL)	BAS (K/μL)	LYM (K/μL)	MON (K/μL)
Before		12.3±2.7[a]	3.8±1.5	0.3±0.3[a]	0.00±0.01	7.4±1.8[a]	0.8±0.3[a]
After (Month)	1	11.6±2.4[a]	3.2±1.1	0.3±0.4[a]	0.01±0.02	7.6±1.6[a]	0.5±0.3[b]
	2	12.4±2.6[a]	3.5±1.1	0.6±0.4[b]	0.00±0.00	8.1±1.9[a]	0.3±0.2[b]
	3	13.0±2.8[a]	3.9±1.2	1.0±0.7[b]	0.05±0.19	7.7±1.9[a]	0.4±0.3[b]
	4	13.6±2.6[b]	3.6±1.2	1.0±0.6[b]	0.00±0.01	8.0±1.9[a]	1.1±0.3[b]
	5	14.0±2.6[b]	4.0±1.2	0.9±0.5[b]	0.00±0.01	8.4±1.9[b]	0.7±0.3[a]

[a,b]Values with different superscripts differ significantly ($P<0.05$).

stock group (B), the values of RBC (M/μL), Hb (g/dL), HCT (%), MCV (fL), MCHC (g/dL), and PLT (K/μL) changed from 11.4±0.6, 10.9±1.0, 44.2±3.5, 38.7±2.2, 24.7±1.2, and 259.3±166.9, respectively, before grazing to 8.1±0.9, 8.3±1.1, 34.0±3.4, 42.3±3.4, 24.3±1.9, and 393.8±190.3, respectively, after grazing for 5 months. The values of RBC, Hb, and HCT decreased significantly ($P<0.05$); however, the values of MCV, MCH, and PLT increased significantly increased ($P<0.05$).

In addition, the values of WBC (K/μL), NEU (K/μL), EOS (K/μL), BAS (K/μL), LYM (K/μL), and MON (K/μL) in livestock group (A) changed from 12.3±2.7, 3.8±1.5, 0.3±0.3, 0.00±0.01, 7.4±1.8, and 0.8±0.3, respectively, before grazing to 14.0±2.6, 4.0±1.2, 0.9±0.5, 0.00±0.01, 8.4±1.9, and 0.7±0.3, respectively, after grazing for 5 months. Compared with those before grazing, the values of WBC, EOS, and LYM increased ($P<0.05$). In livestock group (B), the values of WBC (K/μL), NEU (K/μL), EOS (K/μL), BAS (K/μL), LYM (K/μL), and MON (K/μL) changed from 10.0±2.2, 4.2±0.9, 0.1±0.1, 0.06±0.03, 5.2±1.5, and 0.3±0.2, respectively, before grazing to 8.9±1.8, 3.2±1.0, 0.2±0.2, 0.03±0.04, 5.1±1.1, and 0.3±0.1, respectively, after grazing for 5 months. The NEU and BAS counts decreased significantly ($P<0.05$).

Changes in blood count during the grazing period

Table 3 show the changes in the RBC and WBC counts of livestock group (A) whose blood was sampled every month during the 5-month grazing period. The values of RBC (M/μL), Hb (g/dL), HCT (%), MCV (fL), MCHC (g/dL), and PLT (K/μL) were 8.7±1.0,

11.3±1.0, 32.2±3.7, 37.1±3.5, 35.3±1.8, and 405.8±100.5, respectively, before grazing. Changes were observed in most of the blood cell values during the grazing period. In particular, the RBC count exhibited lower values throughout the grazing period when compared with that before grazing ($P<0.05$). Furthermore, the values of WBC (K/μL), NEU (K/μL), EOS (K/μL), BAS (K/μL), LYM (K/μL), and MON (K/μL) before grazing were 12.3±2.7, 3.8±1.5, 0.3±0.3, 0.00±0.01, 7.4±1.8, and 0.8±0.3, respectively. Compared with those before grazing, WBC and EOS counts showed significantly higher values 4 and 2 months after grazing, respectively ($P<0.05$).

DISCUSSION

The daily herbage intake per head of the Korean native cattle is 8%～10% of its weight. It has been reported that their body weight increases by approximately 0.3～0.4 kg/d when they are fed only the herbage (without the concentrate feed) (Kang et al, 2001). Greig and Boynea (1956) reported that concentrate feeding increased the RBC count in calves. Furthermore, the cattle Hb level was associated with the quality of feed, and the Hb level of cattle that were fed good quality feed increased. Fisher et al. observed higher RBC count in the cattle grazing on all pastures when compared with that in the cattle grazing on the pasture with leguminous plants; however, there was no difference in the WBC count (Fisher et al, 1980).

Wee and Park observed no significant differences in the values of RBC, HCT, Hb, MCV, MCHC, and WBC with age of the Korean native cattle (Wee and Park, 1990). Jung et al (2010) reported that the calves of the Korean native cattle immediately after birth and 1-d-old showed higher WBC count than that of the calves aged two days or more. Kim et al (1989) examined the values of RBC, WBC, Hb, and HCT in the Korean native cattle in Gangwon-do and reported that there were no differences in the blood count with sex and age (Kim, 1989). According to Ha et al, the WBC count varied with the number of cows per pen in the Korean native cattle raised in cowshed (Ha et al, 2013). Furthermore, the WBC count of the calves from two heads per pen group was significantly higher than that of the calves from three heads per pen raised in an equal-sized space. Kim et al. reported that the RBC and PLT counts significantly decreased with increase in age, and the WBC count decreased in 1- to 5-year-old Korean native cattle (Kim et al, 2014). The present study compared the blood cell values of the Korean native cattle born in 2016 (farm A) and 2015 (farm B) whose blood was collected at around the same time in May 2017. In the Korean native cattle from farm A, the values of RBC (M/μL), Hb (g/dL), HCT (%), MCV (fL), MCHC (g/dL), and PLT (K/μL) were 8.7±1.0, 11.3±1.0, 32.2±3.7, 37.1±3.5, 35.3±1.8, and 405.8±100.5, respectively, while those in the Korean native cattle from farm B were 11.4±0.6, 10.9±1.0, 44.2±3.5, 38.7±2.2, 24.7±1.2, and 259.3±166.9, respectively. Significant differences were observed in the values of RBC, HCT, MCHC, and PLT. In heifers from farm A, the values of WBC (K/μL), NEU (K/μL), EOS (K/μL), BAS (K/μL), LYM (K/μL), and MON(K/μL) were 12.3±2.7, 3.8±1.5, 0.3±0.3, 0.00±0.01, 7.4±1.8, and 0.8±0.3, respectively. Conversely, in heifers from farm B, these values were 10.0±2.2, 4.2±0.9, 0.1±0.1, 0.06±0.03, 5.2±1.5, and 0.3±0.2, respectively. Significant differences were observed in the values of WBC, EOS, BAS, LYM, and MON. Kim investigated the RBC count of confined (30 cattle per pen) Korean native cattle aged above 2.5 years in Iksan, Jeollabuk-do (Kim, 1963). The results revealed that the values of RBC (M/μL), Hb (g/dL), and HCT (%) were 6.2±0.8, 11.6±1.0, and 33.9±3.6, respectively. Cho et al. reported that the RBC count decreased (11.0～8.5) with increase in age (Cho et al, 2008). The RBC count obtained in the present study was different from that observed by Cho et al (2008) however, the Hb level was similar.

Choi et al (2016) observed a significant decrease in the values of RBC, Hb, HCT, and WBC among dairy heifers grazing from April to November whose blood was sampled in August when compared with those whose blood was sampled in March before grazing. In particular, the RBC count decreased significantly with increase in the length of grazing period, such as in August and November, compared to that in March before grazing. In addition, grazing livestock groups irre-

spective of season showed significantly lower values of RBC, Hb, HCT, and WBC than those of the confined livestock groups. Kim et al reported significantly higher values of RBC, HCT, Hb, MCV, and MCHC in the Korean native cattle without diseases, such as theileriosis, in rangeland or cowshed from spring to autumn irrespective of grazing and confinement (Kim et al, 2017). Hyun et al. reported that the RBC count in the Korean native cattle raised at an altitude of 800 m was higher than those raised at an altitude of 200 or 400 m (Hyun et al, 2007). Ji et al. observed no significant differences in blood count with altitude (Ji et al, 2011). However, livestock groups at a high altitude showed higher RBC count than that in the livestock groups at a low altitude in the Korean native cattle. In the present study, the RBC count in the Korean native cattle raised in May at around 400 m above sea level before grazing (Farm A) was 8.7±1.0, which was lower than that in the cattle raise at around 600 m above sea level (Farm B) (11±0.6). However, there were no significant differences in the RBC count between the two groups at the end of grazing period, with 7.7±1.0 and 8.1±0.9, respectively.

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