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RESEARCH ARTICLE

Fattening Performance and Some Carcass Characteristics of Hereford and Angus Steers Fed a High Roughage

Tamer KAYAR [1] (*) Duygu BUDAK [2]

[1] Aksaray University, Faculty of Veterinary Medicine, Department of Animal Science, TR-68100 Aksaray - TÜRKİYE
[2] Aksaray University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritionla Diseases, TR-68100 Aksaray - TÜRKİYE

(*) **Corresponding author:** Tamer KAYAR

Phone: +90 382 288 2879
Cellular phone: +90 539 827 2263
Fax: +90 382 288 2899
E-mail: tamerkayar@aksaray.edu.tr

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ABSTRACT

This study was carried out to compare the fattening performances, some slaughter and carcass characteristics of 10-month-old Hereford (HER) and Angus (ANG) steers fed a high roughage with the same care and feeding conditions in Türkiye. A total of 40 steers, 20 HER and 20 ANG from the same herd, were selected as homogeneously and randomly divided into two groups. The average body weights of the breeds were determined as 276.85±9.70 and 288.10±9.86 kg, respectively, and the differences between the breeds were insignificant (P>0.050). All animals were fed *ad-libitum* with two different Total Mixed Rations (TMRs) prepared with a concentrate: roughage ratio of 34:66% during the fattening. In the experiment, fattening feed containing 14.12% crude protein (CP) and 2671 kcal/kg metabolic energy (ME) for the first 300 days and fattening finisher feed containing 14.11% CP and 2717 kcal/kg ME for the last 45 days were used. At the end of the study, which lasted for a total of 345 days, the 1 kg live weight costs of the animals were calculated. Differences were insignificant between the two breeds in terms of body weights, final weights (slaughter weights), total weight gains, daily live weight gains, daily dry matter consumption, feed conversion ratios, hot and cold carcass weights, head weight to carcass ratio and longissimus muscle area (LMA) during fattening (P>0.050). Head and skin weights (P=0.000 and P=0.003) and subcutaneous fat thickness (SFT) (P=0.000) were higher in the HER breed. The profit ratio with the cost did not change. It was concluded that both breeds had similar characteristics.

Keywords: Angus, Carcass, Cattle, Fattening performance, Hereford, Roughage

INTRODUCTION

Due to the rapidly growing population of the world, people's food demands have also increased. Countries are developing different approaches and strategies in order to meet the demand for healthy and reliable animal protein, which increases in parallel with the increase in population. For this, both the number of animals and the productivity per animal need to be increased. The inability to meet this demand is due to the inadequacy of the number of animals and breeding meat breeds in Türkiye [1]. As of June 2021, the total number of cattle in Türkiye was 17.875 672 and the total number of sheep/goats was 58.447.555 [2].

Generally, in cattle breeding for fattening in Türkiye; combined productive breeds such as Simmental and Brown Swiss, and male offspring of dairy breeds such as Holstein or hybrids of these breeds are used. Since the amount of meat produced does not meet the demand, breeding and butchery beef cattle or carcass meat are imported from time to time [3]. Primarily, it is aimed to increase the number of breeding animals in both fattening and dairy cattle by importing pregnant heifers. To this end; Limousine, Charolais, Angus, Hereford and Simmental are the most preferred breeds among imported cattle breeds [4,5]. However, it is seen that there is not enough benefit from the breeders brought to Türkiye for fattening and the required breeder production is not at a sufficient level [5].

In order to increase productivity in animal production, housing high-yielding breeds that can transform this genetic potential into products, as well as high genetic capacities, in appropriate environmental conditions is the basis of economic and profitable production [6]. Animal material and feed constitute the most important cost in meat production in Türkiye. Their share in the costs is approximately 90% and varies according to the fattening period and feed efficiency values. The remaining 10%

belongs to other expenses [4]. Livestock production in Türkiye and especially in the Central Anatolian Region is mostly carried out based on high concentrate feeding due to the inefficient and inadequate pasture lands. In the feeding of animals, concentrated feed is used instead of high-quality roughage [5]. In addition, short-term fattening is mostly preferred in fattening steers. In recent years, the increase in feed raw material and concentrate feed prices has led breeders to mainly feed their animals mainly roughage. Various crossbreeding studies have been carried out on cattle breeds imported from abroad to Türkiye in the past [7,8]. Recently, the number of studies on the fattening performance, slaughter and carcass characteristics of imported beef cattle is increasing daily [4,5,9].

In this study, roughage was mainly used in the feeding of animals and the fattening period was long. At the end of the study, it was aimed to comparatively reveal the fattening performances and such as weight gain and feed efficiency values and some slaughter and carcass characteristics in the fattening steers of HER and ANG breeds.

Material and Methods

Ethical Statement

This study and all experimental procedures were carried out in accordance with ethical standards approved by Aksaray University Animal Experiments Local Ethics Committee (Approval no: 2021/8-15).

Animals and Feeds

In the study, a total of 40 male steers, 20 each of HER and ANG breeds, at an average age of 10 months, imported in 2021 to a private enterprise with an altitude of 939 m in Aksaray, were used as animal material. The fattening period of the animals started in mid-March 2021 and ended in early March 2022. The animals were kept in a quarantine barn for 21 days and foot and mouth disease and smallpox vaccines and antiparasitic applications were made. During the fattening period, these preventive vaccination and drug application procedures were repeated periodically. The steers were placed in the paddocks in two groups (20 heads each). In a semi-open free stall barn system, 10.5 m^2 area per animal and 60 cm feeder length were calculated. The steers in each group were fed at the same time, under the same environmental conditions and with the same ration. Fattening was continued for 345 days.

All animals were given two different Total Mixed Rations (TMRs) *ad-libitum*, with a roughage: concentrate ratio of 66:34%. Animals were fed with TMRs containing fattening feed (14.12% CP and 2671 kcal/kg ME) for the first 300 days and fattening finisher feed (14.11% CP and 2717 kcal/kg ME) for the last 45 days. TMR application was made twice a day, morning and evening (07:00-17:00). Crude nutrient matters analyzes of feeds were conducted according to the AOAC [10], cell wall components (ADF; acid detergent fibre and NDF; neutral detergent fibre) were determined in accordance with the detergent analysis system reported by Van Soest [11]. The rations given to the animals were formulated according to the daily nutrient requirements of the cattle [12]. The TMR-1, TMR-2 contents and chemical compositions fed to animals are presented in *Table 1*.

Table 1. *Ingredients and chemical composition of the TMRs*

Ingredients, (% in a DM basis)	**TMR-1**	**TMR-2**
Wheat straw	8	7
Alfalfa hay	8	7
Meadow hay	0	10
Alfalfa silage	7.9	0
Corn silage	17	20
Wheat silage	25	21.5
Barley grain, flaked	15	19
[1]Vitamin-mineral premix	0.1	0.5
[2]Fattening feed	19	0
[3]Fattening finisher feed	0	15
Chemical composition, % DM		
Dry matter	64.91	68.32
Crude protein	13.42	12.30
Ether extract	2.10	1.96
Crude ash	8.09	7.37
Crude cellulose	21.04	22.20
ADF	25.24	25.38
NDF	42.04	44.13
Starch	17.90	19.57
[4]ME, kcal/kg	2671.72	2745.15

[1] *Per kilogram of contains: 1.000.000 IU Vit. A, 875.000 IU Vit. D3, 550 mg Vit. E, 625 mg Vit. K3, 625 mg Vit. B1, 63.000 mg Mn, 38.000 mg Zn, 7.700 mg Fe, 7.500 mg Cu, 71 mg Co, I, 80 mg Se*
[2] *Crude protein; 14.12%, 2671 kcal/kg ME*
[3] *Crude protein; 14.11%, 2717 kcal/kg ME*
[4] *ME, metabolizable energy; was calculated according to NRC, 2001*

Fattening Performance Parameters

The animals were subjected to the process of adaptation to feed for 15 days before fattening. At the end of the adaptation period, the animals were fasted overnight and their initial weights were determined by weighing in the morning. Weighing processes were continued regularly every month during the fattening period and the average daily weight gains (ADG) of the animals were calculated individually. Each weighing were carried out before feeding in the morning.

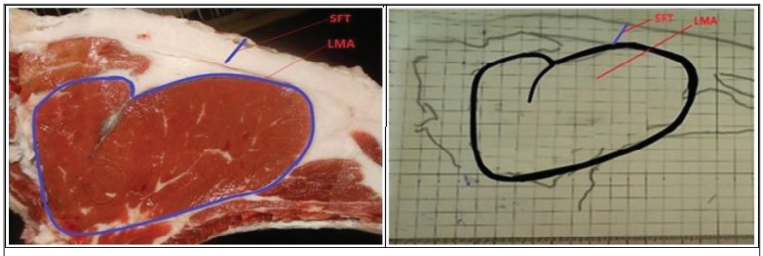

Fig 1. Drawing of LMA and SFT on tracing paper and measurement locations

The rations given to the groups in the group feeding, were mixed daily homogeneously with an uni-feed wagon pulled by a tractor in the form of TMR and poured into the feeders. The feeds given to the groups were recorded daily by weighing them on the scale of the TMR trolley. The amount of TMR consumed by the groups was determined by subtracting the amount of TMR left in front of them the next morning from the amount of TMR given to the animals. This procedure was continued three times in each month (39 replicates in total) during the fattening period. Average dry matter (DM) consumption was calculated by multiplying the consumed TMR amounts and the DM analysis results. The feed conversion ratio (FCR) was calculated by using daily DM consumption and average daily weight gain values.

$$\text{FCR} = \frac{\text{Daily DM consumption (kg)}}{\text{Average daily weight gain (kg)}}$$

At the end of the fattening, the total cost was determined from the cost elements that constituted the cost of animal material, feed, labour, veterinary-health, energy-fuel and other costs (maintenance-repair and general administration expenses). In order to determine the cost of the feed consumed per kg body weight in the groups, the feed prices in that period were taken as a basis. One kg live weight costs of animals were calculated using the ratio of total cost/total end of final weight [13].

Carcass Parameters

The animals that reached the slaughter weight after the fattening period were weighed with the electronic scale in the enterprise after 16 h of fasting, and their live weights were determined before slaughter. The slaughter process of all steers was completed at Aksaray Municipality Meat Integrated Facilities on the same day. After slaughter, some slaughter and carcass characteristics of the breeds were examined. During slaughter, the carcasses were numbered and at the end of the slaughter, the hot weights, skin and head weights of the carcasses were recorded separately. In addition, percentages of skin and head were calculated by dividing skin and head weights by hot carcass weights. Cold carcass weights were determined after the carcasses were rested for 24 h in a cold storage at +4°C. The hot and cold carcass dressing percentages (%) were determined using these data.

$$\text{Hot carcass dressing percentage (\%)} = \frac{\text{Hot carcass weight (kg)}}{\text{Slaughter weight (kg)}} \text{x } 100$$

$$\text{Cold carcass dressing percentage (\%)} = \frac{\text{Cold carcass weight (kg)}}{\text{Slaughter weight (kg)}} \text{x } 100$$

In the shredding process for the determination of some slaughtering and carcass characteristics; forequarter and hindquarter weights were recorded individually. In addition, the longissimus dorsi muscle cross-sectional areas (LMA) and subcutaneous fat thickness (SFT) of all carcasses, 12-13 were drawn on tracing paper from the intervertebral section. Calculations were then made from these drawings using a planimeter and ruler *(Fig. 1)*.

Statistical Analysis

Statistical analyses were performed using SPSS 21.0 for Windows. Fattening duration and initial weights are continuous factors that can affect fattening performance and carcass characteristics except the breed property. Since the fattening duration were equal, the initial weights were considered in the analyses. An independent sample t-test was used to compare the fattening performance, slaughter and carcass characteristics regarding the importance of this factor between breeds. Data were given as mean ± SD and $P<0.050$ was considered statistically significant.

Results

The findings for the fattening performance obtained from the groups at the end of the fattening are presented in *Table 2*. The differences observed among the groups were found to be insignificant in terms of initial and final weights, total weight gain, ADG, FCR, daily TMR, roughage, concentrate feed and total DM consumptions throughout the experiment. No difference also was observed between breeds in terms of feed costs consumed by HERs and ANGs for 1 kg of live weight cost during fattening ($P>0.050$) *(Table 2)*.

The average values of some slaughter and carcass characteristics obtained from the groups at the end of fattening are given in *Table 3*. The differences between pre-slaughter mean body weights, hot and cold carcass weights

Table 2. *The results of the fattening performance and the feed cost obtained from the animals during the experiment*

Properties	Hereford (n=20)	Angus (n=20)	P Values
Fattening duration (day)	345	345	
Initial age (day)	315.500±7.013	320.900±6.463	0.575
Initial weight (kg)	276.850±9.700	288.100±9.865	0.421
Final (slaughter) weight (kg)	648.400±17.128	653.400±22.042	0.859
Total weight gain (kg)	371.550±13.726	365.300±16.115	0.769
Average daily weight gain (kg)	1.074±0.040	1.056±0.047	0.770
Daily TMR consumption (kg)	19.186±0.433	18.449±0.369	0.199
Daily DM consumption (kg)	12.854±0. 290	12.361±0.247	0.199
Feed conversion rates (FCR)*	11.968±0.270	11.704±0.234	0.462
1 kg live weight cost (₺)	14.039±0.519	13.732±0.605	0.702

** FCR: Daily DM consumption (kg)/Average daily weight gain (kg)*

Table 3. *Results of slaughter and carcass parameters obtained from the groups at the end of fattening*

Properties	Hereford (n=20)	Angus (n=20)	P Values
Slaughter age (day)	660.500±7.013	665.900±6.463	0.575
Slaughter weight, kg	648.400±17.128	653.400±22.042	0.859
Hot carcass weight, kg	376.225±11.613	378.700±12.762	0.887
Chilling loss, %	1.361±0.018	1.379±0.030	0.619
Cold carcass weight, kg	371.115±11.469	373.460±12.554	0.891
Hot carcass dressing percentage, %	57.928±0.660	57.996±0.458	0.933
Cold carcass dressing percentage, %	57.139±0.653	57.197±0.448	0.942
Half carcass weight, kg	185.557±5.734	186.730±6.277	0.891
First front quarter, kg	102.763±3.224	104.625±3.502	0.698
First back quarter, kg	82.743±2.585	82.275±2.831	0.904
Second front quarter, kg	105.238±3.229	104.870±3.579	0.940
Second back quarter, kg	80.373±2.517	81.690±2.746	0.726
Head weight, kg	16.225±0.117	15.350±0.171	0.000
Skin weight, kg	54.275±1.549	47.300±1.583	0.003
LMA, cm^2	91.025±1.024	86.375±2.020	0.057
SFT, cm	1.479±0.453	1.197±0.483	0.000
Half carcass, %	49.320±0.009	49.311±0.015	0.613
First front quarter, %	27.676±0.113	28.014±0.116	0.043
First back quarter, %	22.303±0.103	22.034±0.125	0.104
Second front quarter, %	28.354±0.114	28.068±0.129	0.104
Second back quarter, %	21.667±0.128	21.884±0.132	0.245
Head, %	4.384±0.124	4.124±0.115	0.133
Skin, %	14.450±0.095	12.493±0.023	0.000
LMA, %	24.900±0.669	23.355±0.517	0.076

LMA (%): Longissimus muscle area as calculated per 100 kg carcass (LMA / cold carcass weight x 100)

and dressing percentages, LMAs and mean chilling loss values were insignificant (P>0.050). The mean head and skin weights (P=0.000) and SFT (P=0.000) were found to be higher in the HER breed than in ANG.

Discussion

Selection of breeds suitable for fattening and environmental conditions is very important in order to obtain high fattening performance and quality carcasses. Chambaz et al. [14] reported that the effect of breed is important in fattening, and that there are significant differences in the level of intramuscular adiposity of beef cattle of different breeds under the same conditions. Another important factor affecting the fattening period and fattening performance is the age of the animals at the start of fattening.

The growth rates of animals and feed conversion rates (FCR) differ according to their age [15]. In fact, young animals have low purchasing costs and high feed efficiency. The growth rate remains high until the animal reaches 75-80% of it adult body weight. The growth in this period is mostly in the form of protein and muscle accumulation [16]. As the age of the animal increases, the amount of feed consumed for 1 kg of live weight gain increases and therefore the profitability of the fattening decreases. Therefore, it is recommended to use male bulls in the growth period.

Fattening duration in livestock may vary depending on many factors such as the breed of the animal, age, initial fattening weight, daily live weight gain and market conditions. In our study, the differences in both the initial ages and initial weights were found to be insignificant between the breeds. In some studies using HER and/or ANG breeds to obtain high fattening performance and carcass characteristics, the starting age of fattening has been reported to be approximately 10 months, in line with our study [4,5,17]. On the contrary, there are studies reporting the age of onset of fattening to be approximately 6-9 months [1,18-22].

Fattening duration are generally kept short in the fattening of steers imported to Türkiye. It can be said that this is because the regional pasture conditions are unsuitable for stockbreeding and hence, a high rate of concentrated feed is required in the ration. In studies, there are reports that the average fattening period for HER and/or ANG steers was 5-6 months [1,5,23] or 7-10 months [4,21]. Contrary to these stated times, in this study, fattening was continued for 345 days in order to evaluate the results of traditional fattening carried out under variable market conditions.

While there are studies in which the initial fattening weights of the animals used were similar [4,17,18,24], lower [20,22] and higher [1,5] weights are also noteworthy.

Differences in ADG, FCR and carcass quality of livestock are of enormous economic importance for cattle breeders and the meat industry. Santin et al.[25], reported ADG in pasture-fed ANGs was reported (1.06 kg/day) in consistent with our study. However, there are also studies were lower [26] or higher [1,27,28] ADG values in ANG and/or HER steers were reported, largely depending on the roughage: concentrated feed ratio.

The results obtained in this study regarding feed consumption and DM intake are inconsistent with the results of some studies. According to Fidancı et al.[23] these differences are related to the amount of DM in the diet and the amount of concentrate used. Kazhgaliyev et al. [29] emphasised that feed consumption of Hereford and Angus heifers can be assessed based on their behavioural properties relation to their adaptation capabilities to environmental conditions. While the average feed consumption and DM intake were found to be similar for HER and ANG steers in some studies [27], it was observed that the DM intake obtained in our study was higher [5,28,30]. According to some studies, the lower ADG and FCRs obtained in this study can be explained by the feeding method of the animals, the ration content, the amount of concentrated feed used in the rations, and the length of time the animals remained in fattening.

The slaughter weight of the breeds that were the research material and accordingly the hot and cold carcass weights were higher than some studies with the same breeds [9,24,31] (*Table 3*). Bartoň et al.[17] emphasised that high carcass weights were associated with initial body weight, and the time that had elapsed before and during the fattening period. The carcass weights obtained in our study were consistent with the results reported by Pesonen and Huuskonen [32], and slaughter weights reported by Bureš and Bartoň [21].

Şenyüz et al.[1], Bartoň et al.[17] and Holló et al.[28] showed similar results to the present study for carcass dressing percentage. Although Kayar and İnal [9] reported similar carcass yields for ANGs, they calculated lower yields for HERs. In some studies, lower values for ANGs [22,24,31] and HERs [26,31] have been reported. Duru and Sak [4] reported higher carcass dressing percentage for HERs and ANGs (58.9% vs 58.5%). When the studies were evaluated in general, the differences between hot and cold carcass weights, hot and cold carcass dressing percentages and chilling loss values were found to be insignificant in our study, which can be explained by the similar slaughter weights of the breeds.

Kayar and İnal [9], in accordance with our study, reported that HER and ANGs are morphologically similar to each other and these similarities are reflected in most of the carcass characteristics. In addition, head and skin weight

and skin ratios were higher in HERs in our study. While these values were consistent with those reported by Pesonen and Huuskonen [32], they were higher than those reported by Duru and Sak [4]. Mazzucco et al.[31] reported lower LMA values for HER and ANGs. In our study, LMA values calculated in ANG carcasses were found to be higher than those reported by Albertí et al.[19], Holló et al.[28], Santin et al.[25], Jiu et al.[27] but close to those of Barker-Neef et al.[33] and Retallick et al.[20]. Pesonen and Huuskonen [32] also emphasised that the SFT is higher in HERs than in ANGs. Butler et al.[34] and Kayar and İnal [9] found that cold carcass weights and LMA values were similar in both breeds. When SFT values were analysed, Kayar and İnal [9] obtained higher SFT values in HE carcasses. These findings were compatible with our study in this respect. In contrast to our study, Butler et al.[34] reported that there was no difference in SFT values as well as similarity in cold carcass weights between breeds. The reasons why the LMA and SFT values obtained in our study were not compatible with those reported in previous studies may be explained by the differences in the breed characteristics, slaughter weights and carcass weights of the steers.

As a result, between applying a long-term fattening programme based on roughage in HERs and ANGs in the study and applying a short-term fattening programme based on concentrate feed reported in the previous literature; there were no significant differences in daily body weight gains, FCR and most carcass traits. Additionally, it was observed that HER and ANG breeds did not have any superiority to each other. HER and ANG steers are normally early-developing breeds that achieve weight gain in a short time. With this study, it can be said that the fattening period can be extended to a longer term by increasing the roughage ratio in the ration. Thus, breeders can keep their feed costs at an optimum level for 1 kg of live weight by feeding their animals based on roughage for a longer time, instead of feeding their animals for a shorter time with concentrated feed, and they can make more profit periodically. Furthermore, especially in times of economic crisis and uncertainty, breeders can maintain their activities and production at an optimum level in accordance with meat/feed parity. On the other hand, since the animal costs are high in livestock breeding, it is important to carry out similar studies with livestock of different breeds in terms of efficient use of resources.

Availability of Data and Materials

All data generated or analysed during this study are included in this manuscript. The data are original and available from the corresponding author (T. Kayar) on reasonable request.

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Conflict of Interest

The authors declared that there are no conflicts of interest.

Ethical Statement

This study and all experimental procedures were carried out in accordance with ethical standards approved by Aksaray University Animal Experiments Local Ethics Committee (Approval no: 2021/8-15).

Author Contributions

All authors contributed to design of the study. TK and DB conducted all experiments. TK and DB collected, analysed and interpreted the data. TK wrote the first draft of the manuscript. All authors contributed to the critical revision of the manuscript and have read and approved the final version.

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