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Performance of Burdizzo Castrated Young Sokoto Gudali Bulls Raised in the Feedlot

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Target audience: Small holder cattle farmers, Researchers, Livestock marketers, Extentionist officers

Abstract

This study investigated the effect of castration on growth performance, behaviour and carcass characteristics of young bulls. A total of twenty-four young Sokoto Gudali bulls, ranging in age from 1.5 to 2.0 years and weighing between 175 and 185 kg at live, were used for the study and randomly assigned to two treatments: intact – control (CTR) and or burdizzo castration (BURD). The groups were administered Digitaria smutsii hay as needed, along with concentrate (2 % of body weight). The ninety-day feedng trial ended with the bulls being slaughtered. Castration did not significantly(P>0.05) affect growth rate but intact bulls slightly had significant higher (P<0.05) feed conversion ratio. Castration reduced agonistic and sexual behaviours and testosterone levels were significantly lowwer (P>0.05) in castrated bulls. Carcass characteristics showed that castration increased fat deposition and reduced (P>0.05) muscle tissue. Meat chemical composition revealed that intact bulls had higher (P<0.05) protein and water content while castrated bulls had higher (P<0.05) fat content. The results of this study suggest that castration affects growth pefomance, behaviour and carcass characteristics of bulls and that intact bulls have better meat quality.

Keywords: Behaviour, Burdizzo, cattle; carcass, castration; growth rate

Description of problem

Bos indicus genotypes fed mostly on pasture/forage-based diets and occasionally supplemented with concentrates are the main source of beef cattle in Nigeria. According to Forbes *et al.* (1), bos indicus cattle have evolved to withstand the extremes of temperature and nutritional stress that are characteristic of the tropics and subtropics. The common consensus is that beef from Bos indicus cattle is less tender than beef from Bos taurus cattle due to decreased postmortem proteolysis and greater muscle calpastatin activity (2;3).According to Prado *et al*. (4) and Rotta *et al*. (5), sex plays a significant role in the growth pattern, body development, and carcass composition of beef cattle. When compared to castrates, intact bulls exhibit significantly higher ADG and more efficient feed usage (6, 7, 8). This results in lower production costs. However, because intact bulls have a propensity for aggressive and sexual activity, managing them can be difficult and puts human caregivers at danger (9). Bulls were and are castrated for a variety of reasons, including low softness rates and dark meat (10). Castration of male cattle intended for beef production is a common managerial practice in many developed countries. Castration has been suggested as a way to improve the quality of meat, despite the fact that intact males grow quicker and have better feed efficiency than castrates (11). Bull castration lowers the incidence of high ultimate meat pH and increases carcass backfat (12; 13), intramuscular fat content (12; 14), and tenderness (14). Furthermore, castrating bulls improves animal handling, lessens bruising from carcasses, and decreases aggressive and sexual behaviour (9; 15; 16). The key time that productivity differences between bulls and steers occur is after puberty, which in the improved breeds is reached at an average age of 14 months (17). The testes are the primary source of androgens during puberty, with testosterone being the most potent (18). Male behaviour, external secondary sexual traits, and the development of male accessory organs are all attributed to androgens. With only an average of 3% greater daily feed intake than steers, the anabolic properties of androgens, particularly testosterone, influence bulls' average daily increase by up to 15% (5). By lowering the frequency of injuries to animals and their handlers, minimizing damage to pastures, fences, feeding and handling equipment, and allowing the animals to store energy for growth, less aggressive behaviour can boost the farm's economic return. However, castration lowers development rate and feed efficiency, necessitates more work, is painful, and raises stress (19).

Bulls have better feed efficiency and higher daily gains than steers, according to several studies feeding bulls and steers in feedlots (20; 21, 6). After analyzing numerous studies, Field (10) came to the conclusion that bulls gained weight 17% faster than steers and were 13% more efficient at converting feed to live weight gains. Steers may gain more weight than bulls when raised on grass, according to a different literature analysis by Seideman *et al*. (22). Cobic (23) asserts that on a higher plane of nutrition than on a lower plane, the negative effects of castration on growth rate and feed efficiency are more strongly displayed. In a study conducted in Costa Rica, Ardaya and Zapata (24) did not identify any differences between steers and bulls in average daily increase or ultimate weight. In a high-nutrient environment, like a feedlot, bulls typically outgrow steers in terms of gain and feed efficiency. However, under low nutritional conditions, this improved performance might not materialize.

While the practice of castrating male cattle for meat production has been around for a long time and is still widely used, there is a dearth of experimental data regarding the impact of castrating male cattle at different ages and at the same age on the growth and development of body proportion in farm animals. However, compared to the vast body of literature on the subject for foreign breeds, knowledge about cow castration in the context of beef production is scarce in Nigeria. Therefore, the purpose of this study was to evaluate how castrating young Sokoto Gudali bulls that were fed a diet based on *Digitaria smutsii* hay supplemented with concentrate might affect the bulls' performance in the feedlot.

Materials and Methods

Location of the study

The National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria, Nigeria, was the site of the study. At 640 meters above sea level, Shika is located in Nigeria's Northern Guinea Savannah region between latitudes 11° 8 19.56 N and longitudes 7°45 51.22 E (25). The rainy season, which begins in April or May, settles in June and concludes in October, is what defines the zone. Average yearly rainfall is 1100 mm. April records the highest temperature range of 27°C to 35.0°C, while December through February has the lowest mean minimum temperature of 11.5°C and the highest relative humidity of roughly 72% (25). The harmattan season, which runs from October to January, is a time of dry, chilly weather that precedes the dry season. From March to May, there is hot, dry weather that follows the harmattan season.

The experimental animals

Twenty- four young, intact Sokoto Gudali bulls, weighing between 175 and 185 kg at birth, were chosen for the study from the National Animal Production Research Institute's Beef Research Program herd at Ahmadu Bello University in Zaria. The bulls were aged 1½ to 2.0 years old.

Period of adaptation

The bulls were fed a concentrate diet gradually over the course of two weeks to allow their gut microflora to adjust to the new diet and to allow them to make up for any prior feed restrictions. Throughout the acclimation and experimental period, *Digitaria smutsii* hay was provided *ad libitum*, and the concentrate was fed at a rate of 2% of their body weight.

Experimental procedures

Following the conclusion of the adaptation period, each bull was weighed separately. Two treatment groups were created. One of the two groups was castrated one day before the experiment started and was called burdizzo castration (BURD) having 12 animals, while the other group was left intact and was called bulls-control (CTR) with 12 animals also. The mean life weights of the intact and castrated groups were 180.5+3.5 kg. Each animal was individually confined within a 5.0 x 10.2 m/pen. Iron pipes made up the pens' sides, and shade was given by a roof that was 3.0 meters above the ground. The pen was equipped with feeding troughs and watering stations. Burdizzo was used for a bloodless castration procedure. This approach was chosen since the experiment was carried out during the wet season and to prevent wound infection, which is sometimes observed with certain other castration methods. The spermatic cord and blood veins supplying the testicles were crushed and destroyed by the tool "under local anesthesia," leaving the scrotal skin unbroken. The bulls were forced to lie on the ground while being restrained. One by one, the spermatic cords were pulled in the direction of the scrotal wall, and then the burdizzo jaws were applied, ensuring that the cord-stops held the cord in place. The handles were then securely closed, about two inches above the testicle and maintained for a duration of twenty seconds. To keep the scrotum from falling off and to increase the effectiveness of the operation, the procedure was repeated with a space below the first crush, causing the testicle to atrophy and stop functioning. On the opposing side's other cord, the identical process was carried out once more. Following the conclusion of the adaption period, the experiment was conducted from 2nd May to 30th July, 2020. Individual bull weights were taken once the adaptation period reached.

Experimental diet

Roughage (Digitaria smutsii hay) and concentrate (Maize offal, cottonseed cake, and table salt at 60, 39, and 1%, respectively) were fed to the animals individually as part of the experimental diet (Table 1). Table 1 also displays the chemical makeup of roughages and concentrate feed. All chemical analyses were carried out using the techniques recommended by AOAC. (26). The following formula was used to determine the diet's metabolic energy (ME) content in accordance with MAFF (27): ME = 0.012CP + 0.031EE + 0.005CF + 0.014NFE (MJ/kg DM). where CF stands for crude fiber, CP for crude protein, EE for ether extract and NFE for nitrogen-free extract.

Data collection at the feedlot

Feeding and feed intake

During the trial, each animal received individual feedings. At 8 a.m., they were given the concentrate ration, which was 2 percent of their body weight. Throughout the trial period, Digitaria smutsii was then given to them on an as-needed basis after the concentrate was finished. Every animal's daily feed intake was totaled and documented. The difference between the amount of feed supplied and the feed that was rejected—which was gathered the next morning—was used to compute daily intake. For the duration of the experiment, the animals had unrestricted access to fresh water.

Live weight changes

For the duration of the trial (ninety days), the animals were weighed every two weeks to assess their performance. The difference between fed feed and feed that was refused in the trough was used to estimate daily feed consumption. Samples of the provided feed and refusals were gathered during the collection time, and for analysis, a representative composite sample was produced for each animal in each treatment.

Animal behaviour

On the days when they are opened and brought to the scale for weighing— 14, 28, 42, 56, 70 and 84 days — the bulls' behavior was noted from 07:30 to 10:00 am. The animals' overall activities were assessed using six scan samplings of 10 seconds at 5-minute intervals, while their social behavior (agonistic interactions, nonagonistic interactions, and sexual interactions) was scored using two continuous behavior samples of 15 min every day (28). Bulls engage in a variety of aggressive behaviors, such as fighting, butting, displacement, chasing, and chasing-up. Fighting occurs when a bull pushes its head forcefully against another bull's head, butting occurs when a bull pushes its head forcefully against any part of another bull's body, and chasing-up occurs when a bull uses forceful physical contact to push an animal that is resting up against a wall or other object. Non-aggressive behaviors encompassed social licking, which occurs when a bull touches any part of another animal's body with its tongue, self-licking, and horning, which is similar to fighting but does not involve physical contact. Flehmen, attempted mounts (head on the back of another animal), and successful mounts were examples of sexual encounters. The animals were mostly sleeping, standing, ruminating, and consuming concentrate—the quantity of animals in the feeders with their heads inserted through the feeding rack. The percentage of animals engaged in a comparable activity was determined for every pen.

Measurement of testes

Blood samples (10 ml) were taken during the slaughterhouse's exsanguination process in order to measure the serum testosterone content. At the time of slaughter, the testes' weight was also noted.

Carcass component analysis

The animals were brought to a slaughterhouse, weighed, and slaughtered after an overnight fast at the conclusion of the feeding trial. Using a knife, the carotid artery and jugular vein were severed to slaughter the animals. The blood's weight was noted when it was emptied into a bucket. To avoid forming adhesions between fat and tissue, the skin was carefully flayed. Ears and the instant following the excision of legs below the fetlock joints were used to weigh the skin. The entire gastrointestinal tract—aside from the oesophagus—was taken out and its contents weighed. The intestines were emptied, and then their contents were measured again. Both the kidney and the gastrointestinal tract's fat were extracted and weighed separately. Internal organs were also removed and weighed individually, including the pancreas, liver, kidney, spleen, heart, lung, trachea, and oesophagus. After eliminating the weight of the head, thorax, abdomen, pelvic cavity, and legs below the hock and knee joints, the heated carcass weight was measured. Gut content was subtracted from slaughter weight to determine the empty body weight. The total amount of the trachea, heart, liver, empty gut, kidney, testis, head, legs, and fat (omental, kidney knob, and channel fat) was added up to determine the percentage of total edible offal components (TEOC). The combined amount of horn, blood, and gut content was used to calculate the percentage of total non-edible offal component (TNEOC). The percentage of empty body weight and hot carcass weight was used to compute the dressing percentage.

Chemical analyses

Feed samples were oven-dried for 24 hours at 65°C to evaluate the dry matter content of the feed ingredients (hay and concentrate mixture). After drying the oven-dried samples for five hours at 105°C, the analytical DM concentration was ascertained (27). The content of organic matter (OM) was computed by subtracting the dry matter (DM) content from the ash content, which was obtained by burning the ash for five hours at 550°C. NDF and ADF were assessed using the heat-stable alpha-amylase (29). The Kjeldahl method (26) was utilized to ascertain the nitrogen (N) level. So-lid phase radioimmunoassay (Kit Coat-A-Count Total Testosterone, Diagnostic Products Corporation, Los Angeles, USA) was used to measure the serum concentration of testosterone.

Data analysis

To determine the significance of the differences between the two treatments, the Student t-test for independent samples was applied to all of the study's data. Every analysis was conducted in accordance with the guidelines provided by a for-profit statistics program (30). $Yij = \mu + S_i + e_{ij}$ was the feed intake model that was employed. Where $_{eij}$ = random error, B_i = Sex Effect: 1 and 2, μ = Overall Mean, and Y_{ij} = Sex observation.

Table 1: Chemical composition (%) of *Digitaria Smutsii* hay, Maize offal, Cotton seed cake and concentrate

	Ingredients			
Nutrients%	*D. Smutsii*	Maize offal	Cottonseed cake	Concentrate
Dry Matter	92.72	91.92	92.99	92.37
Organic matter	83.9	81.87	88.01	80.82
Crude protein	5.86	14.31	30.88	19.63
Ether Extract	4.05	8.03	11.05	10.01
Crude Fibre	41.09	31.21	37.23	27.4
Neutral Detergent Fibre	68.89	53.92	50.21	35.95
Acid Detergent Fibre	42.35	34.99	42.35	51.27
Ash	8.82	10.05	4.98	11.55
ME (MJ/kg DM)	11.03	10.88	11.51	10.52

The ME values of the experimental feed ingredients were calculated as per Maff(1975) as follows: ME= (MJ/kg DM) = 0.012CP +0.031EE +0.005CF+0.014NFE. Where CP = Crude Protein, EE = Ether extract, CF = Crude Fibre, A = Ash, NFE = Nitrogen free extract

Results and Discussion

Feed conversion ratio

The intact bulls had a slightly lower feed conversion ratio than the castrated bulls, although the differences were not statistically significant (Table 2). Castration reduced the efficiency of feed conversion, with intact males being 3.23% more efficient than castrates, despite the non-significant difference. This could be explained by the hormone testosterone, which is known to improve diet-induced nitrogen uptake efficiency (36). In the end, this causes castrated bulls' muscle protein breakdown to decrease and intact bulls' muscle protein accretion to grow. It is unknown, therefore, how castration directly affects protein turnover (36). This is consistent with findings from other species, where male castration reduced the efficiency of feed conversion into live body weight compared to intact males (37; 38; 39). Grings et al. (31) discovered that bulls' feed efficiency resulted in a 14g increase in live weight gain per kg DMI over steers. Similarly, castration was found to impair feed conversion efficiency by 13% (40).

Growth rate

Table 2 displays information about the performance of both intact and castrated bulls. Bulls that were left whole grew 0.07 kg/day more than those that had been castrated, but there was no discernible difference between the two groups. This outcome is consistent with the results of Grings et al. (31), who found that there was no significant difference between the two groups and that steers grew 0.09 kg/day less than bulls. For bulls, steers, and heifers, respectively, Berg and Butterfield (32) observed live weight gains of 1.07, 0.98, and 0.87 kg/day. The reason for this poor weight growth could likely be attributed to the influence of the post-puberty age at castration, which was delayed in these experiments. This is corroborated by Heaton et al. (33) and ZoBell et al. (34), who proposed delayed castration of beef calves as a way to enhance the rib-eye region and live animal performance. In a similar vein, Knight et al. (12) discovered that postpubertal castrates might retain some of the advantages of bulls' live weight while obtaining the carcass and meat qualities of steers. However, numerous studies demonstrated that bulls acquire weight far more quickly than steers do (13). This could be because castration was done in these experiments at early ages. The negative impact of castration on the animal's hormonal condition may be the cause of the decrease in the growth rate of castrates in both the current study and the studies previously mentioned. One incredibly powerful growth stimulator is the androgen testosterone. The higher-than-expected concentration of this hormone in intact bulls' blood may be directly responsible for the animals' faster pace of growth. This supports the discovery made by Lee et al. (18) that bulls have enough endogenous anabolic steroids to support optimal growth. In support of this, Arnold et al. (35) linked the existence of testicular hormones to the better capacity for muscular growth in intact males.

Animal behaviour

Castration had no effect on the percentage of animals in each pen that were resting (16.3 ± 1.31%), drinking (1.2 ± 0.17%), eating concentrate (9.7 ± 0.50%), eating straw (8.4 ± 0.56%), or ruminating (6.2 ± 0.52%). There was also no significant interaction between time and treatment. As far as we are aware, no research has documented the overall behaviors of animals over extended periods following capture. But according to Ting et al. (41), Holstein bulls that had surgery to castrate them at the age of 11 months continued to be more likely to stand and less likely to rest in the first six hours following the castration, as opposed to the control group. Robertson et al. (42), in contrast, did not note any changes in the stances or behaviours of calves castrated with burdizzo at 6, 21, or 42 days of age during the first two hours following the procedure. The frequency of animal fighting and displacements per pen, which are related to agonistic interactions, were higher ($P < 0.05$) in CTR animals compared to BURD animals (IRR = 1.86 and IRR = 0.39, respectively). Animal fighting occurred in CTR animals on average 0.3 ± 0.11 times per 5 minutes, while animal displacements per pen occurred in CTR animals on average 2.3 ± 0.39 times per 5 minutes and in BURD animals on average 1.9 ± 0.32 times per 5 minutes. There were no variations in the butting, chasing, and chasing-up behaviours between treatments. Furthermore, the therapy had no effect on the nonagonistic interactions, with an average incidence of 4.8 ± 0.33, 3.9 ± 0.49, and 5.2 ± 0.40 times/5 min, respectively, for animal horning, self-licking, and social licking per pen. As anticipated, the frequency of mounts dropped ($P < 0.05$) in BURD animals from 60 to 121 days following castration (from 2.5 to 0.3 times/5 min per pen), but it was constant (3.0 ± 0.56 times/5 min) in CTR animals. Additionally, from 60 to 121 days following castration, the number of attempted mounts dropped ($P < 0.01$) (from 2.3 to 0.1 times/5 min per pen), but in CTR bulls, the number of attempts remained constant at 2.9 ± 0.46 times/5 min. Additionally, the flehmen response in CTR animals (2.4 ± 0.33 times/5 min per pen) remained stable while decreasing ($P < 0.05$) in BURD animals from 42 to 86 d (from 1.8 to 0.4 times/5 min). According to these findings, agonistic and sexual behavior in pre-pubertal bulls decreased between 60 and 86 days following bur-dizzo castration. The agonistic, nonagonistic, and sexual behavior of prepubescent bulls castrated by the burdizzo method have not been studied, but Katz (16) noted a decrease in the incidence of sexual behavior after castration, and Huxsoll et al. (43) also discovered that active immunization against GnRH not only decreased the amount of testosterone in the serum but also decreased the degree of aggressive behavioral traits in intact bulls as compared to castrates.

Testes measurements

As anticipated, CTR bulls had an average testes weight of 520.7 ± 29.96 g at slaughter, which was higher than BURD animals' weight of 169.7 ± 27.32 g ($P < 0.001$). Consequently, a quick and easy way to determine if animals have been castrated successfully would be to visually evaluate the size of the testes at the butcher. Furthermore, the CTR animals had higher serum levels of testosterone (3.7 ± 0.68 ng/ml) at slaughter ($P < 0.05$) than the BURD animals (1.8 ± 0.68 ng/ml). In accordance, intact bulls had higher blood testosterone concentrations (2.9 ± 0.41 ng/ml) than animals that had been surgically castrated at 4 months of age (0.1 ± 0.01 ng/ml) according to Price et al. (15)'s analysis of animals 16 months of age. In BURD animals, the serum levels of testosterone was not entirely eliminated. This indicates that the tension used on the Burdizzo clamp during animal cage testing was insufficient to cut off the blood flow to the testes and scrotum. Approximately 23% of BURD animals did not exhibit total testicular atrophy. For this reason, the Burdizzo castration technique may not work perfectly on calves that are not yet pubertal.

External live body measurements

Table 3 illustrates how castration affected the external live body measurements used in this investigation. The measurements of body length, depth of hook, hip height, heart girth,

Table 2. Performance of intact and castrated Sokoto Gudali bulls

	Class		
Item	CTR	BURD	LOS
Con. intake (kg/head)	559.79±83.53	597.50±62.91	NS
Hay intake (kg/head)	130.61±16.12	141.19±13.54	*
Total DM intake (kg/head)	690.40±99.06	738.69±75.46	NS
Daily Con intake (kg/head)	6.24±00.34	6.25±00.34	NS
Daily hay intake (kg/head)	1.43±00.01	1.44±00.01	NS
ADF intake (kg/head)	7.67±00.32	7.69 ±00.26	NS
Initial weight	144.83±02.81	146.83±3.32	NS
Final weight	236.33±03.87	233.35±3.23	NS
Weight gain	91.50±02.59	86.52±2.57	NS
Average weight gain	1.02±00.14	0.896±0.08	NS
FCR	7.55±01.43	8.54 ±00.97	NS

LOS = level of significance= Significant at P<0.05, NS = Not significant, CTR = Control, BURD = Burdizzo castration, FCR = Feed convertion ratio*

Table 3. External live body measurements (cm) of intact and castrated young Sokoto Gudali bulls

	Class		
Parameter	CTR	BURD	LOS
Slaughter weight (kg)	258.33 ± 3.89	258.33 ± 3.26	NS
Heart girth	147.75±1.56	147.33±3.59	NS
Heart girth around the hump	163.58±1.61	160.67±3.91	*
Width of shoulders	030.13±1.14	028.75±2.40	*
Height at withers	116.44±2.71	115.17±0.81	NS
Height at tip of hump	122.54±3.08	119.63±3.52	*
Hump base length	027.83±2.75	023.79±2.75	*
Height at hips	120.25±3.52	120.00±3.08	NS
Depth of hook	014.13±0.81	014.67±2.71	NS
Length from patella to posterior midline	039.71±2.40	041.42±1.14	*
Depth of patella from tail junction	058.13±3.91	060.50±1.61	*
Body length	119.21±3.59	121.04±1.56	NS

L.S = level of significance= Significant at P<0.05, N.S = Not significant, CTR = Control, BURD = Burdizzo castration*

and height at withers showed no (P < 0.05) significant variations between the two groups. This is consistent with the results of Purchas et al. (13), who found that when values were corrected to the same live weight, there was no significant difference in wither heights between treatment groups. Males gained more weight and had shorter withers than females, according to Akbar et al. (44), however no statistically significant results were found. In contrast, intact bulls showed significantly (P<0.05) higher scores than castrated bulls for the measurements of shoulder width and hump base length. They also showed significantly higher disparities (P<0.05) for the measurements of heart girth around the hump and height at the tip of the hump.

On the other hand, compared to the overall group, castrates had considerably (P<0.05) greater values for the depth of patella from tail junction and the distance from patella to posterior midline. This outcome might be the result of castration's impact on hormonal state, which is in charge of the phenotypic variations and traits that set males apart from females. This is evident from the fact that compared to females or castrates, intact males have comparatively more muscle in the forequarter, particularly in the neck and crest region (for reproductive functions) (45 ; 46). In a similar vein, Cosgrove et al. (47) discovered that when finishing, castrates kept the prominent neck musculature of bulls but lost the elevated eye muscle area. But there isn't a clear explanation for why some muscles expand allometrically (46).

Carcass yield

Table 4 provides information on dressing percentages and empty body weight (EBW.). Between the whole and castrated bulls, there were no significant variations in the hot and cold carcass weights or any of the dressing percentages, with the exception of the chilled dressing percentage (EBW). For the castrated group, the chilled dressing % was significantly greater ($P<0.05$). Regarding EBW and the hot dressing percentage on an EBW basis, the same pattern was noted. Neither the hot nor cold carcass weight differed significantly depending on the treatment. This is most likely the result of the animals being killed at the same desired weight. There was a small rise (2.17 kg) in the cold carcass weight of castrates. The current study's finding that castration dramatically ($P<0.05$) decreased the proportion of carcass shrinkage may help to explain this. This may be because castrated bull carcasses have thicker subcutaneous fat, which acts as insulation and reduces evaporation as compared to intact carcasses (48).

Castration has no discernible effects on the hot dressing percentage on either an empty body weight basis or a slaughter weight basis. Comparable patterns are noted in the cold carcass dressing percentage based on slaughter weight; however, on empty body weight basis, the dressing percentage of castrated bulls was considerably ($P<0.05$) higher than that of intact bulls. This may be caused in part by the intact bulls' non-carcass components weighing more and the fact that castrates were fatter than whole bulls—the substance that developed the previous resistance to chilling shrinkage. This was consistent with the finding of Mohamed (38) that the percentage of dressed out animals was somewhat higher in castrates than in whole animals, albeit not being statistically different.

Non-carcass components

The features of the two groups' non-carcass components are displayed in Table 5. There was no statistically significant difference in the combined weight of the reproductive organs, including genital fat, between the intact and castrated bulls. This may be because the animals who were castrated had a marked development of genital fat to make up for the relatively reduced weight of their testicles and penis, which degraded as a result of the castration. The amount of kidney, pelvic, mesenteric, and omental fat depots differed significantly between the two groups; castrated bulls had much larger fat depots than intact bulls. This is due to the fact

Table 4. Carcass yield and characteristics of intact and castrated young Sokoto Gudali bulls

	Class		
Item	CTR	BURD	LOS
Slaughter weight (kg)	258.33 ± 3.89	258.33 ± 3.26	NS
Empty body weight (kg)	215.68 ± 4.66	213.74 ±3.94	NS
Empty body weight (%)	083.49 ± 1.25	082.74 ±1.51	NS
Hot carcass weight (kg)	136.59 ± 5.35	137.58 ±3.69	NS
Cold carcass weight (kg)	132.91 ± 5.36	135.08 ±3.54	NS
Chiller shrinkage (%)	002.70 ± 0.39	001.82 ±0.27	*
Cold carcass side weight (kg)	067.92 ± 3.05	068.44 ±1.81	NS
Hot dressing % (Slaughter wt base)	052.87 ± 1.84	053.27 ±1.77	NS
Hot dressing % (Empty body wt base)	063.33±2.14	064.38 ±1.60	NS
Chilled dressing % (Slaughter wt base)	051.45±1.86	052.30 ±1.70	NS
Chilled dressing % (Empty body wt base)	061.63±2.15	063.20 ±1.48	*
Gut fill %	014.98±1.66	016.00 ±2.16	NS

L.S = level of significance= Significant at P<0.05, N.S = Not significant, CTR = Control, BURD = Burdizzo castration*

Table 5.Carcass yeild and characteristics of intact and castrated young Sokoto Gudali bulls

	Class		
Parameters	CTR	BURD	LOS
Blood	04.84 ± 0.43	04.90 ± 0.40	*
Head	06.92± 0.45	06.56±0.38	NS
Hide	08.57±0.52	08.36±0.86	NS
Four feet	02.83±0.27	02.73±0.19	NS
Stomach weight (full)	16.91±1.51	18.06±1.95	NS
Intestine weight (full)	05.20±0.78	04.87±0.73	NS
Stomach weight (empty)	04.03±0.36	04.20±0.38	NS
Intestine weight (empty)	02.84±0.24	02.74±0.28	NS
Reproductive organs	00.09±0.19	00.85±0.04	*
Testicles	00.16±0.06	00.03±0.01	*
Penis	00.25±0.03	00.16±0.02	*
Genital fat	00.50±0.12	00.67±0.05	*
Mesenteric fat	00.42±0.12	00.55±0.15	*
Omental fat	00.96±0.25	01.44±0.37	NS
Kidney weight	00.57±0.17	00.54±0.08	*
Kidney fat	01.26±0.37	01.86±0.51	*
Pelvic fat	00.27±0.09	00.37±0.08	NS
Liver	01.59±0.41	01.77±0.18	NS
Heart	00.47±0.06	00.47±0.06	NS
Tail	00.42±0.06	00.40±0.03	NS
Lungs and trachea	01.72±0.49	01.74±0.24	NS
Diaphragm	00.66±0.04	00.65±0.03	NS
Spleen	00.42±0.06	00.42±0.07	NS
Pancreas	00.17±0.11	00.13±0.02	NS

L.S = level of significance= Significant at P<0.05, N.S = Not significant, CTR = Control, BURD = Burdizzo castration*

that castration accelerated the accumulation of fat and caused maturity disparities, causing castrated bulls to mature quicker than complete bulls. The results of this investigation support those of Ahn et al. (49), who found that the weight of the renal and mesenteric fat depots in castrated Butana calves was 9.1g, while it was 13.4g in non-castrated calves. Landon et al. (50) reported that steers would typically have larger kidney, pelvis, and cardiac fat depots than bulls, which lends support to this finding. Grings et al. (31) also found that bulls' average weight in the latter fat stores was

71% that of steers.

However, there was no discernible difference between the two groups in the weights of the visceral organs (Table 5), blood, four feet, or tail. The hide was heavier ($P< 0.05$) in the group as a intact than in the castrated one. Nonetheless, the intact bulls' heads were much ($P<0.05$) heavier than those of the castrated bulls, most likely as a result of the intact bulls' increased muscle mass from the testosterone hormone. There were clear trends for other parameters as well. Ram lambs were found to have lower non-carcass fat than wether and ewe lambs, but heavier heads, feet, reticulo-rumens, and livers (51). In support of the previous study, the current observed that although there were no significant variations in the non-carcass components as a percentage of empty body weight for the head, skin, feet, heart, lungs and trachea, liver, spleen, empty rumen, intestine, and kidney, these values tended to be slightly higher in the overall body.

Fat, muscle and bone percentages

The percentages of weight for the sirloin cut are displayed in Table 6. While the fat percentage was significantly higher ($P<0.05$) in castrated animals compared to entire animals, the muscular tissue in intact bulls was significantly ($P<0.05$) higher. Likewise, there was no discernible difference in the muscle to bone ratio between the two groups. Compared to castrated bull calves, the entire group's muscle to fat and bone to fat ratios were significantly higher ($P<0.05$). In this investigation, the castrates' sirloin cut produced more dissected fat ($P<0.05$) than the whole bulls'. The pattern of muscle deposition was contrary to that of muscle growth, with intact bulls having a considerably larger percentage of muscle tissue from the carcass ($P<0.05$) than castrated bulls. This implies that, while muscle and protein accretion were slowed, variations in the tendency to deposit lipids as energy reserves may be affected by castration (enhancement effect). Castration most likely inhibited the release of testosterone, which explains why. The results of Santidrian et al. (52) and Lobley et al. (53), who found that giving testosterone to rats and lambs enhanced muscle growth by preventing the breakdown of muscle proteins, corroborate the current findings. This is consistent with what most researchers have found. For all metrics of fatness, Purchas et al. (13) discovered that steers were considerably fatter than bulls at the same carcass weight. Research on castrating sheep and goats produced findings similar to these (54; 38 ; 39).

The current results are corroborated by the findings of Santidrian et al. (52) and Lobley et al. (53), who discovered that providing testosterone to rats and lambs improved muscle growth by reducing the breakdown of muscle proteins. This aligns with the findings of the majority of studies. Purchas et al. (13) found that steers were significantly fatter than bulls at the same carcass weight for all parameters of fatness. Similar results were obtained from studies on castrating sheep and goats (54; 38 and 39).

Meat chemical composition

Table 7 displays the chemical makeup of the Longissimus dorsi muscle in both the intact

Table 6. Composition of young Sokoto Gudali carcass as percentage of its weight

Item	Class		LOS
	CTR	BURD	
Muscle	64.87 ± 1.93	62.73 ± 3.38	*
Bone	22.94±1.19	22.24±2.67	NS
Fat	05.36±0.92	08.96±1.34	*
Muscle: bone	02.84±0.20	02.87±0.49	NS
Muscle: fat	12.48±2.51	07.18±1.37	*
Bone: fat	04.39±0.79	02.52±0.37	*

L.S = level of significance= Significant at P<0.05, N.S = Not significant, CTR = Control, BURD = Burdizzo castration*

Table 7. Meat chemical composition of young intact and castrated Sokoto Gudali bulls

Item	Class		LOS
	CTR	BURD	
Moisture (%)	75.24 ± 0.37	74.94 ± 0.21	*
Protein (%)	21.07±0.31	20.86±0.21	*
Fat (%)	02.54±0.13	02.92±0.10	*
Ash (%)	01.05±0.04	00.96±0.06	*
pH	05.88±0.20	05.68±0.17	*

L.S = level of significance= Significant at P<0.05, N.S = Not significant, CTR = Control, BURD = Burdizzo castration,*

and castrated bulls. The percentages of hydration, protein, fat, and ash were all significantly higher in the entire bull's muscles (P<0.05), as well as ash. The undamaged bulls had significantly greater quantities of sarcoplasmic, myofibrillar, and non-protein nitrogen (P<0.05). Between the two groups, there was a significant difference in muscle pH (P<0.05), with the complete group having a higher pH than the castrated one. Soluble protein in the intact and castrated bulls, however, was comparable.

According to the current chemical composition results, whole bulls had lower lipid values than castrates but greater water and protein levels. Given that androgens are known to enhance metabolism and increase the body's retention of nitrogen, this was a reflection of how sex hormones affected the synthesis and deposition of protein. Ether extract was higher in castrates than in whole bulls, most likely because the intramuscular fat content of the castrates' Longissimus dorsi muscle is larger.

Morris (55) observed that bulls' live weight increase was composed of more protein and less fat than steers', and that a comparable differential existed between steers and heifers. This conclusion is consistent with the current findings. According to Schanbacher et al. (56), undamaged ram carcasses had lower fat and gross energy content and higher protein and water content than wethers. Mohamed (38) found similar findings for goats in the Sudan Desert. However, compared to castrates, the ash level of whole bulls (Table 7) was substantially (P<0.05) higher. This may be because meat from whole bulls has a higher protein content than meat from castrates, which has a larger intramuscular fat content. During ignition, fat was lost. It is well known that protein has a higher mineral content than fat. According to Duckett et al. (57), the Longissimus dorsi muscle's contents of ash, protein, and hydration all reduced as fat level increased.

The values of non-protein nitrogen and sarcoplasmic and myofibrillar proteins were substantially greater ($P<0.05$) in whole bulls compared to castrated bulls. Similarly, bulls were found to accumulate more myofibrillar protein than steers by Morgan et al. (14). Sarcoplasmic and myofibrillar proteins were considerably higher in the whole group than in the castrated group, according to Mohamed (38) and Eldow (39). This may be because intact bulls, as opposed to castrated ones, have higher levels of testosterone hormone stimulation to anabolic agents that are responsible for protein synthesis (36).

Conclusion

Castrating young Sokoto Gudali bulls between 1½ and 2 years of age using the Burdizzo procedure did not significantly affect growth rate but it reduced feed conversion efficiency, average daily weight gain (ADG), final body weight (FBW), hot carcass weght (HCW) and altered behaviour. Castration also affected carcass characteristics by increasing fat deposition and reducing muscle tissue. Meat chemical composition showed that the intact bulls had higher meat quality with higher protein and water content. These findings suggest that castration can have significant effect on the growth and development of bulls and that intact bulls may have better meat quality. However, further research is needed to fully understand the effect of castration on bulls' growth and development.

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