

ภาคผนวก

Comparison of the Blood Biochemistry and Performance of Two Sets of Thai Indigenous Steers, Fattened on Grassland Grazing and Fed Corn Silage-Base in a Feedlot with Two Different Protein Supplemented Diets *

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ABSTRACT

This study determined blood biochemistry values and performance of Thai indigenous steers (*Bos indicus*) during fattening for 120 days. Twelve healthy two-year old steers with a mean±sd weight of 183.5±11.32 kg were assigned equally into two groups. One group was allowed free grazing on grassland improved mainly with purple guinea grass (*Panicum maximum*) and the other kept in a feedlot and fed a corn silage-base diet. Both groups were then randomly, equally divided and supplemented with two different protein diets (12 and 14%CP) of about 1% of body weight (BW). The steers in the grassland had a significantly higher total weight and average daily gain than those in the feedlot. However, there was no significant difference of these values between steers supplemented with either of the two protein diets. Blood biochemical values at the end of the trial were not significantly different for the steers fed the different dietary treatments. Glucose, alkaline phosphatase, albumin, mean corpuscular volume and mean corpuscular hemoglobin at the end of the trial had increased, but free serum thyroxine and triiodothyronine had decreased, and differed significantly from their values at the beginning of trial. Other blood biochemical values, triglyceride, total cholesterol, total bilirubin, direct bilirubin, aspartate serum transferase, alanine transaminase, blood urea nitrogen, creatinine, hemoglobin, and white and red blood cell hematocrit platelet counts were not significantly different between the start and end of the experiment. Differences in dietary protein supplementation caused no differences in the blood biochemical and hematological values of the steers. These results imply that the Thai indigenous steer should fatten on grassland with a 1%BW dietary supplemental concentrate of 12%CP.

Key words: Performance, Blood biochemical, Grassland, Feedlot, Thai indigenous steer

INTRODUCTION

Thai indigenous (TI) cattle are a kind of *Bos indicus*. They tolerate tropical ecto- and endoparasites well, use low quality roughage efficiently, and are highly fertile, but have a small frame size and low growth rate (Intaratham, 2002; Kawashima, 2002; Boonprong et al., 2007b; Chantiratikul et al., 2009). Increasingly there is an interest in fattening indigenous cattle as a possible solution to a more efficient livestock production (Boonprong et al., 2007a;), and now TI cattle is developing a niche as a natural beef in the market (Sethakul, et al. 2007). Moreover, its meat has a lower fat content than Brahman crossbred and Charolais (Opatpatanakit, et al. 2007; Sethakul, et al. 2007). Therefore, TI cattle plays an important role in the livestock-cropping production system of a small holder farm because it is a savings account and can be changed into cash when necessary (Tumwasorn et al., 1998).

In northern Thailand there are many residues from sweet corn producing farms. After the harvest, the stem and leaf are always sold to farmers who use them for raising beef and dairy cattle. However, depending on the season, the volumes of corn crop residue fluctuate. Therefore, for the farmer, reserving a corn crop for corn silage can help during periods where roughage for cattle is unavailable. Making corn silage could be a good choice for a farmer to improve feed quality. During cattle fattening, moreover, farmers have to pay attention to the health, quality and welfare of their steers. For this reason blood biological and hematological values are performed in order to assess health status, evaluate body response to nutrition, and indicate adaptability to adverse environmental conditions and the associated stress and welfare (Hall et al., 1995; Jane, 1996; Kaneko et al., 1997; Stanger et al., 2005; Boonprong et al., 2007a; Aengwanich et al., 2009; Kuha et al., 2009). Given these conditions in northern Thailand, farmers have two options available to them, to rear cattle on a feedlot or to allow them to graze freely. A study of which of these options is best suited for fattening TI cattle has not been performed, and diet recommendations have been based largely on analogies to other breeds. The aim of this research was to determine the blood biochemical values and performance and of Thai indigenous steers during fattening by allowing free grazing on improved grassland and compare these parameters with steers kept in a feedlot and fed diets of corn silage. The kind of roughage and feeding regime makes a difference in the steer's

nutritional intake, in particular the protein intake. Therefore, the question of protein supplementation was also addressed and compared for both feed modalities by supplying the steers diets with a protein concentrate at 2 levels.

MATERIALS AND METHODS

Experimental Design and Procedure

Twelve two-year old healthy Thai indigenous steers, with a mean±sd weight of 183.5±11.32 kg, were assigned equally to four groups, following a 2x2 factorial completely randomized design. Six steers were allowed free grazing for about 9 hr per day (8:00am – 5:00pm) on grassland, mainly improved with purple guinea grass (*Panicum maximum*). The other six steers were reared in a feedlot on a corn-silage base diet. Both groups were randomly and equally divided into two subgroups and each was supplemented with a protein concentrate at 1% body weight per day during the evening with an individual feeder. The supplementation diet had two levels of protein content as showed in table 1. Steers were allowed free access to a water basin all the time. The steers were castrated, and full recovery was awaited before the experiment was started. After that, the steers were treated and controlled for internal and external parasites (Abentel, Attantic Laboratories Corp., Ltd, Thailand and Ivomec F[®], Merial (Thailand) Ltd.), and all were injected with a vitamin complex (Catosal[®], OLIC [Thailand] Ltd., under supervision of Bayer Leverkusen, Germany). The body weights of the steers were measured at inception of the trial and then every 30 days during the trial until it concluded after 120 days.

Preparation Grassland and Corn Silage

Before the experiment grassland, mainly consisting of purple guinea grass, was improved by adding cattle manure (250 kg/acre) and urea fertilizer (25 kg/acre). Water was supplied for 2 months, twice a week, using a sprinkler. About 75 days after harvest, corn silage was made from the whole stem of sweet corn and cut into 2-3 cm lengths with a chopper machine. It was tightly packed together with chopped corn, of a weight of about 100 kg, into a plastic bag and tied with a rope after removing the air using a blower. It was then stored in a closed room at ambient temperature for 3 weeks before it was fed to the steers.

Blood Biochemical and Hematological Analysis

At the start and finish of the 120-day trial, blood samples were taken from the jugular vein during fasting (7:00-8:00am) using 10 ml disposable syringes. The specimens were put into K₃EDTA and NaF tubes of 2.5 ml each and the remainder allowed clotting in a blood clot tube. Serum was obtained following centrifugation at 600xg for 10 minutes, stored at 4-6 °C and carried to the laboratory for analysis. Serum blood biochemicals were determined automatically using a COBAS INTEGRA[®] 800 (Roche, Switzerland), and they were glucose (GLC), total bilirubin (TBIL), direct bilirubin (DBIL) aspartate serum transferase (AST), alanine transaminase (ALT), alkaline phosphatase (ALP), blood urea nitrogen (BUN), creatinine (CR), total cholesterol (TC), triglyceride (TG), high density lipoprotein (HDL), low density lipoprotein (LDL), albumin (ALB), free serum thyroxine (FT4) and free triiodothyronine (FT3). Complete blood cell counts (CBC) due to white blood cell (WBC), hemoglobin (HB), hematocrit (HCT), red blood cell (RBC), platelet (PLT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were analyzed using an electrical impedance technique by Sysmex K4500 (GMI, Inc., Minnesota, the United States).

Statistical Analysis

Data were analyzed using a statistical experimental design model with the generalized linear model (GLM) procedure (SAS, 1999). The productive traits were analyzed for covariance (ANCOVA) by running an initial body weight as a covariate. The least square mean and standard error of the mean were calculated and compared using the PDIFF (SAS, 1999) for a significant F-test (p≤0.05). Blood biochemical and hematological values were compared between the periods of the experiment using the paired T-test.

RESULTS

Productive Performance

There were no significant differences of body weight gain (BWG), average daily gain (ADG), daily dry matter feed intake (DMI), and feed per gain ratio (FGR) between the two levels of dietary protein supplementation for the two groups of cattle, improved grassland and feedlot fed corn silage-base. For steers supplemented with diet 1, those in the feedlot had lower BWG and ADG than those feeding on grassland, however, DMI concentrate consumption showed that steers in the feedlot consumed more concentrate than steers in the grassland (table 2). Steers that were allowed free grazing on grassland tended to have a higher cumulative BWG than those in the feedlot and fed corn silage-base at 60, 90, and 120 days of the experiment ($p=0.08$). Furthermore, steers feeding on improved grassland had the highest ADG during 30-60 days of the experiment and this value differed significantly ($p<0.05$) from the steers in the feedlot (figure 1).

Blood Biochemical and Hematological Values

The blood biochemical and hematological values did not differ significantly between steers randomly assigned to the different treatments at the beginning of the trial, and are shown in table 3. The end results also found no significant difference of blood values between steers given the different dietary treatments in both the feedlot or within the grassland. However, the PLT of steers fed on grassland and supplemented with diet 1 tended to be lower than that of the other groups ($p=0.068$).

Blood biochemical and hematological values were compared between the initiation and conclusion of the trial. GLC, ALP, ALB, MCV, MCH at the end of the trial increased and were significantly different ($p<0.05$) from those of at beginning of the trial. The final TG of the steers by average tended to be higher than that at the beginning ($p=0.073$). In contrast, the values of FT4 and T3 decreased significantly at the end of the trial. The blood biochemical values TBIL, DBIL, ALT, BUN, and CR did not change significantly before and after fattening the steers. The hematological values WBC, HB, HCT, RBC, MCHC, and PLT were not significantly different for the two dietary treatments when compared at the conclusion (table 3) and between the initiation and conclusion of the trial (table 4).

DISCUSSION

Productive Performance

Our study started in March, the beginning of summer. During this season, cattle mostly loose body weight because of the scarcity of the roughage supply (Kawashima, 2002; Kuha et al., 2009). Therefore, steers were restricted in their feed intake before starting the experiment. This could influence BWG and ADG during the early stages of fattening, as compensatory growth affected the steers and they could take in more feed than they needed during this period. This especially applied to those allowed free grazing on improved grassland. Horton and Holwes (1978) found that cattle with restricted feed intake gained weight more rapidly during subsequent full feeding in the first 8 weeks. They claimed the compensatory gain paralleled the increased intake with no change in ration digestibility. Compensatory growth was influenced more by differences in severity of restriction than by duration of the restriction period (Drouillard et al., 1991).

The ADG of this study was higher by about 25% than that reported by Sritrakulpecth et al., (1990) on the same breed (0.30 ± 0.21 kg/d). This was a lower ADG than observed in TI x Brahman crossbreds by about 19.2% (0.60 kg/d; Wanapat et al., 1995), and by about 40% of Brahman crossbred (0.89 ± 0.10 kg/d; Tumwasorn, 2007). The ADG and DMI of this study, however, were nearly the same as those reported for TI by many researches (Keawpila et al., 2010; Bunseelarp et al., 2010; Harnsamere et al., 2010). ADG is related to the dietary proteins (Chantiratikul et al., 2009) accepted as a recommendation of standard nutrient requirements for TI cattle in Thailand (WTSR, 2007). For steers fed roughage (feed lot) ADG was not significantly affected by the level of dietary crude protein supplementation. This result means

that concentrate (12% CP) can effectively supplement fattening in TI, and it agrees with the recommendations of Wanapat et. al. (1995) and Wanapat et. al. (1997).

Blood Biochemical and Hematological Values

The blood biochemical and hematological values of steers were not significantly different between the two dietary treatments when they were compared at the beginning and end of the trial. Steers allowed free grazing on grassland tended to have a higher PLT count than animals in the feedlot ($p=0.06$) throughout the 120 days of the experiment. This may indicate that a steer in the grassland produced more PLT against blood parasites that may embed more in tropical regions.

Plasma GLC concentration increased dramatically during the experiment for the steers supplied with dietary protein treatment. Although GLC concentration at initiation (53.33 ± 3.56 mg/dL) was in the normal range (Kaneko et al., 1997), yet it was closer to the lower limit of normal values (50.0 mg/dL). This means that before the trial steers lacked energy supply because they were restricted of roughage (Kawashima, 2002; Kuha et al., 2009). At the conclusion of the trial, plasma GLC of steers on the average was high, at 65.08 ± 1.36 mg/dL, indicating an adequate energy supply as result of the dietary treatment.

Serum ALB at the end, 3.17 ± 0.06 g/dL, differed significantly from that at the onset of the trial (2.82 ± 0.05 g/dL; $p < 0.001$). As ALB is produced in the liver and plays many important functions, these values indicated that before starting the steers were at risk of malnutrition and feed malabsorption. However, for both sets of steers ALB was in the range given by Kaneko et al. (1997).

At the end of the 120 days, steers tended to have higher plasma triglyceride (TG) than at the beginning ($p=0.07$). The TG before starting the trial was nearly the same as for Japanese black crossbred fed rice straw and receiving enough TDN (Kita, et al., 2003). The values of total cholesterol (TC) were not significantly different between steers fed different dietary treatments, and between onset and conclusion of the trial. The TC values of our study were higher than those for Japanese black crossbred cattle (129.33 ± 3.15 mg/dL; Kita, et al., 2003), and buffalo calves (129.4 ± 4.96 mg/dL; Kumar and Dass, 2006). TC, TG, and LDL values at the end of the trial correlated positively with each other (TG vs. TC = 0.99, TG vs. LDL = 0.97, TC vs. LDL = 0.98), but correlated negatively with TBIL (-0.63, -0.65, and -0.68, respectively).

AST, ALT, and ALP levels were not significantly different between the dietary treatments for the duration of the trial and were within the reference range of Kaneko et al. (1997). However, ALP of steers at the end, was significantly different than that at the beginning of the trial ($p < 0.05$). At the end, AST and ALT had a strong correlation with T3 (0.74 and 0.69). This study also found lower AST and ALT values than reported in TI cattle by Boonprong et al. (2007a).

Serum FT4 and T3 decreased significantly at the end of the trial (table 5). Herson et al. (2004) stated that increased availability of T3 induces more extensive protein degradation than synthesis. In addition, decreased concentrations of thyroid hormone have been shown to decrease the requirements to maintain energy (Murphy and Loerch, 1994) and decrease protein degradation (Buttery, 1983; Ellenberger et al., 1989). This result either indicates that proteins mobilized from muscle for maintenance before the trial, or it was evidence of a low protein intake. Then, during fattening, steers consumed enough protein and that could decrease secretion of T3 and FT4 and this may be responsible for the increased energy being used for growth. Herson et al., (2004) claimed that lower concentrations of T3, and T4 in steers, when they entered the feedlot, did not inhibit their growth as a response to the previous restriction. BUN, however, was not significantly different between the periods of the study although BUN relates closely to protein intake in beef cattle (Hall et al., 1995).

Although, MCV and MCH differences were not significant between dietary treatments within the study period, pooled values at the end were significantly higher than those at the beginning. Both these values for TI steers were lower than for Holstein Friesian crossbred (Aengwanich, 2002) and crossbred beef cattle (Aengwanich et al., 2009). Both values, however, were within the reference range of Kaneko et al., (1997). This indicated that RBCs of TI steers were higher than those of other breeds.

TBIL, DBIL, and CRT were not different between dietary treatments when compared between feed modalities and for the onset and conclusion of the trial, and were in the normal range (Kaneko et al., 1997; Jane, 1996). Steers on grassland tended to have a higher PLT count than steers in the feedlot ($p=0.068$). Low PLT counts could increase bleeding risks. However, the values were in the range of Kaneko et al. (1997).

WBC, HB, HCT, RBC, and MCHC were not significantly different for steers fed with different dietary treatments. These values for the beginning of the trial were not different and indicated that steers were correctly assigned to the experiment.

We have studied how TI cattle respond to a fattening regimen in two environments. In the first, cattle was allowed to freely graze on grassland, in the other it was fed roughage in a feed lot. In both cases the diets were supplemented with a protein concentrate. Even though both fattened, given the evidence, we recommend that the most effective way to fatten cattle in Thailand is to allow it to graze on grassland and be given a 1%BW protein dietary supplemental concentrate of 12%CP.

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Table 1 Ingredients and composition of the experimental diets

Ingredients	Diet 1 (kg)	Diet 2 (kg)
Corn	70.00	70.00
Rice bran (from local rice mill)	25.00	20.00
Soybean meal	-	5.00
Urea	2.00	2.00
Di-calcium phosphate	1.90	1.90
Sodium chloride	1.00	1.00
Sulfur	0.10	0.10
Total	100.00	100.00
CP, %	12.00	14.00
TDN, %DM	86.16	85.76
ME, MJ/kg	3.34	3.27

Table 2 Productive performance of the Thai indigenous steers during fattening: Feedlot fed corn silage-base, and grassland free grazing

Item *	Feedlot fed corn silage-base		Grassland free grazing	
	Diet 1	Diet 2	Diet 1	Diet 2
	LSM ± SEM	LSM ± SEM	LSM ± SEM	LSM ± SEM
Initial weight, kg	180.33 ± 7.44	178.50 ± 9.25	188.00 ± 6.79	187.17 ± 3.68
Final weight, kg	237.57 ± 4.30 ^a	243.17 ± 4.38 ^{ab}	252.12 ± 4.35 ^b	241.48 ± 4.32 ^{ab}
Final weight, kgBW ^{.75}	60.49 ± 0.80 ^a	61.56 ± 0.81 ^{ab}	63.23 ± 0.81 ^b	61.25 ± 0.80 ^{ab}
BWG, kg	54.07 ± 4.30 ^a	59.67 ± 4.38 ^{ab}	68.62 ± 4.35 ^b	57.98 ± 4.32 ^{ab}
ADG, g/d	439.67 ± 3.50 ^a	485.14 ± 3.56 ^{ab}	558.14 ± 3.54 ^b	471.39 ± 3.51 ^{ab}
ADG, g/ kgBW ^{.75} /d	7.24 ± 0.45 ^a	7.89 ± 0.46 ^{ab}	8.78 ± 0.45 ^b	7.70 ± 0.45 ^{ab}
DMI concentrate, kg/d	1.98 ± 0.15 ^b	1.96 ± 0.15 ^b	1.15 ± 0.15 ^a	1.42 ± 0.15 ^a
DMI roughage, kg/d	3.17 ± 0.01	3.13 ± 0.01	-	-
Total DMI, kg/d	5.16 ± 0.01	5.10 ± 0.01	-	-
Feed/gain ratio	12.05 ± 0.02	10.71 ± 0.16	-	-

* BWG = body weight gain, ADG = average daily gain, DMI = dry matter intake

^{a,b} Different superscript on the same row differed at $p \leq 0.05$.

Table 3 Blood biochemical values of Thai indigenous steers at the conclusion of the trial (120 days)

Item *	Feedlot		Grassland		SEM	<i>p</i> -Values
	Diet 1	Diet 2	Diet 1	Diet 2		
GLC, mg/dL	65.67	66.00	67.00	61.67	2.84	0.347
TBIL, mg/dL	0.37	0.17	0.37	0.33	0.07	0.288
DBIL, mg/dL	0.08	0.03	0.03	0.02	0.02	0.294
AST, U/L	50.00	51.00	61.00	68.00	5.85	0.622
ALT, U/L	19.00	22.00	26.67	26.00	1.72	0.317
ALP, U/L	246.33	144.00	171.33	162.00	29.14	0.149
BUN, mg/dL	14.00	15.00	15.67	14.00	0.97	0.207
CR, mg/dL	1.46	1.50	1.27	1.37	0.07	0.663
TC, mg/dL	143.00	222.67	177.67	163.67	50.25	0.379
TG, mg/dL	63.00	146.00	82.67	67.00	50.67	0.359
HDL, mg/dL	40.33	36.67	51.33	48.00	8.12	0.984
LDL, mg/dL	90.07	156.80	109.80	102.27	40.64	0.388
ALB, g/dL	3.20	3.30	3.00	3.17	0.11	0.760
FT4, ng/dL	0.97	0.83	0.90	0.87	0.06	0.412
T3, ng/dL	94.33	92.00	145.00	114.33	12.72	0.298
WBC, $\times 10^3/\mu\text{L}$	13.03	11.66	10.59	12.15	1.51	0.362
RBC, $\times 10^6/\mu\text{L}$	8.52	8.18	7.11	8.91	0.85	0.241
HB, g/dL	12.70	12.23	10.80	13.73	1.33	0.237
HCT, %	39.00	38.33	34.00	43.00	4.46	0.310
MCV, fL	45.87	46.90	47.67	47.97	1.59	0.823
MCH, pg	14.97	15.00	15.17	15.33	0.48	0.893
MCHC, g/dL	32.63	32.03	31.80	32.00	0.56	0.494
PLT, $\times 10^5/\mu\text{L}$	1.47	2.55	2.64	2.30	0.34	0.068

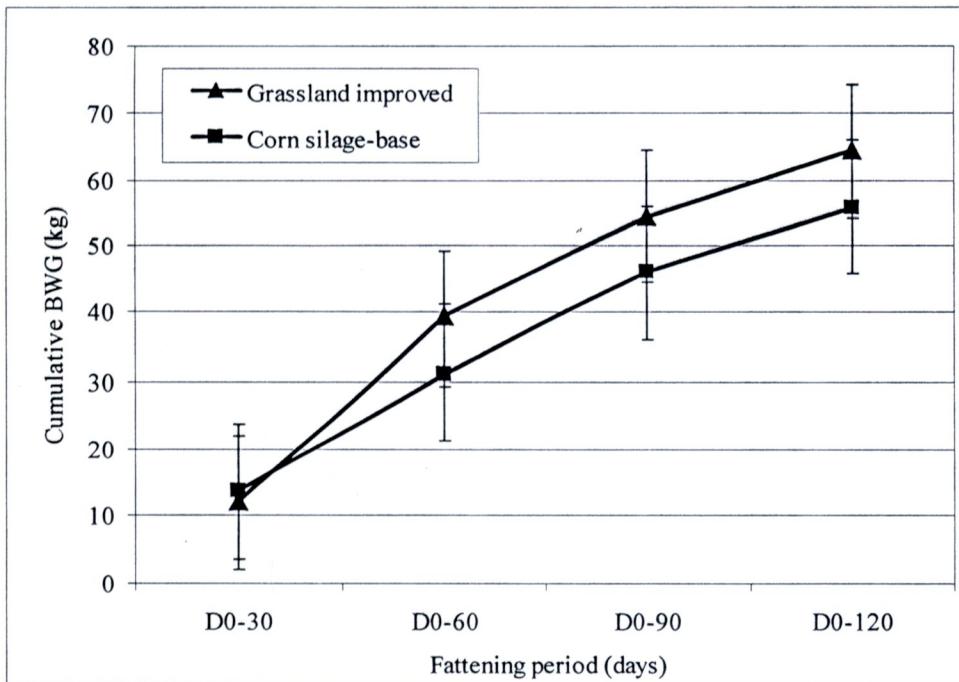
* Different superscript on the same row differed at $p \leq 0.05$.

Table 4 Comparison of blood biochemical values of Thai indigenous steers at the initiation and conclusion of the trial

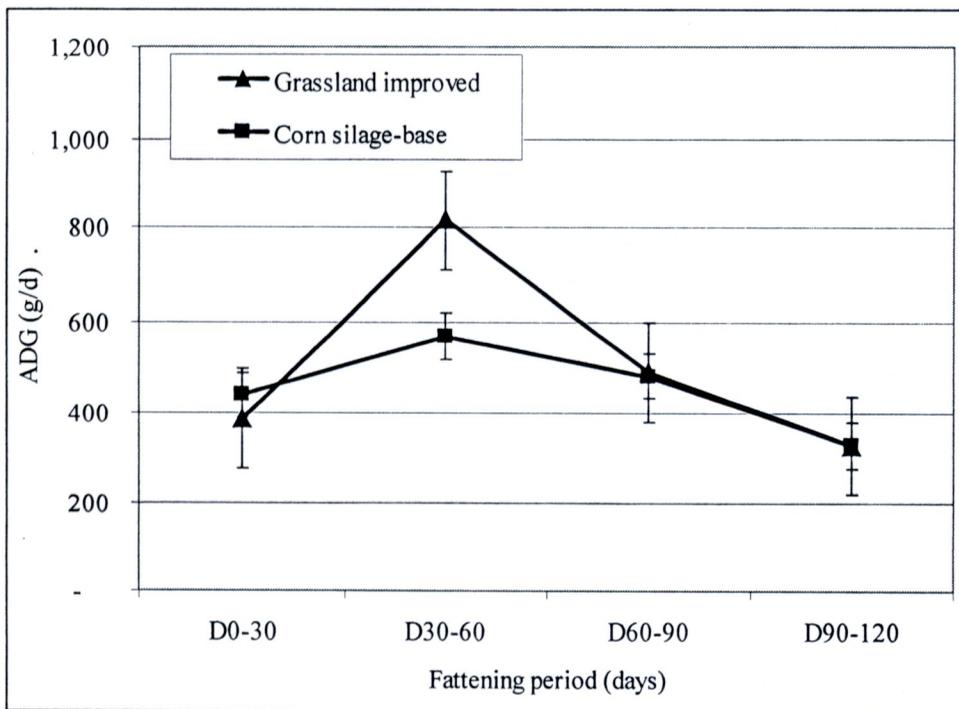
Item *	Pooled, for beginning of trial		Pooled, for end of trial		<i>pr</i> > t	Reference range †
	mean ± SEM	range	mean ± SEM	range		
GLC, mg/dL	53.33 ± 3.56 ^a	29-72	65.08 ± 1.36 ^b	55-71	0.002	50.0-75.0
TBIL, mg/dL	0.28 ± 0.02	0.22-0.39	0.31 ± 0.04	0.01-0.5	0.453	-
DBIL, mg/dL	0.04 ± 0.01	0.01-0.1	0.04 ± 0.01	0.01-0.12	0.885	-
AST, U/L	55.58 ± 3.81	39-81	57.50 ± 3.35	43-81	0.622	75.0-135.0
ALT, U/L	23.42 ± 1.57	17-33	23.42 ± 1.19	17-29	1.000	11.0-40.0
ALP, U/L	148.75 ± 11.97	87-228	180.92 ± 17.11	100-327	0.034	0-488
BUN, mg/dL	13.88 ± 0.77	9.6-18.9	14.67 ± 0.47	12-17	0.421	10.0-20.0
CR, mg/dL	1.43 ± 0.05	1.27-1.92	1.40 ± 0.04	1.2-1.67	0.556	0.7-1.5
TC, mg/dL	146.00 ± 4.68	112-167	176.75 ± 23.17	115-419	0.299	-
TG, mg/dL	40.25 ± 1.78 ^a	28-53	89.67 ± 23.83 ^b	38-347	0.073	-
ALB, g/dL	2.82 ± 0.05 ^a	2.35-3.01	3.17 ± 0.06 ^b	2.8-3.5	<.0001	2.8-3.5
FT4, ng/dL	1.64 ± 0.14 ^b	1-2.4	0.89 ± 0.03 ^a	0.7-1.0	<.0001	-
T3, ng/dL	213.08 ± 11.07 ^b	151-287	111.42 ± 8.39 ^a	79-182	<.0001	-
WBC, x10 ³ /μL	12.08 ± 0.73	8.8-18.7	11.86 ± 0.70	7.6-16.7	0.653	4.0-20.0
RBC, x10 ⁶ /μL	8.76 ± 0.20	7.71-9.81	8.18 ± 0.41	6.2-11.3	0.176	5.0-10.0
HB, g/dL	12.53 ± 0.30	10.9-14.3	12.37 ± 0.65	9.3-17.8	0.780	8.0-15.0
HCT, %	39.08 ± 1.09	33-45	38.58 ± 2.13	28-56	0.789	24.0-46.0
MCV, fL	44.58 ± 0.64 ^a	40.4-48.5	47.10 ± 0.72 ^b	41.4-50.1	<.0001	40.0-60.0
MCH, pg	14.31 ± 0.20 ^a	12.8-15.3	15.12 ± 0.21 ^b	13.7-16.1	<.0001	11.0-17.0
MCHC, g/dL	32.13 ± 0.31	30-34.1	32.12 ± 0.26	30.3-33.3	0.925	30.0-36.0
PLT, x10 ⁵ /μL	2.11 ± 0.35	1.24-5.61	2.24 ± .20	1.4-3.7	0.547	1.0-8.0

* Different superscript indicates significantly different

† adapted from Jane (1996); Kaneko *et al.* (1997)



(a)



(b)

Figure 1 Cumulative body weight gain (a) and average daily gain (b) of Thai indigenous steers during fattening during 120 days with supplemented diets

Blood Biochemical Examination of Nan Indigenous and Brahman Crossbred Cattle in Nan Province

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ABSTRACT

Thirty Nan Indigenous (NNI) and twenty Brahman crossbred (BHx) cattle were collected for blood sampling to measure its biochemical during dry season. Serum was analyzed for complete blood count (CBC) and biochemical hematology. The CBC consisted RBC, HB, HCT, MCV, MCH, MCHC, WBC, NEU, LYM, MONO and PLT. The biochemical hematology was ALB, AST, BUN, CRT and GLC. The least square means±SEM of those parameters in NNI breed were $8.18\pm0.20 \times 10^{12}/L$, 12.91 ± 0.31 g/dL, $39.14\pm0.94\%$, 48.02 ± 0.59 fL, 15.94 ± 0.24 pg, 33.13 ± 0.44 g/dL, $12.04\pm0.86 \times 10^9/L$, $49.54\pm3.67\%$, $42.64\pm3.44\%$, $2.39\pm0.35\%$, $1.76\pm0.24 \times 10^{12}/L$, 2.83 ± 0.08 g/dL, 78.15 ± 5.48 U/L, 10.98 ± 0.84 mg/dL, 1.36 ± 0.14 mg/dL and 59.51 ± 3.55 mg/dL, respectively. Those parameters in BHx cattle were $7.92\pm0.23 \times 10^{12}/L$, 11.47 ± 0.35 g/dL, $36.38\pm1.06\%$, 46.47 ± 0.67 fL, 14.67 ± 0.27 pg, 31.13 ± 0.49 g/dL, $15.56\pm0.97 \times 10^9/L$, $39.22\pm4.16\%$, $51.96\pm3.91\%$, $2.10\pm0.42\%$, $2.01\pm0.27 \times 10^{12}/L$, 3.20 ± 0.08 g/dL, 83.49 ± 6.09 U/L, 8.15 ± 0.93 mg/dL, 1.39 ± 0.16 mg/dL and 54.55 ± 3.94 mg/dL, respectively. Parameters measured indicated that both cattle received low nutritional intake during dry season especially protein and energy supplying. The HB, HCT, MCH and MCHC indicated that NNI breed can be responsible for carrying oxygen and carbon dioxide throughout the body more efficiency than the BHx cattle. Those were the reason that NNI was the breed of choice for rearing on highland area of Nan province.

Keywords: Blood biochemical, Nan indigenous cattle, Nan province

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INTRODUCTION

Nan province locates on the East of Northern of Thailand. The area was steep slope mountain more than 30 degree about 85 percent of the total. People mostly are farmer and grow plant as a major career by rearing some livestock like chicken, pig and cattle for supplementation. The cattle production can be divided into two types according to area of grazing, which are the highland and the low plain production systems. People on highland area are always rearing Nan indigenous (NNI) cattle. Because of The advantages of NNI breed are tolerance to tropical ecto- and endoparasites, very well usage low quality roughage, high fertility and low investment (Intaratham, 2002; Kuha *et al.*, 2006; Dongpalee *et al.*, 2007). The disadvantages of NNI breed are small frame, low growth rate and low quality of meat in term of marbling. The farmer on highland always allowed NNI cattle to free grazing on the mountain in the forest park during rainy until the end of winter (Kuha, *et al.*, 2006). Cattle, after that, were carried to village and sold to market. Some were kept in the field crops and orchard during summer. At this time, the cattle become to lose in body weight as a plentiful feed decrease in dry season. The farmers at the low plain area mostly are rearing Brahman crossbred (BHx) cattle, which is a cross breed between the NNI and the Brahman (Bh). The BHx has an advantage in term of large frame size, more growth rate than the NNI and parasite tolerance moderately. The disadvantages of BHx are low fertility, need intensive feeding and can not climbing the mountain that are the most area of Nan province. So, the BHx production is restricted by grazing area. Farmer at low plain area are always taking the BHx to

graze in public area and sometime in the rice field after harvested and carrying grass by cutting from the road side for feeding. Farmer is usually reserve rice straw hay for cattle during dry season (Kuha *et al.*, 2006). However, both production systems play the role an important for people of Nan and nearby. Cattle can be a saving account of small farmer and can be change to cash as necessary and meat quality are more suitable for local food of local people (Kuha *et al.*, 2006; Boonprong *et al.*, 2007b). The interest in indigenous cattle is increasing as a possible solution to increased efficiency of production (Otto *et al.*, 2000; Boonprong *et al.*, 2007a; Dongpalee *et al.*, 2007). Indigenous cattle can be stand for a niche market as its meat has low cholesterol. If one known more about them one can improve it the production efficiency. The objective of this research needed to investigate blood biochemical values of apparently healthy NNI and BHx cattle during the beginning of dry season which roughage feed initiate to scarcity.

MATERIALS AND METHODS

Blood collection and biochemical examination

Fifty cattle consisted of 30 and 20 healthy according to Nan indigenous (NNI) and Brahman crossbred (BHx) cattle were used to study blood biochemical profile during the beginning of summer (dry season). Blood specimen was taken from the jugular vein during fasting (07.00-11.00 am) for 10 ml, and put into K₃EDTA and NaF tubes for 2.5 ml each, and the remain allowed to clot in blood clot tube. Serum was obtained following a centrifugation at 600 xg for 10 minutes, stored at 4-6 °C and transport to the laboratory for analysis. Complete blood cell count (CBC) was analyzed by an electrical impedance technique using the Sysmex K-4500 (GMI, Inc., Minnesota, the United States) Enzymes, protein and metabolites were determined using the COBAS INTEGRA 800 (Roche, Switzerland).

Statistical analysis

To compare parameters, the analysis of variance was used for analyses using the statistical model as below,

$$y_{ijkl} = \mu + b_i + s_j + a_k + c_l + bs_{ij} + ba_{ik} + bc_{il} + e_{ijkl}$$

where, y_{ijkl} was the observation, μ was an overall mean, b_i was fixed effect due to breed of cattle i (i = NNI and BHx), s_j was fixed effect due to cattle sex j (j = female and male), a_k was fixed effect due to age group of cattle k (k = <2 year, 2-4 year and >4 year), c_l was fixed effect due to body condition of cattle l (l = thin and moderate), bs_{ij} , ba_{ik} and bc_{il} were interaction effect due to breed by cattle sex, breed by age group of cattle and breed by body condition of cattle, and e_{ijkl} was random residual effect, which $e_{ijkl} \sim \text{NID}(0, \sigma_e^2)$.

To compare those effects, least square means and standard error of mean were calculated and paired comparing was tested using the t-test. The effect of pregnancy of cow was tested against the t-test between pregnant and non-pregnant cow. All analysis had been done using many procedure of the Statistical Analysis System software (SAS, 1998).

RESULTS

The least square means of blood biochemical of Nan indigenous (NNI) and Brahman crossbred (BHx) was showed in table 1. The results found that white blood cell count (WBC) and albumin (ALB) of BHx were higher and differed significantly than those of NNI cattle. Hemoglobin (HB), hematocrit (HCT), Mean corpuscular hemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC) and blood urea nitrogen (BUN) of NNI was higher than those of Bhx cattle significantly ($p \leq 0.05$). This indicated that the NNI was more healthy or tolerance than the BHx during dry season. For blood urea nitrogen (BUN), the BHx was lower value than those of NNI cattle significantly ($p \leq 0.05$). However, others blood biochemical values due to red blood cell count (RBC), Mean corpuscular volume (MCV), platelet count (PLT), Neutrophil (NEU), lymphocyte (LYM), monocyte (MONO), glucose (GLC), Creatinine (CRT) and aspartate serum transaminase (AST) were differed not significantly different ($p > 0.05$).

The values of blood biochemical analyses classified according to breed by sex are shown in table 2. There were significant differences between female and male of NNI and BHx with albumin level, which the male of NNI cattle was higher and lower in BHx cattle than those of the female. HB, MCH, MCHC, MCV and WBC were nearly the same between the female and the male in NNI cattle. However, MCH and MCV of BHx cattle were higher, but WBC was lower in the female group. No significant different had been found in the rest of measured blood biochemical analyses.

The less than 2 year old cattle found to be higher RBC, HB, and HCT than those of the older cattle. In contrast, MCH and MCV of the young one were lower than those of the older one. WBC of both breed was not significant different between age group of cattle, but the NNI cattle was lower WBC than the BHx cattle. There were higher ALB, BUN and CRT of more than 4 year old NNI cattle than the young one (less than 2 year old) cattle. Those parameters were nearly the same between age group of BHx cattle. GLC of the less than 2 year old BHx cattle was the highest, but was not significant different with the 2-4 year group. The less than 2 year old, however, was highly significant different with the oldest group (> 4 year old) for GLC level in BHx cattle. The rest of blood biochemical measured were not significant different between age group of cattle within and between breed as showed blood biochemical analyses classified according to breed by age group of cattle in table 3.

The body condition of cattle due to thin ($BCS \leq 2$) and moderate ($BCS \geq 3$) were not effecting to blood biochemical of NNI breed. These were the same as in the BHx cattle, except for MCV and CRT of moderate cattle were higher than those of thin cattle. WBC of BHx was higher than NNI breed significantly different. The BUN of moderate cattle duet o NNI trended to higher than BHx at the same condition. The blood biochemical obtained is shown in table 4.

The pregnancy cow was found RBC and HCT lower than those of the non-pregnancy, but the MCV, MCH, MCHC and CRT of the pregnancy was higher than those of the non-pregnancy significantly different. No significant different had been found in the rest measured blood biochemical analyses as showed details in table 5.

DISCUSSION

A CBC can be an important extension of the physical examination in ruminants and may be used to suggest certain disease processes when exam findings are vague and is useful for establishing a prognosis in many cases. Since the cattle used in this study showed no clinical signs or pathological symptoms, they were considered in healthy and the data obtained can serve as reference values for future study in veterinary medicine and animal production. The data in this study can serve as reference values for NNI cattle on highland area and BHx at low plain condition in Nan province. CBC of both breeds was in range of Kaneko *et al.* (1997) and found the HB, HCT, MCH and MCHC of NNI higher than those of BHx cattle. This indicated that NNI breed can be responsible for carrying oxygen and carbon dioxide throughout the body more efficiency than the BHx breed or indicated the healthier of NNI cattle than the BHx. This could support that NNI breed can be survive in highland condition. HCT of NNI breed of this study was a bit higher than Thai native breed reported by Koatdoke *et al.* (2006) who measured in term of packed cell volume (PCV). The high values of HCT in NNI breed may possible that cattle dissipated body temperature more using sweating response than respiration (Shell *et al.*, 1995; Hammond *et al.*, 1996; Hammond *et al.*, 1998; Stull and Rodiek, 2000).

Both species were found BUN lower than the reference range reported by Kaneko *et al.* (1997), although BUN of the NNI was higher significantly different than the BHx. As urea is the major end product of protein nitrogen metabolism. This indicate that the two breed cattle was insufficient protein intake during dry season and need to be supplemented to maintain its metabolism to normal range and the Bhx needed to be more supplement than the NNI. During this period, farmers always supply only rice straw to their cattle. So, they need to learn quickly how to improve quality of rice

straw by treating it with urea for their own cattle. ALB of NNI breed was lower than BHx breed ($p \leq 0.05$), but was in range reported by Kaneko *et al.* (1997); Boonprong *et al.* (2007a). However, this may indicate the NNI sometime may influence by parasite such as hookworm and insect which was plentiful in the forest park in highland condition. Although, NNI breed was tolerance to tropical insect and parasite, but the farmer have to be take carefully treating anti-parasite medicine as necessary. The AST, CRT and GLC measured of the NNI and the BHx in this study were within reference range of Kaneko *et al.* (1997). GLC, however, reported for both breed was slightly lower than Al-Shami (2003) who reported GLC in Hassawi cattle in Saudi Arabia and Boonprong *et al.* (2007a) who reported the values of Thai indigenous cattle and crossbreed cattle between Simmental and Brahman in central part of Thailand. This may indicate a risk of an inadequate energy supply for cattle during dry season.

No significant different found between male and female in NNI breed except for ALB of the female was lower than the male ($p \leq 0.05$). In contrast, many parameters of BHx found to be highly significant between the male and the female (see table 2). Differences were seen between age group of cattle in both breed, which trended to the report in Angoni cattle in Mozambique by Otto *at al.* (2000). The young cattle (< 2 year) in NNI breed had lower ALB, CRT and GLC than those of the mature one. These may indicate the risk of malnutrition of young NNI cattle during dry season. No significant different of blood biochemical found between different body condition of NNI breed, the thin body condition had lower CRT than the moderate ($p \leq 0.05$) and references range in BHx breed. As CRT is a by-product of muscle metabolism and is excreted by the kidneys. Low level of CRT and BUN indicated low protein intake in BHx cattle and needed quickly supplementation especially during dry season.

CONCLUSION

Blood biochemical values of this study can be serving as references parameter for NNI, BHx and Thai indigenous cattle in other part of Thailand. Many parameters indicated that cattle received low nutritional intake during dry season especially protein and energy supplying. The HB, HCT, MCH and MCHC indicated that NNI breed can be responsible for carrying oxygen and carbon dioxide throughout the body more efficiency than the BHx breed and were the reason that NNI breed was more suitable for highland condition of Nan province.

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TABLE 1 Least square means and standard error of blood biochemical of Nan Indigenous (NNI) and Brahman Crossbred (BHx) cattle

Parameter	NNI (n = 30)		BHx (n = 20)		P r> F	Ref. Range *
	LSM ± SEM		LSM ± SEM			
RBC (x10 ¹² /L)	8.18 ± 0.20		7.92 ± 0.23		0.45	
HB (g/dL)	12.91 ± 0.31 ^a		11.47 ± 0.35 ^b		0.01	8.0 – 15.0
HCT (%)	39.14 ± 0.94 ^a		36.38 ± 1.06 ^b		0.09	24 – 46
MCV (fL)	48.02 ± 0.59		46.47 ± 0.67		0.13	
MCH (pg)	15.94 ± 0.24 ^a		14.67 ± 0.27 ^b		0.00	
MCHC (g/dL)	33.13 ± 0.44 ^a		31.13 ± 0.49 ^b		0.01	
WBC (x10 ⁹ /L)	12.04 ± 0.86 ^b		15.56 ± 0.97 ^a		0.02	
NEU (%)	49.54 ± 3.67		39.22 ± 4.16		0.11	
LYM (%)	42.64 ± 3.44		51.96 ± 3.91		0.12	
MONO (%)	2.39 ± 0.35		2.10 ± 0.42		0.63	
PLT (x10 ¹² /L)	1.76 ± 0.24		2.01 ± 0.27		0.55	
ALB (g/dL)	2.83 ± 0.08 ^b		3.20 ± 0.08 ^a		0.01	2.8 – 3.5
AST (U/L)	78.15 ± 5.48		83.49 ± 6.09		0.57	75 – 135
BUN (mg/dL)	10.98 ± 0.84 ^a		8.15 ± 0.93 ^b		0.05	15 – 30
CRT (mg/dL)	1.36 ± 0.14		1.39 ± 0.16		0.90	0.7 – 1.5
GLC (mg/dL)	59.51 ± 3.55		54.55 ± 3.94		0.41	50 – 75

^{a, b} different superscript at the same row differed significantly (P ≤ 0.05); * adapted from Kaneko *et al.* (1997)

RBC, red blood cell; HB, hemoglobin; HCT, hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; WBC, white blood cell; NEU, Neutrophil; LYM, lymphocyte; MONO, monocyte; PLT, platelet; EOS, eosinophil; ALB, albumin and AST, aspartate aminotransferase; BUN, blood urea nitrogen; CRT, creatinine; GLC, glucose;

TABLE 2 Least square means and standard error of blood biochemical due to breed by sex of cattle

Parameter *	Nan Indigenous Breed (NNI)		Brahman Crossbred (BHx)	
	Female (n=9)	Male (n=21)	Female (n=16)	Male (n=4)
	LSM ± SEM	LSM ± SEM	LSM ± SEM	LSM ± SEM
RBC (x10 ¹² /L)	7.75 ± 0.33	7.99 ± 0.39	7.62 ± 0.27	7.56 ± 0.56
HB (g/dL)	12.80 ± 0.49 ^a	12.39 ± 0.58 ^{ab}	11.58 ± 0.40 ^{ab}	10.73 ± 0.83 ^b
HCT (%)	37.43 ± 1.58	37.54 ± 1.85	36.57 ± 1.27	33.79 ± 2.66
MCH (pg)	16.72 ± 0.36 ^a	15.53 ± 0.42 ^a	15.36 ± 0.29 ^a	14.36 ± 0.61 ^b
MCHC (g/dL)	34.56 ± 0.66 ^a	33.07 ± 0.77 ^{ab}	31.03 ± 0.53 ^b	31.96 ± 1.11 ^b
MCV (fL)	48.52 ± 0.91 ^a	47.05 ± 1.07 ^{ab}	48.49 ± 0.73 ^a	44.79 ± 1.53 ^b
PLT (x10 ¹² /L)	20.67 ± 3.73	15.18 ± 4.38	17.08 ± 3.00	19.99 ± 6.28
WBC (x10 ⁹ /L)	11.30 ± 1.30 ^b	13.32 ± 1.53 ^b	13.28 ± 1.42 ^b	20.61 ± 2.65 ^a
MONO (%)	1.77 ± 0.61	3.02 ± 0.51	1.80 ± 0.67	2.80 ± 1.38
NEU (%)	39.03 ± 6.45	44.00 ± 7.59	33.01 ± 5.20	49.29 ± 10.88
LYM (%)	51.13 ± 5.54	45.13 ± 6.51	59.91 ± 4.46	36.69 ± 9.34
NEU:LYM ratio	0.81 ± 0.41	1.20 ± 0.49	0.59 ± 0.33	1.46 ± 0.70
EOS	8.85 ± 3.04	7.77 ± 3.57	6.02 ± 2.49	11.09 ± 5.11
ALB (g/dL)	2.58 ± 0.11 ^c	3.08 ± 0.13 ^a	3.22 ± 0.07 ^a	3.05 ± 0.17 ^b
AST (U/L)	70.33 ± 8.37	68.55 ± 9.84	87.68 ± 5.78	71.16 ± 13.15
BUN (mg/dL)	10.84 ± 1.24	10.60 ± 1.46	8.27 ± 0.86	8.43 ± 1.95
CRT (mg/dL)	1.19 ± 0.20	1.67 ± 0.24	1.44 ± 0.14	0.94 ± 0.32
GLC (mg/dL)	65.79 ± 5.17	56.47 ± 6.07	54.20 ± 3.57	60.20 ± 8.12

^{a, b, c} different superscript at the same row indicated significantly different (p ≤ 0.05)

* see table 1 for an abbreviation

TABLE 3 Least square means and standard error of blood biochemical due to breed by age group of cattle

Parameter *	Nan Indigenous Breed (NNI)			Brahman Crossbred (BHx)		
	< 2 Year (n=16)	2-4 Year (n=7)	> 4 Year (n=7)	< 2 Year (n=8)	2-4 Year (n=6)	> 4 Year (n=6)
	LSM± SEM	LSM± SEM	LSM± SE	LSM± SEM	LSM± SEM	LSM± SEM
RBC (x10 ¹² /L)	8.97± 0.27 ^a	7.97± 0.40 ^b	6.67± 0.50 ^c	9.04± 0.38 ^a	7.07± 0.40 ^{bc}	6.66± 0.49 ^c
HB (g/dL)	13.20± 0.40 ^a	12.61± 0.59 ^a	11.98± 0.74 ^{ab}	12.57± 0.57 ^a	10.39± 0.59 ^b	10.49± 0.73 ^b
HCT (%)	39.81± 1.28 ^a	37.69± 1.89 ^{ab}	34.97± 2.37 ^{ab}	40.42± 1.80 ^a	33.01± 1.89 ^b	32.11± 2.32 ^b
MCH (pg)	14.78± 0.29 ^{cd}	15.79± 0.43 ^b	17.81± 0.54 ^a	13.96± 0.41 ^d	14.72± 0.43 ^{bc}	15.90± 0.53 ^{bc}
MCHC (g/dL)	33.37± 0.54 ^{ab}	33.47± 0.79 ^{ab}	34.61± 0.99 ^a	30.11± 0.75 ^c	31.55± 0.79 ^{bc}	32.82± 0.97 ^b
MCV (fL)	44.35± 0.74 ^c	47.33± 1.09 ^b	51.68± 1.36 ^a	44.68± 1.04 ^c	46.40± 1.09 ^{bc}	48.84± 1.33 ^{bc}
PLT (x10 ¹² /L)	21.41± 3.03	15.59± 4.46	16.77± 5.60	15.67± 4.26	15.98± 4.46	23.96± 5.48
WBC (x10 ⁹ /L)	11.66± 1.06 ^b	11.78± 1.56 ^b	13.49± 1.96 ^b	15.96± 0.15 ^a	15.35± 1.75 ^{ab}	19.53± 2.27 ^a
MONO (%)	2.14± 0.43	2.24± 0.56	2.82± 0.82	2.90± 0.76	1.50± 0.60	2.50± 1.20
NEU (%)	49.09± 5.25	41.46± 7.73	34.01± 9.69	41.30± 7.38	41.00± 7.72	41.14± 9.49
LYM (%)	45.46± 4.51	44.97± 6.64	53.97± 8.32	51.96± 6.34	46.55± 6.63	46.39± 8.15
NEU:LYM ratio	1.44± 0.34	0.79± 0.49	0.78± 0.62	0.82± 0.47	1.03± 0.49	1.23± 0.61
EOS	5.01± 2.55	10.63± 3.69	9.29± 4.60	4.78± 3.60	10.51± 3.63	10.37± 4.46
ALB (g/dL)	2.60± 0.09 ^c	2.79± 0.13 ^{bc}	3.09± 0.16 ^{ab}	3.18± 0.12 ^a	3.15± 0.12 ^a	3.08± 0.15 ^{ab}
AST (U/L)	69.82± 6.81	66.96± 10.02	71.54± 12.56	86.64± 9.21	65.87± 9.63	85.74± 11.56
BUN (mg/dL)	8.77± 1.01 ^b	8.71± 1.49 ^b	14.68± 1.87 ^a	7.27± 1.37 ^b	9.20± 1.43 ^b	8.58± 1.72 ^b
CRT (mg/dL)	1.02± 0.16 ^b	1.46± 0.24 ^{ab}	1.80± 0.30 ^a	1.22± 0.22 ^{ab}	1.08± 0.23 ^b	1.27± 0.28 ^{ab}
GLC (mg/dL)	63.33± 4.21 ^{ab}	61.71± 6.19 ^{ab}	58.34± 7.76 ^{ab}	65.32± 5.69 ^a	56.77± 5.95 ^{ab}	49.50± 7.14 ^b

^{a, b, c and d} different superscript at the same row indicated significantly different (p ≤ 0.05)

* see table 1 for an abbreviation

TABLE 4 Least square means and standard error of blood biochemical due to breed by body condition of cattle

Parameter *	Nan Indigenous Breed (NNI)		Brahman Crossbred (BHx)	
	Moderate (n=26)	Thin (n=4)	Moderate (n=9)	Thin (n=11)
	LSM ± SEM	LSM ± SEM	LSM ± SEM	LSM ± SEM
RBC (x10 ¹² /L)	7.96 ± 0.19 ^a	7.78 ± 0.50 ^{ab}	7.64 ± 0.31 ^b	7.55 ± 0.45 ^b
HB (g/dL)	12.57 ± 0.28 ^a	12.62 ± 0.74 ^a	11.54 ± 0.46 ^{ab}	10.77 ± 0.67 ^b
HCT (%)	38.04 ± 0.89	36.93 ± 2.36	35.96 ± 1.48	34.41 ± 2.13
MCH (pg)	16.08 ± 0.20 ^a	16.17 ± 0.54 ^a	15.33 ± 0.34 ^{ab}	14.39 ± 0.49 ^b
MCHC (g/dL)	33.36 ± 0.37 ^a	34.27 ± 0.99 ^a	31.68 ± 0.62 ^b	31.30 ± 0.89 ^b
MCV (fL)	48.14 ± 0.51 ^a	47.44 ± 1.36 ^{ab}	48.01 ± 0.85 ^a	45.26 ± 1.22 ^b
PLT (x10 ¹² /L)	20.68 ± 2.11	15.17 ± 5.58	18.35 ± 3.51	18.71 ± 5.03
WBC (x10 ⁹ /L)	11.60 ± 0.74 ^b	13.02 ± 1.95 ^{ab}	14.62 ± 1.31 ^a	19.28 ± 2.01 ^a
MONO (%)	2.08 ± 0.37	2.72 ± 0.71	2.30 ± 0.67	2.30 ± 1.08
NEU (%)	40.86 ± 3.65	42.18 ± 9.66	37.43 ± 6.07	44.86 ± 8.71
LYM (%)	47.59 ± 3.13	48.67 ± 8.29	54.26 ± 5.21	42.34 ± 7.48
NEU:LYM ratio	1.13 ± 0.23	0.88 ± 0.62	0.75 ± 0.39	1.30 ± 0.56
EOS	11.06 ± 1.76	5.55 ± 4.62	7.19 ± 2.86	9.92 ± 4.11
ALB (g/dL)	2.73 ± 0.06 ^b	2.93 ± 0.16 ^{ab}	3.16 ± 0.10 ^a	3.11 ± 0.14 ^{ab}
AST (U/L)	74.26 ± 4.73	64.62 ± 12.52	87.37 ± 7.70	71.47 ± 10.74
BUN (mg/dL)	10.24 ± 0.70	11.20 ± 1.86	7.80 ± 1.15	8.90 ± 1.60
CRT (mg/dL)	1.30 ± 0.11 ^a	1.56 ± 0.30 ^a	1.65 ± 0.19 ^a	0.73 ± 0.26 ^b
GLC (mg/dL)	58.46 ± 2.92	63.80 ± 7.73	53.79 ± 4.76	60.61 ± 6.63

^{a, b} different superscript at the same row indicated significantly different (p ≤ 0.05)

* see table 1 for an abbreviation

TABLE 5 Least square means and standard error of blood biochemical due to pregnancy condition of cattle

Parameter *	Non-pregnancy cows (n=16)	Pregnancy cows (n=7)	Pr> t
	LSM ± SEM	LSM ± SEM	
RBC (x10 ¹² /L)	8.01 ± 0.32 ^a	6.52 ± 0.29 ^b	0.003
HB (g/dL)	12.22 ± 0.37	11.41 ± 0.42	0.171
HCT (%)	38.09 ± 1.09 ^a	33.71 ± 1.23 ^b	0.018
MCV (fL)	47.87 ± 1.00 ^b	51.44 ± 1.06 ^a	0.026
MCH (pg)	15.44 ± 0.49 ^b	17.57 ± 0.27 ^a	0.001
MCHC (g/dL)	31.61 ± 0.77 ^b	34.23 ± 0.60 ^a	0.014
WBC (x10 ⁹ /L)	14.33 ± 1.01	11.85 ± 1.90	0.282
NEU (%)	36.00 ± 4.11	32.43 ± 3.05	0.493
LYM (%)	8.20 ± 1.99	7.57 ± 1.49	0.803
MONO (%)	54.63 ± 3.44	60.00 ± 2.55	0.224
PLT (x10 ¹² /L)	1.90 ± 0.24	2.06 ± 0.36	0.720
ALB (g/dL)	1.12 ± 0.06	1.71 ± 0.43	0.218
AST (U/L)	3.09 ± 0.08	2.80 ± 0.15	0.122
BUN (mg/dL)	58.83 ± 3.56	57.86 ± 9.00	0.922
CRT (mg/dL)	8.89 ± 0.85 ^b	12.14 ± 1.10 ^a	0.035
GLC (mg/dL)	2.11 ± 0.26	1.50 ± 0.50	0.415

^{a, b} different superscript at the same row indicated significantly different ($p \leq 0.05$)

* see table 1 for an abbreviation

Factors effecting to hematological and serum biochemical values of indigenous cattle on highland in Nan province, Thailand

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ABSTRACT: Blood samples of one hundred healthy indigenous cattle, raising on highland in Nan province, were collected all year round to examine hematological and some serum biochemical values. The generalized linear model was used to determine effects of sex, age group of cattle, body condition and season. Hematological and biochemical values were examined for WBC ($12.09 \pm 0.57 \times 10^3/\mu\text{L}$), RBC ($7.57 \pm 0.14 \times 10^6/\mu\text{L}$), HB ($11.70 \pm 0.15 \text{ g/dL}$), HCT ($36.08 \pm 0.51\%$), MCV ($47.90 \pm 0.43 \text{ fL}$), MCH ($15.66 \pm 0.17 \text{ pg}$), MCHC ($32.59 \pm 0.18 \text{ g/dL}$), PLT ($15.99 \pm 1.01 \times 10^5/\mu\text{L}$), NEU ($42.52 \pm 1.92\%$), LYM ($48.03 \pm 1.78\%$), MONO ($2.31 \pm 0.14\%$), EOS ($8.11 \pm 0.84\%$), GLC ($57.92 \pm 1.07 \text{ mg/dL}$), BUN ($10.99 \pm 0.43 \text{ mg/dL}$), CRT ($1.25 \pm 0.05 \text{ mg/dL}$), ALB ($2.90 \pm 0.04 \text{ g/dL}$) and AST ($75.77 \pm 2.06 \text{ U/L}$). MCV, MCH and LYM of female were higher than those of the male ($p \leq 0.01$). MCV, MCH, MCHC and GLC were increasing, but RBC, HCT and BUN were decreasing as age group of cattle was increased. RBC, HCT and NEU of fat cattle ($\text{BCS} \geq 4$) were lower than those of thin and moderate cattle ($\text{BCS} \leq 3$), in contrary MCV, MCH, EOS and CRT of fat cattle were higher than those of thin and moderate cattle. WBC, RBC, HB, HCT and PLT found to be high during dry season and differed with wet season ($p \leq 0.01$). BUN was lower than reference values during hot and early rainy season, indicating of insufficient protein intake of cattle on highland. Low levels of AST during early rainy and rainy indicate risk of body tissue damaged or diseased. However, high levels of RBC, HB, and MCH indicated cattle on highland responsible for carrying oxygen and carbon dioxide throughout the body more efficiency. (Key words: hematological values, serum biochemical, indigenous cattle, highland, Nan province)

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INTRODUCTION

Nan province locates in Northern part of Thailand, in the remote valley of the Nan River surrounding by high mountains and covering with forests. The area about 85 percent is steep slope mountain more than 30 degree. Peoples mostly are growing plant as a major agriculture and raising livestock like chicken, pig and cattle supporting their production system. A kind of cattle production mostly is Nan indigenous breed (NNI) for about 84 percent of the total (DLD, 2009). NNI cattle play an important role for people in Nan province and nearby. It can be a saving account of farmers and can be changed to cash as necessary. Its meat quality is more suitable for local food of local people (Boonprong *et al.*, 2007b; Kuha *et al.*, 2009). Advantages of NNI cattle are tolerance to tropical ecto- and endoparasites, very well usage low quality roughage, high fertility (Intaratham, 2002), low investment and can climbing high mountain (Kuha *et al.*, 2009). Farmer always allowed NNI cattle to free grazing on the mountain in the forest park during rainy until the end of cool season (Kuha, *et al.*, 2009). Cattle, after that, were carried to rice field and sold to market. Some were kept in field crops or orchard during summer (Kuha *et al.*, 2009). Cattle become to loose in body weight gain during dry season as plentiful feed was decreasing. Therefore, body condition and weight gain can be changed by different seasons depended on plentiful of roughage and can affect to blood biological and hematological values of cattle. As blood biological and hematological values are performed for assessing healthy status, for evaluating body response to nutrition, for indicating adaptability to adverse environment condition and for indicating stress or welfare (Jane, 1996; Kaneko *et al.*, 1997; Stanger *et al.*, 2005; Boonprong *et al.*, 2007a; Aengwanich *et al.*, 2009). So that, the objectives of this research aimed to determine reference range of hematological and some serum biochemical values, and to investigate factor effecting to those values of apparently healthy indigenous cattle on highland in Nan province.

MATERIALS AND METHODS

One hundred healthy Nan indigenous (NNI) cattle were collected for blood sampling all year round and used to examine hematological and some serum biochemical values. Blood specimen were collected during December (cool, $n=30$), February (early hot, $n=20$), June (early rainy, $n=20$) and

August (rainy seasons, n=30) due to the hypothesis of plentiful or scarcity of roughage. Blood sample was taken from jugular vein of cattle during fasting (07.00-11.00am) for 10 ml using disposable syringe, and put into K₃EDTA and NaF tubes for 2.5 ml each, and the remain allowed to clot in blood clot tube. Serum was obtained following a centrifugation at 600xg for 10 minutes, stored at 4-6 °C and transport to laboratory for analysis. Complete blood cell count (CBC) was analyzed by an electrical impedance technique using the Sysmex K-4500 (GMI, Inc., Minnesota, the United States) biochemical hematology were determined using the COBAS INTEGRA 800 (Roche, Switzerland). The analysis of variance was used to determine factors effecting hematological values using statistical model; $y_{ijkl} = \mu + s_i + a_j + c_k + m_l + e_{ijkl}$, where, y_{ijkl} was an observation, μ was an overall mean, s_i was sex of cattle i (i = male and female), a_j was age group of cattle j (j = less than 2 years old, 2-3 years old and more than 3 years old), c_k was body condition k (k = thin (BCS \leq 2), moderate (BCS=3), and fat (BCS \geq 4)), m_l was season effect l (l = cool, early hot, early rainy and rainy seasons) and e_{ijkl} was residual effect, which $e_{ijkl} \sim \text{NID}(0, \sigma_e^2)$. Least square means and standard error of mean were compared using the GLM procedure of the Statistical Analysis System software (SAS, 1998).

RESULTS

Hematological and biochemical values of highland indigenous cattle were examined as showed in Table 1. The values were found within the normal reference range reported by others. However, BUN and AST were lower than reference range during early hot until early rainy and early rainy until rainy seasons, respectively. MCH, MCHC and LYM of the female cattle were higher than those of the male significantly, but NEU of the female was lower than the male ($p \leq 0.01$). No significant different had been found in the rest of measured complete blood count (CBC). For serum biochemical values, ALB, AST, BUN, CRT and GLC were found not significant different between sex. RBC and HCT of less than 3 years old cattle found to be higher than those of more than 3 years old significantly. In contrast, the values of MCV, MCH and MCHC revealed opposite between those age group of cattle. NEU and PLT of yearling cattle were lower than those of more than 2 years old cattle significantly ($p \leq 0.01$). GLC of yearling cattle was the highest and the value was decreased as age group of cattle was increasing. BUN of more than 3 years old cattle was higher than that of others, which was significantly different ($p < 0.05$). For body condition of cattle, the result found MCV, MCH, EOS and CRT of fat cattle were higher than those of thin cattle significantly. In contrast, RBC, HCT and NEU of fat cattle were lower than those of thin and moderate cattle. PLT during rainy was lower than reference range and differed significantly of others season. During cool season, the result found NEU was higher and LYM was lower than that of reference range values significantly. WBC during beginning of hot season was lower than during early rainy season but was not different to cool and rainy season. RBC, HB and HCT were highest during cool season and those were lowest during early rainy season. MCH and MCHC during early hot season were lowest and differed with others. BUN during rainy was highest, and decreased following by cool, hot and early rainy seasons, respectively. However, BUN during early hot and early rainy were lower than normal range and differed from other season. AST during early rainy and rainy seasons was lower than reference range and differed significantly from cool and early hot season. ALB was lowest during cool season, but it became highest during early hot season, which were differed between those significantly ($p < 0.05$).

TABLE 1 Effect of season on hematological and serum biochemical values of indigenous cattle on highland

Parameters ^{1/}	Cool (n=30)	Early hot (n=20)	Early Rainy (n=20)	Rainy (n=30)	Pooled (n=100)	Reference Range ^{2/}
	LSM ± SEM	LSM ± SEM	LSM ± SEM	LSM ± SEM	MEAN ± SEM	
WBC, x10 ³ /μL	12.13 ± 1.21 ^{ab}	15.25 ± 1.55 ^a	8.60 ± 1.83 ^b	12.19 ± 1.11 ^{ab}	12.09 ± 0.57	4.0 – 20.0
RBC, x10 ⁶ /μL	8.61 ± 0.19 ^a	7.94 ± 0.23 ^b	6.90 ± 0.28 ^c	7.52 ± 0.17 ^b	7.57 ± 0.14	5.0 – 10.0
HB, g/dL	13.11 ± 0.27 ^a	11.48 ± 0.33 ^{bc}	10.74 ± 0.40 ^c	11.75 ± 0.24 ^b	11.70 ± 0.15	8.0 – 15.0
HCT, %	40.07 ± 0.86 ^a	36.33 ± 1.07 ^b	33.15 ± 1.30 ^c	36.62 ± 0.79 ^b	36.08 ± 0.51	24.0 – 46.0
MCV, fL	46.66 ± 0.66 ^b	46.11 ± 0.82 ^b	47.75 ± 1.00 ^{ab}	48.82 ± 0.60 ^a	47.90 ± 0.43	40.0 – 60.0
MCH, pg	15.41 ± 0.24 ^a	14.49 ± 0.30 ^b	15.64 ± 0.36 ^a	15.84 ± 0.22 ^a	15.66 ± 0.17	11.0 – 17.0
MCHC, g/dL	32.83 ± 0.32 ^a	31.14 ± 0.40 ^b	32.68 ± 0.48 ^a	32.37 ± 0.29 ^a	32.59 ± 0.18	30.0 – 36.0
PLT, x10 ⁵ /μL	1.88 ± 0.18 ^a	2.00 ± 0.22 ^a	2.12 ± 0.27 ^a	0.62 ± 0.17 ^b	1.60 ± 0.10	1.0 – 8.0
NEU, %	48.76 ± 3.22	41.16 ± 4.08	43.10 ± 5.59	-	42.52 ± 1.92	15.0 – 47.0
LYM, %	45.34 ± 3.19	50.63 ± 4.04	45.48 ± 5.53	-	48.03 ± 1.78	45.0 – 75.0
EOS, %	6.57 ± 1.61	6.81 ± 1.89	9.02 ± 2.57	-	2.31 ± 0.14	0.0 – 20.0
MONO, %	2.42 ± 0.31	2.14 ± 0.42	2.28 ± 0.49	-	8.11 ± 0.84	2.0 – 7.0
GLC, mg/dL	59.87 ± 2.22	57.84 ± 2.74	57.60 ± 3.30	59.07 ± 2.04	57.92 ± 1.07	50.0 – 75.0
BUN, mg/dL	11.01 ± 0.63 ^b	7.39 ± 0.78 ^c	8.31 ± 0.92 ^c	14.48 ± 0.58 ^a	10.99 ± 0.43	10.0 – 20.0
CRT, mg/dL	1.23 ± 0.10	1.34 ± 0.12	1.27 ± 0.15	1.29 ± 0.09	1.25 ± 0.05	0.7 – 1.5
ALB, g/dL	2.79 ± 0.07 ^b	3.20 ± 0.09 ^a	2.82 ± 0.10 ^b	3.00 ± 0.06 ^{ab}	2.90 ± 0.04	2.8 – 3.5
AST, U/L	76.47 ± 4.33 ^{ab}	84.36 ± 5.33 ^a	67.77 ± 6.31 ^b	74.51 ± 3.97 ^{ab}	75.77 ± 2.06	75.0 – 135.0

^{a, b, c} least square mean (LSM) in different superscript on the same row differed significantly ($P \leq 0.05$)

^{1/} RBC was red blood cell; HB was hemoglobin; HCT was hematocrit; MCV was mean corpuscular volume; MCH was mean corpuscular hemoglobin; MCHC was mean corpuscular hemoglobin concentration; WBC was white blood cell; NEU was Neutrophil; LYM was lymphocyte; MONO was monocyte; PLT was platelet count; EOS was eosinophil; GLC was glucose; BUN was blood urea nitrogen; CRT was creatinine; ALB was albumin and AST was aspartate aminotransferase

^{2/} adapted from Kaneko *et al.* (1997)

DISCUSSION

The indigenous cattle in this study showed no clinical signs or pathological symptoms, they were considered in healthy and the data obtained can serve as reference values for future study in veterinary medicine and animal production. Hematological values of cattle on highland were in reference range of Kaneko *et al.* (1997). However, the result found RBC, HB and MCH higher than those reported in Holstein Friesian crossbred (Aengwanich, 2002); in crossbred beef cattle in North-eastern, Thailand (Aengwanich *et al.*, 2009). This indicated that cattle on highland can be responsible for carrying oxygen and carbon dioxide throughout the body more efficiency. HCT of highland indigenous cattle of this study was slightly higher than Thai native breed (Koatdoke *et al.*, 2006); crossbred cattle (Aengwanich *et al.*, 2009) who measured in term of packed cell volume (PCV). The high values of HCT may possible that cattle dissipated body temperature more using sweating response than respiration (Shell *et al.*, 1995; Hammond *et al.*, 1996; Hammond *et al.*, 1998; Koatdoke *et al.*, 2006). BUN during early hot until early rainy seasons found to be lower than reference range of Kaneko *et al.* (1997). This indicates that cattle may receive insufficient protein intake during hot season. Plasma urea can useful to evaluate kidney function in conjunction with creatinine (Jane, 1996). ALB was found lowest during cool and early rainy season this may indicate the cattle may influence by parasite such as hookworm and insect which was plentiful in the forest park especially during rainy season that may a residual effect of rainy and hot seasons. The cattle during early rainy and rainy found AST lower than reference range of Kaneko *et al.* (1997), although other season was nearly the same reported in Thai indigenous (Boonprong *et al.*, 2007a). Low levels of AST are normally found when body tissue or an organ such as the heart or liver is diseased or damaged, additional AST is released into the bloodstream. The amount of AST in the blood is directly related to the extent of the tissue damage (Jane, 1996; Kaneko *et al.*, 1997). For GLC, the value reported in this study was slightly lower than Al-Shami (2003) who reported in Hassawi cattle in Saudi Arabia; Boonprong *et al.* (2007a) who reported the values in Thai indigenous cattle. This may indicate a risk of an inadequate energy supply for cattle on highland.

CONCLUSION

Hematological and biochemical values of this study can be serving as references values for future study in veterinary medicine and cattle production in Thailand and the other countries having similar geographically. Low BUN can indicate risk in insufficient protein intake during hot and early rainy seasons. Low levels of AST during early rainy and rainy may indicate risk of body tissue damaged or diseased. However, high RBC, HB, and MCH may indicated an efficiency of cattle responsible for carrying oxygen and carbon dioxide throughout the body more efficiency and were the reason that indigenous breed was more suitable on highland condition in Nan province.

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