Some Important Blood Parameters of Dairy-Beef Crossbred Calves

DOI:10.31274/air.11932

Nadiia Stepanchenko, Graduate Research Assistant;
Janaka Wickramasinghe, Graduate Research Asistant;
Ranga Appuhamy, Assistant Professor,
Department of Animal Science, Iowa State University

Summary and Implications

In this report, we describe the differences in some important blood parameters between Holsten × Angus (HA) and Holsten × Angus × Simmental (AHS) calves. This report also includes the correlation coefficients (R) describing the strength and direction of associations of those blood parameters with weight gain. Blood (jugular) was drawn from 18 AH and 12 AHS calves at 6, 45, and 90 d of age. Body weight was recorded on the same days and daily weight gain during 6 to 45 d (P1) and 45 to 90 d (P2) were calculated. The correlations were analyzed aligning weight gain during P1 with blood parameters of d 45, and weight gain during P2 with blood parameters of d 90. The results highlighted several blood parameters were significantly different between AH and AHS. Regardless of them being different or similar between breeds, some blood parameters, however, had strong relationships with weight gain. Serum albumin was greater in HA than HAS (P = 0.008) and had a strong relationship with weight gain across breeds (R = 0.73). Similarly, hemoglobin was greater in HA than HAS (P = 0.050) and had a significant relationship with weight gain across breeds (R = 0.52). On the other hand, blood creatinine concentrations were similar between breeds but had strong relationship with weight gain across breeds (R = -0.78). Overall, this report provides valuable information that would be useful in developing tools to describe and evaluate within or between breed differences in the performance of dairy-beef crossbred cattle.

Introduction

In recent years, there has been a significant interest in breeding dairy cows to beef bulls as a way to add value to bull calves. Such extra income has helped dairy farms to be resilient against low milk prices, for instance, those in 2019. Selling surplus calves is not a novelty particularly for farms maintaining longer productive life of cows and thus require fewer replacements. However, dairy × beef steers produce better carcasses (e.g., more attractive cuts) and thus sold at greater prices than dairy steers. Even though Angus, and Simmental are typically used, the choice of best beef breed is what dairy farmers often argue about. Despite the potential of dairy × beef crossbreeding programs, there is a paucity of data to evaluate the performance of those crossbred cattle. Some studies conducted previously in feedlot and grass-fed cattle highlighted significant relationships between several hematology parameters and feed efficiency providing efficient way to evaluate the success of different breeding options. The objectives of this study were 1) to examine the effects of the breed on hematology and blood chemistry of dairy × beef calves and 2) to determine the relationships of those parameters with weight gain.

Materials & Methods

All animal-related procedures in this study were conducted under the approval of the Animal Care and Use Committee at Iowa State University. The present study was conducted at Iowa State University dairy farm (September to December, 2019) and included 18 Holstein × Angus calves (HA, 11 female and 7 male), and 12 Holstein × Angus × Simmental calves (HAS, 4 female and 8 male). Calves were raised from 6 to 90 d of age housing in calf hutches (2.4m × 1.4m × 1.3m) bedded with straw. Calves had free access to clean water and a starter ration throughout the study and were weaned from a milk replacer (6.0 L of milk/d) at 49 d of age. Body weight of individual animals were measured at the beginning (6 d), middle (45 d) and end (90 d) of the study. The body weight difference was divided by the time interval in days to calculate weight gain during 6 to 45 d and 45 to 90d. Following body weight measurements, blood was drawn from the jugular vein of individual animals into a 2 mL with EDTA and a 10 mL tube without an anticoagulant for the hematology analyses and blood (serum) chemistry analysis, respectively. The blood analysis were performed (Quality-Vet Laboratory, Davis, CA) in compliance with Good Laboratory Practices (GLP) guidelines.

The statistical significance of breed effect on weight gain, hematology and blood chemistry parameters were analyzed using MIXED procedure of SAS (version 9.4) with repeated option. The model included fixed effects of breed, age (6, 45, and 90 d), sex, and interaction between breed and age, and random effect of calf. Data were prepared for correlation analysis by aligning weight gain during 6 to 45 d with blood parameters of d 45, and weight gain during 45 to 90 d with blood parameters of d 90. The Pearson correlation coefficients (R) for relationships between blood parameters

Iowa State University Animal Industry Report. 2021. 17(1):13843. https://doi.org/10.31274/air.11932.

and weight gain were determined using CORR procedure of SAS.

Results and Discussion

As shown in Figure 1A, ADG was similar between AH and AHS during 6 to 45 (pre-weaning, $P = 0.44$) and 45 to 90 d of age (post-weaning, $P = 0.55$). The average values of blood parameters are given in Table 1 and Table 2. Holstein × Angus calves had greater blood albumin concentration than HAS ($P = 0.008$). Albumin is a protein produced in the liver and found in the blood. It serves as a carrier protein for various hormones and fatty acids partly explaining the marked positive relationship between blood albumin and weight gain across breeds (R = 0.73, $P < 0.001$, Table 1) as well as within breeds (Figure 1). Blood calcium concentrations tended to be higher for HA compared to HAS ($P = 0.07$) and had a positive relationship (R = 0.52, $P < 0.001$) with weight gain. Both breeds had similar blood sodium concentration pre-weaning ($P > 0.55$). However, at 90 d of age, AH had a greater sodium concentration than AHS ($P = 0.02$). Even though there was no breed differences, γ-Glutamyltransferase, creatinine, cholesterol, and pyruvate dehydrogenase were negatively correlated with weight gain ($P < 0.001$). Since, elevated γ-Glutamyltransferase, and creatinine in blood signal liver and kidney malfunction, the negative relationships highlight the importance of those organs to growth. Hemoglobin, a vital part of red blood cells plays a key role supplying oxygen to produce energy in the body. Blood hemoglobin concentration was greater ($P = 0.05$) for HA compared to HAS and positively correlated with weight gain (R = 0.52, $P < 0.001$, Figure 1B). In line with hemoglobin, the red blood cell counts were positively related to weight gain (R = 0.73, $P < 0.001$)). Total white blood cell count ($P = 0.045$), mean corpuscular volume ($P = 0.004$), lymphocyte count ($P = 0.02$) and monocyte counts ($P = 0.02$) were greater in HA than HAS. White blood cells are an important part of the innate immunity against various pathogens. Given the present values were within healthy ranges, higher count can be indicative of the presence of better innate immunity in HA compared to HAS.

Conclusions

There were several blood parameters having strong correlations with weight gain. Those parameters would be useful in explaining the heterogeneity of weight gain among individual calves. On the other hand, some other parameters were significantly different between breeds, even though the relationships with weight gain were insignificant. Those parameters would be helpful in understanding differences in other characteristics such as disease tolerance, resilience to environmental challenges, and reproductive efficiency between breeds. Overall, this report provides valuable information that would be useful in developing tools to evaluate dairy-beef crossbred cattle.

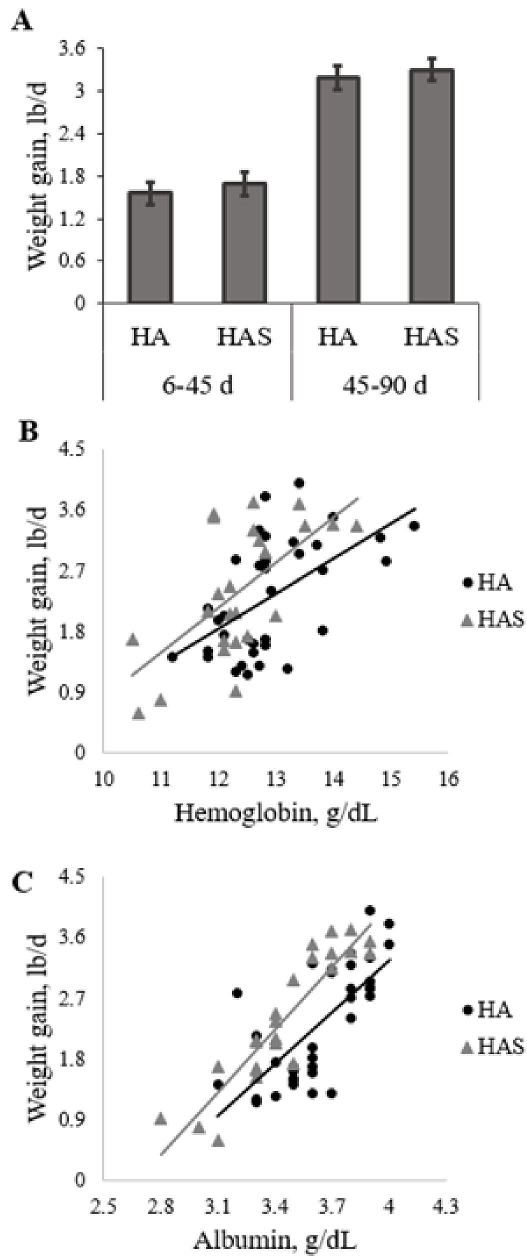

Figure 1. Average weight gain of Holstein × Angus (HA) and Holstein × Angus × Simmental calves (HAS) calves (A). Relationships of weight gain with hemoglobin (B) and albumin (C) in the blood.

Iowa State University Animal Industry Report. 2021. 17(1):13843. https://doi.org/10.31274/air.11932.

Table 1. The average values of blood chemistry parameters, statistical significance of the breed effect, and correlations (R) of each parameter with average daily gain of Holstein × Angus (HA) and Holstein × Angus × Simmental calves (HAS).

Variable	6 d of age		45 d of age		90 d of age		Breed	Correlations	
	HA	HAS	HA	HAS	HA	HAS	(*P*-value)	R	*P*-value
Albumin, g/dL	2.88	2.80	3.46	3.25	3.79	3.68	0.008	0.727	<0.001
Total protein, g/dL	7.08	6.77	6.06	5.96	6.02	6.14	0.367	-0.064	0.626
Blood urea nitrogen, mg/dL	12.37	10.22	10.26	11.22	12.98	11.64	0.388	0.217	0.096
Alkaline phosphatase, U/L	186.77	205.82	223.54	234.32	226.38	288.57	0.108	0.274	0.034
Alanine aminotransferase, U/L	7.77	8.56	12.6	10.98	14.99	14.64	0.511	0.469	0.0002
Asparate aminotransferase, U/L	33.24	36.52	53.41	58.19	74.97	78.10	0.335	0.034	0.569
Lactate dehydrogenase, U/L	520.01	552.39	721.79	731.14	848.4	23.53	0.478	-0.559	<0.001
γ-Glutamyltransferase, U/L	552.38	378.4	17.22	15.57	6.88	6.73	0.333	-0.547	<0.001
Creatine kinase, U/L	46.82	64.14	106.32	88.48	166.07	142.31	0.508	0.506	<0.001
Creatinine, mg/dL	1.16	1.21	0.89	0.89	0.68	0.66	0.779	-0.734	<0.001
Total bilirubin, mg/dL	0.69	0.59	0.15	0.15	0.14	0.11	0.587	-0.337	0.008
Cholesterol, mg/dL	59.16	57.04	78.99	83.29	60.21	65.04	0.523	-0.540	<0.001
Glucose, mg/dL	87.77	81.63	91.1	88.46	116.1	105.21	0.394	0.331	0.010
Calcium, mg/dL	10.81	10.52	9.89	9.59	10.31	10.21	0.074	0.517	<0.001
Inorganic phosphorus, mg/dL	0.20	0.25	0.20	0.25	0.20	0.25	0.544	0.361	0.005
Sodium, mEq/L	139.15	139.68	140.32	140.76	140.54	138.34	0.481	-0.083	0.530
Potassium, mEq/L	5.57	5.53	4.92	4.66	5.87	4.58	0.159	0.063	0.630
Chloride, mEq/L	98.40	97.72	101.57	101.55	98.45	98.39	0.597	-0.462	<0.001
Magnesium, mg/dL	2.28	2.34	2.21	2.19	2.13	2.14	0.777	-0.019	0.885

Table 2. The average values of hematology parameters, statistical significance of the breed effect, and correlations (R) of each parameter with average daily gain of Holstein × Angus (HA) and Holstein × Angus × Simmental calves (HAS).

Variable	6 d of age		45 d of age		90 d of age		Breed (*P* – value)	Correlations	
	HA	HAS	HA	HAS	HA	HAS		R	*P*-value
WBC, ×10³ /uL	9.73	8.62	8.60	7.50	9.38	8.43	0.045	0.176	0.178
RBC, ×106/uL	8.09	8.06	10.13	10.18	9.85	10.11	0.662	0.731	0.045
Hemoglobin, g/dL	10.89	10.20	12.35	11.90	13.36	12.97	0.050	0.520	<0.001
Hematocrit, %	33.92	32.34	36.02	34.88	37.21	36.19	0.115	0.280	0.030
MCV, fL	41.83	40.19	35.60	34.37	37.86	35.90	0.004	0.278	0.031
MCH, pg	13.44	12.67	12.22	11.73	13.60	12.89	0.001	0.470	<0.001
MCHC, g/dL	32.14	31.52	34.30	34.12	35.92	35.88	0.118	0.645	<0.001
RDW, %	18.38	18.94	18.31	19.11	20.93	21.27	0.117	0.607	<0.001
Platelet count, ×10³ /uL	706.12	850.23	586.11	718.73	549.83	586.01	0.049	-0.165	0.211
MPV, fL	9.24	9.24	7.53	7.64	8.28	7.64	0.703	0.006	0.962
Neutrophils, %	49.15	48.10	30.32	34.60	30.99	35.01	0.265	0.065	0.620
Lymphocytes, %	41.27	41.52	59.21	55.02	58.82	56.77	0.387	-0.017	0.896
Monocytes, %	6.84	6.60	8.23	8.01	7.01	5.43	0.304	-0.272	0.036
Eosophils, %	1.78	2.87	1.44	1.62	1.61	1.20	0.274	0.043	0.745
Basophils, %	0.94	1.15	1.11	1.15	1.94	1.82	0.689	0.599	<0.0001
nNEUT, ×10³ /uL	4.88	4.20	2.61	2.65	2.99	3.04	0.569	0.159	0.224
nLYMPHS, ×10³ /uL	3.92	3.59	5.09	4.08	5.45	4.69	0.019	0.146	0.266
nMONO, ×10³ /uL	0.67	0.50	0.71	0.60	0.65	0.46	0.023	-0.139	0.291
nEOS, ×10³ /uL	0.17	0.24	0.12	0.12	0.15	0.10	0.739	0.121	0.357
nBASO, ×10³ /uL	0.09	0.09	0.10	0.09	0.18	0.15	0.240	0.559	<0.001

* white blood count (WBC), red blood count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell volume distribution width (RDW), absolute neutrophils (nNEUT), absolute lumphocytes (nLYMPHS), absolute monocytes (nMONO), absolute eosinophiles (nEOS), absolute basophiles (nBASO)