INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
14–162/2015/17–2–334–338
http://www.fspublishers.org

*Full Length Article*

# Effect of Post-pubertal Castration of Wannan Cattle on Daily Weight Gain, Body Condition Scoring and Level of Blood Hormone

**Xinglong Zhang, Muhammad Aziz Ur Rahman, Zhijie Xue, Xianyou Wang, Yang He and Binghai Cao***
*State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China, 100193,*
*For correspondence: caobinghai@163.com; aziz_ul_rahman@yahoo.com

## Abstract

The objective of this experiment was to evaluate the effects of post pubertal castration on blood hormone level, weight gain and body size of Wannan cattle. Twelve Wannan cattle of 12 month age were randomly selected and equally divided into two groups for castration treatment. Six cattle of body weight 126.22±4.51 kg, height 92.67±6.07 cm, length 94.00±5.00 cm and chest girth 117.67±3.21 cm were castrated surgically (SCG), while other six animals of body weight 128.33±14.05 kg, height 93.00±1.00 cm, length 94.00±4.00 cm and chest girth 118.33±5.77 cm were kept as non-treated control group (NCG). Overall, no significant difference in body weight and body size (height, length and girth) was observed within two groups ($P > 0.05$). However, reduction ($P<0.05$) in live weight was noted at the 18th month of the experiment. A non-significant difference ($P>0.05$) was observed in SCG and NCG on monthly body height, length, chest girth, average daily weight gain (ADWG), blood insulin, thyroid-3 and thyroid-4 concentration. Concentration of blood testosterone of the SCG was extremely low ($P<0.01$) compared to the NCG. During 1st month of castration, concentration of growth hormone decreased ($P<0.01$) in SCG compared to NCG. However, concentration of the growth hormone remained unaltered after a 13th month of age until the end of the experiment. The study revealed that post pubertal castration of the Wannan cattle had no negative effect on average daily weight gain, blood hormone level and indirectly physiology of different body organs. 

**Keywords:** Castration; Wannan cattle; Daily weight gain; Body size; Blood hormone

## Introduction

The demand of beef meat is increasing in China due to the improvement of living standards of Chinese people (Cao, 2012). A lot of indigenous animals are slaughtered to meet the beef requirements of the Chinese people, which lead to reduction of indigenous animals in China (Cao, 2011) and in turn beef in recent years (Guo, 2012). Scientists and farmers are trying to change the Chinese indigenous breeds towards beef production (Chen, 2009; Lan and Wu, 2011; Cao and Su, 2012). There are total 55 local cattle breeds in southern China (Zhang, 2011) having huge developmental prospective (Zhu, 2012). Wannan cattle is one of breeds have slow growth potential.

Castration is one of the possible techniques in order to enhance production. It can be done at different ages before the onset of puberty or at the age of puberty (Lunstra *et al.*, 1978). Traditionally, bulls are castrated 6 months before puberty for ease in handling and avoiding the risk of animal stress, but there is also practice to castrate animals after puberty (12–14 month of age) to get maximum benefits from animals in term of growth (Ford and Gregory, 1983; Gregory *et al.*, 1983).

There are various factors which affect the age at castration. The blood hormones play important roles in the metabolism and growth of animals (Yang, 2002). Sex hormones (mainly testosterone) influence the carcass quality, growth and development of the tissues such as muscle, bone and fat (Takeda *et al.*, 1990; Bender *et al.*, 2006). Castration reduced the secretion of testosterone (Chen *et al.*, 2007). However, studies regarding the effect of castration on hormone level and body condition score are less. Keeping in view the current status of research, the present experiment was conducted to study the effects of post-pubertal castration on daily weight, body condition scoring and blood hormones in Wannan cattle.

## Materials and Methods

### Experimental Design, Animals and Rearing

The experiment was conducted on a beef cattle farm located in the north of China, approximately 5 km northeast of Beijing. Twelve Wannan cattles (12-month-old) were selected for this experiment and equally divided into two groups for castration treatment. Six cattle having average body weight 126.22 kg, mean height 92.67 cm, mean length 94.00 cm and mean chest girth 117.67 cm were selected for surgical castration (SCG), while another six cattle having mean body weight 128.33 kg, mean height 93.00 cm, mean

**To cite this paper:** Zhang, X., M.A.U. Rahman, Z. Xue, X. Wang, Y. He and B. Cao, 2015. Effect of post-pubertal castration of Wannan cattle on daily weight gain, body condition scoring and level of blood hormone. *Int. J. Agric. Biol.*, 17: 334–338

length 94.00 cm and mean chest girth 118.33 cm were non-treated as control group (NCG).

In surgical castrated animals group, for castration procedure, animals were confined and their movement was reduced. Animal's genital organs were washed with warm soapy water. Dirt and organic matter were cleaned carefully. Than removed the lower one third of the scrotum in the first step, which exposed the testicles. A slit was made with a knife on covering membrane of the testicles. The cord was partially withdrawn by scraping it in a shaving motion with the knife. One testicle was pulled down. Sharp knife was used to make an incision on the outside of the scrotum next to the leg and testicle was removed by scraping with the knife. The same procedure was repeated for second testicle.

The animals from both groups were given same condition throughout the experimental period, and were fed high concentrated diets (Table 1) according to 1% of their body weight and provided with Chinese grass hay twice/day. Waterwasavailable to the experimental animals round the clock.

### Data Collection and Sampling

**Live body weight:** Experimental animals were weighed on empty stomach early in the morning on the 25$^{th}$ day of every month after puberty.

**Body condition scoring:** Body sizes (body height, body length and chest girth in cm) were determined at 25$^{th}$ day of every month. The body weight and body size of the NCG and SCG before castration are shown in Table 2.

**Blood sampling and processing:** Blood samples from all experimental animals were collected one week before castration from the jugular vein before the morning feeding (after a 12-h fasting) into evacuated tubes containing sodium heparin as an anticoagulant. The blood sample was centrifuged at 3000 rpm/min for 20 min. After centrifugation, plasma and serum were preserved at about -20$^{o}$C for further analysis. Blood samples again were collected on the 25$^{th}$ day of every month and preserved and processed as before castration (after a 12-h fasting).

**Blood hormone's analysis:** Blood hormones (Testosterone (T), Growth hormone (GH), Insulin (INS), Thyroid-3 ($T_3$) and Thyroid-4 ($T_4$) were analyzed by using enzyme-linked immune-sorbent assay (ELISA) technique. The concentration of blood hormones of the NCG and SCG groups before castration is shown in Table 3.

**Table 1:** Ingredient and nutrient levels of the concentration supplement on dry matter basis

| Ingredient | Formula | Nutrient levels | |
|---|---|---|---|
| corn | 30.00 | DM[2](%) | 88.23 |
| wheat | 25.00 | TDN[2](%) | 70.20 |
| Soybean meal | 10.00 | CP[2](%) | 15.60 |
| Wheat ran | 14.00 | DE[2](MJ/kg) | 12.98 |
| Rice husk | 9.00 | Ca(%) | 0.99 |
| Cottonseed meal | 7.00 | P(%) | 0.63 |
| Calcium hydro-phosphate | 1.00 | | |
| $CaCO_3$ | 2.00 | | |
| Salt | 1.00 | | |
| Premix[1] | 1.00 | | |
| Total | 100.00 | | |

Note: 1,Every kilogram premix contained 2000 IU Vitamin A; 275 IU Vitamin D3; and 25 IU Vitamin E,50mg Fe; 10mg Cu, 30 mg Zn,40 mg Mn, 0.5 mg I, 0.1 mg Se and 0.1 mg Co; 2, Dry matter (DM); Total digestible nutrients (TDN); Crude protein (CP); Digestible energy (DE)

**Table 2:** Mean bodyweight ± MSE and body measurement ± MSE of not-castrated group (NCG) and castrated group (CG) before castration

| | Body weight (kg) | Body height (cm) | Body length (cm) | Chest girth (cm) |
|---|---|---|---|---|
| NCG | 128.33±14.05 | 93.00±1.00 | 94.00±4.00 | 118.33±5.77 |
| SCG | 126.33±4.51 | 92.67±6.07 | 94.00±5.00 | 117.67±3.21 |
| *P value* | 0.82 | 0.89 | 1.00 | 0.815 |

**Table 3:** Mean concentration of blood hormones ± MSE of not-castrated group (NCG) and castrated group (CG) before castration

| | T (nmol/L) | GH (g/L) | INS (mU/L) | T3 (ng/ml) | T4 (µg/L) |
|---|---|---|---|---|---|
| NCG | 12.39±1.43 | 44.56±4.31 | 27.64±8.9 | 150.79±48.25 | 267.82±82.58 |
| SCG | 12.28±0.59 | 45.19±17.79 | 28.27±7.51 | 171.44±35.63 | 291.52±141.66 |
| *P* value | 0.96 | 0.93 | 0.92 | 0.46 | 0.67 |

### Statistical Analysis

All data were analyzed statistically for the effect of castration on daily weight gain (DWG) and average daily gain (ADG), body measurements and blood hormones by analysis of variance of SPSS.17 and carrying on multiple comparison of the single factor. All the data were presented as the mean ±SEM unless otherwise stated.

## Results

### Weight Gain

The effect of castration on average daily weight gain has been shown in Table 5. The reduction of ADWG was highly significant ($P$<0.01) in SCG at first month after castration (Table 5). There was no significant difference observed on ADWG in both SCG and NCG groups from 13$^{th}$ month of age to the end of the experiment (Table 5). The changing of the body weight of NCG and SCG is clear from Table 4. There was a non-significant difference of BW at the start of the experiment when animals were not castrated ($P$ > 0.05), however, a significant difference in BW was noted at the 18th month of age in SCG group. It is also clear from the table that BW of the castrated group was decreased significantly ($P$ < 0.05) at the 18$^{th}$ month of the experiment.

### Body Condition Scoring

There was a non-significant difference in SCG and NCG body height, length and chest girth with respect to different months ($P$>0.05) (Tables 6, 7). Similarly, a significant difference was observed on average daily body length (cm) gain ($P$<0.05) between SCG and NCG cattle.

**Table 4:** Mean body weight ± MSE of not-castrated group (NCG) and castrated groups (CG) (Unit, kg)

| | 12th month | 13th month | 14th month | 15th month | 16th month | 17th month | 18th month |
|---|---|---|---|---|---|---|---|
| NCG | 128.33±14.05 | 156.83±11.5 | 170.83±11.73 | 184.33±11.93 | 204.83±11.9 | 215.67±11.68 | 235.83±9.44[a] |
| SCG | 126.33±4.51 | 144.00±3.46 | 154.00±1.00 | 167.17±2.36 | 187.50±7.57 | 198.33±12.34 | 218.00±18.17[b] |
| *P* value | 0.82 | 0.15 | 0.06 | 0.06 | 0.054 | 0.054 | 0.048 |

Note: a, b in column means significant difference ($P<0.05$)

**Table 5:** Average daily weight gain (DWG) ±MSE of not-castrated group (NCG) and castrated group (CG) (Unit, kg)

| | 12th month | 13th month | 14th month | 15th month | 16th month | 17th month | Average |
|---|---|---|---|---|---|---|---|
| NCG | 0.95±0.09[A] | 0.45±0.10 | 0.45±0.22 | 0.66±0.04 | 0.35±0.01 | 0.72±0.08 | 0.60±0.22 |
| SCG | 0.59±0.08[B] | 0.32±0.12 | 0.44±0.08 | 0.66±0.18 | 0.35±0.22 | 0.70±0.21 | 0.51±0.16 |
| *P* value | 0.004 | 0.26 | 0.92 | 0.96 | 1.00 | 0.87 | 0.45 |

Note: A, B in column means extremely significant difference ($P<0.01$)

**Table 6:** Mean body measurements ±MSE of not-castrated group (NCG) and castrated group (CG) (Unit, cm)

| | Body height | | | Body length | | | Chest girth | | |
|---|---|---|---|---|---|---|---|---|---|
| | NCG | SCG | *P* value | NCG | SCG | *P* value | NCG | SCG | *P* value |
| 12th month | 93.00±1.00 | 92.67±6.03 | 0.89 | 94.00±4.00 | 94.00±5.00 | 1.00 | 118.33±5.77 | 117.67±3.21 | 0.815 |
| 13th month | 95.67±0.58 | 94.83±4.75 | 0.72 | 99.33±3.06 | 97.33±6.11 | 0.365 | 124.67±5.51 | 122.33±3.06 | 0.415 |
| 14th month | 98.33±1.15 | 97.33±3.05 | 0.67 | 102.33±2.52 | 99.00±5.57 | 0.431 | 130.33±2.31 | 127.33±3.79 | 0.296 |
| 15th month | 100.67±1.53 | 98.67±2.51 | 0.40 | 106.00±2.65 | 101.00±6.56 | 0.24 | 135.00±1.73 | 132.00±3.61 | 0.296 |
| 16th month | 102.67±0.58 | 100.67±3.06 | 0.40 | 110.00±2.65 | 103.33±8.74 | 0.121 | 139.00±2.65 | 136.00±1.73 | 0.296 |
| 17th month | 104.00±1.00 | 102.00±3.00 | 0.40 | 113.33±1.53 | 106.33±7.77 | 0.104 | 141.33±3.52 | 138.33±1.53 | 0.296 |
| 18th month | 107.00±1.00 | 105.00±3.64 | 0.40 | 117.00±2.65 | 110.00±6.08 | 0.104 | 145.00±4.36 | 142.33±2.00 | 0.296 |

**Table 7:** Mean monthly body measurements gain ± MSE of not-castrated group (NCG) and castrated group (CG) (Unit, cm)

| | Monthly body height gain ± MSE | | | Monthly body length gain ± MSE | | | Monthly chest girth gain ± MSE | | |
|---|---|---|---|---|---|---|---|---|---|
| | NCG | SCG | *P* value | NCG | SCG | *P* value | NCG | SCG | *P* value |
| 13 months | 2.67±1.15 | 2.17±1.44 | 0.54 | 5.33±1.15 | 3.33±1.53 | 0.068 | 6.33±0.58 | 4.67±0.58 | 0.256 |
| 14 months | 2.67±0.58 | 2.50±1.80 | 0.84 | 3.00±1.00 | 1.67±0.58 | 0.365 | 5.67±3.21 | 5.00±1.00 | 0.646 |
| 15 months | 2.33±0.58 | 1.33±0.58 | 0.22 | 3.67±0.58 | 2.00±1.00 | 0.124 | 4.67±2.08 | 4.67±1.53 | 1.000 |
| 16 months | 2.00±1.00 | 2.00±1.00 | 1.00 | 4.00±0.00 | 2.33±2.31 | 0.124 | 4.00±2.65 | 4.00±2.65 | 0.256 |
| 17 months | 2.00±0.58 | 2.00±0.58 | 1.00 | 3.33±1.15 | 3.00±1.00 | 0.753 | 2.33±1.15 | 2.33±0.58 | 1.000 |
| 18 months | 2.33±0.00 | 2.33±1.00 | 1.00 | 3.67±1.15 | 3.67±2.08 | 1.00 | 3.67±1.53 | 3.67±0.58 | 1.000 |
| verage | 2.33±0.61 | 2.06±0.68 | 0.47 | 3.83±0.82[a] | 2.67±0.79[b] | 0.031 | 4.44±1.44 | 4.06±0.98 | 0.597 |

Note: a, b in row means significant difference ($P<0.05$)

### Blood Hormones

The mean concentration of the growth hormone in all the experimental animals was same before the onset of the experiment at the 12th month of age. Level of growth hormone decreased ($P < 0.001$) at 1st of month of the experiment in SCG after immediate castration as compared to NCG. It is clear from Table 8 that concentrations of the growth hormone remained same after a 13th month of age till the end of the experiment. No significant effect of castration was noted in case of insulin and same was noted for $T_3$ and $T_4$. The mean concentration of the blood testosterone, significantly decreased after castration, and it was more prominent at 13th and 16th month of age (first and 4th month of the experiment respectively) (Table 8).

## Discussion

Castration abruptly reduces the weight gain and affects the normal level of hormones. In the present study, a significant effect was noted on live weight gain, body length and level of testosterone in contrast to $T_3$ and $T_4$. It has been studied that removal of the testes after castration reduces the level of testosterone in the blood (Swenson, 1977; Pang *et al.*, 2008). Average daily weight gain can be influenced by androgen produced by testes due to its anabolic property. Growth hormone also stimulates the liver to produce Insulin growth factor 1 (IGF-1) that plays an important role in cell proliferation and the inhibition of cell death (apoptosis). Apoptosis process in the target tissue start with the removal of trophic hormone (Wyllie *et al.*, 1980; Tenniswood *et al.*, 1994). The mechanism of action of testosterone on bovine skeletal muscle is that it directly affects its specific receptor sites (Sauerwein and Meyer, 1988). Testosterone is also known to stimulate specific muscle groups having higher number of testosterone receptors. Earley and Crowe (2002) also observed that calves castrated surgically had a lower ADWG than un-castrated calves. Fisher *et al.* (2001) reported that at 14 month of age, castrated cattle had slower growth rate than un-castrated cattle. Same were the findings of other scientists (Fisher *et al.,* 1996; Knight *et al.*, 1999; Mach and Bach, 2009). Biagini and Lazzaron (2007) also

**Table 8:** The concentration of blood hormones of not-castrated group (NCG) and surgically castrated group (SCG)

| | 12th month | 13th month | 14th month | 15th month | 16th month | 17th month | 18th month | 13th-18th average |
|---|---|---|---|---|---|---|---|---|
| Testosterone (T) (Unit, nmol/L) | | | | | | | | |
| NCG | 12.39±1.43 | 13.09±0.66$^{A}$ | 12.60±2.41$^{a}$ | 11.96±5.68 | 14.77±3.78$^{A}$ | 12.12±1.96$^{a}$ | 13.20±0.86$^{a}$ | 12.96±1.02$^{A}$ |
| SCG | 12.28±0.59 | 8.63±3.78$^{B}$ | 6.61±2.19$^{b}$ | 8.99±3.57 | 8.04±1.86$^{B}$ | 5.17±0.84$^{b}$ | 8.40±1.55$^{b}$ | 6.98±1.79$^{B}$ |
| *P* value | 0.96 | 0.001 | 0.01 | 0.18 | 0.004 | 0.03 | 0.034 | 0.000 |
| Growth hormone(GH) (Unit, g/L) | | | | | | | | |
| NCG | 44.56±4.31 | 48.15±5.37$^{A}$ | 35.94±1.85 | 40.23±7.57 | 48.15±5.37 | 20.46±8.56 | 45.87±11.32 | 39.80±10.63 |
| SCG | 45.19±17.79 | 29.06±5.39$^{B}$ | 30.97±6.82 | 35.12±2.91 | 44.81±3.02 | 19.67±7.98 | 44.42±11.27 | 34.01±9.65 |
| *P* value | 0.93 | 0.008 | 0.46 | 0.45 | 0.62 | 0.91 | 0.83 | 0.35 |
| Insulin (INS) (Unit, mU/L) | | | | | | | | |
| NCG | 27.64±8.90 | 29.30±2.92 | 22.66±3.43 | 24.23±7.96 | 29.52±15.87 | 33.06±12.60 | 29.97±6.02 | 28.12±3.90 |
| SCG | 28.27±7.51 | 26.07±6.52 | 28.11±3.70 | 26.51±4.46 | 31.16±5.20 | 39.61±4.26 | 34.60±3.10 | 32.68±4.99 |
| *P* value | 0.92 | 0.28 | 0.38 | 0.72 | 0.79 | 0.30 | 0.46 | 0.11 |
| Thyroid-3 (T3) ((Unit, ng/L) | | | | | | | | |
| NCG | 150.79±48.25 | 162.80±27.49 | 125.00±13.72 | 101.32±20.72 | 167.67±51.39 | 123.21±24.57 | 141.31±48.43 | 136.89±25.42 |
| SCG | 171.44±35.63 | 171.20±2.92 | 90.64±32.45 | 85.19±35.80 | 163.54±43.01 | 94.26±28.00 | 131.36±9.07 | 122.70±38.31 |
| *P* value | 0.46 | 0.76 | 0.22 | 0.56 | 0.88 | 0.30 | 0.72 | 0.47 |
| Thyroid-4 (T4) (Unit, μg/L) | | | | | | | | |
| NCG | 267.82±82.58 | 266.80±75.54 | 217.70±31.42 | 188.75±21.71 | 196.26±52.24 | 188.61±41.03 | 181.75±27.69 | 206.64±31.97 |
| SCG | 291.52±41.66 | 239.00±86.48 | 227.70±77.48 | 171.52±64.02 | 156.02±62.37 | 85.30±17.66 | 209.90±56.68 | 181.58±57.02 |
| *P* value | 0.67 | 0.62 | 0.86 | 0.76 | 0.47 | 0.072 | 0.615 | 0.37 |

Note: A, B in columns means extremely significant difference ($P<0.01$); a, b in columns means significant difference ($P<0.05$)

reported that ADWG were higher in the non-castrated animals as compared to the castrated calves whether animal were castrated before or after puberty (Biagini and Lazzaron, 2007; Xiao *et al.*, 2014).

Effect of castration on body condition scoring was same as reported by Biagini and Lazzaron (2007). No effect on the height, length and chest girth was observed that might be due to the same level of insulin like growth factor in both groups, which triggered by GH and also played a key role in the enhancement of cell proliferation along with inhibition of cell death (apoptosis).

In this study, reduction of the growth hormone was noted after castration that might be due to the castration stress on animals. It has been reported that castration had a major effect on pituitary GH concentrations rather than serum GH. Sinha *et al*. (1979) reported that administration of testosterone in castrated animals increases pituitary GH concentrations with no considerable influence on serum GH. In the present trial, no significant effect of castration was observed on insulin, $T_3$ and $T_4$ concentrations in SCG when compared with NCG. Our findings were similar with that of Galbraith *et al*. (1978) who reported insignificant effect on insulin level in castrated bulls. It has been studied that level of testosterone in the current trial decreased at 6th month of trial showing slow effect of the post castration. There is also conflicting information regarding the possible relationship between gonads and physiology of thyroid gland (Money *et al.,* 1950). Interstitial cells of testis (Leydig cells) are the principle secretory source of testosterone hormone; however, a little amount of testosterone is also produced by the outer layer of the adrenal glands in both sexes (Swenson, 1977). In previous studies, fluctuation in testosterone level was noted at different times of age and experiment (Pang *et al.*, 2008). The concentrations of serum testosterone from 7 to13 months of age in cattle increased linearly (Lunstra *et al.,* 1978), it reached to peak value at 15 months of age, then tended to decrease at 18th months of age (Gerrard *et al.,* 1987).

## Conclusion

Post pubertal castration had a significant effect on increase of live weight and level of testosterone. Wannan cattle can be castrated successfully after 12 months of age to gain maximum benefits of early month's growth and high marble beef meat. This research would be helpful for further flourishing of the beef industry of China and all over the world. Results are also satisfactory to shift small cattle breeds towards beef breed.

## Acknowledgments

This work was supported by the earmarked fund for National Beef Cattle Industry and Technology System (CARS-38) and the Projects of Research of Ruminant Fattening and High-quality Meat Production Technology in Southern China (201303144). The authors acknowledge Spring Mountain Farm's management for providing the experimental conditions.

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**(Received 24 February 2014; Accepted 11 August 2014)**