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Comparison of fattening Thai native steers on grassland grazing and in feedlot fed corn silage-base with supplemental two protein concentration diets

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ABSTRACT

This study determined growth performance and blood biochemical values of Thai native steers during 120 days of fattening. Twelve healthy three-year-old steers 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 group was reared in feedlot fed with corn silage-base. Both groups supplemented with different crude protein concentrate diets due with 12 and 14 percent of about 1 percent of the bodyweight a day. The results found that steers on grassland were significantly higher average daily gain than those steers reared under feedlot conditions. There was no significant difference in 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 with different dietary treatments. Glucose, alkaline phosphatase, albumin, mean corpuscular volume and, mean corpuscular hemoglobin after the trial increased, but free serum thyroxine and triiodothyronine decreased and differed significantly from the values at the beginning of the trial. Other blood biochemical values, triglyceride, total cholesterol, total bilirubin, direct bilirubin, aspartate serum transferase, alanine transaminase, blood urea nitrogen, and creatinine were not significantly different between the inception and the conclusion of the trial. Differences in dietary protein supplementation caused no differences in the blood biochemical values of the steers. These results imply that the Thai native steer should fatten on grassland with a 1 percent BW dietary supplemental concentrate of 12 percent of CP.

Keywords: performance, blood biochemical, grassland, feedlot, Thai native steer

INTRODUCTION

Thai native cattle are a kind of Zebu breed (*Bos indicus*). They play an important role in the livestock-cropping production system of smallholder farms in Thailand. Native cattle can be a savings account of farmers that can be changed in cash when necessary (Tumwasorn, 2002). Moreover, they still have many more advantages, such as tolerance to tropical parasites, can use low-quality roughage efficiently, and high fertility (Tumwasorn, 2007). However, they have a small frame size and a low growth rate (Tumwasorn, 2002; Sethakul, 2010). The frame size was more suitable for usage in Hari Raya Aidilfiti festival (Angkulasearanee and Wattanachant, 2010; Pakeechay et al., 2014). Moreover, native cattle meat has a low-fat content (Sethakul, 2010) and can be produced as natural beef production (Duanyai, 2010). So, the interest in fattening native beef is increasing by an opportunity of market increasing (Pakeechay et al., 2014). In Nan province, there are many residuals from the cropping system, especially sweet corn production. After sweet corn was harvested, there is plenty of green stems and leaves of corn that can be cut and carried to feed cattle as a fresh roughage. However, the green corn stem and leaf can become yellow shortly after that; therefore, making corn silage could be a good choice for farmers to reserve corn stem and leaf for feeding cattle. Corn silage can be a good source of quality roughage in fattening beef. During fattening, moreover, farmers needed to pay attention to the health, quality, and welfare of steers. For this reason, blood biological values are needed 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; Jain, 1996; Keneko et al., 1997; Boonprong et al., 2007a; Aengwanich et al., 2009). Given these conditions in northern Thailand, farmers will have two options available to fattening native cattle due to rearing cattle in feedlots or allow grazing in the grassland. A study of these options is best suited for fattening Thai native cattle that have not been performed, and diet recommendations have been based largely on analogies to other breeds.

https://doi.org/10.14456/jsat.2020.8

This research aimed to determine the growth performance and blood biochemical values of Thai native steers during fattening. One group of the steer was allowed free grazing on grassland, and the other group was reared in feedlot fed corn silage base. The kind of roughage and feeding regime makes a difference in the nutritional intake of the steer, in particular the protein intake. Therefore, the question of protein supplementation was also addressed and compared for both feed modalities by supplying the steer diets with a protein concentrate at two different levels.

MATERIALS AND METHODS

Experimental design and procedure

The 2 x 2 factorial in a completely randomized design was conducted for this trial. Factor A was maintained under steer feeding regiment due to free grazing on the grassland and stay in feedlot fed corn silage-base procedures. Factor B has two levels of crude protein concentrate diet with 12 and 14 percent. Twelve three-year-old healthy Thai native steers, bodyweight about 183.5 kg by average, were randomly assigned to the experimental unit. Six steers were allowed free grazing on the grassland about 10 hrs a day (7:00 am – 5:00 pm). The grassland was mainly purple guinea grass (*Panicum maximum*). The other six steers were reared in a feedlot fed corn-silage base diet for two times a day. Steers in both groups were fed a protein concentrate diet of about 1% body weight per day during the evening with an individual feeder. The ingredient and composition of diets showed in Table 1. Steers were allowed free access to the water basin all the time. Before the experiment starts, all steers were castrated and waiting until fully recovered. Steers, after that, were treated for internal and external parasites (Abentel, Attantic Laboratories Corp., Ltd, Thailand, and Ivomec F®, Merial (Thailand) Ltd.) and 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 the inception of the trial and then every 30 days during the experiment until the conclusion at 120 days.

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

Preparation of grassland and corn silage

Preparation of grassland, mainly purple guinea grass, was improved using cattle manure about 100 kg/rai and urea about 10 kg/rai. Then, grassland was supplied water twice a week using a sprinkler for 2 months. For corn silage production, the whole stem and leaf of corn were cut into 2-3 cm lengths with a chopper machine. Then, the chopped corn was tightly packed in a plastic bag and tied with a plastic band or rope after removing air using a blower. After that, the silage bags were stored in a closed room at ambient temperature for three weeks at least and carried for feeding steers.

Blood biochemical analysis

Blood samples were collected at the experiment start and after finishing at the 120-days trial. Blood samples were taken from the jugular vein during fasting (7:00-8:00 am) using 10 ml disposable syringes. The specimens, after that, were put into K3 EDTA and NaF tubes about 2.5 ml each, and the remainder were allowed clotting in a blood clot tube. Serum was obtained following centrifugation at 600 x g for 10 minutes and stored at 4-6 °C before analysis. The blood serum biochemical profile was determined automatically using a COBAS INTEGRA® 800 (Roche, Switzerland). The blood biochemical values were glucose (GLC), total

https://doi.org/10.14456/jsat.2020.8

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). The complete blood cell counts (CBC) were analyzed using an electrical impedance technique by Sysmex K4500 (GMI, Inc., Minnesota, the United States). The hematological values were white blood cell count (WBC), red blood cell count (RBC), hemoglobin (HB), hematocrit (HCT), platelet count (PLT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC)

Statistical analysis

The productive traits were analyzed using analysis of covariance (ANCOV) that determined initial body weight as a concomitant variable. The least-squares mean and standard error of the mean were compared using a significant t-test (P≤0.05). Blood biochemical and hematological values were compared between and within the feeding regiment group and between the periods of the experiment using the paired t-test. The statistical model was following the experimental design using the generalized linear model (GLM) procedure of the Statistical Analysis System (SAS, 1999)

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

Items *	Feedlot fed corn silage-base		Grassland free grazing	
	Diet 1	Diet 2	Diet 1	Diet 2
	LSM ± SEM	LSM ± SEM	LSM ± SEM	LSM ± SEM
BW_{ini}, kg	180.33 ± 7.44	178.50 ± 9.25	188.00 ± 6.79	187.17 ± 3.68
BW_{fin}, kg	237.57 ± 4.30^{a}	243.17 ± 4.38^{ab}	252.12 ± 4.35^{b}	241.48 ± 4.32^{ab}
BW_{fin},kg$BW^{.75}$	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/kg$BW^{.75}$/d	7.24 ± 0.45^{a}	7.89 ± 0.46^{ab}	8.78 ± 0.45^{b}	7.70 ± 0.45^{ab}
DMI_{con}, kg/d	1.98 ± 0.15^{b}	1.96 ± 0.15^{b}	1.15 ± 0.15^{a}	1.42 ± 0.15^{a}
DMI_{rou}, kg/d	3.17 ± 0.01	3.13 ± 0.01	-	-
tDMI, kg/d	5.16 ± 0.01	5.10 ± 0.01	-	-
FGR, kg	12.05 ± 0.02	10.71 ± 0.16	-	-

* BW_{ini} = initial body weight, BW_{fin} = final BW, BWG = body weight gain,
ADG = average daily gain, DMI_{con} = dry matter intake of concentrate, DMI_{rou} = DMI of roughage, tDMI = total DMI, FGR = feed per gain ratio, LSM = least square mean,
SEM = standard error of mean

[a,b] Different superscript on the same row indicated significant differences (p ≤ 0.05).

RESULTS AND DISCUSSION

Productive performance

The result found significant differences in an interaction effect (P < 0.05), as showed in Table 2. So that, the values of final body weight (BWfin), body weight gain (BWG), and average daily gain (ADG) were not significantly different (P > 0.05) between steer in the feedlot and on grassland grazing when fed concentrate at 14% CP. Those values found significant differences (P < 0.05) between steers of two feeding regimes when supplemented 12% CP concentrate diet. Dry matter intake of concentrate indicated that steers in feedlot consumed more concentrate than that of steers in the grassland significantly (P < 0.05).

The steers allowed free grazing on grassland tended to have higher cumulative BW and ADG than those of steer in feedlot fed corn silage-base during 60, 90, and 120 days of the experiment (P = 0.08). Furthermore, during 30 to 60 days of the experiment, the steers on grassland free grazing were the highest ADG, differed from steers in the feedlot significantly (p<0.05) as showed in figure 1. This is because compensatory growth was affecting to steers that body condition score of steers was quite low before the experiment starts. The steers were mostly loose in bodyweight, which may cause by the scarcity of roughage supply (Drouillard et al., 1991; Kuha et al., 2009). This can be influenced by BWG and ADG of steers during the early stages of fattening. These agreed to Horton and Holmes (1978), who 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 increased intake with no change in ration

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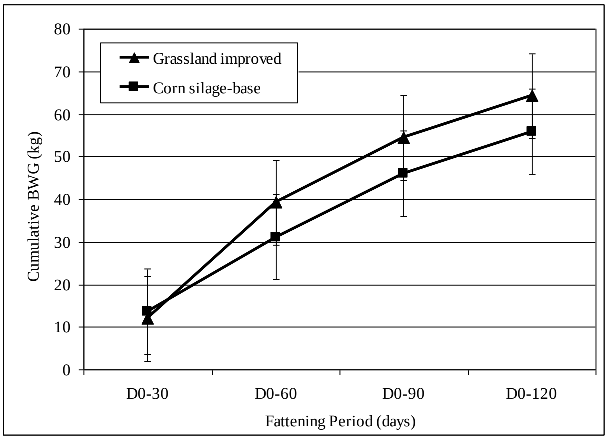
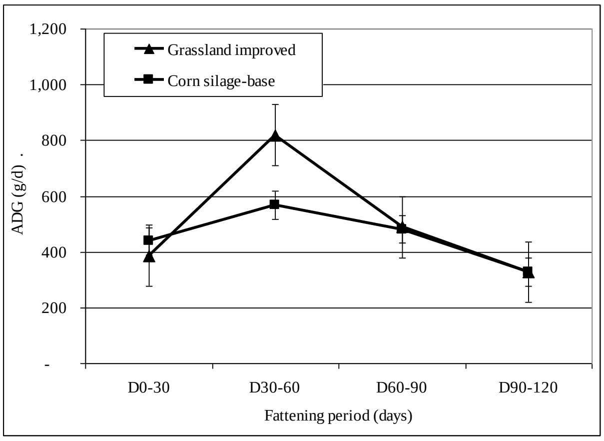
digestibility. Compensatory growth was influenced more by differences in severity of restriction than by the duration of the restriction period (Drouillard et al., 1991).

The ADG of this study was lower than observed in a crossbreed of native cattle with Brahman breed (0.60 kg/d) (Wanapat et al., 1995), and Brahman x Charolais is crossbred (0.89 kg/d) (Tumwasorn, 2007). The ADG and DMI of this study were nearly the same as those reported in native cattle (Bunseelarp et al., 2010; Harnsamer et al., 2010; Kaewpila et al., 2010). This study was accepted as a recommendation of standard nutrient requirements for native cattle in Thailand (WTSR, 2008). Although ADG is related to the dietary proteins reported by Chantiratikul et al., (2009), ADG of steers fed corn-silage base in this research was not significantly different by the level of dietary crude protein. This indicated that concentrate about 12% CP could be effectively and more suitable for fattening native cattle. These agreed to the recommendations by Wanapat et al. (1995).



(a)



(b)

Figure 1. Cumulative body weight gain (a) and average daily gain (b) of Thai native steers during 120 days fattening between grassland grazing and in feedlot fed corn silage base

Blood biochemical values

The blood biochemical and hematological values were not significantly different between steers randomly assigned to the different treatments at the beginning of the trial. Those values of the final experiment were also found to be not significantly different between steers given the different dietary treatments in both the grassland grazing and the feedlot, as shown in Table 3. The PLT values of steers in the feedlot with supplementation of diet 1 were found to be lower than that of the other treatments (P=0.068). Steers on grassland free grazing tended to have a higher PLT count than that of steer in the feedlot throughout the 120 days of the experiment. This may indicate that steers in grassland produced more PLT against blood parasites than that of steers in the feedlot, which may embed more in tropical regions. In contrast, low PLT counts could increase bleeding risks. However, the value of this research was in the range of normal (1.0 – 8.0 x10^5/μL) (Kaneko, et al., 1997).

The values of GLC, ALP, ALB, MCV, MCH at the end of the trial increased significantly different (P<0.05) from those of beginning the trial. The value of TG of the steers by average tended to be higher than that of at the beginning (P=0.07). In contrast, the values of FT4 and T3 decreased significantly at the end of the trial. The blood biochemical values of steers due to TBIL, DBIL, ALT, BUN, and CR were not significantly different between the beginning and the end of the trial. These were the same as hematological values due to WBC, HB, HCT, RBC, MCHC, and PLT that found to be not significantly different between the initiation and conclusion of the trial (Table 4). Plasma GLC concentration increased dramatically during the experiment for steers supplied with the dietary protein treatment. Although GLC concentration at initiation (53.33 ± 3.56 mg/dL) was in the normal range (Kaneko, et al., 1997); however, this was closer to the lower limit of normal values (50.0 mg/dL). This may indicate that before the trial, steers may lack energy supply caused by the restriction of roughage (Kawashima, 2002). At the conclusion of the trial, plasma GLC of steers by average was high (65.08 ± 1.36 mg/dL), indicated an adequate energy supply as a result of the dietary treatment. Serum ALB at the end differed significantly from that at the onset of the trial (p<0.001). Serum ALB is produced in the liver and plays many important functions, including the indicator of plentiful nutritional supply. These may indicate that before starting the experiment, steers were at the risk of malnutrition and

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malabsorption. The fattening process can achieve an abundant nutrition supply to steers. However, for both sets of steers, ALB was in the range given by Kaneko et al. (1997).

At the end of the 120-day trial, steers tended to have higher plasma triglyceride (TG) than that at the beginning ($p = 0.07$). The TG value before starting the trial was nearly the same as for Japanese black crossbred-fed rice straw receiving enough total digestible nutrients (Kita et al., 2003). The value of total cholesterol (TC) was not significantly different between steers fed different dietary treatments and between inception and conclusion of the trial. The TC value of this study was higher than that of 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). The values of TC, TG, and LDL 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). The values of TC, TG, and LDL were negatively correlated to TBIL, which were -0.63, -0.65, and -0.68, respectively. The values of AST, ALT, and ALP levels showed no significant difference between the dietary treatments for the duration of the trial. This study also found lower AST and ALT values than reported in Thai native cattle by Boonprong et al., (20007b) but was in the range reported by Kaneko et al. (1997). The ALP value of steers at the end of the trial was significantly different from that of steer at the beginning of the trial ($P<0.05$). The values of AST and ALT were highly positively correlated with T3 (0.74 and 0.69).

The serum FT4 and T3 were significantly lower at the end of the trial when compared to the beginning (Table 4). The increasing availability of T3 can induce more extensive protein degradation than synthesis (Hersom et al., 2004). The decreasing concentrations of T3 can 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 low protein intake. Then, during fattening, steers consumed enough protein, and that could be decreased secretion of T3 and FT4, and this may be responsible for increasing energy in the used for growth. Hersom et al. (2004) claimed that lower concentrations of T3, and T4 in steers, which entered the feedlot, did not inhibit their growth as a response to the previous restriction. The BUN value showed no significant difference between the periods of this research, although BUN relates closely to protein intake in beef cattle (Hammond, 1998).

The values of MCV and MCH were not significantly different between dietary treatments within the study period. However, the values at the end of the trial were significantly higher than those at the beginning. Those values for Thai native steers in this study were lower than Holstein Friesian crossbreed (Angwanich, 2002) and Brahman crossbred cattle (Angwanich et al., 2009). Both values, however, were within the reference range (Kaneko et al., 1997). This may indicate that RBCs of Thai native steers were larger in cell size than those of other breeds. The values of TBIL, DBIL, CRT, WBC, HB, HCT, RBC, and MCHC were not significantly different between dietary treatments and were in the normal range (Jane, 1996; Kaneko et al., 1997). These values for the beginning were not different from the conclusion of the trials.

CONCLUSIONS

There was no significant difference in daily gain between steers supplemented with either of the two protein diets. Steers on the grassland free grazing had a significantly higher daily gain than those steers in the feedlot. Differences in dietary protein supplementation caused no differences in the blood biochemical values of the steers. Blood biochemical values at the end of the trial were not significantly different for the steers fed the different dietary treatments. The results imply that the most effective way to fatten Thai native cattle is to allow it to graze on grassland and be given a 1% BW protein dietary supplemental concentrate of 12% CP.

https://doi.org/10.14456/jsat.2020.8

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

Items	Feedlot		Grassland		SEM	P-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, $x10^3/_{\mu}L$	13.03	11.66	10.59	12.15	1.51	0.362
RBC, $x10^6/_{\mu}L$	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, $x10^5/_{\mu}L$	1.47	2.55	2.64	2.30	0.34	0.068

Table 4. Comparison of blood biochemical values of Thai native steers at the beginning and the ending of the trial

Items	Beginning of the trial		End of the trial		pr> |t|	Reference
	Mean ± SEM	range	mean ± SEM	range		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, $x10^3/_{\mu}L$	12.08 ± 0.73	8.8-18.7	11.86 ± 0.70	7.6-16.7	0.653	4.0-20.0
RBC, $x10^6/_{\mu}L$	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, $x10^5/_{\mu}L$	2.11 ± 0.35	1.24-5.61	2.24 ± .20	1.4-3.7	0.547	1.0-8.0

[a, b] Different superscript on the same row indicated significantly different ($p \leq 0.05$).
* adapted from Jain (1996)and Kaneko et al.(1997)

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