Indian J. Anim. Res., **47** (1) : 10 - 16, 2013

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com / indianjournals.com

EFFECTS OF DIFFERENT SLAUGHTER AGES ON THE FATTENING PERFORMANCE, SLAUGHTER AND CARCASS TRAITS OF BROWN SWISS AND HOLSTEIN FRIESIAN YOUNG BULLS

R. Aydin[1], M. Yanar*, A. Diler[2], R. Kocyigit[1] and N. Tuzemen[1]

*[1]Department of Animal Science, College of Agriculture,
Atatürk University, 25 240, Erzurum, Turkey

Received: 20-10-2011 Accepted: 15-05-2012

ABSTRACT

The objectives of the study were to compare fattening performance, slaughter and carcass characteristics of Brown Swiss (BS) and Holstein Friesian (HF) young bulls slaughtered at 17-18 months, 19-20 months and 21-22 months of ages. The study was carried out by using 30 young bulls (16 HF and 14 BS). The animals were fed a diet consisting of concentrate and dry meadow hay for 308 days. Final weight (489.5 vs. 455.6 kg for BS and HF) (P<0.05), total weight gain (297.3 vs. 264.1 kg for BS, HF) and feed efficiency ratio (8.0 vs. 8.8 for BS, HF) (P<0.01) were significantly affected by breeds. Amount of feed consumed per kg weight gain increased significantly (P<0.01) with advancing of the ages at slaughter. Higher slaughter age resulted in heavier slaughter and hot carcass weights, as well as higher dressing percentage, yield grade, marbling score and quantities of the kidney, pelvic, heart fat. It was concluded that fattening performance traits, feed efficiency ratio and carcass traits of BS and HF young bulls were adversely influenced by increasing slaughter age, and breeds did not have a large influence on meat quality attributes such as beef color scores, marbling, amounts of kidney, pelvic and heart fat.

Key words: Carcass traits, Fattening, Slaughter age, Young bulls.

INTRODUCTION

Eastern Region of Turkey is the most suitable area for beef production because of having large area under pasture and meadows. About 21.7 % of cattle population is reared in this region. In recent years, surplus Brown Swiss (BS) and Holstein Friesian (HF) males are widely used for beef production in this part of the country (Ozhan *et al.* 2011).

Fattening performance and carcass quality of the cattle are determined by various intrinsic (breed, gender, slaughter age) and extrinsic factors (rearing techniques, slaughter and post-slaughter conditions etc.) (Preziuso and Russo, 2004). Influences of the BS and HF breeds on the fattening performance, carcass and slaughter traits were already investigated by Tuzemen *et al.* (1990), Yavuz (1991), Ekiz *et al.* (2005) and Ozdogan (2007). However, there is no published report on the affect of the different slaughter ages for BS and HF cattle reared in the Eastern Region of Anatolia. Therefore, this study was undertaken to determine the influences of the various slaughter ages on the fattening performance, feed efficiency ratio, slaughter and carcass characteristics of young BS and HF bulls.

MATERIALS AND METHODS

A total of 30 young bulls (16 HF and 14 BS) from cattle herd of the Research Farm of College of Agriculture at Ataturk University, Erzurum, Turkey were used in this study. The animals were housed in a tethered stall barn containing individual stalls furnished with feeders and automatic drinkers. They were fed a diet consisting of concentrate, dry meadow hay and were adapted to the diet over a period of two weeks.

Amount of the feed offered to the young bulls was adjusted based upon their live weights obtained at 14 day intervals throughout the fattening period

[2]Department of Veterinarian Laboratory and Health, Hinis Vocational School, Ataturk University, Hinis, Erzurum, Turkey.

(NRC, 1996). The quantity of the feed offered to each animal was recorded and refusals were collected and weighed daily in order to determine feed consumption. The chemical composition of the dry hay and concentrate is presented in Table 1.

The bulls were weighed on two consecutive days at the initiation and final of the fattening period to determine average initial and final weights after 24 h fast by removing both feed and water.

The ages of the young bulls at the beginning of the fattening period were classified as 7-8 months, 9-10 months and 11-12 months of ages. The fattening lasted for 308 days. Hence, the animals were slaughtered at three different ages, i.e. 17-18, 19-20 and 21-22 months. Slaughtering was done according to industrial routines used in Turkey. The head, fore and hind feet, lungs, hide, heart, liver, kidney and spleen were removed and weighed. Hot carcass weight and carcass measurements such as carcass length, thoracic depth, length of round, width of round and width of round from medial side were also recorded after Ozluturk *et al.* (2004). Dressing percentage was calculated as a ratio of hot carcass weight to the slaughter weight (live weight obtained in slaughterhouse).

The carcasses were split into halves before a chill period at 4 °C for 24 h. The weights of kidneys, pelvic and heart (KPH) fat were determined and also expressed as a proportion of carcass weight. All carcasses were evaluated for cutability (the proportion of boneless, trimmed, saleable retail cuts of meat obtained from a carcass) and yield grade (a numerical value from 1 to 5 based upon the yield of boneless, closely trimmed retail cuts from round, loin, rib and chuck of the beef carcass). They were predicted by using a mathematical equation as reported by Boggs and Merkel (1984).

After 24 h postmortem, the left halves of the carcasses were evaluated subjectively for conformation [scale SEUROP, from S=superior (1), E=excellent (2), U=very good (3), R=good (4), O=fair (5) to P=poor (6)] and fatness (scale 1-5, from 1=none or low fat cover, 2=slight, 3=average, 4=high to 5=entire carcass covered with fat) using photographic patterns according to the routinely used European Union SEUROP classification system (EEC, 1991). The six classes for conformation and five classes for fatness were also divided into three subclasses as +, 0 or -.

One half of the carcass was cut at 12th and 13th rib intersection and the depth of back fat, color score and marbling score were determined at the cut side. Color scores were determined using Standards for Beef Color, developed by New Mexico State University, Agricultural Experimentation Station, USA (NMSU, 1977). The scale used for color assessment ranged from 1 to 8 (1=bleached red, 2=very light cherry red, 3=moderately light cherry red, 4= cherry red, 5= slightly dark red, 6= moderately dark red, 7=dark red, 8=very dark red). The scale used for marbling ranged from 1 to 18 (1=slight$^-$, 2=slight^0, 3=slight$^+$, 4=small$^-$, 5=small^0, 6=small$^+$, 7=modest$^-$, 8=modest^0, 9=modest$^+$, 10=moderate$^-$, 11=moderate^0, 12=moderate$^+$, 13=slightly abundant$^-$, 14= slightly abundant^0, 15=slightly abundant$^+$, 16= slightly abundant$^-$ 17=abundant^0, 18=abundant$^+$).

Fattening performance and carcass data were statistically analyzed using a general linear model to determine the effect of breeds and slaughter ages and breed by slaughter age interactions (SPSS, 2004). Since breed by slaughter age interaction was not statistically significant at the preliminary analysis, the interaction was excluded from the statistical model. The mathematical model used for analysis of variance was as follows:

$$Y_{ijk} = \mu + a_i + b_j + e_{ijk}$$

Where;

Y_{ijk}: Dependent variables (Characteristics of the fattening performance, feed intake, feed efficiency ratio, slaughter traits, carcass attributes and amounts of the non-carcass components, and carcass measurements),

μ: Overall mean,

a_i: Effect of breeds (HF, BS),

b_j: Effects of slaughter ages (17-18 month, 19-20 month and 21-22 month of ages),

e_{ijk}: Residual error.

The Duncan's multiple range test was applied for comparison of subclass means when F-tests for main effects significant (Yildiz *et al.* 2002).

RESULTS AND DISCUSSION

Initial weights of the bulls in 21-22 and 19-20 months of slaughter age groups (201.5 kg and

TABLE 1: Chemical compositions of the feed used in this study.

Nutrients (%)	Concentrate	Dry Meadow Hay
Dry Matter	88.9	93.5
Crude Protein	14.5	9.5
Ether Extract	3.0	2.3
Ash	7.2	8.6
Crude Cellulose	5.2	28.0
Nitrogen free extract	59.0	45.1

204.1 kg) were significantly ($P<0.01$) heavier than the animals in 17-18 months group (170.1 kg). The weight differences could be attributed to the different ages of the animals at the beginning of the trial. There was a significant difference ($P<0.05$) in total final weight between BS (489.5 Kg) and HF (455.6 Kg) BS young bulls had 12.6 % higher ($P<0.01$) total weight gain than HF bulls. Higher weight gain (9 %, 4.4 % and 8.3 %) of BS compared with HF was also reported by Yavuz (1991), Akbulut and Tuzemen (1994) and Ozdogan (2007) respectively.

Total weight gain of the young bulls slaughtered at 17-18 months of age was numerically the highest compared with other two slaughter age groups (19-20 and 21-22 months of ages), but the difference was statistically nonsignificant (Table 2). These results were supported by findings of Campodoni *et al.* (1997) and Sinclair *et al.* (1998) who reported average daily weight gains decreased from 1.523 to 0.780 kg and from 1.70 to 1.47 kg, respectively with progression of slaughter age of the cattle.

Slaughter age and breeds were significant sources of variations in amount of hay, concentrate and total feed consumed per kg weight gain (Table 2). BS bulls consumed lower amount of feed per kg weight gain (8.0 kg vs. 8.8 kg). The result is comparable with the findings of Yavuz (1991) and Ozdogan (2007) who reported feed efficiency ratios as 6.40 vs. 6.85 and 9.95 vs. 11.19 for Brown Swiss and Holstein Friesian young bulls respectively. In the present study a positive relationship between slaughter age and total feed consumed was observed. These results are in agreement with finding of Sinclair *et al.* (1998).

Least squares means with standard errors for slaughter traits are presented in Table 3. Although the slaughter weight, hot carcass weight and dressing percentage were significantly affected by the slaughter ages, BS young bulls had significantly higher hot carcass weight and dressing percentage than HF young bulls. Similarly, Aksoy *et al.* (2006), Plessis and Hoffman (2007), Hessle *et al.* (2007), Sargentini *et al.* (2010) and Shackelford *et al.* (2011) had reported that increase in slaughter age resulted in higher carcass weight and dressing percentage.

The average fleshiness of all carcasses was 10.5 (R^0), and the SEUROP conformation score of BS carcasses was two subclasses better than HF carcasses. BS and HF carcasses were classified as R^+ (higher than good, good muscle development) and R^- (lower than good, less than good muscling) for conformation score respectively. Onenc (2004) compared HF and BS cattle for carcass conformation in SEUROP system and reported that BS had better carcass conformation score than HF (U^- vs. R^+). On the other hand, SEUROP fatness scores of the both breed were not statistically different, and least square means for fatness score of all carcasses was 5.3 (Class 2). In class 2, carcasses are slightly fat covered with flesh visible almost everywhere.

The slaughter age also did not result in significant differences regarding SEUROP conformation scores (R^0, R^+ and R^+ for 17-18, 19-20 and 21-22 months of ages at slaughter, respectively). These results are consistent with the findings of the Sargentini *et al.* (2010).

Least squares means with standard errors for amount of non-carcass components are presented in Table 4. Breed differences in terms of front and hind feet, hide and spleen weights were statistically significant in favor of the BS young bulls. The findings were in accordance with results of Akcan *et al.* (1992) who reported heavier weights of the hide, spleen and four feet of BS young bulls compared with HF young bulls. The weights of hide, lung and spleen increased significantly ($P<0.05$) with increase in slaughter age. Similar trends for the non-carcass components in Zavot cattle breed were also observed by Aksoy *et al.* (2006).

Although carcass fat parameters (fat thickness over *longissimus dorsi* muscle, amount of KPH fat (kg), percentage of KPH fat (%) and marbling score) were not significantly different between the breeds, the slaughter age had significant

TABLE 2. Least squares means with standard errors for fattening performance traits and amount of feed consumed per kg weight gain.

	N	Initial Weight	Final Weight	Total Weight Gain	Amount of Feed Consumed per kg Weight Gain for		
					Hay	Concentrate	Total
		$\bar{x} \pm S_{\bar{x}}$	$\bar{x} \pm S_{\bar{x}}$	$\bar{x} \pm S_{\bar{x}}$	$\bar{x} \pm S_{\bar{x}}$	$\bar{x} \pm S_{\bar{x}}$	$\bar{x} \pm S_{\bar{x}}$
Overall Mean	30	191.9±3.5	472.6 ± 7.1	280.6 ± 5.5	3.1±0.057	5.3±0.095	8.4±0.148
Breeds							
Brown Swiss	14	192.3±5.4	489.5 ± 10.9	297.3 ± 8.4	2.9±0.087	5.1±0.145	8.0±0.227
Holstein Friesian	16	191.5±4.6	455.6 ± 9.3	264.1 ± 7.2	3.2±0.074	5.6±0.124	8.8±0.194
Significance		NS	*	**	*	**	**
Slaughter Age							
17-18 months of Age	14	170.1±4.9^{a}	460.6 ± 9.9	290.4 ± 7.7	2.8±0.079^{a}	5.0±0.132^{a}	7.8±0.207^{a}
19-20 months of Age	7	204.1±7.4^{b}	481.3 ± 14.9	277.1 ± 11.5	3.2±0.119^{b}	5.4±0.198^{b}	8.6±0.310^{b}
21-22 months of Age	9	201.5±6.1^{b}	475.9 ± 12.4	274.4 ± 9.6	3.3±0.099^{b}	5.7±0.164^{b}	9.0±0.257^{b}
Significance		**	NS	NS	**	**	**

*:P<0.05, **:P<0.01, ^{a,b} Means within columns that do not have common superscripts are statistically different.

TABLE 3. Least squares means with standard errors for slaughter characteristics.

	N	Slaughter Weight (kg) $\bar{x} \pm S_{\bar{x}}$	Hot Carcass Weight (kg) $\bar{x} \pm S_{\bar{x}}$	Dressing (%) $\bar{x} \pm S_{\bar{x}}$	Conformation (SEUROP) (1-18 score) $\bar{x} \pm S_{\bar{x}}$	Fatness (SEUROP) (1-15 score) $\bar{x} \pm S_{\bar{x}}$
Overall mean	30	472.9±6.5	266.7±4.3	56.3±0.3	10.5±0.5	5.3±0.3
Breeds						
Brown Swiss	14	485.1±10.0	276.3±6.5	56.9±0.4	9.7±0.7	5.2±0.4
Holstein Friesian	16	460.7±9.0	257.2±5.9	55.7±0.4	11.3±0.6	5.4±0.4
Significance		NS	*	*	NS	NS
Slaughter Age						
17-18 months of Age	14	456.9±9.5^{a}	253.1±6.2^{a}	55.7±0.4^{a}	11.1±0.6	5.7±0.4
19-20 months of Age	7	462.8±13.8^{a}	263.9±9.0^{a}	55.9±0.6^{a}	10.4±0.9	5.4±0.5
21-22 months of Age	9	498.9±11.6^{b}	283.3±7.6^{b}	57.3±0.3^{b}	10.1±0.8	5.0±0.4
Significance		*	**	*	NS	NS

*:P<0.05, **:P<0.01, ^{a,b} Means within columns that do not have common superscripts are statistically different.

TABLE 4. Least squares means with standard errors for amount of non-carcass components (kg).

	N	Head $\bar{x} \pm S_{\bar{x}}$	Hide $\bar{x} \pm S_{\bar{x}}$	Heart $\bar{x} \pm S_{\bar{x}}$	Lung $\bar{x} \pm S_{\bar{x}}$	Liver $\bar{x} \pm S_{\bar{x}}$	Front + Hind Feet $\bar{x} \pm S_{\bar{x}}$	Spleen $\bar{x} \pm S_{\bar{x}}$	Kidney $\bar{x} \pm S_{\bar{x}}$
Overall mean	30	18.4±0.5	34.8±0.6	2.3±0.1	5.5±0.3	7.0±0.2	9.4±0.1	1.2±0.1	1.2±0.1
Breeds									
Brown Swiss	14	18.5±0.8	37.8±1.0	2.2±0.1	5.8±0.3	6.8±0.3	10.0±0.2	1.3±0.1	1.1±0.1
Holstein Friesian	16	18.2±0.7	31.7±0.9	2.3±0.1	5.3±0.2	7.1±0.3	8.9±0.2	1.0±0.1	1.3±0.1
Significance		NS	**	NS	NS	NS	**	*	NS
Slaughter Age									
17-18 months of Age	14	18.2±0.7	32.6±0.9[a]	2.2±0.1	5.0±0.2[a]	7.1±0.3	9.1±0.2	1.0±0.1[a]	1.2±0.1
19-20 months of Age	7	18.8±1.1	34.4±1.4[ab]	2.2±0.1	5.8±0.4[b]	6.7±0.4	9.8±0.3	1.2±0.1[b]	1.2±0.1
21-22 months of Age	9	18.1±0.9	37.2±1.2[b]	2.4±0.1	5.8±0.3[b]	7.1±0.3	9.4±0.3	1.3±0.1[b]	1.2±0.1
Significance		NS	*	NS	*	NS	NS	*	NS

*:P<0.05, **:P<0.01, [a, b]Means within columns that do not have common superscripts are statistically different.

TABLE 5. Least squares means with standard errors for carcass traits.

	N	Color Scores $\bar{x} \pm S_{\bar{x}}$	Marbling $\bar{x} \pm S_{\bar{x}}$	Kidney, Pelvic and Heart Fat (kg) $\bar{x} \pm S_{\bar{x}}$	KPH[1] Fat(%) $\bar{x} \pm S_{\bar{x}}$	Fat Thickness Over LD[2] (mm) $\bar{x} \pm S_{\bar{x}}$	Yield Grade $\bar{x} \pm S_{\bar{x}}$	Cutability $\bar{x} \pm S_{\bar{x}}$
Overall mean	30	5.8±0.1	3.0±0.2	7.8±0.2	3.0±0.1	5.9±0.5	1.2±0.1	53.9±0.1
Breeds								
Brown Swiss	14	5.7±0.2	3.3±0.4	7.7±0.4	2.9±0.2	5.9±0.7	0.9±0.1	54.7±0.2
Holstein Friesian	16	5.9±0.2	2.7±0.3	8.1±0.3	3.1±0.1	5.9±0.6	1.6±0.1	53.2±0.2
Significance		NS	NS	NS	NS	NS	**	**
Slaughter Age								
17-18 months of Age	14	5.1±0.2[a]	2.3±0.3[a]	7.1±0.4[a]	2.9±0.2	5.2±0.7	1.1±0.1[a]	54.3±0.2[a]
19-20 months of Age	7	5.9±0.3[b]	2.8±0.5[a]	7.4±0.5[a]	3.0±0.2	5.9±1.0	1.3±0.2[b]	53.8±0.3[b]
21-22 months of Age	9	6.4±0.2[b]	4.0±0.4[b]	9.1±0.4[b]	3.2±0.2	6.6±0.8	1.3±0.1[b]	53.7±0.2[b]
Significance		*	*	*	NS	NS	*	*

[1]KPH: Kidney, pelvic, heart, [2]LD: *longissimus dorsi*, *:P<0.05, **:P<0.01, [a, b]Means within columns that do not have common superscripts are statistically different.

TABLE 6. Least squares means with standard errors for carcass measurements (cm).

	N	Carcass Length (cm) $\bar{X} \pm S_{\bar{x}}$	Thoracic Depth (cm) $\bar{X} \pm S_{\bar{x}}$	Length of the Round (cm) $\bar{X} \pm S_{\bar{x}}$	Width of the Round (cm) $\bar{X} \pm S_{\bar{x}}$	Width of the Round from Medial Side (cm) $\bar{X} \pm S_{\bar{x}}$
Overall mean	30	141.1±0.9	43.6±0.3	71.4±0.3	27.1±0.3	41.7±0.4
Breeds						
Brown Swiss	14	141.4±1.4	43.8±0.5	71.6±0.5	27.1±0.4	41.6±0.6
Holstein Friesian	16	140.6±1.2	43.3±0.4	71.3±0.4	27.1±0.3	41.8±0.5
Significance		NS	NS	NS	NS	NS
Slaughter Age						
17-18 months of Age	14	139.9±1.3	43.5±0.4	70.4±0.5^{a}	26.6±0.4	41.3±0.5
19-20 months of Age	7	141.3±1.9	43.5±0.6	71.7±0.7^{b}	27.3±0.5	41.5±0.8
21-22 months of Age	9	141.9±1.6	43.7±0.5	72.1±0.6^{b}	27.5±0.4	42.3±0.7
Significance		NS	NS	*	NS	NS

*:P<0.05, **:P<0.01, ^{a,b} Means within columns that do not have common superscripts are statistically different.

(P<0.05) influence on these parameters (Table 5). Marbling score, quantity of KPH fat increased by advancing of slaughter ages. Similar findings were obtained from different cattle breeds (Kang *et al.*, 2004 and Plessis and Hoffman, 2007).

The different slaughter ages had significant (P<0.05) effect on the meat color however, breeds were not significant source of variation for beef color. Prolonging slaughter age from 17-18 months to 21-22 months induced darker and redder color of the meat, and color scores rose from 5.1 to 6.4 with increasing slaughter age. The result was in agreement with finding of Funghi *et al.* (1994) and Plessis and Hoffman (2007) who reported a decrease of lightness and an increase of redness with progressing of slaughtering age. The redder meat color could be attributed to the higher myoglobin content of the beef obtained from older animals (Judge *et al.* 1994).

Yield grade and cutability values were significantly influenced by breeds (P<0.01) and slaughter ages (P<0.05). The higher slaughter age had detrimental effect on the cutability value and the proportion of boneless, trimmed, saleable retail cuts of carcasses of the breeds decreased (P<0.05) from 54.3 % to 53.7 %. Similarly, Shackelford *et al.* (2011) reported that yield grade elevated from 2.2 to 2.6 with increasing ages at slaughter time, while cutability value decreased. The decreased amount of edible meat could be due to increasing amount of the carcass fat of the bulls slaughtered at older ages.

Least squares means with standard errors for carcass measurements are presented in Table 6. BS and HF breeds were not significant sources of variation in the carcass measurements, while there was an increasing trend in carcass measurements with prolonged slaughter age. Length of the round was significantly (P<0.05) affected by the slaughter ages.

In conclusion, increasing slaughter age resulted in favorable effect on the slaughter weight, hot carcass weight, dressing percentage, marbling, while it had adverse effects on the feed efficiency ratio, weight gain as well as meat color, yield grade, cutability and amount of KPH fat of the carcasses from BS and HF young bulls. Fattening performance, feed efficiency, hot carcass weight, dressing percentage, yield grade, cutability and weights of the hide, spleen and front and hind feet had significant differences between breeds.

REFERENCES

Akbulut,O. and Tuzemen N. (1994). Fattening performance and carcass characteristics of Brown Swiss, Holstein and Simmental young bulls subjected to fattening at 8 12 month age. *Atatürk Ü. Zir. Fak. Derg.*, **25**:134-144.

Akcan, A., Alpan O., and Arpacýk R. (1992). The effects of tapioca and canola supplemented rations on fattening, slaughtering and carcass characteristics in Brown and Holstein bulls. *Tr. J. Vet. Anim. Sci.,* **16**:315-326.

Aksoy, A., Kirmizibayrak T. and Saatci M. (2006). The effect of age on slaughter and carcass characteristics in male Zavot cattle. *Tr. J. Vet. Anim. Sci.*, **30**:527-532.

Boggs, D.L. and Merkel R.A. (1984). Live Animal Carcass Evaluation and Selection Manual. 2nd Ed. Kendall/Hunt Publishing Co. Dubuque, Iowa (USA). 215 p.

Campodoni, G., Preziuso G., Berni P. and Pellegrini S. (1997). Effects of rearing system and age at slaughter on the performance of entire and castrated Chianina calves. 1. Growth, slaughter and carcass traits. *Rivista di Scienze dell'Alimentazione*, **26**:37-49.

EEC (1991). Council Regulation EEC No.1026/91 of 22 April 1991 amending Regulation (EEC) No.1280/81 determining the Community scale for the classification of carcasses of adult bovine animals. *Official Journal*, L106, 2-3.

Ekiz, B., Kocak O. and Yýlmaz A. (2005). Certain fattening and slaughter characteristics of Holstein, Brown Swiss and Simmental young bulls in Southeastern Anatolia Region of Turkey. *Bulg. J. Agric. Sci.*, **11**:199-206.

Funghi, R. Pugliese C., Bozzi R. and Lucifero M. (1994). Evaluation of performances of Chianina young bull from 6 to 24 months – 4. Quality parameters of meat. In proc. 7th Int. Congr. on Italian beef cattle contest, Perugia, Italy.

Hessle, A., Nadeau E. and Johnson S. (2007). Beef heifer production as affected by indoor feed intensity and slaughter age when grazing semi-natural grasslands in summer. *Liv. Sci.,* **111**:124-135.

Judge M., Aberle E., Forrest J., Hedrick H., and Merkel R. (1994). Principles of Meat Science (3rd edition), Kendall/ Hunt Publishing Co., USA.

Kang, S.W., Jeong H.Y., Ahn B.S., Oh Y.K. and Son Y.S. (2004). Effects of feeding type of concentrates during growing period and slaughter age on growth performance, feed efficiency and carcass characteristics in growing-fattening Holstein steers. *J. Anim. Sci. Tech.,* **46**:989-998.

NMSU (1977). Standards for Beef Color. New Mexico State University, Agricultural Experiment Station, Research Report:336. Western Regional Research Publication, Las Cruces, New Mexico, USA.

NRC (1996). Nutrient Requirements of Beef Cattle. 7th Ed., National Academy Press, Washington DC. USA.

Onenc, A. (2004). A comparison of Holstein Friesian, Brown Swiss and Eastern Anatolian Red cattle slaughtered in Turkey for carcass conformation and fatness in SEUROP system. *Czech J. Anim. Sci.*, **49**:169-176.

Ozdogan, M. (2007). A research on some fattening performance parameters of Holstein Friesian and Brown Swiss young bulls under summer season conditions in Aydýn Province. *Hayvansal Üretim*, **48**:1-6.

Ozhan, M., Tuzemen,N. and Yanar, M. (2011). Cattle Production. 6th Ed., Atatürk Univ. College of Agriculture Press, Erzurum, Turkey.

Ozluturk, A., Tuzemen N., Yanar M., Esenbuga N. and Dursun E. (2004). Fattening performance, carcass traits and meat quality characteristics of calves sired by Charolais, Simmental and Eastern Anatolian Red sires mated to Eastern Anatolian Red dams. *Meat Sci.,* **67**:463-470.

Plessis, I. and Hoffman L.C. (2007). Effect of slaughter age and breed on the carcass traits and meat quality of beef steers finished on natural pasture in the arid subtropics of South Africa. *South African J. Anim. Sci.,* **37**:143-153.

Preziuso, G. and Russo C. (2004). Meat quality traits of longissimus thoracis, semitendinosus and biceps brachii muscles from Chianina beef cattle slaughtered at two different ages. *Ital. J. Anim. Sci.,* **3**:267-273.

Sargentini, C., Bozzi R., Giangiacomo G., Degl'Innocenti P., Martini A. and Giorgetti A. (2010). Productive performances of Maremmana young bulls reared following organic rules and slaughtered at 18 and 24 months of age. *Ital. J. Anim. Sci.,* **9**:163-168.

Shackelford, S.D., Koohmaraie M., and Wheeler T.L. (2011). Effects of slaughter age an meat tenderness and USDA carcass maturity scores of beef females. *J. Anim. Sci.,* **73**:3304-3309.

Sinclair, K.D., Cuthbertson A., Rutter A. and Franklin M.F. (1998). The effects of age at slaughter, genotype and finishing system on the organoleptic properties and texture of bull beef from suckled calves. *Anim. Sci.*, **66**:329-340.

SPSS (2004). SPSS 13.0 for windows, release 13.0. Chicago, IL, USA.

Tuzemen, N., Yanar M., Tellioðlu S. and Emsen H. (1990). A comparative study on the fattening performances and carcass characteristics of Simmental, Holstein, Brown Swiss and Norvegian Red X Brown Swiss crossbred young bulls. *Tr. J. Vet. Anim. Sci.*, **14**:47-54.

Yavuz, H.M. (1991). A comparison of fattening performance between Holstein and Brown Swiss bulls and effects of initial weight on the fattening performance. *Lalahan Zoot. Arast. Enst. Derg.*, **31**:17-26.

Yildiz, N., Akbulut O., and Bircan H. (2002). Intoduction to Statistics. 3rd Ed. Aktif Pub. Co., Erzurum, Turkey.