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Influence of charolais sires and seasons on growth performance and carcass characteristics in crossbred steers

Thiwaratkoon, P.[1], Sivapirunthep, P.[2], Tuntivisoottikul, K.[2], Sitthigripong, R.[1], Chongcharoen, M.[3] and Chaosap, C.[2*]

[1]Department of Animal Production Technology and Fisheries, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, 10520, Thailand; [2]Department of Agricultural Education, Faculty of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, 10520, Thailand; [3]Pon Yang Kham Livestock Breeding Cooperative NSC.Ltd., Ban Pon Yang Kham Moo 10, Tambon Non Hom, Muang District, Sakhon Nakhon Province, 47000, Thailand.

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Abstract The factors of Charolais sires, and fattened seasons on growth performance and carcass characteristics of beef cattle fattened were determined at Pon Yang Kham Livestock Breeding Cooperatives N.S.C. Ltd., Sakhon Nakhon Province, Thailand. Samples were 18 crossbred (Charolais X (Brahman x Thai Native)) steers. They were offsprings of four different sires (S1 to S4), which were 4, 6, 5, and 3 steers from S1 to S4, respectively. Animals were fed *ad libitum* with fresh grass, concentrate, and rice straw. In addition, the steers received molasses as a supplement after 6 months of fattening period. The data were collected during 8-12 months of fattening time. Weight gain and average daily gain (ADG) were calculated. After the animals were slaughtered, the data of carcass characteristics were collected and analysed. The results showed that the sires did not affect all the growth performance and carcass characteristics, except the trait of lean in kg ($P<0.05$) and percentage of lean ($P=0.09$). In general, sire had no effect on growth performance and carcass characteristics except S4 which frozen semen was imported from aboard showed higher amount of lean meat than others. The fattening seasons affected weight gain, ADG, and carcass length ($P<0.05$). The winter season showed higher weight gain, ADG, and carcass length than summer.

Keywords: Charolais sire, growth performance, carcass characteristics

Introduction

Beef cattle are important economic animals in Thailand. However, the limitations of its production are the slow growth and low reproductive efficiency (Cherdthong *et al*., 2014; Supapong *et al*., 2017). One alternative to improve the production is to use imported high producing purebred cattle as

[*] **Coressponding Author:** Chaosap C.; **Email:** chanporn.ch@kmitl.ac.th

terminal sire, such as Limousin, Simmental, and Charolais. Several studies have been carried out to investigate the influence of breed on growth performance and carcass characteristics of beef (Dhuyvetter *et al*., 1985; Shackelford *et al*., 1994; Gallo *et al*., 2014). The significant variation for most traits of importance to beef production exists both within and between breeds. Growth trait can be improved through breed substitution due to sufficient direct genetic variation exists between breeds however other traits like the shape of the growth curve can be improved through the within breed selection (Jenkins *et al*., 1991).

Charolais breed has high average daily gain and high muscularity compared to other breeds (Shackelford *et al*., 1994; Holló *et al*., 2012; Gallo *et al*., 2014). Charolais is the most common beef breed used for terminal crossing with *Bos indicus* such as Thai native breed and Brahman for commercial beef production in Thailand (Bureau of Biotechnology in Livestock Production, 2018). Waritthitham *et al.* (2010) reported that the growth performance of Thai native beef cattle can be improved by being crossed with Charolais purebred. However, Maher *et al*. (2004) reported that individual sire within the same breed may influence the production of its progenies. The raising season was also one of the most important non-genetic factors that impacted on the variation of growth performance (Marchello *et al*., 1970).

Charolais sires used in beef production in Thailand have been imported both in the forms of frozen semen and live animals. Regarding Charolais sires have influence on growth performance of their crosses. The information about growth performance of the crosses from different sires and also the effect of fattening seasons are very importance for farmers to choose which sires and seasons are better for producing beef. So the objective of this study was to determine the growth performance and carcass characteristics of beef cattle offsprings from different Charolais sires fattened in summer and winter seasons at Pon Yang Kham Livestock Breeding Cooperatives N.S.C. Ltd., located in north-eastern of Thailand. The information could be benefit for farmers to select the best sire and appropriate fattenting season for improving beef production.

Materials and Methods

Animals and feeding

The study was conducted at a Pon Yang Kham Livestock Breeding Cooperatives N.S.C. Ltd. in Sakon Nakhon Province, Thailand. Eighteen crossbred steers born during the year 2015 to 2016 were samples in this study. The animals were the offsprings of Brahman or Brahman crossed with native

dams inseminated by frozen semen from 4 Charolais sires, namely: S1, S2, S3, and S4 (N = 4, 6, 5, and 3, respectively). Semen from S1, S2, and S3 were collected from Charolais sires raised in country, while the other semen (S4) was imported. Steers were started to be fattened only in summer and winter season, 11 and 7 steers in summer and winter, respectively. All bulls were castrated by using burdizzo at the first day of fattening. Thus, factors of sires, and fattening seasons influenced production performance and carcass traits were studied.

At the age around 18-24 months, the animals were fattening at the cooperative. Some steers were fed, under the same condition as at the Cooperative, with fresh grass, concentrate, and rice straw at the farmers' farms for 1-4 months, then they were transported be fattened at the cooperative's farm. During fattening period at the cooperative's farm, they were individual fattened, and were fed *ad libitum* with fresh grass, concentrate, and rice straw. All animals obtained molasses as supplement at month 8 of fattening. Data of growth performance used in this study had to be calculated from 8-12 months of their fattening period, because of the completion of data collection for growth performance in this period. Chemical composition of the concentrates was analyzed by using AOAC (2005). The results show in Table 1.

Table 1. Chemical composition of concentrate (as fed)

Nutrients (%)	**Mean±SD**
Moisure	9.28±0.10
Crude protein	12.81±0.86
Crude fiber	9.39±0.24
Crude fat	3.19±0.05
Crude ash	9.34±0.05
Calcium	1.71±0.02
Phosphorus	0.38±0.03
Calcium:Phosphorus	4.5

SD=Standard devaition

Data collection

Growth performance traits

Each animal was weighed at the month 8 of fattening period and every month until the end of fattening period, months 12. Weight gain was calculated by final weight minus initial weight. Average daily gain (ADG) is the amount of weight gain per day for the animal gained over a given period of time. It was calculated by the following formula:

$$ADG = \frac{Final\ weight - Initial\ weight}{Number\ of\ raised\ days}$$

Carcass traits

When the animals reached the end of fattening period, they were taken to the slaughter house located in the cooperative. They were fasted for 24 h. The animals were weighed (final weight), and then slaughtered. The carcass was splitted into 2 halves, left and right sides, and was weighed as hot carcass weight. Carcass length on the right side was measured (Domingo *et al*., 2014). The halves of carcasses were chilled at 4°C for 7 days. On the 7^{th} day, they were quartering into fore and hind quarters at 12^{th}-13^{th} ribs. All carcasses were weighed as cold carcass weight. The percentage of the hot carcass and that of the cold carcass were calculated by using the hot or cold carcass weight divided with final weight and multiplied with 100. Percentage of fore quarter weight and that of hind quarter weight on the left side were analyzed. Percentage of chilling loss was calculated by using hot carcass weight minus cold carcass weight, then divided with hot carcass weight and multiplied with 100.

Carcass compositions

The fore and hind quarters of the left side of carcass were dressed following the cooperative procedure. The deboned and each trimmed cut were weighed. The weight of lean, bone, fat, and tendon in kg were collected and then were calculated to percentages.

Statistical analysis

Descriptive statistic was used to analyse the data distribution of all traits studied, as show in Table 2-4. The average final weight of fattened steers was 653.78 kg and ADG was 0.34 kg/day (Table 2). The average of hot carcass percentage was 56.14, while that of cold carcass percentage was 55.17 (Table 3). The percentage of chilling loss ranged from 1.02 to 2.53 (Table 3).

The average percentage of lean, bone, and fat were 64.73, 16.53, and 15.39, respectively (Table 4).

Table 2. Data distribution of growth performance traits

Traits	Mean	SD	Min	Max
Initial weight at month 8 (kg)	609.44	61.85	502.00	696.00
Final weight at months 12 (kg)	653.78	63.48	539.00	770.00
Weight gain (kg)	44.33	19.15	5.00	76.00
Average daily gain (kg/day)	0.34	0.14	0.04	0.56

Table 3. Data distribution of carcass traits

Traits	Mean	SD	Min	Max
Final live wt. (kg)	653.78	63.48	539.00	770.00
Hot carcass wt. (kg)	367.11	38.08	298.00	434.00
Cold carcass wt. (kg)	360.72	37.31	294.00	426.00
Hot carcass (%)	56.14	1.55	53.94	60.34
Cold carcass (%)	55.17	1.60	52.73	59.20
Fore quarter carcass wt. (kg)	193.33	19.31	158.00	231.00
Hind quarter carcass wt. (kg)	167.39	18.58	136.00	198.00
Fore quarter carcass (%)	53.623	0.883	51.111	55.243
Hind quarter carcass (%)	46.38	0.88	44.76	48.89
Chilling loss (kg)	6.39	1.65	4.00	10.00
Chilling loss (%)	1.77	0.41	1.02	2.53
Carcass length (inch)	59.86	2.61	66.50	56.00

Table 4. Data distribution of carcass compositions

Traits	Mean	SD	Min.	Max.
Left cold carcass weight (kg)	180.22			
Lean (kg)	116.73	13.75	90.50	138.80
Bone (kg)	29.73	3.95	23.80	37.70
Fat (kg)	27.76	5.51	18.40	37.70
Tendon (kg)	1.33	0.25	1.00	1.70
Lean (%)	64.73	2.71	60.34	69.01
Bone (%)	16.53	1.67	13.41	18.70
Fat (%)	15.39	2.60	10.76	21.67
Tendon (%)	0.74	0.12	0.50	0.97

GLM procedure (SAS, 1990) was used to analyse the factors of sire, and season, affecting studied traits. The differences of least squares means were compared with pdiff option.

Results

The factors affecting studied traits are shown in Table 5-7. Table 5. shows the P-values of the sire and season factors affecting growth performace traits. The sire factor did not influence the growth performance traits ($P>0.05$), while the season affected the weight gain and average daily gain ($P<0.01$).

The sires did not affect carcass traits (Table 6). However, it tended to influence the fore quarter carcass in kg ($P=0.098$). Least squares means of the fore quarter carcass weight from offsprings of S1 to S4 were 178.20±10.66, 188.70±8.21, 202.04±7.90, and 211.20±11.79 kg, respectively. This result

showed that the fore quarter carcass weight of the S4-offsprings tended to be the highest and those of the S1-offsprings tended to be the lowest. Chilling loss of the carcass was neither affected by sire nor season ($P > 0.05$). The length of the carcass was affected by season ($P < 0.01$) but not sire ($P > 0.05$).

Table 5. P-values of sire and season affecting growth performance traits

Growth performance traits	P-values		R^2
	Sire	Season	
[1]Weight at month 8 (kg)	0.241	0.786	0.272
[2]Final weight (kg)	0.270	0.745	0.272
[3]Weight gain (kg)	0.508	0.010	0.681
Average daily gain (kg/day)	0.438	0.008	0.664

R^2 = Coefficient of determination
[1]Weight at month 8 = weight at month 8 of fattening period
[2]Final weight = weight at months 12 of fattening period
[3]Weight gain = [2]Final weight – [1]Weight

Table 6. P-values of sire and season affecting carcass traits

Carcass traits	P-values		R^2
	Sire	Season	
Hot carcass wt. (kg)	0.119	0.636	0.363
Cold carcass wt. (kg)	0.106	0.652	0.373
Hot carcass (%)	0.189	0.603	0.306
Cold carcass (%)	0.169	0.677	0.327
Fore quarter carcass wt. (kg)	0.098	0.724	0.375
Hind quarter carcass wt. (kg)	0.193	0.532	0.364
Fore quarter carcass (%)	0.117	0.590	0.371
Hind quarter carcass (%)	0.193	0.532	0.364
Chilling loss (kg)	0.957	0.486	0.161
Chilling loss (%)	0.709	0.538	0.214
Carcass length (inch)	0.625	0.002	0.634

R^2 = Coefficient of determination

The sire factor had not influenced most of carcass composition except lean in kg ($P<0.05$). This factor tended to affect tendon in kg ($P=0.080$) and percentage of lean ($P=0.090$) as shown in Table 7.

The difference of least squares means of the studied traits which effected by the studied factors are shown in Table 8 and Figure 1 The steers fattened during winter showed higher weight gain and average daily gain than those fattened during summer as seen in Table 8.

Table 7. P-values of sire and season affecting carcass compositions

Carcass compositions	P-values		R^2
	Sire	Season	
Lean (kg)	0.012	0.637	0.637
Bone (kg)	0.913	0.378	0.234
Fat (kg)	0.870	0.722	0.098
Tendon (kg)	0.080	0.562	0.488
Lean (%)	0.090	0.977	0.383
Bone (%)	0.147	0.502	0.445
Fat (%)	0.730	0.430	0.199
Tendon (%)	0.603	0.333	0.381

R^2 = Coefficient of determination

Table 8. Least squares means and standard error for weight gain, average daily gain, and carcass length influence by season

Traits	Season	
	Summer (N=11)	Winter (N=7)
Weight gain (kg)	33.26±4.10[b]	58.57±6.90[a]
Average daily gain (kg/day)	0.26±0.03[b]	0.46±0.05[a]
Carcass length (inch)	58.15±0.59[b]	63.03±0.98[a]

[ab] Different letters in the same row differed (P<0.05)

All offsprings from 4 different sires were significant differences in lean as shown in Figure 1. The S4-offspring had more lean in kg than others (132.46±7.03 kg) but not differed from those of S3-offspring (123.79±4.71 kg). While, lean from S1-offspring was the lowest (103.21±6.36 kg) but did not differ from that of S2-offspring (113.17±4.90 kg).

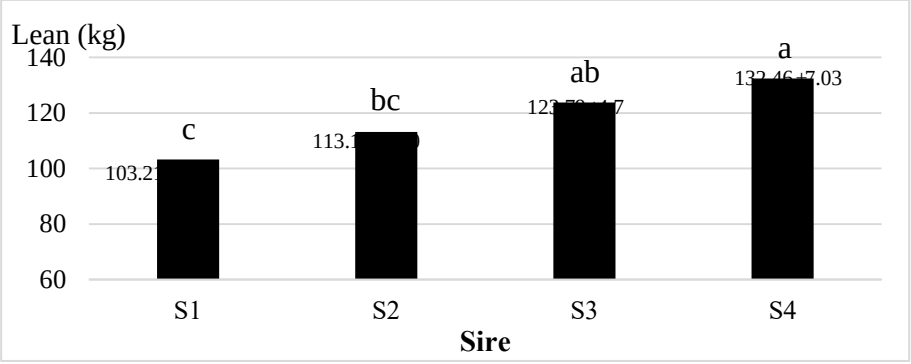

Figure 1. Least squares means of lean in kg from 4 sires offsprings

The tendency of tendon in kg of S4 and S1-offsprings (2.94±0.39 kg and 2.83±0.35 kg) were higher than those of S3 and S2-offsprings (2.34±0.26 kg and 2.31±0.27 kg). The percentage of lean of S3 and S4-offsprings tended to be higher than those of S2 and S1-offsprings, 66.49±1.10, 66.46±1.64, 63.87±1.14, and 62.56±1.49 % for the offsprings from S3, S4, S2, and S1, respectively. The S4-offspring tended to have higher performance than others.

Discussion

The sire factor did not influence the growth performance traits ($P>0.05$), while the season affected the weight gain and average daily gain ($P<0.01$). The steers fattened during winter showed higher weight gain and average daily gain than those fattened during summer as seen in Table 8. The reason might be there is more fresh grass available for cattle in winter than in summer. Because after rainy season the soil is still continuing fertility and humidity during winter time, so it suitable for grass to grow. Thus, there is more good roughage source for beef cattle so they have better growth performance in winter than in summer. In addition, hot summer condition decreased the frequency of eating activity and the stresses imposed by high summer temperatures, which are major factors limiting feedlot performance of beef and dairy cattle (Ray and Roubicek, 1971; Marielena and Liang, 2004).

The sires did not affect carcass traits (Table 6). However, sires tended to influence the fore quarter carcass in kg. The fore quarter carcass weight of the S4-offsprings tended to be the highest and that of the S1-offsprings tended to be the lowest. Chilling loss of the carcass was neither affected by sire nor season. The length of the carcass was affected by season but not by sire. It might be that the S4 sire may have better genetics than S1, S2, and S3. Furthermore, the cooperative imported S4 frozen semen from France, while S1, S2, and S3 were imported as live animals to raise and produce frozen semen in Thailand. Therefore, the imported frozen semen has better genetics than the semen from sires raise in Thailand. As in the study of Tuntivisoottikul and Jirajaroenrat (2016) who reported that the imported frozen semen of Charolais sire gave the best estimated breeding value (EBV) of offspring for ribeye area of beef cattle from Pon Yang Kham Livestock Breeding Cooperatives farms. The EBV is used to identify the genetically superior sire in order to pass the best genetics on to its progeny. However, the carcass composition traits might not be affected by different sires within the same breed as the study of Maher *et al*., (2004) that reported the offsprings from two sires in expected progeny difference for musculature showed no significantly different in the content (g/kg) of muscle, fat, and bone.

Conclusion

In this study, sire had no effect on growth performance and carcass characteristics except S4 which frozen semen was imported from aboard showed higher amount of lean meat than others. The winter season showed higher weight gain, ADG, and carcass length than summer. In conclusion, it might be more efficient to improve performance and carcass characteristics by using the better quality of imported frozen semen and fattening beef cattle during the winter season.

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