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The Utilization of Whole Cotton Seed as a Substitute in Diets on General Physiological Changes, Animal Welfare Behavior and Productivity of Fattening Beef Cattle in Thailand

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Abstract: This experiment was conducted to study on general physiological changes, animal welfare behavior and productivity of Whole Cotton Seed (WCS) substitute in diets 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 (RCBD) with 4 diets. Diet 1 was WCS substitute 0 percentage, diet 2 was 5 percentages of WCS, diet 3 was 10 percentages of WCS and diet 4 was 15 percentages of WCS. 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 significant differences ($p<0.05$).

Key words: General physiological changes, animal welfare behavior, production performance, Pon-Yang-Kham fattening beef 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 fattening beef consumption has also been very confident for consuming good quality fattening beef.

The analyses of climatic condition and of problems of fattening beef cattle raising in Sakon Nakhon province has found that the strain of fattening beef cattle is one factor of the problems that cause the cattle can not adjust themselves in tropical climate which has high temperature and relative humidity due to the original strain of the said fattening beef cattle has characteristics genes that are suitable for temperate zone so it affects on the body adjustment, physiology changes, hematology, hormone and the productive performance of the fattening beef cattle.

Therefore, this research was conducted by applying the appropriate technology (whole cotton seed substitute in diets) for the integration of characteristics genes of the cattle with local community context and climatic condition, for alleviating the productive performance of the cattle to be consistent with market demand, obtaining good quality and safe fattening beef for consumption and the consumers have been confident and satisfied as well as for value-adding of beef and products.

MATERIALS AND MEDTHODS

The fattening beef cattle (50-75% Charolais crossbred cattle) were used as experimental animal. 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 cattles were allocated in Randomized Complete Block Design (RCBD) with 4 diets. Diet 1 was WCS substitute 0 percentage, diet 2 was 5 percentages of WCS, diet 3 was 10 percentages of WCS and diet 4 was 15 percentages of WCS. Each isolated fattening beef cattle

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in each individual pen was fed rice straw ad libitum as roughage source and concentrate 1.5% of body weight in each day and provided freely fresh water for entire period of experiment.

The data collection was conducted in many aspects which composed of meteorological values, values of physiological changes, animal welfare behaviors, values of hematology, cortisol hormone level, Heat Tolerance Co-efficiency (HTC), sweating rate and productive performance of fattening beef cattle.

These data were analyzed for comparing the differences of each studied characteristics by using T-test (Steel and Torrie, 1980). This research was conducted during October 2008-September 2009.

RESULTS AND DISCUSSION

The table below showed the mean values of the parameter of meteorological data, general physiology, HTC, hematology, endocrine, animal welfare behaviors and fattening cattle performance production in this experiment (Table 1-10).

Table 1: Mean values of meteorological data of experimental

The environment effects	Means±Std. error
Maximum temperature (°C)	34.97±0.36
Mean temperature (°C)	29.61±0.19
Minimum temperature (°C)	24.12±0.13
Different temperature (°C)	10.85±0.24
Relative humidity (%)	83.92±0.31
Black glob temperature (°C)	48.66±0.74
Dry temperature (°C)	37.04±0.39
Radiation (°C)	11.45±0.47
Temperature Humidity Index (THI)	88.97±3.37

Table 2: Effect of solar radiation on experimental house

The environment effects	Means±Std. error
Black glob temperature (°C)	36.25±0.34
Dry bulb temperature (°C)	33.90±0.31
Radiation (°C)	2.35±0.13
Micro climate (temperature) in housing (°C)	33.86±0.13
Maximum temperature (°C)	34.97±0.31
Mean temperature (°C)	29.54±0.19
Minimum temperature (°C)	24.12±0.13
Different temperature (°C)	10.85±0.24
Temperature Humidity Index (THI)	82.64±0.12

Table 3: The composition ingredient of feed formulas

	WCS (%)			
Nutrition	0	5	10	15
Moister (%)	8.20±0.24	8.04±0.34	8.28±0.42	9.60±0.46
Dry matter (%)	91.80±3.02	91.86±4.64	90.60±2.80	90.40±2.64
Protein (%)	18.16±0.68	18.20±0.74	18.14±0.46	18.60±0.82
Fat (%)	3.80±0.04	3.78±0.04	5.20±0.06	6.90±0.24
Cell wall (%)	26.50±0.84	26.30±0.64	28.60±0.76	30.20±0.68
Lignocelluloses (%)	20.10±0.72	19.90±0.84	21.34±0.86	24.60±0.96
Ash (%)	9.06±0.24	9.20±0.46	9.82±0.52	10.20±0.76
Calcium (%)	1.20±0.02	1.30±0.03	1.34±0.02	1.40±0.06
Phosphorus (%)	0.62±0.04	0.64±0.02	0.68±0.02	0.70±0.03
Energy (kcal/kg)	4.25±0.48	4.20±0.08	4.36±0.06	4.80±0.02

Mean within row with different superscript differ significantly ($p<0.015$)

Table 4: General physiology of beef cattle

	WCS (%)			
General physiology	0	5	10	15
Rectal temperature (°C)	39.46±0.03	39.45±0.03	39.45±0.03	39.09±0.02
Pulte rate (°C)	82.43±4.76	82.31±2.73	82.31±2.73	79.59±4.53
Respiration rate (time/mn)	82.18±5.73	82.00±6.73	82.00±6.73	78.34±3.51
HTC (%)	80.95±4.60^{c}	80.94±6.03^{b}	85.94±6.03^{a}	87.65±4.38^{a}
Sweating rate (ml/m^2/h)	1020.40±46.72^{a}	1050.27±0.28^{a}	950.27±00.28^{b}	881.15±25.74^{b}
Water intake (l/d)	70.68±1.36^{b}	68.48±2.20^{b}	66.84±2.48^{a}	64.37±2.60^{a}

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

Table 5: The animal welfare behaviours

	WCS (%)							
	0		5		10		15	
Animal welfare behaviors	Mean ± S.D	Result	Mean ± S.D	Result	Mean ± S.D	Result	Mean ± S.D	Result
Rumination	2.42±0.71^{c}	Low	3.24±0.46^{b}	Normal	3.18±0.64^{b}	Normal	4.42±0.58^{a}	High
Panting	4.74±0.68^{a}	Highest	4.24±0.52^{b}	High	4.02±0.47^{b}	High	4.60±0.62^{c}	Normal
Standing up and walking for water drinking	4.67±0.42^{a}	Highest	4.28±0.48^{b}	High	4.20±0.67^{c}	Normal	3.26±0.47^{c}	Normal
Rest for sleeping	4.72±0.54^{a}	Highest	4.36±0.62^{b}	High	3.62±0.54^{c}	Normal	3.48±0.64^{c}	Normal

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

Table 6: The average of haematocrit

WCS (%)	Haematocrit (%)			
	Before	During	End	Throughout
0	31.34±0.89	36.52±0.81^{b}	41.04±0.92^{b}	36.36±0.80^{a}
5	31.23±0.96	37.30±0.24^{a}	41.70±0.94^{a}	36.88±0.61^{b}
10	31.35±0.04	39.68±0.40^{a}	46.84±0.27^{a}	40.05±0.64^{b}
15	31.35±0.04	38.74±0.62^{a}	46.20±0.36^{a}	40.05±0.64^{b}

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

Table 7: The average of haemoglobin

WCS (%)	Haematocrit (%)			
	Before	During	End	Throughout
0	42.00±0.82	50.63±0.47^{a}	56.00±0.82^{a}	49.81±0.84^{a}
5	42.50±0.29	52.13±0.98^{a}	55.50±0.94^{a}	50.56±0.64^{a}
10	42.25±0.26	55.50±0.34^{b}	62.25±0.67^{b}	53.88±0.64^{b}
15	42.34±0.20	55.80±0.30^{b}	62.30±0.40^{b}	53.48±0.30^{b}

Mean within column with different superscript differ significantly ($p<0.01$)

Table 8: The average of cortisol

WCS (%)	Cortisol (ηg/ml)			
	Before	During	End	Throughout
0	96.00±2.58	89.88±2.85^{a}	80.25±1.26^{a}	89.00±6.27^{a}
5	96.75±1.71	80.38±4.34^{b}	72.25±1.26^{b}	82.44±9.71^{b}
10	96.25±1.71	76.13±3.44^{b}	69.25±0.96^{b}	80.54±0.73^{b}
15	98.75±1.60	75.80±1.04^{b}	68.54±0.86^{b}	81.03±1.16^{b}

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

Table 9: The average of blood glucose

WCS (%)	Blood glucose (mg/100 ml)			
	Before	During	End	Throughout
0	53.23±0.45	54.48±0.68	56.32±0.87	54.63±0.30
5	53.17±0.74	54.69±0.99	56.64±0.92	54.80±0.53
10	53.56±1.12	55.27±1.10	57.94±0.68	55.51±0.88
15	53.40±0.60	55.24±0.42	57.60±0.28	56.04±0.60

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

When THI mean was raised up high it caused heat stress to fattening cattle. The fattening cattle were raised in heat stress condition the THI mean would increase that affected on body heat balance and caused the physiological changes for regulating the increased body temperature (Johnson, 1985). When body heat accumulation was increased as the rules of Van't Hoff effect, so the cattle would regulate to static body temperature by many means, the most outstanding responses were the increase of general physiology, HTC, animal welfare behaviours, hematology, cortisol and performance production (Yates *et al*., 1961; Brown and Barbara, 1993; Umpapol *et al*., 2010).

The fattening cattle fed with the supplement of WCS showed HTC mean higher than the other groups ($p<0.01$). The fattening cattle fed WCS would acquire the efficiency increment in heat ventilation of body so to keep the body heat balance efficiently and would be one way to increase energy obtaining for performance production. WCS has high protein (23%), high energy in the form of fat (20%) and crude fiber (24%) on a dry matter basis. Compared with other commonly available protein supplements, WCS is the only one with both additional high energy and high fiber (NRC, 2002). This combination is especially attractive when feeding the high producing, growth rate of fattening cattle in energy balance and fiber (Wanapat, 1999). Also, the energy (fat) content of WCS makes it a valuable addition for cattle under heat stress that may have a reduced appetite

Table 10: The average of blood urea nitrogen

WCS (%)	Blood urea nitrogen (mg/100 ml)			
	Before	During	End	Throughout
0	14.04±0.25	15.17±0.41	15.66±0.32	15.66±0.32
5	14.06±0.27	15.09±0.51	16.12±0.14	16.12±0.14
10	14.06±0.09	14.97±0.36	16.11±0.37	16.11±0.37
15	14.10±0.06	15.24±0.20	16.08±0.24	16.14±0.20

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

Table 11: The performance of beef cattle production

Biological values	WCS (%)			
	0	5	10	15
Feed intake				
Roughage (kg)	6.64±0.25	6.48±0.32	6.72±0.08	6.48±0.32
Concentrate (kg)	14.50±0.60	14.50±0.60	14.50±0.60	14.50±0.60
Performance production				
Initial weight (kg)	420.64±3.80	428.36±2.20	426.40±4.80	424.62±2.25
Final weight (kg)	644.20±4.60^{c}	667.40±3.40^{b}	678.80±4.50^{a}	680.60±3.47^{a}
Growth rate (kg/d)	0.621±3.71^{c}	0.664±2.82^{b}	0.701±4.17^{a}	0.721±2.86^{a}
Carcass quality				
Dressing percentage (%)	56.48±0.86^{b}	62.64±0.70^{a}	63.82±0.84^{a}	64.68±0.61^{a}
Marbling (%)	3.52±0.02^{c}	3.64±0.03^{b}	3.72±0.02^{b}	4.03±0.04^{a}

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

(NRC, 2002). The management of a mechanism of body heat balance for increasing heat ventilation efficacy of the fattening cattle would cause in feed intake quantity and feed energy gain more than the mitigated heat stress cattle (Vajrabukka and Thwailes, 1984; Umpapol *et al*., 2010).

Conclusion and recommendations:

- 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 diets in every group and more apparently affected in the cattle in group 1 and 2.
- The fattening beef cattle in group 1, 2 and 3 had more positive physiological changes than those cattle in the group 4 (15 percentages of WCS) which had higher sweating rate but lower in HTC.
- The fattening beef cattle in group 1 and 2 had effected on hematological values such as hematocrit and hemoglobin levels were higher than those cattle in group 3 and 4, but there was no inferior affect on blood glucose and blood urea nitrogen levels.
- The fattening beef cattle in group 1, 2 and 3 would face the heat stress which caused on the increasing of cortisol hormone level when compared with those cattle in group 4.
- The productive performance of the fattening beef cattle such as ADG, dressing percentage and marbling percentage of the cattle in group 4 were higher than those cattle in the normal house.

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