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Morphometric and zootechnical characterization of dwarf goats in Northeastern Benin

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Abstract

In Benin, there are less documented reports on zootechnical characteristics of dwarf goats. The objective of this study was to determine the zootechnical and phenotypic traits of dwarf goats. A total of 50 breeders were surveyed on dwarf goat husbandry practices in the Department of Borgou. Measurements were taken from 245 goats (74 males and 171 females) and meat performance was assessed in 30 dwarf goats. The investigated breeders are mainly men (76%); 70% are married and 52% are of Bariba sociolinguistic group with an average age of 42 years. The selection criteria for dwarf goat breeding are its prolificity (73.69%), low production cost (63.16%), early maturity (57.89%), marketability (47.37%) and the tradition of breeders (47.37%). Most of the breeders (86%) have normal housing for their goats and 81.4% have improved goat farms. The type of goat-shed built by breeders is either traditional (18.6%) or modern (81.4%). Goats are fed on fodder,however nearly all (98%) of the breeders provide feed supplements to their animals. The goats are predominantly black-pie (24.6%) and black (21.3%). About 95% of the goats have horns but none has goatees and pendeloque. The abortion rate is 15.13% and the stillbirth rate is 8.23%. The fertility is 269.53% and the weaning viability is 86.04%. The dwarf goat has an average birth weight of 2.09 kg for females and 2.05 kg for males. The slaughter weight is 14.89 kg and the yield of the carcass is 58.11%. These results provide scientific background information to improve the zootechnical performances of dwarf goats in Benin.

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Introduction

Local breeds of cattle, sheep, goats and poultry are the main sources of animal protein in sub-saharan africa. Among these species, small ruminants (sheep and goats) are the most widespread and play important socio-economic roles (Chouamo *et al.,* 2005). They are produced in all agro-ecological areas and in different production systems (Gnanda *et al.,* 2008; Abegaz, 2014). These animals, highly appreciated by the people, are good specimens to improve and increase animal production due to their adaptation to the environment. Compared to sheep, goats have the additional benefits of resisting heat and drought (Delgadillo *et al.,* 2009; Mdladla *et al.,* 2017). Under traditional goat breeding conditions, weaning is natural and occurs only when the udders have no more milk or when the kid goat is able to ruminate (4-5 months of age). The adaptation of goats to an arid environment dates back to several millennia. Goats are satisfied with little and make use of all kinds of vegetation: grass, bushes, even thorny branches to survive (Tekodjinan, 2011, Tendonkeng *et al.,* 2013). Apart from meat, milk, manure and leather, goats are very prolific and this helps the recovering of the herds after high mortalities in the dry seasons (ILCA, 2011). Goat production in general and the dwarf goats, in particular, is an activity within the reach of all social strata especially women, the youth, and elders. In sub-Saharan Africa, the most representative goat species on farms is the dwarf goat (Tedonkeng Pamo, 2004, Tekodjinan, 2011). It is mainly used for meat production. Regarded as a fast source of income for small peasants, goats have long been neglected by the public authorities and researchers. The enhancement of goat's productivity depends on the improvement of its zootechnical performances and its production system.

In Benin, dwarf goat keeping is practiced in almost all households in both rural and peri-urban areas. According to statistics from the Benin Directorate of Livestock, sheep and goats are the third sources of meat with 13%, after cattle (58%) and poultry (21%) (DE, 2015).Nevertheless, very few scientific studies were conducted on this animal species in order to better characterize it and devise strategies to improve its productivity. The general objective of this study is to characterize dwarf goat production in order to improve its productivity, which is essential for food security in Benin in terms of protein of animal origin. Specifically, this involves: a) characterizing the dwarf goat breeding system; b) phenotypic, morphological and zootechnical characterization of the dwarf goat; and (c) assessment of meat production ability of this breed. To achieve these objectives, the Department of Borgou, located in Northeastern Benin, was chosen because of the predominance of dwarf goats in that area.

Materials and methods

Study area

The study was conducted in the Department of Borgou located in the North-East of Benin. It is limited in the North by the Department of Alibori, the South by the Departments of Collines and Donga, the East by the Federal Republic of Nigeria and the West by the Department of Atacora. It covers an area of 25, 856 km² made of 13,962 km² of arable land, about 54% of the total are. Its Sudanian climate is characterized by a succession of a rainy season (May to October) and a dry season (November to April) with harmattan generally blowing between December and February.

The average rainfall is 1100 - 1200 mm with the maximum occurring in July and August. The average annual temperature varies between 26 and 27 °C with maxima between 35 °C and 38 °C (March to April) and the minimum between 18 °C and 21 °C (December to January – Harmattan period). The soil is sandy but also amixture of sand and clay in some places. The vegetation is herbaceous composed of annual and perennial grasses with a predominance of *Andropogon gayanus* and some woody legumes. The population of the Department was estimated at 1, 214, 249 inhabitants during the national census of May 2013. The agricultural population recorded in 2003 was 491, 865 people, representing 67.92% of the total population of the Department. The dominant ethnic groups are Baatombou, Peulh, Dendi and Yoruba.

Methods

Data were collected from 50 dwarf goat farms and dwarf goat breeders were selected based on their accessibility and availability. Once these conditions were met, breeders were enrolled and interviewed. The measurements and observations involved 716 animals. Meat production capacity was evaluated on 30 dwarf goats.

The age at first birth, the interval between farrowing, the number of pregnant females per farm, the number of abortions, the number of farrowing, the number of births, the number of stillbirths, the number of Lived and weaned per year were collected during the interviews. Reproduction parameters were calculated using the following formulas:

$$Abortion\ rate = \frac{\text{Number of abortion}}{\text{Number of pregnancy}} \text{ x } 100$$

$$Stillbirth\ rate = \frac{\text{Number of stillbirths}}{\text{Number of births}} \text{ x } 100$$

$$Fertility\ rate = \frac{\text{Number of live births}}{\text{Number of pregnant females}} \text{ x } 100$$

$$Weaning\ viability\ rate = \frac{\text{Number of deaths at weaning}}{Number\ of\ live\ births} \text{ x } 100$$

Body weight and carcass weight were taken before and after slaughter. Then the gross yield was deduced from these two data using the formula below:

$$Gross\ yeild = \frac{\text{Carcass weight}}{Body\ weight} \text{ x } 100$$

The body measurements taken by age group and sex were determined as follows: thoracic perimeter measured behind the shoulders and the tip of the elbow on the animal in exhalation; height at the withers measured next to an anterior limb of the animal and on its withers; scapulo-ischial length (distance between the tip of the elbow and the tip of the ischium); length of horns measured from the base of the horn to its end; length of the ears (taken from the hollow upper part of the ear, connected to the head to the end of the ear) and pelvis length measured between the two vertical lines that pass through the tip of the hip and the tip of the buttock.

Statistical analyses

An Excel database was designed and the statistical analyses were performed using the SAS software (2006). The mean (weights, and other measurements) and the percentages related to data on the identity of breeders (religion, occupation, etc) were calculated respectively by the procedures Proc means for means and Proc freq for percentages. A 95% confidence interval (CI) was calculated for each percentage. The significance of sex (males and females) on the measurements and meat performance was determined following an analysis of variance using F test. The significance of age on meat performance and the measurements was also revealed by F test. Two by two comparisons were made using t-test. In addition, Chi-square test revealed the overall differences between proportions, and the two-by-two comparisons between these proportions were made by the two-tailed Z test.

$$ICP = 1,96\sqrt{\frac{[P(1-P)]}{N}}$$

P is the relative percentage and N the sample size.

Moreover, the correlations between the different variables (age, morphometric measurements, weight, etc.) were determined by the Proc corr procedure of SAS (2006).

Results

Status of the breeders and origin of the dwarf goats of the different herds

Goat breeding is essentially practiced by men (76%) mostly married (70%), with an average age of 42 years who are predominantly Muslims (74%). The study revealed that there is a diversity of ethnic groups among the breeders. They are predominantly ($p<0.05$) Bariba (52%) followed by Dendi (10%) and other ethnic groups (Fon, Idaatcha and Peulh). The majority of breeders have secondary education (54%), followed by 26% of illiterates and 12% with only primary education. Most breeders (74%) are craftsmen (carpentry, mechanics, electricity, etc.). Agro-breeders, civil servants, and retirees represent 26% of the respondents. Generally, dwarf goats keeping in the Department of Borgou is primarily for prestige (66%), before being a source of income (44%)

for the households. The surveyed goat breeders have been practicing this activity for over 10 years and are responsible for an average of 5 people.

They buy a dwarf goat at 12,300 F CFA and resell it at 18,166 FCFA after 3 to 6 months of rearing. Breeders buy the goats from other breeders (36%) or from the market (36%). Others get animals by inheritance (34%), donation (30%) or watching over for another former (2%).

Selection criteria for dwarf goats

The selection criteria for dwarf goat breeding are its prolificity (73.69%), its low production cost (63.16%), its early maturity (57.89%), the ease marketability (47.37%) and the tradition (47.37%). Apart from these important criteria, self-consumption (26.32%), the resilience of the animal (21.05%) and the quality of its meat (10.53%) were also cited by the breeders (Table 1).

Table 1. Selection criteria for dwarf goat by breeders.

Selection criteria	Percentage (%)	Confidence interval
Quality of the meat	10.53c	13.80
Resilience of the animal	21.05bc	18.33
Tradition	47.37ab	22.45
Prolificacy	73.68a	19.80
Early maturity	57.89ab	22.20
Low production cost	63.16a	21.69
Easy marketability	47.37ab	22.45
Auto-consumption	26.32bc	19.80

Percentages followed by different letters are significantly different at 5%.

Herd structure

The visited herds have goats of different age categories (Fig. 1). These include pregnant goats (14.3%), lactating goats (13.35%), antennae (12.03%), castrated males (11.65%), unweaned goats (10.8%) and non-pregnant goats (10.51%), which are relatively higher proportions. On the other hand, weaned goats (2.75%) and non-castrated goats (4.73%) are very low in the herds.

Habitat of dwarf goats

Most of the interviewed goat breeders (86%) have a goat farm. Among them, 81.4% have improved goat housing. Some breeders use straw for the construction of the walls (65.12%) while others use metal sheets (27.91%) and fences (27.91%) but rarely bricks (9.3 %).

The type of habitat built by breeders is either traditional (18.6%) or modern (81.4%). All goat-sheds encountered are covered with metal sheets. Some of them have good aeration (58.14%), others have satisfactory aeration (23.26%) and very few have poor aeration (4%). Information on goat habitat is summarized in Table 2**.**

Table 2. Habitat of dwarf goats in the Department of Borgou in Benin.

Variables		Total number	Observed number	Percentage (%)	Confidence Interval (%)
Possession of goat-shed	Yes	50	43	86.00a	9.62
	No	50	7	14.00b	9.62
Nature of the walls of the goat-shed	Wood	43	7	16.28bc	11.03
	Bricks	43	4	9.30c	8.68
	Straw	43	28	65.12a	14.25
	Metal sheets	43	12	27.91b	13.41
	Fences	43	12	27.91b	13.41
Nature of the roof of the goat-shed	Metal sheets	43	43	100	0
Type of building	Traditional	43	8	18.6a	11.63
	Modern	43	35	81.4b	11.63
Aeration in the habitat	Good	43	25	58.14a	14.75
	Poor	43	4	9.3b	8.68
	Satisfactory	43	10	23.26b	12.63

The intra-class percentages followed by different letters are significantly different at 5% ; CI: Confidence Interval.

Feeding of dwarf goats

Natural grazing provides the staple feed to these animals, and almost all (98%) the herders provide feed supplements during both dry and rainy seasons (Fig. 2). Among these supplements, millet bran is the most used. Cassava peels are often used in the dry season, as well as yam peels. Peanut haulms and beans, corn bran and kitchen remains are always used. Overall, 83.67% of the breeders provide feed supplements to all animals regardless of their physiological condition. However, 6.12% only give supplements to castrated goats and 4.08% distribute them to breeding females. They distribute feeds either once a day (58%) or twice a day (34%) and in rare cases (8%), three times per day. These feeds are served mostly (89.8%) in a container. Few breeders serve on the ground (10.02%) (Table 3).

Table 3. Frequency and mode of distribution of feeds and category of animals that receive feed supplements.

Variables		Total number	Proportions (%)	Confidence Interval (%)
Feed supplement based on physiological status	Yes	50	90a	8.32
	No	50	10b	8.32
Category of goats that receive feed supplements	Reproductive females	49	4.08b	5.54
	Castrated goats	49	6.12b	6.71
	All	50	83.67a	8.32
Frequency of distribution of feeds per day	Once	50	58a	13.68
	Twice	50	34b	13.13
	Thrice	50	8c	7.52
Mode of distribution of feeds	On ground	49	10.02b	7.67
	In a dry container	49	89.8a	8.48

Reproduction of dwarf goats in the department of Borgou

In Borgou, all the interviewed breeders practice free coupling for the reproduction of their animals. The males go *ad libitum* to the females during the most favorable moment of their heat. Table 4 presents the reproduction parameters of dwarf goats in the Department of Borgou.

Table 4. Breeding parameters of dwarf goat herds.

Variables	Number	Mean	Standard error
Age at the first farrowing (months)	48	11.19	3.37
Interval between births (months)	49	5.35	1.18
Number of pregnant females per year per farm	47	4.89	2.42
Number of abortions per year	46	0.74	1.14
Number of farrowing per year	46	3.24	2.24
Number of birth per year	44	14.39	7.42
Number of stillbirths per year	45	1.27	1.34
Number of live births per year	44	13.18	7.34
Number of alive at weaning per year	44	11.34	6.63

The age at first farrowing is 11.19 months and the interval between two births is 5.35 months.

About 4.89 females get pregnant and 4.24 farrowings are recorded for a total of 14.39 births per farm in a year. The abortion rate in goat herds is 15.13% and the stillbirth rate is 8.23% according to respondents. In addition, the fertility rate is 269.53% with a weaning viability of 86.04%.

Diseases encountered, causes and seasons of death

Several pathologies affect goats in the Department of Borgou. The dominant cases are diarrhea (68.75%), Peste des Petits Ruminants (43.75%) and cases of foot rot (26.67%). Only 6.25% of animals suffer from skin diseases. Causes of disease-related mortality (90.91%) are higher than those related to accidents (9.09%). The proportion of animals dying in the rainy season (83.33%) is higher ($p < 0.05$) than that of animals that die in the dry season (25%).

The pathologies encountered the causes and the periods of maximum deaths are presented in Table 5.

Table 5. Pathologies encountered causes and periods of death.

Variables		Proportions (%)	Confidence Interval
Encountered diseases	Respiratory diseases	18.75b	19.13
	Peste des Petits Ruminants	43.75a	24.31
	Skin diseases	6.25b	11.86
	Diarrheal diseases	68.75a	22.71
	Foot rot	26.67b	22.38
	Others	53.33a	25.25
Causes of mortality	Disease	90.91a	16.99
	Accident	9.09c	16.99
Seasons of mortality	Dry season	16.67b	24.50
	Rainy season	83.33a	21.09

Intra-class proportions of the same column followed by different letters do not differ significantly at 5 %.

Treatments and prophylaxis

In the Department of Borgou, 78.95% of herders have their animals treated by a veterinarian, compared to 16.5% who apply the treatments themselves ($p < 0.05$). The products used by breeders for the treatment of sick animals are either veterinary products (83.33%) or natural products of the local pharmacopeia (11.11%). For prevention against peste des petits ruminants (PPR), 18.95% of the breeders use vaccines. Similarly, 4.11% of them use dewormers to control gastro-intestinal parasites. Albendazole is the product mentioned by half of the breeders. They also associate this molecule with Bolumisol (12.5%) or Levamisol (25%) as reported in Table 6**.**

Table 6. Treatments and prophylaxis.

Variables	Modalities	Proportions (%)	Confidence Interval
Who treat the animals	Veterinarian	78.95a	18.33
	Breeder	16.5b	23.73
	Other	5.88c	11.18
Mode of treatment	Pharmacopeia	11.11b	14.52
	Veterinary products	83.33a	17.22
	Others	5.56b	19.21
Use of vaccines		78.95	18.33
Type of vaccines used	CP peste	20a	20.24
	Ocpeste	13.33a	17.20
	Ovipeste	13.33a	17.20
Deworming		42.11	22.20
Deworming drugs used	Albendazole+Bolumizol	12.5b	22.92
	Albendazole+Lévamizol	25b	30.01
	Albendazole	50a	34.65
	Lévamizol	12.5b	22.92

Intra-class proportions of the same column followed by different latters do not differ significantly at 5 %.

Color of the dwarf goats' coat

The study revealed that there is a wide variety of colors of the coat in the dwarf goats. Among these colors, black-pie and black are the most dominants (24.6% and 21.3% respectively). These two colors were more frequent (P <0.05) than the fawn color (15.36%). Gray, reddish-brown, reddish-white, and white-colored were not enumerated (Table 7).

Table 7. Proportions of the different coat colors of dwarf goats.

Color	Number	Number of case	Proportion (%)	Confidence Interval
White	712	29	4.06[e]	1.452
Fawn	716	110	15.36b	2.641
Black	716	152	21.23a	2.995
Gray	716	9	1.26f	0.816
Pie-black	716	95	13.27d	2.485
Reddish-brown	716	27	3.77[e]	1.395
Black-pie	716	173	24.16a	3.136
Reddish white	716	42	5.87[e]	1.721
Other colors	716	80	11.17d	2.308

Proportions followed by the same letters do not differ significantly at 5%.

Presence and shape of the horns of dwarf goats

Almost all goats have horns (94.99%). The most commonly encountered horns are pointed horns, crowned horns, hooked horns, and arched horns. Goats with hooked horns (51.44%) were significantly in higher number (p<0.05) compared to other shapes (Table 8).

Table 8. Presence and shape of the horns of dwarf goats.

Variable	Numbers	Number of cases	Proportions (%)	Confidence interval
Presence of horns	419	398	94.99a	2.046
Absence of horns	419	20	5.01b	1.894
Pointed horns	419	160	51.44a	4.652
Crowed horns	419	6	1.43d	1.138
Hooked horns	419	129	30.79b	4.420
Arch horns	419	102	24.34c	4.109

Percentages followed by the same letters do not differ significantly at 5%.

Table 9. Frequency of goatees and pendeloques in the dwarf goats.

Parameters	Numbers	Number of cases	Proportions (%)	Confidence intervals
Presence of goatees	419	30	7.16a	9.338
Absence of goatees	419	389	92.84b	9.095
Presence of pendeloque	716	21	2.93a	8.513
Absence of pendeloque	716	695	97.07b	7.096

Proportions followed by the same letters do not differ significantly at 5%

Presence of goatees and pendeloques in the dwarf goats

Almost none of the goats had goatees and pendeloques. Only 7.16% possess goatee and 2.93% have pendeloques (Table 9).

Morphometric measurements of dwarf goats

The thoracic perimeter, the height at the wither, the scapilo-ischial length and the length of the horns did not vary according to sex. The average length of the pelvis (11.48 cm *vs* 10.82 cm) and the average length

of the ears (9.55 cm *vs* 8.92 cm) were significantly higher ($p < 0.05$) in females compared to males (Table 10). Beyond 42 months, males have longer horns than females (11 cm *vs* 8.61 cm). Apart from horns, the age and sex interaction was not significant on the morphometric measurements of these goats (Table 10).

Table 10. Effect of sex on morphometric measurements of dwarf goats in Borgou, Benin.

Variables	Females		Males	
	Means	SE	Means	SE
Adult weight (kg)	20.82a	1.97	18.44	2.31
Thoracic perimeter (cm)	55.52a	0.55	54.31a	1.34
Height at the withers (cm)	40.83a	0.4	40.52a	0.98
Scapulo-ischial length (cm)	39.22a	0.45	37.03a	1.1
Length of the pelvis (cm)	11.48a	0.11	10.82b	0.27
Length of the ears (cm)	9.55a	0.1	8.92b	0.25
Length of the horns (cm)	4.23a	0.17	5.1a	0.42

Means of the same row followed by different letters are significantly different at 5%. SE : standard error.

Correlations between morphometric measurements

Morphometric measurements were strongly ($p<0.001$) correlated with each other, with correlation coefficients varying between 0.58 and 0.83. The thoracic perimeter was proportional to the height at the withers ($r = 0.73$, $p<0.001$), scapulo-ischial length ($r = 0.76$, $p<0.001$), pelvic length, 83, $p<0.001$) and length of ears ($r = 0.6$, $p<0.001$). Taller goats have a scapulo-ischial length, a pelvic length and generally longer ears ($p<0.001$). Similarly, longer goats have a longer pelvis and relatively more developed ears ($p<0.001$). Dwarf goats with the highest body weights had the largest morphometric measurements ($p<0.001$). This observation was identical for the old goats as well. The correlation coefficients between the morphometric measurements of dwarf goats are shown in Table 11.

Table 11. Correlations between morphometric measurements of dwarf goats.

	BW	LH	TP	HW	SIL	PL	LE
Age	0.84***	0.75***	0.77***	0.69***	0.72***	0.74***	0.51***
PV		0.85***	0.88***	0.77***	0.84***	0.86***	0.64***
LC			0.75***	0.77***	0.8***	0.78***	0.58***
PT				0.73***	0.76***	0.83***	0.6***
HG					0.81***	0.8***	0.68***
LSI						0.82***	0.67***
LB							0.67***

BW: Body weight; LH : length of horns ; TP: Thoracic perimeter ;HW :height at the withers; SIL :scapulo-ischial length; PL : pelvic length ;LE : length of ears ;*** : $p<0.001$.

Weight performances

The dwarf goat has an average birth weight of 2.09 kg for females and 2.05 for males. The weight of the males was 8.81 kg and that of the females, 8.90 kg at 7.5 months old and no significant difference was observed between the standard weights of males and females. Fig.3 shows the growth curve of dwarf goats by sex.

Body weight and morphometric measurements of dwarf goats by age group

Body weight and morphometric measurements increased with goat age ($p<0.001$). The thoracic perimeter increased significantly with age, from birth to 12 months ($p<0.001$). Beyond 12 months, it also increased but non-significantly with age. The same tendencies were recorded for the scapulo-ischial

length and the length of the pelvis. In addition, goats with ages between 13 and 18 months and between 42 and 60 months had intermediate average height at the wither of goats aging between 7 to 12 months and 24 to 36 months.

The average length of goat horns at the age of 24-36 months is similar to those of ages between 7-12 months and 13-18 months. In addition, the length of ears did not vary between goats with ages between 4 and 6 months, 7 and 12 months, 13 and 18 months and 42 and 60 months. Nevertheless, the trend was to a slight increase in the length of the ears as animals get older. Furthermore, average lengths of ears of goats at the age of 13-18 months and at ages 42-60 months are close to those of 7-12 months and 24-36 months old with no significant difference. Morphometric and live body weight measurements of dwarf goats are presented in Table 12**.**

Table 12. Effect of age on body weight and morphometric measurements of dwarf goats in Borgou, Benin.

Variables	0 to 3 months		4 to 6 months		7 to 12 months		13 to 18 months		24 to 36 months		42 to 60 months		ANOVA
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Body weight (kg)	4.91e	0.68	8.59d	0.61	11.97c	0.70	16.48b	0.81	17.58ab	1.14	20.82a	1.97	***
Thoracic perimeter (cm)	40.96d	1.10	48.82c	0.99	53.65b	1.14	59.88a	1.31	61.44a	1.86	64.75a	3.20	***
Height at the wither (cm)	31.28d	0.81	37.90c	0.81	40.59b	0.84	43.68ab	0.96	45.4a	1.37	45.19ab	2.36	***
Scapulo-ischial Length (cm)	27.78d	0.90	34.30c	0.82	37.48b	0.94	41.89a	1.09	41.18a	1.53	46.11a	2.64	***
Length of the pelvis (cm)	8.18d	0.22	10.13c	0.20	11.16b	0.23	12.27a	0.27	12.14a	0.38	.	.	***
Length of the ears (cm)	7.44c	0.20	9.04b	0.19	9.26b	0.21	9.65ab	0.24	10.18a	0.35	9.86ab	0.60	***
Length of the horns (cm)	0.27e	0.35	2.45d	0.31	4.19c	0.36	5.82b	0.41	5.45bc	0.59	9.8a	1.01	***

SE: Standard Error; ANOVA: Analysis of variance; *** : p<0.001; means of the same row followed by the same letters do not differ significantly at 5%.

Meat performance of dwarf goat in Borgou, Benin

At slaughter, dwarf goats are aged on average 20 months with a mean body weight of 14.89 kg and a carcass weight of 8.68 kg giving a yield of 58.11%. Females have a higher body weight (P <0.01) compared to males (16.47 kg *vs* 12.15 kg) at slaughter and were also older than the males (24.3 ± 6.4 months *vs* 13.4 ± 3.2 months).

Similarly, they have a carcass heavier than that of males at the respective ages at slaughter (9.44 ± 0.65 kg vs. 7.19 ± 0.86 kg). However, no significant difference was observed between the carcass yield of males (58.7 ± 2.26%) and that of females (57.77 ± 1.72%).

The correlation between age and body weight is positive (r = 0.70, p <0.001), same applies between age and carcass weight (r = 0.51, p<0,01). Body weight was strongly correlated with carcass weight (r = 0.91, p<0.001) and carcass weight was positively related to carcass yield (r = 0.47, p<0.01). There was no significant correlation between carcass yield and age at slaughter and body weight.

Discussion

Status and origin of dwarf goats from the different herds

The present study shows that most dwarf goat farmers in Borgou are married men and responsible for an average of 5 people and have been involved in this activity for more than 10 years. This breeding is mostly practiced by men as supported by the study of Kassa (2015) in the Commune of Cobly. A study conducted by Tendonkeng (2013) in southern Cameroon also shows that dwarf goats are predominantly reared by married men with family responsibilities. According to that study, Cameroonian breeders have extensive experience in keeping dwarf goats (Tendonkeng, 2013).

Dwarf goats' production is partly a source of income

to solve a number of daily problems in households. A similar observation was reported by Tchouamo *et al.* (2005). In the Department of Borgou, several ethnic groups are involved in the breeding of dwarf goats. Apart from the ethnic groups identified in this Department, small ruminant breeding is also the prerogative of ethnic groups, especially the Yom and Kotokoli in the Department of Donga where these ethnic groups predominate (Bonnassieux *et al.,* 2013). Most animals are supplied by breeders or from the market. This shows that each investigated breeder knows the origin of his animals.

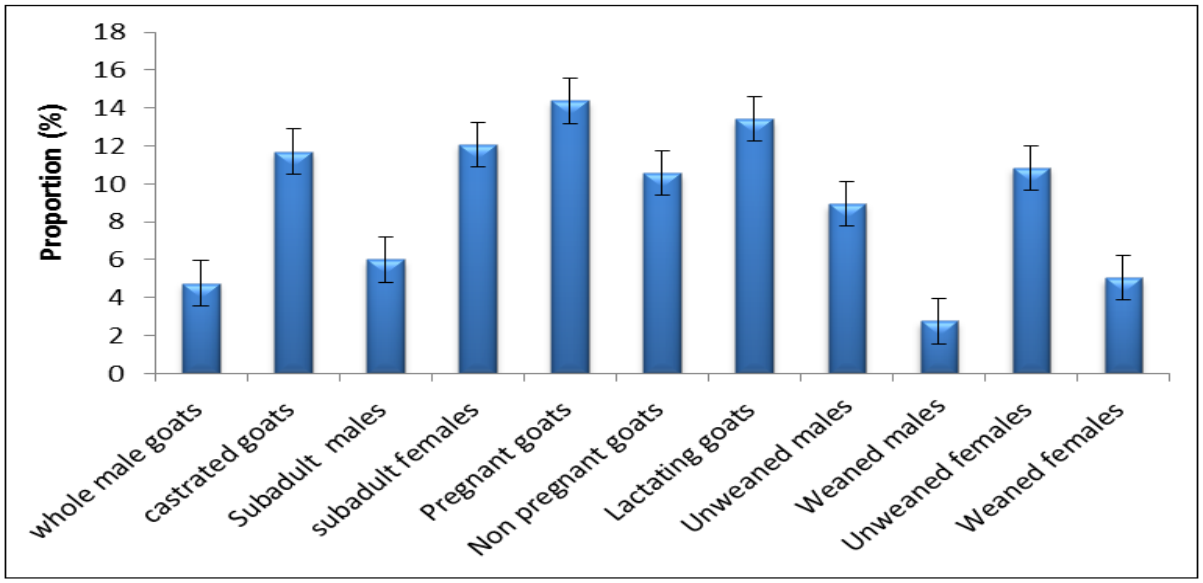

Fig. 1. Structure of the dwarf goat population in the Department of Borgou in Northeastern Benin.

These results are in accordance with those of Wikondi (2010) in Northern Cameroon where the majority of breeders acquired their animals by purchase.

In order to make more money, breeders buy cheaper goats and sell them more expensive. Tékodjinan (2011) reported that such marketing strategy is adopted by dwarf goat farmers in the Department of Atacora. The present study revealed that the average purchase and sale prices of a goat are 12,300 FCFA and 18,166 FCFA respectively. Contrary to this study, in 2010, the average selling and buying prices of a goat were 10,218 FCFA and 17,933 CFA francs in the same Department (Tekodjinan 2011). This difference in price can be explained by the current rise in living costs. Another form of goats farming was reported by Missohou *et al*. (2000) who concluded that breeders can exchange seven goats for a heifer in Senegal, for example. Moreover, in Borgou, most breeders have secondary education. This level of education is an asset that the public authorities in charge of rural development can use in order to improve goat farming in this region. The level of education facilitates the involvement of breeders in the implementation of innovations related to health protection and feeding of small ruminants (Chouamo *et al.,* 2005).

Selection criteria in dwarf goats farming

Breeders interviewed in the Department of Borgou are motivated in dwarf goats farming for precise reasons: prolificacy, early maturity and low cost of production. Dwarf goat farming is not demanding. Goats are generally resilient and value the fodder they consume when they are in free ranging. In addition, dwarf goat herds have high numerical productivity. Generally, the high numerical productivity of goats remains one of the adaptive characteristics of local goat breeds in the warm regions of Africa (Blanc *et al.,* 2013). The most expressive selection criteria in this study are also reported by Gunia (2012) on the Creole goat, in Guadeloupe. However, the Creole goat is usually kept for its good conformation and growth performances (Gunia, 2012), unlike dwarf goats. On

the other hand, the local goat of the western part of the Ethiopian plane is chosen because of its size and milk production (Nigussie *et al.,* 2013; Abegaz, 2014).

Structure and habitats of dwarf goat herds

The farms surveyed in the Department of Borgou are composed of goats of different agegroups. Females are the basis for the constitution of goat herds. They ensure the renewal and increase the size of the herd. For example, in Mali, females are kept longer in the herd not only for breeding but also for the production of milk for household consumption (Kamissoko *et al.,* 2013).

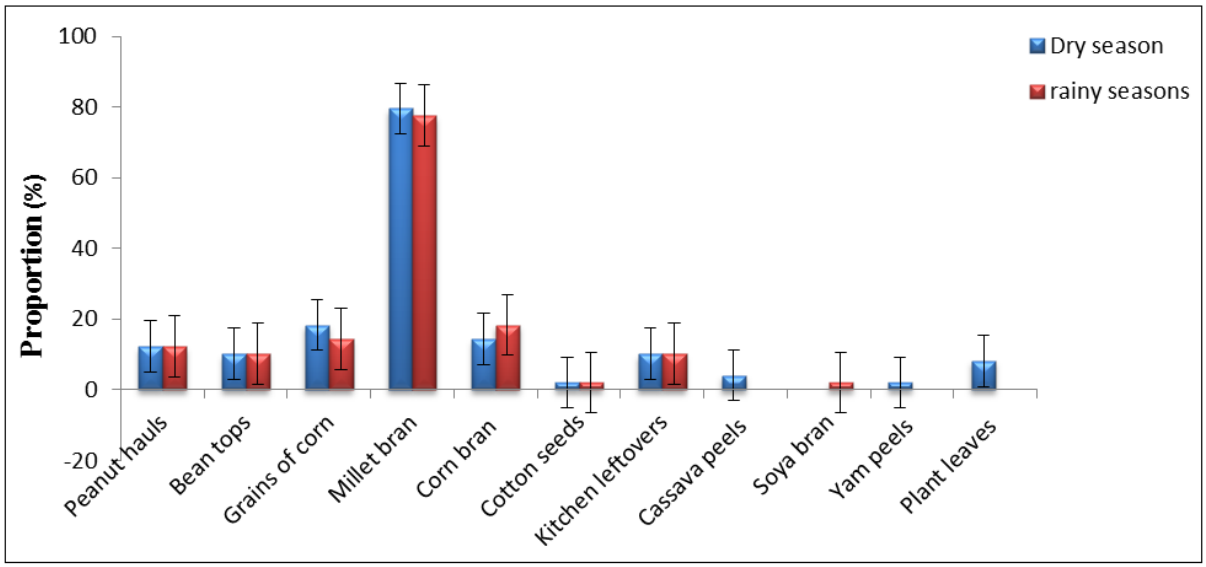

Fig. 2. Proportion of breeders who use feed supplements in the dry season and rainy seasons in their dwarf goats farming in the Department of Borgou in Benin.

The slaughtering of young females and especially pregnant females is a constraint to the development of goat rearing (Nana *et al.,* 2014). As far as habitats are concerned, dwarf goat breeders have mostly an improved type of goat housing made of straw walls and roofed with metal sheets. This effort to improve the quality of the goats' housing proves that these breeders are doing their best for animal welfare. In contrast to this study, small ruminants are generally kept in free ranging in southern Cameroon. They spend the night under verandas and in abandoned houses (Tendonkeng *et al.,* 2013). In addition, Saanen goats are housed in old hangars in the mountainous regions of Algeria (kadi *et al.,* 2013).

Feeding of dwarf goats

Dwarf goats in the Department of Borgou are mainly fed on natural grazing associated with crop residues. Overall, in the tropics, ruminants are maintained year-round on natural pastures (Tendonkeng *et al.,* 2013). In accordance with the present study, Jana *et al.* (2014) reported that most ruminant producers in the Burdwan region of India feed their animals on natural rangelands and also bring them crop residues. Feed supplements are provided throughout the year by the breeders of the Department of Borgou. For this purpose, millet bran is the most used. Apart from this supplement, other types of supplements are distributed to animals, in particular, corn kernels, peanut kernels, corn bran, bean toppings and the like. Kassa (2015) also reported that bean tops are widely used for goat feeding in the commune of Cobly. Similarly, harvest residues are also used in goat feeding in the Burdwan region of India (Jana *et al.,* 2014). In Algeria, the supplements used are breweries and olive pomace (kadi*et al.,* 2013). Tedonkeng Pamo *et al.* (2004) recommended fresh *Leucaena leucocephala* leaves as goat feed supplement because they improve their weight growth. Farmers are also advised to use agro-industrial by-products such as molasses concentrates, urea but also mineral supplements such as phosphorus and calcium. This

mineral supplementation is essential for the health of goats: it is provided in the form of stones or lick blocks that can be bought in all veterinary pharmacies in Africa. It is particularly necessary for goats that have just given birth and for those that are lactating (CTA, 2006).

Reproduction of dwarf goats

The reproduction of dwarf goats in Borgouis based on *ad libitum* coupling. Reproduction is also not monitored in goat farms in the Department of Mvila in southern Cameroon (Tendonkeng *et al.,* 2013). The females are serviced by scavenging males (Tendonkeng *et al.,* 2013). The mean age at first farrowing in dwarf goats in herds from Borgou Department is similar to the one (12.1 months) reported by Marichatou *et al.* (2002) in Moradi goatsof Niger but less than the 15 months reported by Mayeriya *et al.* (2017) in local goats of Lubumbashi in the Democratic Republic of Congo. The fertility rate in goat farms shows that dwarf goats are very fertile. This fertility rate is almost the double of the 119.43% in Maradi goat farms in Niger (Moussa, 2005). This difference could be related to genotypes. In the Department of Borgou, dwarf goats are very prolific. This prolificacy is higher than the 1.5 live births per farrowing reported by Tchouamo *et al.* (2005) in Bafou, Cameroon. In addition to prolificacy, the number of births per year in the goat herds of this Northern region is very high compared to that (1.6) obtained by Tchouamo *et al.* (2005). The differences observed in these parameters may be due to the reduced numbers of goats in the herds in Cameroon. Similarly, these gaps can be justified by the fact that the average number of abortions per year in the Department of Borgou is 0.74 while that recorded in the region of Bafou is on average 5.

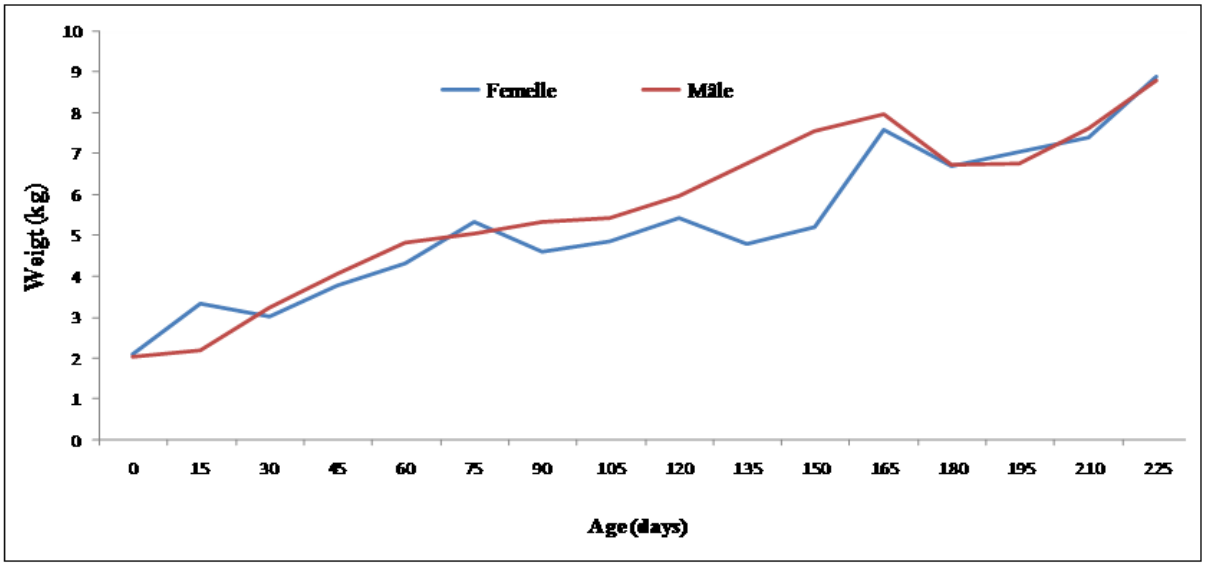

Fig. 3. Growth curve of dwarf goats by sex.

Pathologies and treatments in goat herds

Several pathologies affect goats in the Department of Borgou. The predominant pathologies are manifested in the form of diarrhea, followed by peste des petits ruminants and scabies. These pathologies were previously reported by Anago (2014) in the dwarf goat herds in the municipality of Kpomassè in Benin. Most of the pathologies encountered in the Department of Borgou were reported by Koanda (2005) and Tchouamo (2005), respectively in Burkina Faso and Cameroon. With regard to the causes of animal mortality in this study, more than 90% of the mortalities recorded are due to pathologies. The results of Kumar *et al.* (2013) in Madhya Pradesh, India, also prove that pathologies are the leading cause of goat mortality. In the Department of Borgou, the period of mortality of the animals is the rainy season because this season is very favorable to the

manifestation of a number of pathologies (Emikpé, 2013; Biyanka *et al.,* 2013).

The breeders increasingly attach more importance to the treatment of their animals. To prevent peste des petits ruminants, breeders vaccinate animals. This attitude was also reported by Jana *et al.* (2014) in the Burdwan region of India where goat breeders vaccinate their animals against peste des petits ruminants and in addition to other diseases such as goat pox and foot-and-mouth disease. These treatments are usually done by veterinarians in the Department of Borgou. Goat breeders also use veterinary drugs in Cameroon, specifically in Mvila (Tendonkeng *et al.,* 2013). A reverse trend is reported by Tekodjinan (2011) in the Department of Atacora where a large proportion of breeders personally treat their herds. This attribuatble to the level of production that is still low in some areas of Atacora. Similarly, this can be ascribed to the lack of veterinarians in the area or the low level of income of the breeders who would not be able to afford treatment expenses. In addition, this study also revealed that breeders use natural products from local pharmacopeia to treat certain pathologies. According to the breeders, medicinal plants are cheaper and give them satisfaction. A study by Ogni *et al.* (2014) on the ethnopharmacological inventory of plants used in the treatment of pathologies in extensive and semi-intensive livestock in Benin shows that the use of plants such as *Ceratotheca sesamoides*, *Hyptis suaveolens*, *Lactuca taraxacifolia* and *Annona senegalensis* are very effective for the treatment of scabies in small ruminants. Marie-Magdeleine *et al.* (2010) also reported that cassava leaves in Guadeloupe effectively limit the development of the larvae of *Haemonchus contortus* in adult goats. However, these leaves are not recommended in lambs because they limit their ingestion and slow down their growth (Marie-Magdeleine *et al.,* 2010).

Effect of age on weight and morphometric measurements of dwarf goats

The present study shows that the body weight and the morphometric measurements of dwarf goats in the Department of Borgou increase with age. This result is consistent with that of Khandoker (2016) on the Katjang goat in Malaysia, which shows that head length, tail length, ears length, body weight, height at wither increase with Age of the goat. Haldar *et al.* (2014) also reported that the oldest black Bengal goats are larger in size and also heavier. The effect of age was also revealed by Ibnelbachyr *et al.* (2015) in Morocco on the Draa goats. In general, age is related to body measurements in animals (Ngona*et al.,* 2012).

Colors of the coat of the dwarf goats

The present study shows that there is a wide diversity of colors of the coat in dwarf goats. The colors black-pie and black are dominant. The great variability of the color of the coat indicates that this breed has not yet been purified by selection. This diversity of color was also observed in Lubumbashi goats in the Democratic Republic of Congo, which is predominantly black (Ngona *et al.,* 2012). Unlike dwarf goats in Benin, dwarf goats of the local Mossi breed from Burkina Faso have a white-brown, brown and white dominated coat (Traoré *et al.,* 2006). Similarly, the study by Mdladla *et al.* (2017) on dwarf goats in the Northwest Provinces of South Africa reveals that the predominant color is white. These differences are justified by the ethnological peculiarities.

Shape of horns, goatees, and pendeloques in dwarf goats

A varied form of horns characterizes the dwarf goats in the Department of Borgou: pointed horns, crowned horns, hooked horns, arched horns. The pointed horns are horns with sharp pointed tips. The horns are said to be crowned when they are curved, and their points are on the same horizontal plane as the basis, and look at each other; they are hooked when the tips are slightly raised upwards. On the other hand, the horns are arched when they rise, curving inwards, in the plane of the frontonasal line (Youssao, 2017). In the dwarf goat, the most commonly encountered horns are pointed horns. This result is similar to that reported by Mdladla *et al.* (2017) in

dwarf goats in the North-West Provinces of South Africa. Very few goats possess goatees and pendeloques. Results consistent with those of the present study are obtained by Mdladla *et al.* (2017) in South Africa in dwarf goats. Goatees and pendeloques are generally found in goats in the Sahel (Mani *et al.,* 2014).

Effect of sex on meat performances and morphometric measurements of dwarf goats

The study revealed that females are heavier than males at slaughter, and have the best average carcass weights. Although some authors reported sexual dimorphism in favor of males (Khandoker *et al.,* 2016 and Ibnelbachyr *et al.,* 2015), the results of this study can be explained by the dominance of old goats and young goats in the herds. However, Traoré *et al.* (2006) and Gnanda (2008) demonstrated that there is no difference between males and females before 12 months of age in Mossi goats of Burkina Faso and goats of the Burkinabe Sahel. Compared to morphometric measurements, the pelvis and ears are longer in females. A consistent result was reported by Assouma (2012) in the Department of Atacora.

Conclusion

Goat farming is generally practiced by married men and by a diversity of sociolinguistic group in the Department of Borgou. It is primarily a source of prestige but also a source of income for households. The criteria for choosing the dwarf goat are the prolificacy, the low cost of production, the precocity, the ease of sale and the tradition of the breeders. The goat herds surveyed have good numerical productivity. In the herd composition, the number of females is higher than that of males. However, abortions and stillbirths are the limiting factors. The feeding of the goats is not rationed and is generally not controlled.

The animals are exposed to several pathologies and the means of treating diseases and conditions are limited. Older goats have more body weights and higher linear measurements than the young. Considering all the morphometric measurements, sexual dimorphism is marked in relation to the length of the ears and the length of the pelvis, in favor of the females. Meat performances are low. Nevertheless, these performances are better in females.

References

Abegaz S. 2014. Design of community based breeding programs for two indigenous goat breeds of Ethiopia. PhD thesis, Vienna, Austria: University of Natural Resources and Life Sciences. Vienna, 115 p.

Anago ED. 2014. Etude diagnostique des systèmes d'élevage caprin, principaux facteurs étiologiques des pathologies parasitaires dans la commune de kpomasse. Mémoire Pour l'obtention du Diplôme de Licence professionnelle en Sciences Agronomiques. Département de production animale. Faculté des sciences agronomiques. Université d'Abomey-Calavi. République du Bénin, 53 p.

Assouma M. 2012. Caractérisation phénotypique et zootechnique de la chèvre naine dans les départements du Borgou et de l'Atacora. Rapport de fin de formation pour l'obtention de la Licence Professionnelle en Production et Santé Animales. Ecole Polytechnique d'Abomey-Calavi, Université d'Abomey-Calvi, Abomey-Calavi, Bénin, 58 p.

Biyanka HAY, Ginigaddara GAS, Jayaweera BPA. 2013. Present status of goat farming in Kurunegala district: management systems and constraints. ISAE Proceedings of the International Symposium on Agriculture and Environment, 28 November 2013, University of Ruhuna, Sri Lanka, p.406-409.

Blanc F, Dumont B, Brunschwig G, Bocquier F, Agabriel J. 2010. Robustesse, flexibilité, plasticité: des processus adaptatifs révélés dans les systèmes d'élevage extensifs de ruminants. Productions animales **23,** 65-80.

Blanc F, Ollion E, Puillet L, Delaby L, Ingrand S, Tichit M, Friggens N.C. 2013. Evaluation quantitative de la robustesse des animaux et du

troupeau: quels principes retenir. Rencontres Recherches Ruminants **20,** 265-272.

Bonnassieux A, Hiernaux P, Diawara M, Droy I,Bidou JE. 2013. Dynamique des marchés du bétail dans la commune de Hombori, au Mali, de Dantioandou, au Niger et de Djougou au Bénin. Agence Nationale de la Recherche (ANR), Elevage, Climat et Société (ECliS), 32 p.

CIPEA. 2011. Elevage des petits ruminants. Cirad-emvt, 175-197.

Centre Technique de Coopération Agricole et rurale. 2006. Centre Technique de Coopération Agricole et rurale. Élevage des caprins, 39 p.

Centre Technique de Coopération Agricole et rurale. 2008. Elevage des chèvres laitières, collection Guides pratiques du CTA N°1, 4 p.

Delgadillo CAC, López OR, Montaldo VHH, Berruecos VJM, Luna E, Shimada MA, Vásquez PCG. 2009. Caracterización de la curva de crecimientodelciervorojo (Cervuselaphusscoticus) en el centro de México. TécnicaPecuaria en México **47,** 117–123.

Emikpe BO, Jarikre TA, Eyarefe OD. 2013**.** Retrospective study of disease incidence and type of pneumonia in nigerian small ruminants in Ibadan, Nigeria. African Journal of Biomedical Research **16,**107-113.

Gnanda IB, Nianogo AJ, Zoundi JS, Faye B, Zono O. 2008.Effet d\'une complémentation énergétique en période humide sur la production laitière de la chèvre du Sahel Burkinabé. Agronomie africaine **20**, 109-118.

Gunia MJ. 2012. Conception et optimisation d'un programme de sélection de petits ruminants en milieu tropical : cas du caprin Créole en Guadeloupe. Thèse de Doctorat. Unité de Recherches Zootechniques INRA Antilles-Guyane, Domaine Duclos, Prise d'eau, 97170 Petit-Bourg, Guadeloupe, 172 p.

Haldar A, Pal P, Datta M, Paul R, Pal S K, Majumdar D, Pan S. 2014. Prolificacy and its relationship with age, body weight, parity, previous litter size and body linear type traits in meat-type goats. Asian-Australasian journal of animal science **27**, 628.
https://doi.org/10.5713/ajas.2013.136.58

Ibnelbachyr M, BoujenaneI, Chikhi A. 2015. Morphometric differentiation of Moroccan indigenous Draa goat based on multivariate analysis. Animal Genetic Resources 57, 81-87.
http://dx.doi.org/10.1017/S2078633615000296

Jana C, Rahman FH, Mondal SK, Singh AK. 2014. Management practices and perceived constraints in goat rearing in Burdwan district of West Bengal. Indian Research Journal of Extension Education **14,** 107-110.

Kadi SA, Hassini F, Lounas N, Mouhous A. 2013.Caractérisation de l'élevage caprin dans la région montagneuse de Kabylie en Algérie. In 8th International Seminar of the FAO-CIHEAM Subnetwork on Sheep and Goats Production Systems "Technology creation and transfer in small ruminants: roles of research, development services and farmer associations" Tanger, Maro, 11-13 P.

Kamissoko B, Sidibé CAK, Niang M, Samake K, Traoré A, Diakité A, Sangare O, Diallo A, Libeau G. 2013. Prévalence sérologique de la peste des petits ruminants des ovins et des caprins au Mali. Revue d'élevage et de médecine vétérinaire des pays tropicaux **66**, 5-10.
http://dx.doi.org/10.19182/remvt.1014.8

Kassa TJ. 2015. Technique de production de conservation et d'utilisation des fanes de niébé pour l'alimentation des petits ruminants en élevage traditionnel dans la commune de Cobly. Rapport de Licence en Production Animale. Centre Autonome de Perfectionnement, Ecole Polytechnique d'Abomey-

Calavi, Université d'Abomey-Calvi, Abomey-Calavi, Bénin, 51 p.

Khaldi G, Lassoued N. 1991. Interactions nutrition-reproduction chez les petits ruminants en milieu méditerranéen. Isotope and related techniques. p. 379.

Khandoker MAMY, Syafiee M, Rahman MSR. 2017. Morphometric characterization of Katjang goat of Malaysia. Bangladesh Journal of Animal Science **45**, 17-24. http://dx.doi.org/10.3329/bjas.v45i3.31035

Koanda S. 2005. Possibilités d'amélioration de la production laitière caprine dans le nord du Burkina Faso, mémoire présenté en vue de l'obtention du diplôme d'études spécialisées en gestion des ressources animales et végétales en milieux tropicaux Production Animale, Communauté française de Belgique, 92 p.

Kumar D, Dohare AK, Singh B, Bangar Y, Prasad S, Shakya G. 2013. Influence of age, sex and season on morbidity and mortality pattern in goats under village conditions of Madhya Pradesh, Indian Journal of Animal Sciences **6,** 329-331. http://dx.doi.org/10.5455/vetworld.2013.329-331.

Mani M, Marichatou H, Mouiche MMM, Issa M, Chaïbou I, Sow A, Chaïbou M, Sawadogo JG. 2014. Caractérisation de la chèvre du sahel au Niger par analyse des indices biométriques et des paramètres phénotypiques quantitatifs. Animal Genetic Resources **54,** 21–32. http://dx.doi.org/10.1017/S2078633614000046.

Marichatou H, Mamane L, Banoin M, Baril G. 2002. Performances zootechniques des caprins au Niger : étude comparative de la chèvre rousse de Maradi et de la chèvre à robe noire dans la zone de Maradi. Revue d'Élevage Médecine vétérinaire Pays tropicaux **55**, 79-84.

Marie-Magdeleine C, Mahieu M, Philibert L, Despois P, Archimede H. 2010. Effect of cassava (Manihot esculenta) foliage on nutrition, parasite infection and growth of lambs. Small Ruminant Research **93,** 10-18. http://dx.doi.org/10.1016/j.smallrumres.2010.04.024

Mayeriya K, Ngona IA, Mbiya L, Khang'Maté AB. 2017. Détermination de la puberté et de l'âge à la première mise-bas des chevrettes en élevage familial à Lubumbashi, République Démocratique du Congo. Journal of Applied Biosciences **109**, 10673-10679. http://dx.doi.org/10.4314/jab.v109i1.11.

Mdladla K, Dzomba EF, Muchadeyi FC. 2017. Characterization of the Village Goat Production Systems in the Rural Communities of the Eastern Cape, KwaZulu-Natal, Limpopo and North West Provinces of South Africa. Tropical Animal Health and Production **49**, 515-527. http://dx.doi.org/10.1007/s11250-017-1223-x.

Moussa S. 2005. Performance de reproduction et de production de la chèvre rousse de Maradi en milieu rural au Niger. Thèse, Médecine Vétérinaire. Dakar, 16.

Nana FCN, Tume C, Daouda DFK, Dandji MBS, Zoli AP, Beckers JF. 2014. Impact de l ´abattage des chèvres gravides sur l'élevage des petits ruminants au Cameroun. Livestock Research for Rural Development **26(11).** http://www.lrrd.org/lrrd26/11/nana26210.html

Ngona IA, Beduin JM, Khang'Maté ABF, Hanzen C. 2012. Etude descriptive des caractéristiques morphométriques et génitales de la chèvre de Lubumbashi en République démocratique du Congo. Revue d'Elevage et de Médecine vétérinaire des Pays Tropicaux **65** ,75-79.

Nigussie H, Mekasha Y, Kebede K, Abegaz S, Sanjoy PalK. 2013. Production objectives, breeding practices and selection criteria of indigenous sheep in eastern Ethiopia. Livestock Research for Rural

Development **25(9).**
http://www.lrrd.org/lrrd25/9/nigu25157.htm

Ogni CA, Kpodékon MT, Dassou HG, Boko CK, Koutinhouin BG, Dougnon JT, Akoegninou A. 2014. Inventaire ethno-pharmacologique des plantes utilisées dans le traitement des pathologies parasitaires dans les élevages extensifs et semi-intensifs du Bénin. International Journal of Biological and Chemical Sciences **8**, 1089-1102. http://dx.doi.org/10.4314/ijbcs.v8i3.22.

SAS. 2006. SAS/STAT User's guide, vers, 6, 4th ed, Cary, NC,USA, SAS Inst.

Tchouamo IR, Tchoumboue J, Thibault L. 2005. Caractérisation socio-économique des élevages des petits ruminants dans la province de l'Ouest du Cameroun. Tropicultura **23,** 2001-2011.

Tedonkeng Pamo E, Tendonkeng F, Kana JR, Loyem PK, Tchapga E, Fotie FK. 2004. Effet de différents niveaux de supplémentation avec Leucaena leucocephala sur la croissance pondérale de la chèvre Naine de Guinée. Revue d'Élevage et de Médecine vétérinaire des Pays tropicaux **57**, 107-112.

Tekodjinan T. 2011. Caractéristiques de l'élevage des caprins de race naine dans le département du Borgou. Rapport de fin de formation de Licence Professionnelle en Production et Sante Animales. Ecole Polytechnique d'Abomey-Calavi, Université d'Abomey-Calvi, Abomey-Calavi, Bénin, 56 p.

Tendonkeng F, Pamo TE, Boukila B, Defang FH, Njiki EW, Miégoué E, Lemoufouet J, Djiomika TJ. 2013. Socio-economic and technical characteristic of small ruminant rearing in south region of Cameroon: case of Mvila Division. Livestock Research for Rural Development, **25(4).**
http://www.lrrd.org/lrrd25/4/fern25064.htm .

Traoré A, Tamboura H, Kaboré A, Yaméogo N, Bayala B, Zaré I. 2006.Caractérisation morphologique des petits ruminants (ovins et caprins) de race locale "Mossi" au Burkina Faso. Animal Genetic Ressources Information **39,** 39-50. http://dx.doi.org/10.1017/S2078633612000513

Wikondi J. 2010. Caractéristiques socio-économiques et techniques de l'élevage des petits ruminants dans le département du Mayo Danay (Extrême nord du Cameroun). Mémoire de fin d'étude, FASA Dschang, 70p.

Youssao AKI. 2017. Cours de zootechnie générale. Département de Production et Santé Animales, Ecole Polytechnique d'Abomey-Calavi, Université d'Abomey-Calavi, Abomey-Calavi, Bénin, 78 p.