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Response on General Physiology, Animal Welfare Behavior and Productivity of the Different Lineage Level of Charolais Crossbred Cattle for Fattening Beef Cattle Production Performance in Thailand

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Abstract: This experiment was conducted to study on general physiological changes, animal welfare behavior and productivity of the different lineage level of Charolais crossbred cattle for Pon-Yang-Kham fattening beef cattle production. 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. Sixteen cattle were allocated in randomized complete block design (RCB) with 4 groups. Group 1 was Charolais crossbred cattle with 30 percentages till less than 50 percentage of Charolais lineage level, group 2 was 50 percentage of Charolais crossbred cattle, group 3 was 75 percentage of Charolais crossbred cattle and group 4 was over 75 percentage of Charolais crossbred cattle. The environment effects and blood samples were collected and analyzed for examining the cortisol concentration level by RIA technique. General physiological, hematological changes, animal welfare behavior and productive performance were recorded for the entire period of experiment. The result showed that temperature humidity index (THI) effected on the increasing of general physiological changes, heat tolerance co-efficient (HTC), sweating rate, hematology, cortisol concentration and activities of animal welfare behavior with highly significant differences ($p<0.01$). The statistical analysis showed that the productive performance, carcass quality and beef marbling of carcass of the fattening Charolais crossbred cattle were significantly different ($p<0.05$).

Key words: General physiological, animal welfare behavior, charolais crossbred cattle

INTRODUCTION

The raising of fattening beef cattle in Sakon Nakhon province was widely conducted for supplying many co-operatives in Sakon Nakhon province as well as for slaughtering and consuming in each local community, especially Pon-Yang-Kham Co-operative in Sakon Nakhon province has had various members which has mostly covered many provinces in the upper northeastern region of Thailand such as Udon Thani, Nongkhai, Nakhonpanom, Yasothorn, Roi-et and Kalasin provinces and from the data analysis of fattening beef marketing has found the trends of demand has been continuously increased and the satisfaction of consumer for fattening beef consumption has also been very confident for consuming good quality fattening beef (Pon-Yang-Kham Co-operative limited, 2001).

The analyses of climatic condition and of problems of fattening beef cattle raising in Sakon Nakhon province has found that the breed of fattening beef cattle is one factor of the problems that cause the cattle can not properly adjust themselves in tropical climate which has high temperature and relative humidity due to the European cattle breed of the fattening beef cattle has characteristics genes that are suitable for temperate zone so it affects on the body adjustment, physiological changes, hematology, hormone and the productive performance of the fattening beef cattle. As well as, the farmers and technocrats need to obtain the information of the genetic productive potential of the lineage level of Charolais crossbred cattle that suitable in the local climatic condition and the context of the community for improving the productive performance of the said fattening beef cattle which will be consistent with the market demand, obtaining good beef quality and safety for the consumers, the consumers will be confident for consuming fattening beef that leads to the increasing of added value of beef and beef products continuously.

This research was conducted to study on some general physiological changes, animal welfare behavior and productivity of the different lineage level of Charolais

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crossbred cattle for Pon-Yang-Kham fattening beef cattle production under the management of small holders.

Definition of specific terms:

1: Some general physiological changes mean the physiological work of animal body has been increased or reduced such as body temperature, respiration rates, pulse rates, sweating rates and heat tolerance co-efficiency (HTC) while the environmental condition has been changed
2: Animal welfare behavior means the apparent behavior of the fattening cattle to survive under changed environmental condition such as panting, frequency of cattle standing up and walking for water drinking, motionless lying down for resting or sleeping at the back of stall and rumination for normal living
3: Productive performance means the productivity of the fattening beef cattle that measured from feed intake, average daily gain (ADG), carcass quality and beef marbling
4: Pon-Yang-Kham fattening beef cattle means the fattening beef cattle that are raised under the management of small holders who are the member of Pon-Yang-Kham co-operative limited

Conceptual framework: The environmental factors such as temperature and relative humidity could effect on body heat balancing of the fattening beef cattle, especially those cattle which had lineage from European cattle (*Bos tuarus*) such as Charolais (Yousef, 1985) when they have been raise in tropical zone such Thailand, so they will adjust themselves for living and surviving in new environmental condition by changing the general physiology (Yates *et al*., 1975; Wiersma *et al*., 1973), hematology and endocrine system of their bodies and these changes will effect on the productive performance of the fattening beef cattle (Yates *et al*., 1961; Umpapol *et al*., 2011). Therefore, the selection of the suitable level of Charolais lineage in producing crossbred cattle for fattening beef cattle production should be profoundly considered, because Charolais cattle have good breeding value which could transmit the genetic potential and lead to the productive performance of beef cattle under the environmental condition in Thailand (Vajrabukka, 1996).

MATERIALS AND METHODS

Sixteen castrated male 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. Experimental cattle were allocated in randomized complete block design (RCB) with 4 groups. Group 1 was Charolais crossbred cattle with 30% till less than 50% of Charolais lineage level, group 2 was 50% of Charolais crossbred cattle, group 3 was 75% of Charolais crossbred cattle and group 4 was over 75% of Charolais crossbred cattle. Each group was raised in a normal house of the small holders who were the members of Pon-Yang-Kham Co-operative limited in Sakon Nakhon province. Each house was divided into individual pen with individual water container and feed trough for each cattle which was fed *ad libitum* dried rice straw as roughage source and fed concentrate based on the amount of 1.5% of body and drinking water providing for the whole time of experiment.

The data collection comprised meteorology information, general physiological changes, hematological value, cortisol concentration level, co-efficient of heat tolerance, sweating rate, animal welfare behavior and productive performance. The analysis of environmental factors was conducted by using multiple regression and the comparison on each characteristics between the different lineage level of Charolais blood was operated by using an analysis of Variance (ANOVA) (Steel and Torrei, 1980). The experiment was conducted during October, 2008 until September, 2009.

RESULTS

Influence of environmental condition: The result showed that temperature humidity index (THI) affected on the increasing of general physiological changes and sweating rate of the fattening beef cattle ($p<0.01$) that caused to decreased the value of HTC ($p<0.01$). The response of the fattening beef cattle to THI was found at the most level in group 4 (over 75% of Charolais crossbred cattle) ($p<0.01$) (Table 2).

From the observation of the animal welfare behavior such as rumination, panting, frequency of cattle standing up and walking for water drinking and motionless lying down for resting or sleeping at the back of the stall were found that the cattle in group 4 had higher value than those in group 1, 2 and 3 with significant different ($p<0.05$) (Table 3).

Hematological change and cortisol concentration level: From the analysis of data in Table 2 was found that the fattening beef cattle in group 3 (75% of Charolais lineage level) or in group 4 (over 75% of Charolais crossbred cattle) showed the reduced level of hematocrit and hemoglobin with highly significant difference ($p<0.01$) when comparing with other groups that had

Table 1: Results of reducing the influence of the radiation of the sun in the housing

Item	Means ± Standard error
lack globe temperature (°C)	37.24±0.42
Normal temperature (°C)	33.62±0.36
Radiation (°C)	2.40±0.08
Mean temperature (°C)	29.84±0.20
Different temperature (°C)	10.76±0.10
Temperature humidity index (THI)	81.20±4.36

Table 2: Effects of difference lineage level of Charolais crossbred cattle on general physiology and hematology

	Charolais crossbred cattle (%)			
Item	30 to < 50	50	75	>75
General physiology				
Rectal temperature (°C)	39.10±0.30^{b}	39.20±0.30^{b}	39.24±0.30^{b}	39.36±0.36^{a}
Pulse rates (breaths/min.)	73.68±1.56^{b}	74.48±1.56^{b}	74.88±1.56^{b}	84.24±5.48^{a}
Respiration rates (b/t)	43.30±1.50^{b}	44.20±1.50^{b}	45.34±1.50^{b}	50.62±2.86^{a}
Heat Tolerance Co-efficiency (HTC) (%)	89.28±0.68^{b}	86.24±0.74^{b}	85.20±0.86^{b}	80.60±1.82^{a}
Sweating rates (mL/m^{2}/h)	940±16.74^{b}	980±18.68^{b}	988±14.74^{b}	1.81±32.54^{a}
Drinking water (L/d)	61.42±1.36^{b}	62.74±2.20^{b}	67.84±2.48^{a}	70.60±2.60^{a}
Hematology				
Hematocrit (%)	40.20±0.60^{a}	42.80±0.40^{a}	36.20±0.20^{b}	32.80±0.40^{b}
Hemoglobin (mg/100 mL blood)	12.10±0.04^{a}	13.60±0.02^{a}	10.40±0.02^{b}	9.10±0.01^{b}
Blood glucose (mg/100 mL)	56.40±0.70	57.80±0.20	54.80±0.80	54.20±0.40
Blood urea (mg/100 mg)	15.80±0.07	16.10±0.04	14.80±0.04	14.10±0.04
Cortisol (0g/mL)	10.40±0.02^{b}	11.04±0.02^{b}	13.60±0.04^{a}	13.80±0.06^{a}

Mean within row with different superscript differ significantly ($p<0.05$)

Table 3: Average values of animal welfare behavior of Charolais crossbred cattle

	Charolais crossbred cattle (%)							
	30 to <50		50		75		>75	
Item	Mean	Result	Mean	Result	Mean	Result	Mean	Result
Rumination	3.30^{a}	normal	3.40^{a}	normal	3.70^{b}	low	4.70^{b}	low
Panting	3.40^{c}	normal	3.50^{c}	normal	3.80^{b}	high	4.60^{a}	highest
Standing up and walking for	3.45^{b}	normal	3.48^{b}	normal	4.20^{a}	high	4.30^{a}	high
water drinking rest for sleeping	3.05^{b}	normal	3.36^{b}	normal	3.80^{a}	high	4.40^{a}	high

Mean within row with different superscript differ significantly ($p<0.05$)

Table 4: Effects of difference lineage level of Charolais crossbred cattle on the productive performance of Pon-Yang-Kham fattening beef cattle

	Charolais crossbred cattle (%)			
Item	30 - >50	50	75	<75
Feed intake				
Roughage (kg/d)	6.94±0.12^{a}	6.98±0.14^{a}	6.40±0.16	6.32±0.16
Concentrate (kg/d)	14.50±0.60	14.64±0.2	14.70±0.40	14.80±0.60
Growth performance				
Initial weight (kg)	420.64±6.80	430.50±4.20	426.40±4.80	426.40±5.20
Final weight (kg)	662.30±8.60^{a}	674.50±7.40^{a}	642.80±7.50^{b}	640.60±6.40^{b}
Average daily gain (ADG) (kg/d)	0.671±7.71^{a}	0.678±5.82^{a}	0.601±7.50^{b}	0.595±5.79^{b}
Dressing (%)	56.40±0.86^{b}	64.60±0.70^{a}	62.40±0.84^{a}	62.60±0.60^{a}
Marbling (%)	3.40±0.02^{b}	3.64±0.03^{a}	3.60±0.02^{a}	3.52±0.04^{b}

Mean within row with different superscript differ significantly ($p<0.05$)

Charolais lineage level less than 75%. However, this experiment did not find the difference of glucose and blood urea level ($p>0.05$) and the cattle in group 1, 2 and 3 had lower level of cortisol concentration than group 4 with highly significant difference, respectively.

Productive performance of the fattening beef cattle: This experiment found that the cattle in group 2 (50% of Charolais crossbred cattle) and group 3 (75 percent of Charolais crossbred cattle) showed higher values of feed intake, ADG, carcass quality and beef marbling than those in group 1 (Charolais crossbred cattle with 30% till less than 50% of Charolais lineage level) and group 4 (over 75% of Charolais crossbred cattle) (Table 4).

DISCUSSION

The fattening beef cattle that had Charolais lineage level as 75% or over 75% would had general physiological changes that were the mechanisms for body heat balance (McDowell, 1972) and for reducing the body heat by evaporating the sweat which this process needed the increased energy so it affected on the regulation of the energy source for maintaining the body for normal living (Yousef, 1985; Umpapol *et al*., 2011). When the cattle faced heat stress the hematocrit and hemoglobin level would be decreased due to the mechanism of body temperature regulation by sweat secretion and excretion would need more volume of water in body of the cattle so caused anemia condition in circulatory system and caused the increasing of the plasma volume that could relate to the increasing of broken red blood cell but reducing the hematocrit and hemoglobin levels (Ei-Masry and Marai, 1991).

The fattening beef cattle that faced high ambient temperature for long time the process of body heat building would reduced continuously, the main cause was the reducing of feed intake so the cattle body could obtain low net energy for their bodies, similarly Johnson *et al*. (1964); Moody *et al*. (1967); Curran and Okantah

(1982) reported that the environmental condition with high ambient temperature could affect directly to the function process of hypothalamus and anterior pituitary gland and caused the secretion of cortisol hormone from adrenal in increasing level than norm, but when the fattening beef cattle remained in high temperature condition continuously for long time the cortisol hormone level would reduced that might be the mechanism for body temperature regulation by preventing body heat building from food metabolism or might be the adjustment of cortisol hormone metabolism by suppressing 17 Hydroxylase in adrenal to function or might be the elevating Threshold level or set point sensitivity of adrenal (Yates *et al*., 1961; Umpapol, 2001).

From this study it could be concluded that THI was very high for the entire period of the experiment so the fattening beef cattle faced actually the heat stress (Wiersma *et al*., 1973) which affected on the general physiological changes such as rectal temperature, pulse rate, respiration rate and sweating rate values that were all increased (Kabuga, 1992; Legates *et al*., 1991; Singh and Bhattacharyya, 1991) and caused to reduce the hematocrit and hemoglobin levels (Ei-Masry and Marai, 1991) these indicators revealed that HTC was reduced (Boonprong, 1999; Srivastana and Sidhu, 1977; Vajrabukka and Thwaites, 1984) and it affected on the function of endocrine gland especially the concentration of cortisol hormone level was higher (Abilay *et al*., 1975) for reducing body heat building by feed intake reduction (Wannapat, 2004) and later on the fattening beef cattle would adjust themselves for body temperature regulation and reduced the cortisol hormone secretion (Bergman and Johnson, 1963) and finally the fattening beef cattle had lower ADG (Yousef, 1985; Wayman *et al*.,1962; McDowell, 1972; Johnson, 1985, 1987) for the norm of body condition under high temperature environment (Umpapol, 2001; Umpapol *et al*., 2011).

The fattening beef cattle that faced heat stress would be affected on physiological changes, hematological value and function of endocrine glands that caused on the reducing of roughage feed intake to respond to body temperature regulation (Yousef, 1985), so it was an important cause that affected on lower ADG of the fattening beef cattle in the normal house than of those cattle in the modified double shaded house including beef marbling genesis was affected directly because of energy imbalance due to energy utilization for over body heat exhaust and related to fat synthesis for beef marbling of the fattening beef cattle in the normal house (Umpapol *et al*., 2011).

Conclusion:

1: The influence of high value of THI could effect on the general physiological changes, it affected on higher sweating rate and reduced HTC of the fattening beef cattle that had Charolais lineage level in every group and more apparently affected in the cattle in group 4 (over 75% of Charolais crossbred cattle)
2: The cattle in group 4 (over 75% of Charolais crossbred cattle) showed more heat stress effect than other groups and caused the increasing of cortisol concentration level
3: The cattle in group 4 (over 75% of Charolais crossbred cattle) had the productive performance such as ADG, dressing percentage and beef marbling lower than other groups

Recommendations:

1: The farmers should raise the fattening beef cattle that have Charolais lineage level of 50-75% which showed higher efficiency and effectiveness in productive performance
2: In the high ambient temperature and high THI condition, the farmers should find the means for relieving this negative influence on the fattening beef cattle by improving the house condition, feed formula with the integration of the selection of the Charolais lineage level of crossbred cattle for efficient production of the fattening beef cattle

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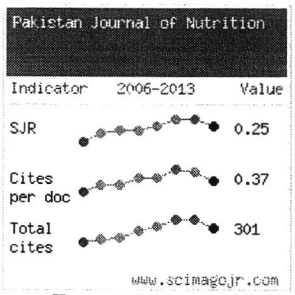

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