

Impact of early castration and health status on the performance of Holstein-Friesian and beef crossbred calves

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Abstract

Introduction: This article presents the analysis of the correlation between the category and health status of calves and the results of their rearing and levels of selected blood parameters. **Material and Methods:** The study included 105 Polish Holstein-Friesian and beef (Limousine, Charolaise and Hereford) crossbred calves. Young bulls were purchased at the age of two to four weeks. The animals underwent quarantine, were dehorned, and 46 young bulls were castrated. The germ horns were removed by burning out. Castration was carried out with a bloodless method using a rubber band. The calves were kept in groups and fed a milk replacer administered *via* teats from automated milk-feeding stations. After the period of milk feeding, the calves were fed grass silage *ad libitum* and a concentrate at 2.5 kg/animal/day. The calves were weighed every two weeks. Blood for analyses was sampled at 43 d of age. **Results:** After the rearing period finished at the age of six months, young bulls and steers had similar body weights (176.17 and 176.55 kg) and approximate average daily weight gains from birth (0.756 and 0.767 g/day). The healthy calves at six months of age weighed 180.47 kg, whereas the animals which at least once suffered from some diseases during rearing were lighter by approx. 30 kg ($P \leq 0.01$). A statistically significant ($P \leq 0.01$) difference was found for the count of red blood cells and white blood cells. In comparison with healthy individuals, the diseased animals had less RBC (8.33 and 9.42 $10^{12}/L$ respectively) and more WBC (27.03 and 12.26 $10^9/L$ respectively). **Conclusion:** Castration of young bulls did not have any impact on the results of rearing and health status of the calves. The magnitude of the analysed parameters depended on the health status of the calves. Thus RBC and WBC parameters may be used to predict the health status of calves during rearing.

Keywords: calves, gender, rearing, blood parameters, performance.

Introduction

In Poland, cattle are predominantly reared for milk. The participation of beef breeds in the whole population is only 1%. Therefore, beef originates mainly from dairy breeds and does not always meet the requirements of consumers. Among the slaughtered young cattle, young bulls constitute approx. 72% and 28% are heifers (1). Steers are not fattened. In order to improve the quality of beef, commercial crossbreeding of local cattle breed with beef cattle is practised. Steer fattening may also be a way to change the quality of beef as steers' meat is of lighter colour and more tender. Optimal rearing of calves is the basis for

achieving good fattening results. Body weight at separation and at the end of rearing (at six months of age) as well as daily weight gains in this period depend on the level of feeding, gender, and health status of calves. It was found that comparable rearing results can be obtained with different systems and feeding strategies with milk feeds. In general, higher weight gains are achieved by young bulls than by steers and heifers (14). Differences in body weight between young bulls and steers of the same age depend on the timing of castration (7). To benefit from the high growth potential of young bulls, it is suggested to perform castration at the final stage of rearing. However, considering animal welfare, castration at a younger age

is more beneficial because the level of stress reaction in such animals is lower. Castration-induced stress results directly in reduced productivity, causing a drop in daily weight gains and indirectly increasing susceptibility to diseases (3, 15, 16, 21). Diarrhoea and respiratory diseases are the main cause of morbidity in calves during rearing (22). A decision to implement treatment is taken based on observations of clinical symptoms. However, the level of some biochemical blood indicators may also be used to this end as evidenced by the studies of Jagos *et al.* (10), Martin and Lumsden (14), Pekcan *et al.* (19), and Stojević *et al.* (24). This is of particular importance as calves are often diseased without any visible symptoms.

The objective of the study was to determine the relationship between the category and health status in calves, and the results of their rearing and the levels of selected blood parameters before the start of observations.

Material and Methods

Animals. The study included 105 Polish Holstein-Friesian/beef (Limousine, Charolaise and Hereford) crossbred calves. Young bulls were purchased at the age of two to four weeks from different locations. After purchase, a two-week quarantine was implemented during which the calves were dehorned and 46 young bulls were castrated. The germ horns were removed by burning out. Castration was carried out with a bloodless method using a rubber band.

Feeding. The calves were milk-fed with a milk replacer administered *via* teats from automated milk-feeding stations. The daily dose of liquid feed was 8 L at the age of two to four weeks, 6 L between week five and seven, 4 L between week eight and eleven, and 3 L between week eleven and thirteen. One kg of milk replacer contained: 22% of total protein, up to 0.8% of crude fiber, and 15% of crude fat with water at a 1:8 ratio. During the period of liquid feeding, the calves had unlimited access to concentrate and hay. Hay was composed of the first swath of dried grass mixture and concentrate containing maize grain and oat administered simultaneously with liquid feeding. The end of liquid feeding was set at the body weight of 135 kg for young bulls and 130 kg for steers. Having been liquid-fed, the calves were fed grass silage *ad libitum* and the concentrate at 2.5 kg/animal/day. The chemical composition and nutritional value of feeds are presented in Table 1. The concentration of basic components was determined with standard methods (4) and NDF and ADF with the method by Van Soesta *et al.* (25). The nutritional value of solid feeds was determined based on the chemical composition according to IZ PIB-INRA (9).

Body weight control. The calves were weighed at two-week intervals. Body mass was determined using an electronic scale for animals and the measurements

were always taken in the morning before feeding. Based on the measurements, the average daily weight gains were calculated by dividing the weight gains in the period between measurements by the number of days in a period.

Health status control. Throughout the rearing period, experienced staff monitored the health status of the calves. Behaviour, feed intake, respiration, and faecal consistency were observed. All deviations from the standards were reported to a veterinarian who decided whether to implement treatment. On this basis, the calves were divided into two groups: the first included healthy animals (90 heads) whilst the second comprised individuals that were ill and needed veterinary treatment at least once during the rearing period. The reasons for veterinary treatment were different, and the group of diseased calves comprised 15 animals – eight bulls and seven steers.

Blood sampling and analyses. At the beginning of the observation period at the age of 43 d, blood was sampled from all calves. The blood was collected from the jugular vein into two tubes: 2 mL of blood for haematology into a tube without additives and 9 mL of blood for biochemistry into a tube with K2 EDTA. The haematological parameters were measured in the whole blood directly after sampling (within 2 h) with a BC2800Vet automated analyser (Mindray, China). The biochemical parameters were determined in serum obtained after blood centrifugation at 300 rpm for 10 min. The serum was stored at -80°C until analyses. The measurements were taken with a photometric method on a BS 120 biochemical analyser (Mindray, China). Absorbance was recorded at wavelengths from 340 to 670 nm. The content of immunoglobulins in the blood samples was determined with ELISA. The commercial sets suitable for measurements of immunoglobulins in bovine serum (Bethyl Laboratories, USA) were used. The concentration of immunoglobulins was determined with an ELISA reader by taking an absorbance measurement at 450 nm.

Statistical analysis. The results were statistically processed with Statistica v. 10 (23). The impact of the category (young bulls – 59 animals, steers – 46 animals) and health status (healthy – 90 animals, diseased – 15 animals) on the magnitude of daily weight gains, body weight at six months of age and the level of selected blood parameters was determined using the analysis of variance with the following model:

$$Y_{ij} = \mu + A_i + B_j + (AB)_{ij} + e_{ij}$$

where:

Y_{ij} – value of the analysed parameter,

μ – mean for the population,

A_i – impact of a given category (1, 2),

B_j – impact of health status (1, 2),

$(AB)_{ij}$ – interaction category x health status,

e_{ij} – random error.

The significance of differences was estimated by Tukey's test at the level of 0.05.

Table 1. Chemical composition and nutritional value of experimental feeds

| Specification | Milk replacer * | Hay | Grass silage | Concentrate I | Concentrate II |
|-----------------------|-----------------|-----|--------------|---------------|----------------|
| Dry matter (DM), g/kg | 965 | 867 | 408 | 875 | 876 |
| Content in DM, g/kg | | | | | |
| Organic matter | 976 | 919 | 827 | 827 | 900 |
| Crude fat | 100 | 14 | 39 | 21 | 17 |
| NDF | | 576 | 529 | 185 | 189 |
| NE MJ** | | 4.8 | 5.32 | 6.94 | 6.96 |
| NEL MJ | 11.59 | | | | |

* declared by the manufacturer

**NE MJ – acc to IZ PIB-INRA, 2009

***acc to DLG, 1997

Table 2. Results for calves reared up to the age of six months by categories and health status

| Specification | Category (C) | Health status (HS) | | | | Total | | Interaction C x HS |
|---------------------------------------|--------------|--------------------|-------|-----------|-------|-----------|-------|-----------------------|
| | | Healthy | | Sick | | | | |
| | | \bar{x} | SEM | \bar{x} | SEM | \bar{x} | SEM | P - value |
| Age at weaning (days) | Bulls | 117.90 | 3.63 | 150.77 | 3.92 | 123.47 | 3.47 | 0.031 |
| | Steers | 111.31 | 3.23 | 161.14* | 4.00 | 116.72 | 3.94 | |
| | Total | 114.90 | 2.47 | 154.23** | 5.19 | 120.51 | 2.61 | |
| Body weight at the age of 182 d (kg) | Bulls | 180.34* | 3.59 | 155.74 | 7.66 | 176.17 | 3.45 | 0.399 |
| | Steers | 180.48** | 3.26 | 144.33 | 8.42 | 176.55 | 3.45 | |
| | Total | 180.47** | 2.44 | 151.93 | 5.88 | 176.34 | 2.45 | |
| Average daily gain (kg) | | | | | | | | |
| Pre-weaning | Bulls | 0.759** | 0.024 | 0.457 | 0.022 | 0.708 | 0.025 | 0.539 |
| | Steers | 0.765** | 0.026 | 0.522 | 0.071 | 0.739 | 0.027 | |
| | Total | 0.762** | 0.018 | 0.478 | 0.028 | 0.721 | 0.018 | |
| Post-weaning | Bulls | 0.929 | 0.105 | 1.250 | 0.179 | 0.953 | 0.092 | 0.793 |
| | Steers | 0.914 | 0.035 | 1.224* | 0.232 | 0.925 | 0.039 | |
| | Total | 0.922 | 0.059 | 1.242 | 0.140 | 0.940 | 0.055 | |
| Overall (0-182 d) | Bulls | 0.788 | 0.020 | 0.652 | 0.016 | 0.756 | 0.017 | 0.399 |
| | Steers | 0.788* | 0.018 | 0.590 | 0.046 | 0.767 | 0.019 | |
| | Total | 0.788* | 0.013 | 0.632 | 0.019 | 0.766 | 0.013 | |

Mean values in horizontal rows are significantly different: * – P < 0.05; ** – P < 0.01

Results

Performance. The average age of the calves at the beginning of observation was 43 d. Liquid feed was fed to young bulls up to 135 kg and to steers up to 130 kg. The performance results for the calves are presented in Table 2. The period of milk feeding lasted for an average of 120 d. The young bulls reached the assumed body weight six days later than the steers. Their daily

weight gains in this period were 0.708 kg and were slightly lower than those of the steers. In the post-weaning period, the daily weight gains of the calves increased, amounting to 0.940 kg on average. At that time, the young bulls had higher gains than the steers. At the age of six months, all calves had the same body weight and comparable daily weight gains from birth till six months of age. The performance results were diversified by health status. The animals that were

diseased had statistically significantly ($P \leq 0.01$) lower daily weight gains, a longer period of liquid feeding and lower body weight at six months of age. After separation, daily weight gains in the calves that were previously diseased were higher than those in the calves previously categorised as “healthy”.

Blood parameters. The evaluation of haematological parameters involved 59 young bulls and 46 steers, with 15 animals out of the total considered as unhealthy (Tables 3 and 4). The average values of analysed parameters (except WBC) were within a wide range of reference values (5, 27). No differences between young bulls and steers were found. The values of the analysed parameters depended on the health status of the calves. The diseased calves had a statistically significantly ($P \leq 0.01$) lower number of RBC and higher counts of WBC (including lymphocytes) than healthy calves. In addition, in the diseased calves there was a decreased level of glucose and increased concentration of total protein in blood serum; however, these differences were not confirmed statistically. The analysis of the concentration of immunoglobulins in blood serum demonstrated that calves which needed veterinary treatment at least once during the rearing period had a higher level of IgG and lower levels of IgM and IgA than their healthy counterparts, although the difference was not confirmed statistically.

Discussion

In Poland, steer rearing and fattening is not a part of traditional animal production. The selection of timing and method of castration were thus influenced by the results reported by other authors. The age of castration and the procedure impair animal welfare and reduce daily weight gains (15, 21, 26). Studies on both timing (after birth, at six or twelve months of age) and the method of castration (with a rubber band or surgically) carried out by Knight *et al.* (12) showed that the age of castration did not differentiate the body weight of steers at slaughter. It causes a transient reduction of daily weight gains. Fisher *et al.* (8) did not demonstrate any differences in the stress level after castration performed with different methods. According to Mellor *et al.* (17), the level of stress may be higher when the animals are castrated at the older age. Considering this and the age of calves at purchase, in the present study the young bulls were castrated before puberty and the average age at castration was 37 d. The conducted study did not find any differences between young bulls and steers in the size of daily weight gains during rearing or body mass at the age of six months. This finding is consistent with observations of other authors.

Table 3. Blood parameters for calves with regard to their health status and category

| Specification | Category (C) | Health status (HS) | | | | Total | | Interaction C x HS |
|---------------------|--------------|--------------------|------|-----------|-------|-----------|------|--------------------|
| | | Healthy | | Sick | | | | P - value |
| | | \bar{x} | SEM | \bar{x} | SEM | \bar{x} | SEM | |
| RBC ($10^{12}/L$) | Bulls | 9.45 | 0.25 | 8.64 | 0.77 | 9.32 | 0.25 | 0.369 |
| | Steers | 9.38** | 0.19 | 7.70 | 0.67 | 9.19 | 0.20 | |
| | Total | 9.42* | 0.16 | 8.33 | 0.56 | 9.26 | 0.16 | |
| WBC ($10^9/L$) | Bulls | 12.11 | 1.54 | 23.32 | 11.62 | 14.01 | 2.34 | 0.271 |
| | Steers | 12.43 | 1.12 | 34.45** | 20.17 | 14.83 | 2.44 | |
| | Total | 12.26 | 0.98 | 27.03** | 9.93 | 14.37 | 1.69 | |
| Limf ($10^9/L$) | Bulls | 5.76 | 0.98 | 14.27 | 9.82 | 7.2 | 1.84 | 0.127 |
| | Steers | 5.03 | 0.75 | 25.72** | 8.10 | 7.28 | 2.13 | |
| | Total | 5.43 | 0.63 | 18.39** | 8.64 | 7.24 | 1.39 | |
| GLU (mg/dL) | Bulls | 73.04 | 2.19 | 66.80 | 3.44 | 71.98 | 1.92 | 0.279 |
| | Steers | 72.93 | 2.65 | 76.80 | 8.70 | 73.35 | 2.52 | |
| | Total | 72.99 | 1.69 | 70.13 | 3.72 | 72.58 | 1.54 | |
| TP (g/dL) | Bulls | 5.12 | 0.08 | 5.30 | 0.12 | 5.15 | 0.07 | 0.529 |
| | Steers | 5.00 | 0.07 | 4.98 | 0.41 | 5.00 | 0.08 | |
| | Total | 5.07 | 0.06 | 5.19 | 0.15 | 5.08 | 0.05 | |

Mean values in horizontal rows are significantly different: * – $P < 0.05$; ** – $P < 0.01$

Table 4. Blood protein profile by category and health status

| Specification | Category (C) | Health status (HS) | | | | Total | | Interaction C x HS |
|---------------|--------------|--------------------|------|-----------|------|-----------|------|--------------------|
| | | Healthy | | Sick | | | | |
| | | \bar{x} | SEM | \bar{x} | SEM | \bar{x} | SEM | P - value |
| IgG (g/L) | Bulls | 13.64 | 0.25 | 15.75** | 0.57 | 13.99 | 0.25 | 0.322 |
| | Steers | 14.13 | 0.23 | 15.27 | 0.90 | 14.25 | 1.56 | |
| | Total | 13.86 | 0.17 | 15.59** | 0.47 | 14.11 | 0.17 | |
| IgM (g/L) | Bulls | 0.93 | 0.10 | 0.85 | 0.17 | 0.92 | 0.09 | 0.526 |
| | Steers | 0.76 | 0.06 | 0.47 | 0.09 | 0.73 | 0.05 | |
| | Total | 0.86 | 0.06 | 0.72 | 0.12 | 0.84 | 0.05 | |
| IgA (g/L) | Bulls | 0.34 | 0.13 | 0.14 | 0.03 | 0.31 | 0.11 | 0.534 |
| | Steers | 0.16 | 0.02 | 0.20 | 0.06 | 0.16 | 0.02 | |
| | Total | 0.26 | 0.07 | 0.16 | 0.03 | 0.25 | 0.06 | |

Mean values in horizontal rows are significantly different: ** – $P < 0.01$

As androgens are responsible for the development of secondary external sexual features (growth of neck muscles and shoulder area), differences in productivity between young bulls and steers are seen mainly after puberty (10). Bretschneider (7) also reported that castration of calves at birth allows animals to achieve the same body weight at the age of six to nine months as intact individuals.

A reduction in daily weight gains after castration is caused not only by stress, but also by higher susceptibility of animals to diseases (16, 20), especially when castration is performed at the older age (15). In the present study, no significant impact of castration on the incidence of diseases in the calves was recorded. Treatment was needed in 17% of the young bulls and 16% of the steers. In the present study, there were no differences recorded between young bulls and steers in haematological parameters. The analysed blood indices were within a wide range of reference values (5, 27). However, Pavlik *et al.* (18) found that gender had an impact on the level of total protein in blood serum; the heifers had a significantly higher ($P < 0.05$) concentration of total protein than young bulls. In the present study, no signs of diseases were recorded in tested blood parameters. Nevertheless, it was found that the values of blood parameters at the beginning of the experiment were associated with health status during rearing. The diseased calves had a statistically significantly ($P \leq 0.01$) lower number of RBC and a higher count of WBC, including lymphocytes, than healthy animals. Martin and Lumsden (14) also noted differences between healthy and diseased calves, and these findings may be used to predict future health status. An increase in the number of WBC indicates inflammatory processes in the body. Aksionova and Nikulina (2) also found that the beginning of disease in animals led to a decrease in erythrocyte count in blood.

Litwińczuk *et al.* (13) found differences in haematological profile of blood between calves slaughtered in summer and autumn. Higher percentage of WBC and significantly higher lymphocyte count were shown by calves slaughtered in summer. However, Winnicka (27) reported that in cattle, especially in young ruminants, this parameter undergoes substantial fluctuations and is therefore less important in predicting health status compared to other animal species. In the diseased animals, there was a tendency towards a reduction in the level of glucose and an increase in the concentration of total protein in blood serum. These differences were not confirmed statistically. Jagos *et al.* (10) and Pekcan *et al.* (19) reported a statistically significant reduction in the concentration of glucose in blood serum in calves during bronchopneumonia and diarrhea, and these authors believe that this parameter may be a diagnostic tool. In the present study, the analysis of blood parameters was performed at the beginning of observations, *i.e.* after purchase and quarantine at the age of 43 d, and changes in the level of glucose were therefore statistically insignificant. No statistically significant difference in the concentration of measured immunoglobulins in blood serum collected from healthy and diseased calves was recorded. Moreover, it was not confirmed that calves with a lower level of immunoglobulins were ill more often. Both in the group of healthy calves and in the animals showing symptoms of a disease at least once during the experiment there were animals with very high and very low levels of passive immunity indices. It is thus concluded that the concentration of measured immunoglobulins in blood serum did not have any relation to the category or health status of the calves. The results are consistent with the findings reported by Ježek *et al.* (11) and Bender and Bostedt (6) who did

not record any statistically significant relation between the concentration of IgG and IgM in blood serum and the incidence of diseases in calves. However, Jagos *et al.* (10) and Pekcan *et al.* (19) found a higher level of globulin proteins in blood serum of calves with diarrhoea and bronchopneumonia, and reported that it might be associated with inflammatory conditions.

In conclusion, it was demonstrated that early castration of young bulls did not have any negative impact on their health status, blood parameters, or body weight at the end of rearing period (*i.e.* at the age of six months). The magnitude of the analysed features depended on the health status of the calves. The performance parameters were diversified by the health condition of the calves. The animals that were ill had lower daily weight gains, longer period of liquid feeding, and lower body weight at the age of six months in comparison to healthy animals. A lower number of RBC and a higher number of WBC in animals without any visible disease symptoms may be indicative of their future health status. These parameters may thus be used to predict the health condition of calves during rearing.

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Animal Rights Statement: The authors declare that the experiments on animals were conducted in accordance with the local Ethical Committee laws and regulations as regards care and use of laboratory.

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