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Effect of Potassium Chloride Supplement in Salt Blocks on the Fattening Performance of Charolais Crossbred Beef Cattle under Heat Stress

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Abstract: The effect of potassium chloride (KCl) supplement in salt blocks on the fattening performance of Charolais crossbred cattle under heat stress was evaluated in the present experiment. The fattening performance of beef cattle improved due to KCl supplemention of salt blocks during heat stress conditions in Thailand. Eight crossbred beef cattle (50 to 75% Charolais crossbred cattle) were randomly assigned into two groups. They were raised under the management of small holders in Sakon Nakhon, Thailand. Group 1 was provided a salt block supplemented with KCl, while group 2 was given a salt block without KCl. After a preliminary experimental period of 2 weeks, the temperature and relative humidity in the experimental houses were recorded and blood samples were collected on day 0, 90 and 180 of the experiment to determine cortisol concentrations. Changes in general physiology (rectal temperature, pulse rates, respiration rates, heat tolerance co-efficiency, HTC and sweating rates) and hematology (hematocrit, hemoglobin, blood glucose and blood urea nitrogen and cortisol concentrations) were recorded throughout the experimental period. The temperature humidity index (THI) had a highly significant effect ($p<0.01$) on the general physiology of the cattle between group 1 and group 2, including the following respective differences: rectal temperature (39.39±0.02 vs., 39.45±0.03°C), pulse rate (66.59±4.50 vs., 70.31±2.74 breaths/min), respiration rate (64.34±3.52 vs., 66.04±5.76 time/sec), HTC (82.65±4.38 vs., 80.94±5.04%) and sweating rate (890.14±16.74 vs., 840 ml/m^2/h). Additionally, hematology and cortisol concentrations in the blood serum of fattening beef cattle in both groups were increased ($p<0.01$). Cattle without KCl substitute had significantly higher values ($p<0.01$) for animal welfare behaviors such as rumination, panting, frequency of cattle standing up and walking for water, drinking and lying down motionless for rest or sleep at the back of the stall compared to cattle given KCl supplemented in a salt block. The fattening performance of group 1 and group 2 cattle were significantly different ($p<0.05$) as follows: final weight (672.20±2.80 vs., 652.62±4.48 kg), ADG (0.660±0.003 vs., 0.609±0.001 g/d), dressing percentage (61.40±0.74 vs., 57.20±0.80%) and marbling (3.74±0.02 vs., 3.74±0.02%). It is concluded that KCl-supplemented salt blocks are capable to improve fattening performance of beef cattle in semi-tropical countries.

Key words: KCl, salt block, fattening performance, heat stress conditions

INTRODUCTION

Beef cattle are widely raised in Sakon Nakhon province for slaughter and consumption in local communities and to supply many co-operatives in this area. For example, the Pon-Yang-Kham co-operative in Sakon Nakhon province has various members from the provinces of the upper northeastern region of Thailand, including Udon Thani, Nongkhai, Nakhonpanom, Yasothorn, Roi-et and Kalasin. Based on analyses of the fattening beef market, demand has been continuously increasing, especially for good quality fattening beef. Climate has an important effect on beef cattle performance. Thermal stress, as found in tropical climates and during summer in temperate climates, is a major limiting factor in beef cattle production. Heat stress occurs when the ambient temperature lies above the thermoneutral zone. Based on analyses of climatic condition and of problems encountered during beef cattle raising in Sakon Nakhon province, fattening beef cattle strain is a determining factor whether cattle can adjust themselves in tropical climates, which have high temperature and relative humidity. The original strain of fattening beef cattle has

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characteristic genes that are suitable for temperate zones and as such, effects on body adjustment, heat balance, water balance, energy input, physiology, hematology and hormone levels, can affect the productive performance of fattening beef cattle. Climate change can result in an increase in heat stress. KCl supplementation in fattening beef cattle may improve heat balance and, thereby, positively affect physiology and metabolic mechanisms, maintain a fairly constant body temperature and improve growth. High temperature may elevate glucocorticoid concentrations and has been related to potassium metabolism and balance (Beed, 1981). Potassium is predominantly present in lean tissue. Short-term heat exposure loss of potassium from the body is cause by tissue catabolism (Johnson, 1987). Therefore, KCl supplement was provided to beef cattle in this research to alleviate genetic deficiencies caused by raising in a suboptimal climate. This will improve the productive performance of the cattle and ensure consistency with market demand, i.e., to obtain beef that is of good quality and safe for consumption. Furthermore, our study will improve consumer confidence and satisfaction for the added value of beef products.

MATERIALS AND METHODS

Fattening beef cattle (50-75% Charolais crossbred cattle) were used as the experimental animals. All cattle were uniform in body condition score in each group and were raised under the management of small holders in Pon-Yang-Kham co-operative, Sakon Nakhon. Eight cattle were allocated randomly in two groups. Group 1 was provided KCl-supplemented salt blocks, while group 2 was provided salt blocks without KCl. Each isolated beef cattle in each individual pen was fed rice straw ad libitum as a roughage source at a concentration of 1.5% of body weight per day and freely provided fresh water for the entire experimental period. Various types of data were collected, including meteorological values, physiological changes, animal welfare behaviors, hematology values, cortisol hormone level, heat tolerance co-efficiency (HTC), sweating rate and productive performance of fattening beef cattle. The differences of each studied characteristic were compared by T-test (Steel and Torrei, 1980). This research was conducted during October 2008-September 2009.

RESULTS AND DISCUSSION

The results of this study demonstrate that the temperature humidity index (THI) affect the general physiology and SR of the fattening beef cattle ($p<0.01$), causing a decrease in HTC ($p<0.01$). The effect of fattening beef cattle on THI was found to be highest in cattle without KCl substitute ($p<0.01$) (Table 2). The process of sweat secretion and excretion for body

Table 1: The effect of environment on housing

Environment effects	Mean ± S.E.
Maximum temperature (°C)	34.60 ± 0.40
Mean temperature (°C)	29.45 ± 0.12
Minimum temperature (°C)	24.30 ± 0.16
Different temperature (°C)	10.30 ± 0.08
Relative humidity (%)	78.90 ± 2.40
Black glob temperature (°C)	49.20 ± 1.02
Dry temperature (°C)	37.20 ± 0.20
Radiation (°C)	12.00 ± 0.03
Temperature Humidity Index (THI)	87.84 ± 2.37

Table 2: General physiology change of beef cattle

General physiology	Supplemented KCl	Without supplemented KCl
Rectal temperature (°C)	39.39±0.02	39.45±0.03
Skin temperature (°C)	37.04±0.08	37.10±0.06
Pulse rate (breaths/minute)	66.59±4.50	70.31±2.74
Respiration rate (time/sec)	64.34±3.52	66.04±5.76
H.T.C (%)	82.65±4.38	80.94±5.04
Sweating rate (ml/l2/hr)	890.14±16.74^{b}	1,050.27±10.28^{a}
Water consumption (l/d)	61.42±1.36^{b}	67.84±2.48^{a}

Means within the same row with different superscripts differed significantly ($P<0.05$)

temperature regulation requires more energy, so fattening beef cattle that have greater heat stress utilize more energy for maintenance (Johnson, 1985; Umpapol *et al*., 2014a).

Based on the observations of animal welfare behavior, rumination, panting, frequency of cattle standing up and walking for water drinking and lying down motionless for resting or sleeping at the back of the stall were all significantly higher in value ($p<0.01$) in cattle without KCl substitute compare to cattle given KCl supplemented in salt blocks (Table 3).

Based on analysis of the data in Table 4-5, fattening beef cattle without KCl substitute showed a significant reduction ($p<0.01$) in hematocrit and hemoglobin levels compared with cattle given the KCl supplement. However, this experiment did not find any differences in glucose and blood urea levels ($p>0.05$) and the cattle supplemented with KCl salt blocks showed significantly lower concentrations of cortisol than cattle without KCl. Environmental conditions of high ambient temperature can directly affect the function of the hypothalamus and anterior pituitary gland and cause increased secretion of cortisol hormone from the adrenal gland than beef cattle substitute KCl in salt block (Yates *et al*., 1961; Umpapol *et al*., 2014b).

This experiment found that cattle supplemented with KCl showed higher values of feed intake, ADG, carcass quality and beef marbling than cattle without KCl (Table 6). The mechanism of this response is likely due to the effects of KCl on intracellular water maintenance and heat load balance. The ADGs of KCl-supplemented fattening beef cattle were also affected through this mechanism compared to non-KCl-supplemented cattle. Beef marbling genesis has been shown to be affected

Table 3: Effects of KCl supplemented in salt blocks on animal welfare behaviors

	--------- Supplemented KCl ---------		---- Without supplemented KCl ----	
Behaviors	Mean±S.D	Result	Mean±S.D	Result
Rumination	3.42±0.46[a]	Normal	2.80±0.52[b]	Low
Panting	3.48±0.64[b]	Normal	3.62±0.48[a]	High
Standing up and walking for water drinking	3.46±0.34[b]	Normal	3.68±0.36[a]	High
Rest for sleeping	3.42±0.60[b]	Normal	4.54±0.32[a]	High

Means within the same row with different superscript differed significantly ($p<0.05$)

Table 4: Effects of the KCl supplemented salt block on hematological parameters

Item	Before	During	End	Throughout
Hematocrit (%)				
Substitute KCl	32.40±0.40	39.80±0.40[a]	46.84±0.30[a]	39.68±0.37[b]
Without KCl	32.35±0.34	37.20±0.28[b]	41.60±0.40[b]	36.36±0.80[a]
Hemoglobin (%)				
Substitute KCl	40.60±0.40	54.20±0.42[a]	56.80±0.32[a]	50.53±0.38[a]
Without KCl	41.50±0.20	50.64±0.40[b]	52.40±0.24[b]	48.18±0.28[a]

Means within the same row with different superscript differed significantly ($p<0.05$)

Table 5: Effects of the KCl supplemented in salt block on hematological and cortisol hormone levels

Item	Before	During	End	Throughout
Cortisol (g/ml)				
KCl	93.00±0.70	80.88±0.80[b]	70.25±0.86[b]	81.38±0.79[a]
Without KCl	92.70±0.50	87.38±0.84[a]	84.25±0.76[a]	88.11±0.70[b]
Blood glucose (mg/100 ml)				
KCl	52.20±0.40	54.80±0.60	56.60±0.80	54.53±0.60
Without KCl	53.40±0.70	54.90±0.90	56.84±0.42	55.05±0.67
Blood urea (mg/100 ml)				
KCl	14.10±0. 04	15.20±0.02	15.80±0.02	15.03±0.03
Without KCl	14.04±0.02	15.14±0.04	16.10±0.04	15.09±0.03

Means within the same row with different superscript differed significantly ($p<0.05$)

Table 6: Beef productive performance

Biological values	Supplemented KCl	Without KCl
Feed consumption		
Roughage (kg)	7.24±0.28[a]	6.82±0.36[b]
Concentrate (kg)	13.72±0.08	13.54±0.04
Productive performance		
Initial weight (kg)	434.60±2.04	433.40±3.50
Final weight (kg)	672.20±2.80[a]	652.62±4.48[b]
Average daily gain (kg)	0.660±0.003[a]	0.609±0.001[b]
Carcass quality		
Dressing (%)	61.40±0.74[b]	57.20±0.80[a]
Marbling (%)	3.74±0.02[b]	3.68±0.02[a]

Means within the same row with different superscript differed significantly ($p<0.05$)

directly by energy imbalance due to energy utilization for body heat exhaust and related to fat synthesis for beef marbling in fattening beef cattle (Umpapol *et al.*, 2010).

Conclusion:

1: Environmental factors such as heat stress affects beef cattle, including growth physiology, HTC, hematology and animal welfare behaviors.

2: KCl substitute in salt blocks can be used to relieve heat stress of beef cattle; KCl-supplemented salt blocks also improve feed consumption, roughage, growth rate, average daily gain, carcass quality, dressing percentage and marbling in high temperature environments.

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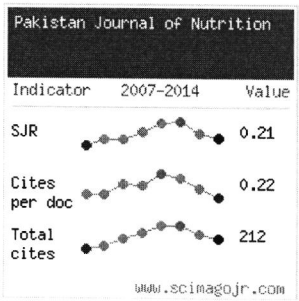

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Cites / Doc. (2years)	-	-	-	-	0,00	0,13	0,00	0,13	0,27	0,26	0,46	0,42	0,66	0,57	0,38	0,22
References / Doc.	-	-	-	-	0,00	0,00	26,33	21,64	23,93	23,05	24,27	25,34	28,03	28,67	27,33	27,87
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