# YIELD AND CARCASS CHARACTERISTICS OF IMPROVED BOER AND AUSTRALIAN FERAL GOATS SLAUGHTERED AT 30 KG LIVE WEIGHT

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## SUMMARY

With the objective of evaluating the yield and carcass characteristics of full blood Improved Boer (B) and feral (F) goats, a total of 20 male kids that grazed on pastures, and supplemented with grassy lucerne hay and *ad libitum* weaner goat pellets (12.3 MJ ME and 18 % CP per kg DM) were slaughtered at 30 kg live weight. At the start of the experiment six-month old kids of each breed were either left entire (E) or castrated (C) using elastrator rings. BE and BC reached 30 kg live weight significantly at younger ages than FE and FC (256, 258, 326 and 350 days, respectively). Carcasses from BC kids had significantly higher empty bodyweights, carcass weights and dressing percentages than carcasses from BE goats. These differences were not detected for feral bucks. Overall, goat carcasses in this trial contained 70.5% muscle, 9.5% dissectible fat and 17.6% bone. Carcasses of Boer goats, both entire and castrated, had higher carcass conformation scores than those of feral carcasses. Breed and castration had no significant effect on the proportion of muscle. More fat was stored between muscles (intermuscular fat) than between the muscles and the skin (subcutaneous fat). BE carcasses had significantly lower total dissectible fat and higher bone proportion than other groups. The higher proportion of bone in BE carcasses resulted in lower muscle to bone ratio.

*Keywords:* goat, Improved Boer, feral, carcass composition, castration, growth

## INTRODUCTION

Feral goats have been Australia's main source of live goat and goat meat exports. The growing demand for goat meat with desirable quality characteristics cannot be met by the opportunistic harvesting of feral goats (Mitchell 1982; Black 1998). This has led to the introduction of the Improved Boer goat and crossbreeding with other established goat breeds such as the Angora, Saanen and feral (Dhanda *et al.* 1999a, b; Husain *et al.* 2000a,b). In South Africa, the Boer has been reported to have superior growth rates, carcass yield and carcass characteristics than any other breeds (Van Niekerk and Casey 1988; Malan 2000). In October 1995 after five years under quarantine, approximately 3,000 Improved Boer goats were released and distributed throughout Australia to improve goat meat production (Johnson 1999). Crossbreeding Boers with other breeds was reported to improve growth rates and overall carcass characteristics in the first and second cross offspring (Dhanda *et al.* 1999 a, b; Husain *et al.* 2000 a,b). There is little doubt that Boer goats will have a major influence on the future of goat meat production in many countries. There is, however, very limited published information on the yield and carcass characteristics of full blood Improved Boer bucks reared outside South Africa and specifically under Australian conditions and management practices. Their superior performance and ability to produce carcasses and meat with desirable quality characteristics need to be investigated and compared with breeds of goats that have been well adapted to local conditions. Therefore, the objective of this study was to evaluate the yield and carcass characteristics of entire and castrated full blood Improved Boer bucks and ferals slaughtered at 30 kg live weight.

## MATERIAL AND METHODS

*Experimental animals, diet and management*

This trial used 10 full blood Improved Boer bucks and 10 Australian feral bucks initially approximately six months of age with an average initial live weight of 24.3 ± 0.95 kg for castrated groups and 27.3 ± 0.95 kg for entire groups. Half the bucks of each breed were castrated using elastrator rings. All goats were reared on a Rhodes grass-dominatedpasture with an additional supply of grassy lucerne hay (75-125 kg/day) and *ad libitum* access to commercial weaner goat pellets (12.3 MJ ME and 18% CP per kg DM). Fecal egg counts were measured regularly and goats drenched as necessary with Levamisole (32 g/l levamisole hydrochloride, Nilverm™). All goats were vaccinated against clostridial diseases and caseous lymphadenitis (Glanvac™ 6 in 1 vaccine) at the beginning of the experiment and then every six months.

*Procedures*

**Slaughter and dissection** When animals reached the target slaughter weight of 30 kg they were confined in a holding yard off feed with access to drinking water for 18 hours before slaughter. Slaughter weights were recorded before and after fasting (fasted live weight, FLW) and then goats were slaughtered using standard commercial techniques at the University of Queensland's abbatoir. Loss of body weight was calculated as the difference between the weight before and after fasting. The dressed carcass composed of the body after removing the skin, head (at the occipito-atlantal joint), fore feet (at the carpal-metacarpal joint), hind feet (at the tarsal-metatarsal joint) and the internal organs (Dhanda *et al.* 1999a). Internal organs were weighed immediately after removal as well as the weight of kidney/pelvic and omental fat depots. Empty body weight (EBW) was calculated as the difference between fasted slaughter weight and weight of gastrointestinal tract contents. Hot carcass weight (HCW) was determined approximately an hour and a half after slaughter and cold carcass weight (CCW) was determined 24 hours after chilling at $2^0$C. Loss in carcass weight was calculated as the difference between hot and cold carcass weight. Dressing percentage (DP) was expressed as the proportion of HCW to EBW and FLW. Chilled carcasses were split along the vertebral column midline into left and right halves using a band saw. One half of the carcass was cut into five commercial cuts following the standard procedures proposed by Colomer-Rocher *et al.* (1987) and then dissected into dissectible muscle, fat (subcutaneous and intermuscular fat, separately), bones and remainder (ligament, connective tissues, etc). All dissection was completed within 78 hours after slaughter in a temperature-controlled room.

**Measurements** Carcass length was measured from the posterior edge of the pubic symphysis to the upper part of the anterior edge of the first rib. Subcutaneous fat thickness, carcass conformation and visual fat cover scores were measured and assessed on the cold carcass. Subcutaneous fat thickness was recorded using a caliper at the rump (2 cm lateral to 3$^{rd}$ sacral vertebra) and the 12/13$^{th}$ rib. Scoring of body condition was done using the standard for body condition scoring as described by Mitchell (1986) while carcass conformation was assessed using a 15 point scale (1: very thin to 15 very thick and bulging) as described by Oman (1999). Visual fat cover (1:low fat to 5: very high) and kidney fat (1:little to 3:excessive) were assessed as described by Colomer-Rocher *et al.* (1987).

*Data analysis*

All data recorded were analyzed using General Linear Model procedures and differences between means were compared using Tukey's Studentized Range (HSD) Test (SAS INSTITUTE INC. 1988). Effects fitted in the model included breed effect, castration effect and appropriate interactions.

**RESULTS**

Results are summarised in Table 1. The slaughter age of both Boer groups was significantly lower than for the feral bucks. Entire bucks were younger than castrated bucks when slaughtered, although in feral goats the differences were not significant. Fasted live weight and weight lost over 18 hours without feed were similar among all four groups, however the EBW, HCW, CCW and DP for the Boer bucks were significantly lower than those of feral bucks. All goats lost about 7% of their body weight due to fasting and their carcasses lost about 1.7% of their weight due to dehydration during cooling at $2^oC$ for 24 hours. The castrated goats had slightly thicker subcutaneous fat over the rump than entire goats (1.6 *vs*. 1.0 and 2.3 *vs.* 1.2 in Boer and feral groups, respectively) although for visual fat cover and kidney fat assessments there were no significant differences between the groups. Feral bucks tended to have longer carcasses than Boer bucks. The scores for the body condition of BC bucks were higher than BE and feral bucks and all Boer buck groups had better conformation scores than feral buck groups. The proportion of muscle was similar among groups and entire goats deposited less total fat on their carcasses than castrated bucks. More fat was stored between muscles (intermuscular) than between the muscles and the skin (subcutaneous) in all groups. BE bucks had a significantly higher proportion of bone in the carcass and lower muscle to bone ratio than other groups.

The proportions of empty body weight made up by the head, heart, lungs and kidney were not significantly different between groups but Boer bucks had heavier feet than feral bucks (Table 2). The BE bucks also had significantly heavier empty gastrointestinal tracts than other buck groups. Feral goats, both entire and castrated, tended to store more internal fat (kidney/pelvic and omental fat stores) than Boer goats.

**Table 1. Least square means ± standard error (SE) of slaughter data and carcass characteristics of entire and castrated Improved Boer and feral goats slaughtered at 30 kg live weight**

| | Boer | | Feral | | SE |
|---|---|---|---|---|---|
| | Entire | Castrated | Entire | Castrated | |
| Slaughter age (days) | $205.8^a$ | $257.8^b$ | $326.4^c$ | $350.0^c$ | 8.52 |
| Full live weight (kg) | $30.5^a$ | $32.0^a$ | $31.8^a$ | $32.0^a$ | 0.39 |
| Fasted live weight (kg) | $28.8^a$ | $29.4^a$ | $29.7^a$ | $29.6^a$ | 0.39 |
| Weight lost over 18 hours (%) | $5.6^a$ | $8.1^a$ | $6.6^a$ | $7.5^a$ | 0.83 |
| Empty body weight (kg) | $22.7^a$ | $26.1^b$ | $26.6^b$ | $26.8^b$ | 0.39 |
| Hot carcass weight (kg) | $11.7^a$ | $14.3^b$ | $15.1^b$ | $14.9^b$ | 0.23 |
| Cold carcass weight (kg) | $11.3^a$ | $14.2^b$ | $14.9^b$ | $14.7^b$ | 0.22 |
| Loss in carcass weight (%) | $2.9^a$ | $0.8^b$ | $1.4^{ab}$ | $1.7^{ab}$ | 0.40 |
| Dressing percentage (%) | | | | | |
| - as proportion of FLW | $40.6^a$ | $48.7^b$ | $50.8^b$ | $50.6^b$ | 0.76 |
| - as proportion of EBW | $51.6^a$ | $54.9^{ab}$ | $56.9^b$ | $55.9^b$ | 0.97 |
| Carcass length (cm) | $64.1^a$ | $65.3^{ab}$ | $68.5^c$ | $67.8^{bc}$ | 0.66 |
| Subcutaneous fat thickness (mm) | | | | | |
| - Rump | $1.0^a$ | $1.6^{ab}$ | $1.2^a$ | $2.3^b$ | 0.22 |
| - 12/13 ribs | $0.9^a$ | $1.3^a$ | $1.0^a$ | $1.4^a$ | 0.19 |
| Scoring | | | | | |
| - Body condition | $2.0^a$ | $2.9^b$ | $2.3^a$ | $2.3^a$ | 0.13 |
| - Carcass conformation | $7.2^a$ | $7.4^a$ | $5.2^b$ | $5.3^b$ | 0.45 |
| - Visual fat cover | $1.4^a$ | $1.9^a$ | $1.6^a$ | $2.0^a$ | 0.21 |
| - Kidney fat | $2.0^a$ | $2.0^a$ | $1.9^a$ | $1.9^a$ | 0.07 |
| Dissectible component (%) | | | | | |
| - Muscle | $70.3^a$ | $69.2^a$ | $71.9^a$ | $70.4^a$ | 0.84 |
| - Total dissectible fat | $6.8^a$ | $11.9^b$ | $8.9^{ab}$ | $10.4^b$ | 0.84 |
| *a. Subcutaneous fat* | $1.4^a$ | $2.8^b$ | $1.9^{ab}$ | $2.8^b$ | *0.25* |
| *b. Intermuscular fat* | $5.5^a$ | $9.1^b$ | $7.1^{ab}$ | $7.7^{ab}$ | *0.64* |
| - Total bones | $20.0^a$ | $16.7^b$ | $17.0^b$ | $16.8^b$ | 0.34 |
| - Remainder | $2.9^a$ | $2.1^a$ | $2.2^a$ | $2.3^a$ | 0.20 |
| Muscle to bone ratio | $3.5^a$ | $4.1^b$ | $4.2^b$ | $4.2^b$ | 0.09 |

[abc]Means in the same row sharing a common letter in the superscript are not significantly different (P>0.05)

**Table 2. Least square means ± standard error (SE) of non-carcass parts of entire and castrated Improved Boer and feral goats slaughtered at 30 kg live weight[1]**

| | Boer | | Feral | | SE |
|---|---|---|---|---|---|
| | Entire | Castrated | Entire | Castrated | |
| Head | $8.6^a$ | $8.2^a$ | $9.0^a$ | $8.0^a$ | 0.25 |
| Feet | $3.2^a$ | $3.1^a$ | $2.8^b$ | $2.7^b$ | 0.07 |
| Skin | $7.8^{ab}$ | $7.3^{bc}$ | $8.1^a$ | $6.6^c$ | 0.20 |
| Testes | $0.8^a$ | - | $0.7^a$ | - | 0.07 |
| Heart | $0.5^a$ | $0.5^a$ | $0.5^a$ | $0.5^a$ | 0.03 |
| Liver | $1.8^a$ | $2.5^b$ | $2.3^{ab}$ | $2.0^{ab}$ | 0.14 |
| Lungs | $1.2^a$ | $1.2^a$ | $1.3^a$ | $0.9^a$ | 0.12 |
| Kidney | $0.3^a$ | $0.4^a$ | $0.4^a$ | $0.4^a$ | 0.03 |
| Gastrointestinal tracts (empty) | $16.1^a$ | $13.9^{ab}$ | $11.2^b$ | $13.9^b$ | 0.77 |
| Internal fat: | | | | | |
| - Kidney and pelvic fat | $0.4^a$ | $0.8^{ab}$ | $0.8^{ab}$ | $0.9^b$ | 0.12 |
| - Omental fat | $0.5^a$ | $1.2^{ab}$ | $1.5^b$ | $1.7^b$ | 0.21 |

[ab]Means in the same row sharing a common letter in the superscript are not significantly different (P>0.05)
[1] Calculated as a proportion to EBW (%)

## DISCUSSION

The fact that Boer groups reached 30 kg slaughter weight at a significantly younger age than feral groups indicates that Boer bucks grow faster than feral bucks. The growth of Boer bucks has been reported to be almost double the growth of feral bucks when reared under Australian conditions (Murray *et al.* 2001). Castration also increased the time to reach slaughter weight and thus reduced growth rates. In this study, DP was expressed as the proportion of HCW to FLW and EBW. Warmington and Kirton (1990) suggested that to eliminate the variation in gut content, DP should be calculated on the basis of EBW. However, DP as a proportion to preslaughter liveweight (FLW) was also calculated because it could be more practical at commercial scales. DP as a proportion of EBW will be used for discussion of this paper unless otherwise stated. Boer goats, especially entire bucks had lower DP than feral bucks (53.3 vs. 56.4%). This result confirmed the finding of Husain *et al.* (2000a) who reported that first cross Boer and feral kids had lower DP than pure feral kids. Several factors contributed to the differences in DP. Firstly, due to the differences in the proportion of empty digestive tracts, which in this case BE was higher than other groups. Secondly, the stage of maturity as DP tended to increase with increasing maturity (Warmington and Kirton, 1990). At 30 kg Boer goats were estimated to be about 20-30% of their mature liveweight, whereas feral goats were about 50% of mature liveweight. Lastly, the weight of testes (191.58 ± 18.60 gr and 184.24 ± 18.60 gr in BE and FE, respectively) contributed to the variation of DP between castrated and entire groups.

Losses of carcass weight during cooling (1.7%) were due mainly to dehydration. Capretto carcasses lost 2.5 to 6.9% of their weight during cold storage for 24 hours (Husain *et al*. 2000a). If carcasses have sufficient cover of subcutaneous fat, dehydration should be minimised. According to Shorthouse and Harris (1991), subcutaneous fat thickness of 3mm and over significantly reduces carcass dehydration during cooling and storage.

On average, goat carcasses had 70.5% muscle, 9.5% fat and 17.6% bone. The remaining 2.4% consisted of connective tissue, blood vessels and lymph nodes. BE goats had significantly lower total carcass fat and a higher proportion of bone than castrated and feral groups. The composition of carcasses changes with increases of age and body weight because composition varies depending on stage of maturity (Warmington and Kirton, 1990). Fat is considered to be the most variable tissue in carcasses (Shorthouse and Harris, 1991). The higher proportion of bone in BE carcasses led to lower muscle to bone ratios.

In general, the proportion of subcutaneous fat and its thickness of castrated groups were higher than those of entire groups. These differences were not detected by visual scoring since the scores of visual fat cover were not significantly different between groups. Likewise, the scores of kidney fat were similar for all groups. At 30 kg live weight, Boer bucks had significantly higher carcass conformation scores than feral bucks. However, there was no clear positive relationship between carcass conformation scores and body condition scores, although Mitchell (1986) stated that body condition scores of live goats is a good indication of carcass conformation.

Breed and castration did not have any significant effect on the proportion of head, heart, lungs and kidney. The skins of entire bucks tended to be heavier than those of castrated bucks. It is important to note that hair was not removed from the skin and consequently variation in hair length contributed to the variation in skin weight, especially in feral goats. The significantly higher gastrointestinal tracts of BE certainly affected the dressing percentage as discussed previously. The feet of Boer goats were significantly heavier than that of feral goats but castration had no effect on feet weight. This study clearly indicates the superiority of Improved Boer goats for meat production, primarily by reducing the time required to achieve a targeted 30 kg slaughterweight.

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