# Effects of Castration on Growth and Meat Quality in Finishing Male Jeju Horses

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# 거세가 비육기 제주마의 증체 및 육질에 미치는 영향

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## 적 요

이 연구는 거세가 제주 수말 비육시 성장 및 육질에 미치는 영향을 구명하기 위해 수행되었다. 24필(16~20개월령)의 제주마를 12두씩 대조구(비거세)와 거세구에 3반복(반복 당 4두)으로 배치하여 380일 동안 비육시험을 실시하였다. 건초와 물은 자유급식 시켰고, 농후사료는 초기 260일 동안 체중의 1.25%, 후기 120일 동안은 체중의 1.5% 급여하였다. 일당증체량과 사료섭취량은 처리 간 차이가 없었다. 등심단면적은 거세시 다소 증가되었고($P < 0.05$), 근내지방도도 유의적 차이는 없었지만($P = 0.08$) 거세에 의해서 개선되는 경향을 보였다(2.10 vs 1.59). 거세에 의해서 말고기 등심의 조지방 함량은 증가된($P < 0.01$) 반면, 수분과 조단백질 함량은 감소되는 경향을 보였다. 등심의 육색, pH, 가열감량 및 보수력은 거세 유무에 따른 차이를 보이지 않았으나, 전단력은 거세구가 다소 감소하는 경향을 보였다(5.2 vs 6.4 kg / 1.0-cm diameter core). 말고기 관능평가에서는 거세구가 비거세에 비해 다즙성, 연도 및 향미에서 개선된 경향을 보였다. 이 연구 결과, 제주마를 거세 비육함으로써 근내지방도를 증가시켜 말고기의 육질을 개선시킬 수 있을 것으로 사료된다.

(**Key words** : Horsemeat, Castration, Growth, Carcass traits)

## I. INTRODUCTION

The increasing number of Jeju horses (including unregistered crossbred) has been produced in recent years. Some of them are used for race and others that are not fit for race are used for horseback ridding and also for meat after being fattened. Horsemeat contains a high level of monounsaturated fatty acids (Badiani et al., 1997), such as palmitoleic acid that is known to have a beneficial function for skin health. Horse bones have traditionally been used to cure various bone diseases are selling at a high price. This may be justified because of a high level of calcium and copper in the horse bone, which may stimulate osteoblasts to grow. Recently, horsemeat consumption has increased because the quality of meat and its taste have improved with improved feeding programs for fattening. The increasing horsemeat consumption may be contributed to the concomitant enlargement of horsemeat industry such as slaughter, processing and relevant restaurants.

To improve meat quality, feedlot systems have been developed by increasing the ratio of concentrates / roughages, and fattening period, and

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castrating male calves (Park et al., 2002; Destefanis et al., 2003), pigs (Dunshea et al., 1993) and lambs (Koohmaraie et al., 1996).

We hypothesized that castration of horses for meat production can be beneficial, improving marbling as shown in other meat animals and conducted a study to determine the effects of castration on growth and meat quality in Jeju horses.

## II. MATERIALS AND METHODS

### 1. Animals and diets

Twenty-four male unregistered Jeju horses (at 16~20 mo of age) were divided into six pens of four horses each on the basis of body weight, and three pens were randomly assigned to either control (intact) or castration (surgically gonadectomized). Horses were allowed to have free access to orchard grass hay containing 10.3 % CP, 37.9 % ADF and 64.8 % NDF, and water during the entire feeding period. In addition they were daily fed concentrates (Table 1) at 1.25 % for the first 260 days and at 1.5% of their body weight for the last 120 days. Feed consumption and body weight were monitored monthly, and average daily gain (ADG) and average daily feed intake (ADFI) were calculated over the entire feeding period.

Table 1. Composition of concentrates used (on an as-fed basis)

| Ingredient | % |
|---|---|
| Corn | 43.0 |
| Soybean meal | 17.3 |
| Wheat | 11.5 |
| Wheat bran | 11.0 |
| Tapioca | 8.0 |
| Molasses | 5.0 |
| Tallow | 0.2 |
| Salt | 0.6 |
| Limestone | 2.5 |
| Premix[1)] | 0.9 |
| ME (calculated Mcal / kg) | 2.59 |
| CP (calculated %) | 15.9 |
| Ca (analyzed %) | 0.98 |
| P (analyzed %) | 0.58 |

[1)] Provided the following per kg of diet: Fe, 50 mg; Cu, 7 mg; Mn, 24 mg; Zn, 30 mg; I, 0.6 mg; Se, 0.15 mg; vitamin A, 3,800 IU; vitamin D3, 400 IU; vitamin E, 20 IU; vitamin B2, 2.5 mg; vitamin B6, 2.0 mg; pantothenic acid, 4 mg; niacin, 2.6 mg; biotin, 0.1 mg.

### 2. Evaluation of meat quality

At the end of the feeding experiment, horses (4 horses a day) were slaughtered after 16-h fasting. After a 24-h chilling period at 1 ℃, the left side of M. *longissimuss dorsi* was cut between the last rib and the first lumbar vertebra to determine marbling score, ribeye area and backfat thickness.

Meat quality was evaluated using *M. longissimuss dorsi* samples that were vacuum-packaged and stored at 4 ℃ for 7 d. Objective color (Hunter L*, a* and b*) was determined using a colorimeter (Model CR-301, Minolta, Osaka, Japan) after 30-min blooming at room temperature.

Water-holding capacity (WHC) was measured using the procedure of Honikel et al. (1994). For the determination of cooking loss, muscle samples (3 cm thick) were boiled at 70 ℃ for 1 h, cooled under running water for 20 min and weighed. Water loss during boiling represented cooking loss, which was expressed as a percentage of total water. Cores (1 cm in diameter) were taken parallel to myofiber from the samples used for the determination of shear force using a Rheo meter (G-R Elec. Mfg. Co., Manhattan, NY, USA) and forces required were expressed as kilograms/core. For sensory evaluation, steaks (2.5 × 4-cm 2-mm thick cube) from *longissimus* muscle were roasted at 250 ℃ of surface temperature to approximate medium doneness, and scored by 10 trained panels for juiciness, tenderness and flavor on the basis of the 6-point evaluation method (from 6; extremely

juicy, tender and favorable flavor to 1; extremely dry, tough and unfavorable flavor). The proximate analysis of *longissimus* muscle was done by the AOAC procedure (1996).

### 3. Statistical analysis

The student t-test was used to compare individual means of the two groups using the SAS package (SAS, 1988).

## Ⅲ. Results

Average daily gain and average daily feed intake were not influenced by castration (Table 2). Dressing percentage and back-fat thickness were not different between the two groups (Table 3). Ribeye area was slightly ($P < 0.05$) increased by castration. Castration tended to increase ($P = 0.08$) marbling score (1.59 vs 2.10), compared to the control group (Table 3). The muscle (*longissimus dorsi*) fat content increased (5.0 vs 7.1 %) with a little decrease in moisture content (73.8 vs 72.8 %) and protein content (21.0 vs 20.2%) was significantly ($P < 0.01$) decreased by castration (Table 4).

Meat color, pH, cooking loss and water-holding capacity in *longissimus* muscle were not different ($P > 0.05$) between the two groups. Castration tended to decrease slightly ($P = 0.10$) the shear force (5.2 vs 6.4 kg/1.0-cm diameter core) compared to the control (Table 4). Sensory evaluation showed that castration slightly improved juiciness ($P = 0.06$), tenderness ($P = 0.08$), and flavor ($P < 0.05$) (Table 4).

## Ⅳ. Discussion

Many studies have shown that castration decreases growth rate in cattle (Field, 1971), lambs (Koohmaraie et al., 1996) and pigs (Dunshea et al.,

Table 2. Effects of castration on growth and feed intake in fattening Jeju horses

| Item | Control | Castration | P |
|---|---|---|---|
| Body weight[1], kg | | | |
| Initial | 177.5 ± 4.7 | 181.2 ± 5.5 | |
| d 170 | 229.2 ± 6.3 | 231.3 ± 7.6 | |
| d 360 | 300.2 ± 7.8 | 301.3 ± 8.0 | |
| ADG[1], kg | | | |
| d 0 ~ 170 | 0.38 ± 0.02 | 0.39 ± 0.02 | 0.805 |
| d 171 ~ 380 | 0.27 ± 0.01 | 0.25 ± 0.01 | 0.403 |
| d 0 ~ 380 | 0.28 ± 0.01 | 0.27 ± 0.01 | 0.779 |
| ADFI[2], kg | | | |
| Concentrates | | | |
| d 0 ~ 170 | 2.52 ± 0.03 | 2.55 ± 0.02 | 0.503 |
| d 171 ~ 380 | 3.68 ± 0.04 | 3.72 ± 0.05 | 0.630 |
| d 0 ~ 380 | 3.15 ± 0.03 | 3.20 ± 0.05 | 0.536 |
| Hay | | | |
| d 0 ~ 170 | 3.43 ± 0.20 | 3.36 ± 0.12 | 0.791 |
| d 171 ~ 380 | 3.16 ± 0.31 | 3.06 ± 0.14 | 0.789 |
| d 0 ~ 380 | 3.28 ± 0.26 | 3.23 ± 0.12 | 0.879 |

[1] Values are means with SE of 12 horses.
[2] Values are means with SE of three pens of four horses each.

Table 3. Effects of castration on carcass traits in fattening Jeju horses[1)]

| Item | Control | Castration | P |
|---|---|---|---|
| Live wt., kg | 303.3 ± 7.7 | 309.7 ± 8.2 | |
| Hot carcass wt., kg | 160.4 ± 5.8 | 170.1 ± 4.9 | |
| Dressing percentage | 55.8 ± 0.5 | 56.4 ± 0.9 | 0.193 |
| Backfat thickness, cm | 2.25 ± 0.37 | 2.63 ± 0.33 | 0.453 |
| Ribeye area[2)], $cm^2$ | 70.2 ± 5.3 | 85.1 ± 6.8 | 0.044 |
| Marbling score[3)] | 1.59 ± 0.14 | 2.10 ± 0.25 | 0.088 |

[1)] Values are means with SE of 12 horses.
[2)] Mean values differ between two groups according to the student t-test ($P < 0.05$).
[3)] Score ranges from 7 (extremely well marbled) to 1 (extremely poorly marbled).

Table 4. Effects of castration on meat quality in *longissimus* muscle of fattening Jeju horses[1)]

| Item | Control | Castration | P |
|---|---|---|---|
| Meat color, Hunter | | | |
| L | 29.7 ± 0.50 | 30.3 ± 0.6 | 0.343 |
| a | 17.2 ± 0.4 | 17.3 ± 0.4 | 0.221 |
| b | 6.4 ± 0.2 | 6.2 ± 0.2 | 0.666 |
| Cooking loss, % | 17.9 ± 0.7 | 16.4 ± 0.6 | 0.145 |
| Shear force, kg | 6.4 ± 0.5 | 5.2 ± 0.4 | 0.109 |
| Water holding capacity, % | 88 ± 0.4 | 87 ± 0.4 | 0.596 |
| pH | 5.70 ± 0.04 | 5.68 ± 0.02 | 0.719 |
| Proximate analysis, % | | | |
| Moisture | 73.8 ± 0.3 | 72.8 ± 0.5 | 0.350 |
| Ether extracts[2)] | 5.03 ± 0.55 | 7.13 ± 0.39 | 0.006 |
| Protein | 21.0 ± 0.3 | 20.2 ± 0.2 | 0.876 |
| Ash[2)] | 1.97 ± 0.13 | 1.43 ± 0.08 | 0.046 |
| Sensory evaluation | | | |
| Juiciness | 3.57 ± 0.16 | 3.97 ± 0.12 | 0.066 |
| Tenderness | 3.63 ± 0.24 | 4.21 ± 0.18 | 0.082 |
| Flavor[2)] | 3.88 ± 0.07 | 4.15 ± 0.10 | 0.050 |
| Overall assessment[2)] | 3.74 ± 0.15 | 4.26 ± 0.13 | 0.019 |

[1)] Values are means with SE of 12 horses.
[2)] Mean values differ between two groups according to the student t-test ($P < 0.05$).

1993) suggesting that testosterone promotes the growth by increasing muscle deposition. However, our study showed that castration did not appear to influence daily gain maybe because the horses were castrated at maturity. This castration method is not avoidable because local horses used for fattening are those removed from racing. ADFI in both concentrates (fed at limited amount) and hay (fed ad lib.) were not different between the two groups. Free access to concentrates or grains should not be allowed because horses are susceptible to colic, and hence long term fattening is inevitable

to improve meat quality significantly.

Our study clearly showed that intramuscular (*longissimus dorsi*) fat deposition can be increased by castration. Castration has long been known to have a beneficial effect on intramuscular fat deposition in cattle (Schoonmaker et al., 2002; Destefanis et al., 2003; Park et al., 2002; Morgan et al., 1993), lambs (Koohmaraie et al., 1996) and pigs (Dunshea et al., 1993). Destefanis et al. (2003) reported that either early (5 mo) or late (13 mo) castration increased intramuscular fat contents in Piemontese cattle .

Most consumers prefer highly marbled meat and thus livestock producers including those in horse fattening business aim at increasing marbling score. Our study showed that castration improves not only marbling, but also tenderness and flavor shown in sensory evaluation. In conclusion, results show that castration of Jeju horses used for meat production may be beneficial, increasing marbling (intramuscular fat deposition) and in turn improve tenderness and flavor. Further studies are needed to show that whether castration at an early age is more beneficial.

## V. ABSTRACT

A study was conducted to determine the effects of castration on growth and meat quality in finishing male Jeju horses. Twenty-four male Jeju horses (16 ~ 20 mo of age) were divided into six groups of four horses each and three groups (or pens) were assigned to a control (intact) or castration. Horses were allowed to have free access to orchard grass hay and water during the entire feeding period, and a mixed concentrate feed was given at 1.25% and 1.5% of body weight for the first 260 days and for the last 120 days, respectively. Average daily gain, average daily feed intake, dressing percentage and back fat thickness were not influenced by castration. Ribeye area was slightly ($P < 0.05$) increased by castration. Castration tended to increase ($P = 0.08$) marbling score (1.59 vs 2.10) compared to the control. The muscle (*longissimus dorsi*) fat content (5.0 vs 7.1 %) was significantly ($P < 0.01$) increased by castration, meanwhile moisture content (73.8 vs 72.8 %) and protein content (21.0 vs 20.2 %) were decreased. Meat color, pH, cooking loss and water-holding capacity in *longissimus* muscle were not different ($P > 0.05$) between the two groups. Castration tended to decrease slightly ($P = 0.10$) the shear force (6.4 vs 5.2 kg / 1.0-cm diameter core) compared to the control. Sensory evaluation showed that castration slightly improved juiciness ($P = 0.06$), tenderness ($P = 0.08$), and flavor ($P = 0.05$). These results indicate that castration for fattening Jeju horses is beneficial, increasing marbling (intramuscular fat) and hence improving tenderness and flavor.

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