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Influence of castration and dressing mode on body composition and meat quality of the dwarf goat male in Benin

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Abstract

The castration of males and the slaughtered animals burning at the dressing are practices used in Benin. The current study aims to evaluate the influence of castration and dressing mode on body composition and meat quality of the dwarf goat. Thus, 20 goats of average 12 months old were slaughtered. At slaughter, 5 castrated males and 5 entire males were burned and other 5 castrated males and 5 entire males were shaved. Data on the carcass and the technological and nutritional meat quality were collected. Slaughter weight, warm carcass weight, and cold carcass weight of the castrated were higher than those of the entire males ($p<0.05$). Castrated males had higher quantity and percentage of abdominal fat than the entire ones ($p<0.01$). Meat dry matter, organic matter and crude protein percentages of the entire males were higher than those of the castrated males ($p<0.001$). The meat dry matter, organic matter, total ash, lipid and crude protein contents of the burned animals were higher than those of the shaved animals ($p<0.001$). Drip loss was the highest in the entire males ($p<0.05$) whereas the cooking loss was the highest in the castrated males ($p<0.001$). After the first hour, burned animals had higher pH values than the shaved ones, with significant differences ($p<0.05$) in pH registered between 4 and 24 hours. Castration improves slaughter weight and carcass characteristics and burning increases the nutritional value of the dwarf goat meat.

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Introduction

In Benin, small ruminants are widespread throughout the country and play an important socio-economic role. They are bred in different agro-ecological zones and according to different production systems (Bassossa Baguima, 2012; Benon, 2016). These animals, highly valued by the population, are particularly interesting to increase animal production because of their rusticity (Anato, 2016). Compared to sheep, goats have the additional benefits to better resist to caloric stress and drought (Delgadillo *et al.*, 1997). The most representative farms goat breed is the dwarf goat (Youssao, 2015). This breed is mainly reared for meat production, in almost all concessions in both rural and peri-urban areas. Considered as the small peasant's cow, the dwarf goat has long been neglected by public authorities and researchers. Its valorization is therefore necessary especially in a context where Benin imports meat products to make up its meat products deficit (CountryStat, 2015).In the research field, some works have been done to ameliorate its productivity through the improvement of its zootechnical performances (Adjibodé, 2012; Bassossa Baguima; 2012; Anato, 2016). Indeed, the dwarf goat was first morphometrically and zootechnically characterized in the Department of Borgou, in Benin North-Eastern (Bassossa Baguima, 2012; Anato, 2016). The non-genetic factors influencing its zootechnical performance were then in the same breeding area evaluated in order to correct them to improve its productivity (Adjibodé, 2012). In sanitary plan, its pathologies have been inventoried and prophylaxis plans have been drawn up in order to improve its health monitoring (Tekodjinan, 2011; Benon, 2016). In the dwarf goat breeding practices, castration is frequently used to avoid the male odor of the he-goat. Castration also improves the growth performance of male goats (Koutinhouin *et al.*, 2012). None of these works have investigated this breed's meat quality. It is then necessary to evaluate the impact of castration on these goats slaughter performance and meat quality. It has also been reported that, at slaughter, goats are often depilated by singeing (burning) or by shaving with a razor blade (shaving) at dressing (Benon, 2016). This practice is not without consequence on the body composition and the meat quality. The current study aims to evaluate the effect of castration and dressing (burning and shaving) on the dwarf goat body composition and meat quality.

Materiels and methods

Area of study

The study was carried out in the Laboratory of Animal Biotechnology and Meat Technology of the Department of Animal Production and Health of the Polytechnic School of Abomey-Calavi. The slaughtered animals came from the Department of Borgou where they were reared under the traditional breeding system. This Department is located in the North-East of Benin and is bounded in the North by the Alibori Department, in the South by the Departments of the Hills and Donga, in the East by the Federal Republic of Nigeria and in the West by The Department of Atacora. It covers an area of 25856 km² of which 13962 km² of cultivable land (54% of the total area of the Department). This area benefits from climatic conditions of sudanian type characterized by a succession of a rainy season (May to October) and a dry season (November to April) with the harmattan generally blowing between December and February. Average rainfall varies between 1100 and 1200 mm per year with a maximum rainfall in July and August. It determines the development of natural pastures (herbaceous and woody), which constitute the main food for animals. The mean annual temperatures varies between 26°C and 27°C with the maximum between 35°C and 38°C (March to April) and the minimum between 18°C and 21°C.

Animal choice and breeding

The research works was carried out on entire and castrated males of the dwarf goat. The castration was done at three months old that is, just after the weaning. These animals came from the farm of the Sustainable Management Center of Animal and Plant Resources, a Non-Governmental Organization based in Parakou. A total of twenty (20) males of dwarf goats of an average of 10 months old were selected.

These goats were constituted of 10 entire males and 10 castrated males. Once identified, animals were reared under the same conditions (habitat, feeding and health monitoring) for two months at the same Center, in order to minimize especially the breeding conditions including feeding biases. At 12 months age, they were transported to the slaughterhouse in Cotonou where they were slaughtered. Animals slaughter on the eve of the slaughter day, the *ante-mortem* inspection of animals was first performed. Four flocks were then constituted.

The first one was composed of entire males to be burnt during dressing, the second of entire males to be shaved during dressing, the third of castrated males to be burnt during dressing and the last flock of castrated males to be shaved during dressing. Each flock is constituted of 5 animals of homogeneous weight. After the composition of the groups, animals were slaughtered during 5 days, one animal per flock and per day. The slaughter was done by section of the jugular vein after 4hours of feed withdrawal. The dressing was done according to the flock, by burning with a soft wood fire or by shaving with a razor blade. Animals were then washed before evisceration with water and soap using a steel sponge. The paunch and intestines were emptied of their contents and properly washed. Legs and head were blanched in order to remove hooves and hair.

Meat sampling for analysis

After slaughter, the *Longissimus dorsi* and the *infraspinalus* muscle of the left shoulder of each slaughtered animal were collected. Each muscle was divided into 3 pieces. One piece was used to determine the water holding capacity and tenderness, the second for color measurement and the third for the meat chemical composition. Each piece of muscle was packed in a well labeled plastic bag.

The samples were transported in a cooler containing dry ice to the Laboratory of Animal Biotechnology and Meat Technology of the Department of Animal Production and Health of the Polytechnic School of Abomey-Calavi for the analyzes.

Data collecting

The live weight, the hot carcass weight (1hour after slaughter) and the cold carcass weight (24h after slaughter) were first taken using a scale. Immediately after slaughter, carcasses were kept in a cold room at + 4°C for better storage. The head, feet and each viscera organ (spleen, diaphragm, bile, liver, heart, kidneys and lungs) and abdominal fat were weighted on the slaughter day and 24 hours after slaughter. The pelvis length, thorax width, shoulder width, breast depth, carcass length, leg length were measured the day after slaughter according to Laville *et al.* (2002) when left the cold room. After carcass data collecting, viscera weight, carcass yield and chilling loss were calculated: The viscera weight is the sum the spleen, diaphragm, bile, liver, heart, kidneys, and lungs weights. The viscera percentage was calculated from the carcass weight. The yield at slaughter is the ratio between the carcass weight and the weight at slaughter. The 1 hour yield is the yield obtained using the hot carcass and the 24 hours yield is the yield obtained using the cold carcass. The chilling loss is the ratio between the water weight loss at chilling (the difference between the hot carcass weight and the cold carcass weight) and the hot carcass weight. When left the cold room, cold carcasses were first weighted before being cut into pieces according to Boccard and Dumont (1955). Each of the cuts was weighted and their percentages were calculated relative to the carcass weight.

The pH was measured using a HANNA pH meter (HI 99163) in the *longissimus dorsi* and in the shoulder *infraspinalus* muscle of the right carcass of each animal slaughtered at 1h, 4h, 8h, 12h , 24h, 36h and 48h *post mortem* in the cold room at the slaughterhouse. The pH meter was previously calibrated with two standards: pH 4 and pH 7, following the procedure described by the manufacturer (HANNA Instruments R, Italy). The meat water holding capacity (WHC) was determined according to Honikel (1987).

The color was measured on the concerning slices at 1, 12 and 24 hours after storage of the carcass in the cold room for 24 hours. The color was determined using a Minolta CR400 colorimeter (Minolta

Corporation, Ramsey, NJ, USA) after oxygenation at 4°C for 1 hour 30 minutes in the trichromatic system (CIE L*a*b *). In total, 5 repetitions were performed by sample at each measure time. The color parameters measured were the red index (a*), yellow index (b*) and lightness (L*).

The samples previously cooked for water holding capacity determination were cut parallel to the muscle fibers in manner to have sticks of 1 $cm^2$of area and of variable length (about 5 cm). The shear test was performed perpendicularly to the muscle fibers axis using a texture analyzer (LLYOD instruments) equipped with a blade of 0.42 cm of thickness with a triangular opening (Warner- Bratzler). The maximum shear force was expressed in Newton (N). Ten (10) repetitions were performed on each sample.

The dry matter was determined according to AOAC (1990) and the total ash according to AFNOR (1986) with three repetitions per sample. The organic matter was obtained by the difference between the dry matter and the ash of each sample. The lipids were determined by direct extraction with soxhlet accordance to AFNOR (1986). The crude protein determination was performed by the kjeldahl method (AOAC, 1990) which consists to determine the total meat nitrogen and multiply the total nitrogen content obtained by the conventional factor 6.25 used for meat.

Statistical analysis

Statistical analyses were performed using the Statistical Analysis System (SAS, 2006) software. Means of the carcass characteristics were calculated by the Proc Means Procedure. The Generalized Linear Models (Proc GLM) procedure was used to determine the significance of sex (entire male and castrated male), dressing mode (burning and shaving), and type of muscle (*Longissimus dorsi* and *infraspinalus*) effects for the body composition, the meat technological and organoleptic quality and the meat chemical composition. The interaction between muscle type and sex was significant and was included in the variance analysis model. The pairwise comparison of means was done by the student test.

Results

Body composition

The body composition of the dwarf goat castrated male and entire male is presented in Table 1.

The slaughter weight, the hot carcass weight and the cold carcass weight of the castrated were higher ($p<0.05$) than those of the entire males. However, no significant difference was observed between the hot and the cold carcass yields of the castrated and of the entire males ($p>0.05$). The carcass juice loss at the chilling didn't even vary between sexes. The head and legs were heavier in the castrated compared to those of the entire male.

Table 1. Body composition of the castrated and entire males of the dwarf goat.

Variables	Castrated male		Entire male		Test of significance
	Means	Standard deviation	Means	Standard deviation	
Live weight (kg)	11.1	1.83	8.2	1.46	**
Hot carcass (kg)	5.62	1.18	4.38	1.19	*
Cold carcass (kg)	5.37	1.14	4.21	1.12	*
Yield 1h (%)	50.35	4.03	52.95	7.22	NS
Yield 24h (%)	48.13	3.8	50.84	6.67	NS
Chilling loss (%)	4.34	2.49	3.94	1.44	NS
Spleen (g)	28.1	6.49	26.7	5.48	NS
Head (g)	624.3	71.82	538	69.69	*
Leg (g)	248.7	32.99	204.1	27.89	**
Neck (g)	401.3	59.53	375.4	41.18	NS
Diaphragm (g)	49.1	15.37	38.9	5.57	NS
Bile (g)	11.4	4.25	10.1	2.28	NS
Liver (g)	204.95	39.38	159.6	20.27	**

Heart (g)	54.7	13.74	47.45	9.44	NS
Kney (g)	35.6	2.92	34.2	2.29	NS
Lung (g)	147.7	19.7	138.1	19.36	NS
Viscera (g)	531.5	78.97	455.2	54.98	*
Viscera (%)	9.61	1.03	10.82	1.93	NS
Fat (g)	325.8	7.00	244.3	7.89	**
Fat (%)	5.22	3.28	0.15	0.18	***
Pelvis length (cm)	14.17	1.23	13.04	0.7	*
Thorax width (cm)	16.72	1.09	15.8	1.2	NS
Shoulder width (cm)	13.8	0.85	13.13	0.55	*
Shest deepth (cm)	16.25	0.81	15.94	0.78	NS
Carcass length (cm)	51.77	4.49	50.01	2.44	NS
Leg length (cm)	20.95	2.7	20.3	2.9	NS

* : P<0.05 ; ** : P<0.01 ; *** : P<0.001 ; NS : P>0.05 ; NS : Non-significant.

Apart from the liver, no significant difference was observed between the weights of the different viscera components of the two categories. However, the weight of the castrated viscera was higher than the one of the entire male (p <0.05). The percentages of the viscera were similar. Castrated males had higher quantity and percentage of abdominal fat than the entire males (p<0.01). They even have a longer pelvis and a wider shoulder distance than the entire males (p<0.05) and the same tendency was observed for the others body measures, although these differences were not significant (Table 1). Carcass characteristics means and those of the fifth quarter elements did not vary overall according to the dressing mode (Table 2). However, lungs were heavier in burned animals than in shaved animals (p<0.001) while shaved had a larger shoulder width and a longer leg (p<0.05) than the burned ones.

Table 2. Body composition of the dwarf goat according to the dressing mode.

Variables	Burned		Chaved		Test of significance
	Means	Standard deviation	Means	Standard deviation	
Live weight (kg)	9.91	2.18	9.39	2.28	NS
Hot carcass (kg)	5.18	1.43	4.83	1.25	NS
Cold carcass (kg)	4.94	1.36	4.65	1.19	NS
Yield 1h (%)	51.96	7.2	51.34	4.48	NS
Yield 24h (%)	49.55	6.69	49.42	4.27	NS
Chilling loss (%)	4.58	2.56	3.7	1.18	NS
Spleen (g)	28.5	7.26	26.3	4.22	NS
Head (g)	592.1	79.32	570.2	79.36	NS
Leg (g)	239.5	35.03	213.3	36.92	NS
Neck (g)	390.4	57.78	386.3	47.59	NS
Diaphragm (g)	42	11.24	46	13.78	NS
Bile (g)	11.5	3.63	10	3.13	NS
Liver (g)	182.75	38.5	181.8	40.27	NS
Heart (g)	50.65	13.37	51.5	11.32	NS
Kney (g)	35.9	2.78	33.9	2.22	NS

Lung (g)	156.1	15.84	129.7	13.28	***
Viscera (g)	507.4	87.10	479.3	75.91	NS
Viscera (%)	10.16	1.62	10.67	1.84	NS
Fat (g)	151.8	266.36	181	211.63	NS
Fat (%)	2.31	3.7	3.06	3.31	NS
Pelvis length (cm)	13.56	1.12	13.65	1.2	NS
Thorax width (cm)	16.35	1.40	16.17	1.05	NS
Shoulder width (cm)	13.14	0.63	13.79	0.8	*
Shest deepth (cm)	16.3	0.74	15.89	0.82	NS
Carcass length (cm)	50.02	3.94	51.76	3.19	NS
Leg length (cm)	19.26	2.9	21.99	1.82	*

* : P<0.05 ; ** : P<0.01 ; *** : P<0.001 ; NS : P>0.05 ; NS : Non-significant.

Meat technological and organoleptic quality of the dwarf goat castrated male and entire male

The technological and organoleptic meat quality of the dwarf goat castrated male and entire male is presented in the Table 3. During the first 4 hours, the pH didn't vary. Between 8 and 24 hours, entire males had the highest pH (p<0.05) and between 36 and 48 hours, pH values became stable without significant differences between castrated and entire males. Shear force and water holding capacity didn't vary between sexes. However, entire males had the highest drip loss (p<0.05) and the castrated had the highest cooking loss (p<0.001).

Table 3. Meat technological and organoleptic quality of the castrated and entire males of the dwarf goat.

Variables	Castrated male		Entire male		Test of significance
	Means	Standard error	Means	Standard error	
pH1	5.72	0.34	5.86	0.24	NS
pH4	5.66	0.36	5.79	0.33	NS
pH8	5.64	0.37	5.79	0.29	*
pH12	5.61	0.36	5.74	0.38	*
pH24	5.59	0.41	5.71	0.37	*
pH36	5.58	0.32	5.67	0.32	NS
pH48	5.55	0.37	5.65	0.25	NS
Shear force (N)	91.2	31.82	82.09	20.93	NS
Cooking loss (%)	18.2	10.82	10.84	3.51	***
Drip loss (%)	26.29	13.82	38.32	12.02	*
Water Holding Capacty (%)	44.5	8.00	49.16	10.52	NS
L*1 (%)	41.5	8.52	41.18	7.09	NS
a*1	12.78	2.69	12.26	2.98	NS
b*1	5.83	2.60	6.29	2.11	NS
L*12 (%)	38.72	6.25	41.62	5.94	NS
a*12	14.38	2.99	13.96	2.72	NS
b*12	6.59	1.80	5.59	1.87	*
L*24 (%)	42.14	6.99	43.13	7.37	NS
a*24	12.85	2.96	11.16	2.89	**
b*24	6.59	2.24	6.58	2.75	NS

* : P<0.05 ; ** : P<0.01 ; *** : P<0.001 ; NS : P>0.05 ; NS : Non-significant ; pHi : pH à i hour; a*i : Red index at i hour; b*i : Yellow index at à i hour ; L* i : Lightness at i hour.

The meat lightness didn't vary according to the sex during the 24hours of measure. On the contrary, the castrated ones had the highest yellow and red indexes respectively at 12 hours and 24 hours after leaving the cold room compared to the entire male.

Meat technological and organoleptic quality of the dwarf goat according to the dressing mode

The technological and organoleptic meat quality of dwarf goat according to the dressing mode is presented in Table 4. One hour after slaughter, the pH of the burnt was identical to the one of the shaved. After the first hour, burnt had the highest pH compared to the shaved with significant differences between 4 and 24hours ($p<0.05$). The dressing mode had no significant effect on the shear force, drip loss, cooking loss, and water holding capacity. Contrary to the red index, whatever the measurement time, the meat lightness and yellowness were higher ($p<0.05$) in the burned animals than in the shaved ones.

Table 4. Meat technological and organoleptic quality of the dwarf goat according to the dressing mode.

Variables	Burned		Chaved		Test of significance
	Means	Standard error	Means	Standard error	
pH1	5.81a	0.32	5.88a	0.24	NS
pH4	5.80a	0.30	5.65b	0.35	*
pH8	5.76	0.38	5.63	0.37	*
pH12	5.73	0.37	5.59	0.39	*
pH24	5.70	0.33	5.58	0.31	*
pH36	5.67	0.36	5.58	0.36	NS
pH48	5.65	0.30	5.58	0.28	NS
Shear force (N)	95.90	25.36	77.40	26.01	NS
Cooking loss (%)	15.26	07.41	13.79	10.07	NS
Drip loss (%)	31.47	14.13	33.14	14.46	NS
Water Holding Capacity (%)	46.72	09.67	46.93	9.61	NS
L*1 (%)	46.86	06.26	35.83	4.58	***
a*1	11.61	02.91	13.44	2.46	*
b*1	07.53	01.65	4.59	2.03	***
L*12 (%)	41.75	06.59	38.59	5.49	*
a*12	13.20	02.89	15.14	2.49	**
b*12	06.04	01.48	4.14	2.24	*
L*24 (%)	47.32	05.96	37.96	4.79	***
a*24	11.30	01.18	12.71	1.73	*
b*24	08.18	01.57	4.99	2.19	***

* : P<0.05 ; ** : P<0.01 ; *** : P<0.001 ; NS : P>0.05 ; NS : Non-significant; pHi : pH à i hour; a*i : Red index at i hour; b*i : Yellow index at i hour ; L* i : Lightness at i hour.

Meat technological and organoleptic quality of the dwarf goat castrated male and entiremale according to the muscle

The meat technological and organoleptic quality of dwarf goat castrated male and entire male according to the muscle is presented in the Table 5. In the *Longissimus dorsi*, the pH values of the entire males were higher ($p<0.01$) than those of the castrated males, whatever the measure time. However, except the pH at the first hour of slaughter, in the shoulder muscle, no significant differences were observed between castrated and non-castrated. The type of muscle and the sex didn't influence the shear force, color parameters and the water holding capacity.

Nevertheless, differences between the drip loss and cooking loss of castrated and entire males were only observed for the *Longissimus dorsi*.

Meat chemical composition of the dwarf goat

The meat chemical composition of the dwarf goat castrated males and entire males is presented in the Table 6. The percentages of dry matter, organic matter and meat protein of entire males were higher than those of the castrated males ($p<0.001$). But, the total ash percentage and the lipid content were identical in the castrated and entire males. The Table 7 shows the meat chemical composition of the dwarf goat according to the dressing mode. The dry matter, organic matter, total ash, lipid and protein contents of burnt animals were higher than those of shaved animals ($p<0.001$).

Table 5. Meat technological and organoleptic quality of the castrated and entire males of the dwarf goat according to the muscle.

Variables	*Longissimus dorsi*				Shoulder muscle				Test of significance
	Castrated male		Entire male		Castrated male		Entire male		
	Means	Standard Error	Means	Standard Error	Means	Standard Error	Means	Standard Error	
pH1	5.70b	0.09	5.91a	0.10	5.78b	0.07	5.90a	0.06	**
pH4	5.49b	0.12	5.89a	0.09	5.76a	0.07	5.74a	0.07	**
pH8	5.41b	0.10	5.86a	0.12	5.73a	0.06	5.75a	0.07	**
pH12	5.41b	0.12	5.83a	0.12	5.70a	0.08	5.68a	0.08	**
pH24	5.40b	0.09	5.81a	0.11	5.68a	0.06	5.66a	0.09	*
pH36	5.40b	0.09	5.80a	0.08	5.65a	0.09	5.63a	0.07	**
pH48	5.39b	0.11	5.71a	0.09	5.65a	0.07	5.62a	0.06	**
Shear Force (N)	108.46a	7.69	84.12a	7.69	82.58a	5.44	81.08a	5.44	NS
CL (%)	32.35a	1.12	9.23b	1.12	11.14a	0.79	11.64a	0.79	***
DL (%)	10.90b	3.14	45.14a	3.14	33.99a	2.22	34.91a	2.22	***
WHC (%)	43.24a	2.9	54.37a	2.90	45.13a	2.05	46.55a	2.05	NS
L*1 (%)	41.65a	1.78	41.6a	1.78	41.44a	1.26	40.96a	1.26	NS
a*1	12.99a	0.87	11.68a	0.87	12.67a	0.61	12.55a	0.61	NS
b*1	6.15a	0.59	5.86a	0.59	5.66a	0.42	6.51a	0.42	NS
L*12 (%)	38.15a	1.91	40.95a	1.91	39.00a	1.35	41.95a	1.35	NS
a*12	14.51a	0.87	13.76a	0.87	14.32a	0.62	14.07a	0.62	NS
b*12	7.57a	0.54	6.82a	0.54	6.10a	0.38	4.94a	0.38	NS
L*24 (%)	42.50a	1.75	43.75a	1.75	41.96a	1.23	42.87a	1.23	NS
a*24	12.43a	0.68	9.32a	0.67	13.05a	0.61	12.08a	0.61	NS
b*24	6.41a	0.61	7.38a	0.61	6.68a	0.43	6.19a	0.43	NS

* : P<0.05 ; ** : P<0.01 ; *** : P<0.001 ; NS : P>0.05; NS : Non-significant; pH i : pH at i hour; a*i : Red index at i hour ; b*i : Yellow index at i hour ; L* i : Lightness at i hour; CL : Cooking Loss; DL : Drip Loss; WHC: Water Holding Capacity.

Discussion

Body composition according to the sex

Slaughter weight, hot carcass weight, cold carcass weight, head weight and legs weight of the dwarf goat castrated males were higher than the one of the entire males. This difference could be related to the sex hormones expression as slaughtered animals have already reached sexual maturity. During the growth phase, the weight of the castrated males doesn't differ from the one of entire males and the weight difference between the entire and the castrated males appears at the puberty time (Youssao *et al.*, 2008; Koutinhouin *et al.*, 2012). In the dwarf goat, this difference is obtained from the 11th month of age (Koutinhouin *et al.*, 2012), which corresponds to the slaughter age of animals in our study.

No significant difference was observed between the hot and the cold carcass yields of the castrated and of the entire males in the current study. Similar results were reported by Youssao *et al.* (2008) in the local pig of Benin with which, sex effect didn't influence the carcass yield at slaughter in females, castrated males and entire males.

Table 6. Meat chemical composition of the castrated and entire males of the dwarf goat.

Variables	Castrated male		Entire male		Test of significance
	Means	Standard deviation	Means	Standard deviation	
Dry matter (%)	29.12	5.39	30.64	6.28	***
Organic matter (%)	27.73	5.14	29.21	5.98	***
Total ash (%)	1.39	0.26	1.43	0.3	NS
Fat (%)	2.76	0.52	2.78	0.59	NS
Protein (%)	25.01	4.67	26.38	5.34	***

*** : P<0.001 ; NS : P>0.05 ; NS : Non-significant.

Similar results were reported by many authors (Youssao *et al.*, 2002a, 2002b; Meffeja *et al.*, 2006). The carcass weight being strongly and positively correlated (r = 0.91, p <0.001) with the goat weight at slaughter age (Anato, 2016), the carcass yield remain constant and doesn't show any variability, whatever the flock (castrated or entire males). The chilling loss didn't even vary between sexes in the present study. However, castrated males carcasses tend to lose more water than the one of the entire males and this is explained by the fact that the chilling loss is proportional to the carcass weight.

The viscera and the liver weights follow the same tendency as the live weight because of the sexual hormone. Since castration has been shown to be a mean of animals growth acceleration (Youssao *et al.*, 2008; Koutinhouin *et al.*, 2012) at sexual maturity, it increases the adipose tissue mass (fat) to the detriment of the muscular mass (meat) on the carcass at slaughter (Peña *et al.*, 2007;Bonvillani*et al.*, 2010; Alexandre and Mahgoub, 2012). This justifies the high percentage of internal fat in the castrated compare to the entire males in the current study.

The increase of the internal fat in the goat is to the detriment of muscle deposition, hence the need to look for an ideal weight for the castrated slaughter in order to ensure a better carcass quality. Finally, it is important to highlight that overall castrated animals have morphometric measures superior to those of the entire males, even though some are not significant and these results are related to the better growth of the castrated.

Body composition according to the dressing mode

Carcass characteristics means and those of the fifth quarter elements didn't vary overall according to the dressing mode. The absence of significant difference between the carcass weight and the carcass yield of shaved and burned goats indicates that the dressing mode doesn't influence the carcass yield. Similar results were reported on the average live weight, the hot carcass weight and the carcass yield of burned ewes and skinned ewes at Cotonou slaughterhouse (Olutchi, 2013). However, the shaved had a larger shoulder width and a longer leg. This difference can be explained by the compactness of the burnt carcass due to the water and fat loss resulting from the burning heat.

Meat technological and organoleptic quality of the dwarf goat

Between 8 and 24, entire males had the highest pH, meaning that castrated males had accumulated more lactic acid from muscular glycogen degradation than the first one. The pH stabilizes when the glycogen reserves are exhausted in the meat (Cartier and Moëvi, 2007), which results in the difference absence between castrated and the entire males pH beyond 24 hours in our study. The shear force didn't vary by sex. However, castrated animals meat should be more tender than the one of the entire animals because castration favors the meat tenderness (Cartier and Moëvi, 2007). Entire males had the highest drip loss and the castrated had the highest cooking loss. The same tendencies were reported in pigs where entire males had the highest drip loss compared to the castrated males (Youssao *et al.*, 2008).

Table 7. Meat chemical composition of the dwarf goat according to the dressing mode.

Variables	Burned		Chaved		Test of significance
	Means	Standard deviation	Means	Standard deviation	
Dry matter (%)	35.39	1.48	24.38	0.49	***
Organic matter (%)	33.72	1.42	23.23	0.52	***
Total ash (%)	1.67	0.07	1.15	0.04	***
Fat (%)	3.29	0.1	2.25	0.09	***
Protein (%)	30.41	1.26	20.98	0.57	***

Legendre : *** : P<0.001.

The water holding capacity didn't vary between sexes because the highest drip loss of the entire males were compensated by the highest cooking loss of the castrated.

After the first hour, burnt had the highest pH compared to the shaved with significant differences between 4 and 24 hours. These pH values difference proves a difference in the treatment of animals after slaughter. The burning technique doesn't allow a normal pH drop. Similar results were reported by Salifou *et al.* (2016) who obtained respectively at 1 hour and 24 hours *post-mortem* higher pH values in the burned sheep compared to the skinned ones. Talmant *et al.* (1994) even obtained pH values slightly higher in flamed pigs than in those depilated.

The dressing mode had no significant effect on the meat shear force of the dwarf goat castrated and entire males in our study 24 hours after slaughter. On 0 and 1 days, shear force of the *Longissimus dorsi* were significantly higher in depilated ewes than in the burned ewes (Olutchi, 2013). The inferiority of the shear force of the *Longissimus dorsi* of the burnt ewes could be explained by the effect of the heat fire which was denaturing the muscular proteins structure and then has softened the meat. The dressing method had no significant effect on the drip loss, cooking loss, and water holding capacity. Similar results were reported in burned and skinned sheep despite the large differences in pH values (Olutchi, 2013).

Contrary to the red index, meat lightness and yellowness were higher in the burned animals than in the shaved ones, whatever the measure time.

The inferiority of the red index of the burnt goats compared to the one of the shaved goats could be related to the burning technique. The meat of burned animals has certainly begun to be cooked with consequence the commencing of proteins and myoglobin denaturation (structural modification). In fact, during the cooking, denatured myoglobin precipitates other denatured proteins to form brown pigments characteristic of cooked meat (Salifou *et al.*, 2016). The meat turns from a light red color to white and then to a brown color when it is cooked (Salifou *et al.*, 2016). The increase tendency of the white index of the burnt goat meat compared to the one of the shaved confirms the passing through the white color of the meat at begin of the cooking process.

Chemical characteristics of the dwarf goat meat

The percentages of dry matter, organic matter and meat proteins of entire males were higher than those of castrated males. This difference is explained by the higher bound water content in castrated animals. This content is justified by a higher cooking loss of the castrated males in this study. As castrated growth is faster, their meat contains more water and consequently, a lower dry matter. Besides, total ash percentage and the lipid content were identical in castrated and entire males. These results are different from those of Youssao *et al.* (2008) who reported that the castrated are fatter than the entire males. According to Ahidoté (2005), the intramuscular fat content of fresh *Longissimus thoracis* is higher in females than in males and the same tendency was observed in the dry matter content. Sex therefore has an effect on the meat chemical composition.

The dry matter, organic matter, total ash, lipid and protein contents of burnt animals were higher than those of shaved animals. This difference is due to the water loss caused by the burning heat. Contrary to these results, the dry matter, the ash and the lipid contents of burnt sheep meat were similar to those of skinned sheep (Ahouanse, 2015). Nevertheless, burnt sheep have higher protein content than the skinned one. This result is in perfect relationship with those of our study.

Conclusion

Castration improves the slaughter weight, the hot carcass weight and the cold carcass weight and increases the abdominal fat content of goat's males. On the contrary, castration reduces the dry matter, organic matter and crude protein contents of the dwarf goat meat. It increases the pH drop speed during the 24 hours following slaughter, reduces the meat drip loss but without incidence on the water holding capacity. Castration affects more the *longissimus dorsi* pH compared to the *infraspinalus* muscle. The dressing mode (burning or shaving) doesn't affect the carcass characteristics and those of the fifth quarter components of the dwarf goat. But, the burning increases the meat dry matter, organic matter, total ash, lipid and protein contents. It also increases the meat pH and doesn't affect the water holding capacity.

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