https://www.scirp.org/journal/ns Natural Science, 2025, Vol. 17, (No. 10), pp: 157-171

Phenotypic Variability within Dwarf Goat (*Capra hircus* Schaller, 1977) Population in Man Department of Western Côte D'Ivoire

Yann Armel Akoto Yao[1], Brahima Soro[1*], André Coulibaly[2], Herbert Michael Kpahé Kanh[3], Didier Paulin Sokouri[1], Simon-Pierre Assanvo N'Guetta[1]

[1]Faculty of Biosciences, Laboratory of Biotechnology, Agriculture and Biological Resource Development, Félix Houphouët-Boigny University, Abidjan, Côte d'Ivoire; [2]Faculty of Agricultural, Forestry and Environmental Engineering, Man University, Man, Côte d'Ivoire; [3]Department of Biochemistry and Genetics, Peleforo Gon Coulibaly University, Korhogo, Côte d'Ivoire

Correspondence to: Brahima Soro, *soro.brahima@ufhb.edu.ci
Keywords: Dwarf Goat, Phenotype, Man, Characterization
Received: March 20, 2025 **Accepted:** October 25, 2025 **Published:** October 29, 2025

ABSTRACT

The dwarf goat, the only local goat breed, has been neglected for long time in Côte d'Ivoire. No national genetic or zootechnical data exists on dwarf goats. Improving the productivity of this breed requires first characterizing its phenotype and zootechnical traits. This study aimed at phenotypically characterize's dwarfs in the Man department. The study was conducted in the rural and urban areas of the Man department. It was performed on 90 goats, including six males and 84 females. The collected data were recorded in a Microsoft Excel spreadsheet and then analyzed using R-3.6.2 software. Statistical tests included multivariate analysis of variance, t-tests, and principal component analysis. Statistical analyses showed that sexual dimorphism was not very evident in the human anatomy. The goat breed studied is multicolored. The frequency of variegation is high, resulting in a significant proportion of piebald coats. All animals of both sexes have curved horns. Not all individuals of both sexes have dewlaps. The coat is mostly short, and the muzzles are almost straight. The ears are all erect and horizontal.

1. INTRODUCTION

West Africa, which includes for 37.2% of the continent's goat breed, is one of the main breeding areas for this species, which plays a particularly important socio-economic role [1]. In Côte d'Ivoire, the goat breed almost doubled between 2015 and 2020, from nearly 2 million to 4 million, and almost 290,288 farmers, which includes 93% of men and 7% women, employed [2]. This resource is known worldwide for its generally low-input systems, whether extensive or semi-intensive ([3, 4]). The Djallonké goat breed, also known as the West African dwarf breed, is the only goat breed in the region. It is found throughout Côte d'Ivoire. These dwarf goats are very prolific and hardy. All social classes can raise them. Furthermore, the quality of the meat is exceptional and highly regarded by the local population, as noted by [5]. However, these animals are only bred with traditional methods in Côte d'Ivoire. Furthermore, the local goat breed has not been the subject of any research and is not generally considered in livestock development projects and programs. Little is known about this breed's performance. There is not virtually zootechnical data on the local dwarf goat available at the national level. However, knowledge of animal genetic resources is vital because they have got a power system of adaptation [6].

In this context, this study proposes a phenotypic characterization of the goats in this department. This study aimed at describing the qualitative and quantitative characteristics of dwarf goats in the Man department. This study could help future researchers to develop and improve the breeding programs.

2. MATERIAL AND METHODS

2.1. Study Area

This study was conducted in urban and rural areas in the Man department of western Côte d'Ivoire. The Department of Man is located in the Tonkpi region, western area of country. This department is composed of 11 sub-prefectures: Bogouiné, Fagnampleu, Gbangbegouiné-Yati, Logoualé, Man, Podiagouiné, Sandougou-Soba, Sangouiné, Yapleu, Zagoué, and Ziogouiné [7]. The department is bordered by the Biankouma department to the north, Bangolo to the south, Danané to the west, and Facobly and Kouibly to the east. With rainfall exceeding 1500 mm per year [8], Man is a fairly humid area due to its mountainous ground and forest covering (**Figure 1**).

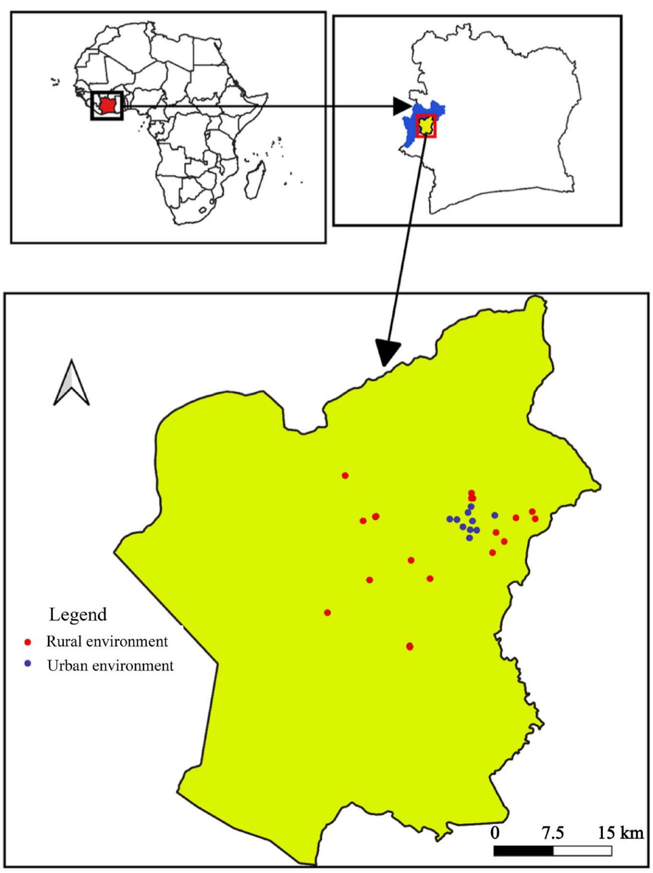

Figure 1. Study area.

2.2. Animal Sampling and Body Measurements

Surveys were conducted to identify and select farmers whose animals were studied. Criteria for identification and selection were established for this purpose. These included the accessibility of the farmer's farm in all seasons, having a herd of at least three (3) goats, and involvement in or support for data collection. A total of 20 villages in the Man Department and 10 neighbourhoods in Man City were visited for 30 sites (**Figure 1**). In each neighbourhood, only one (1) farmer was selected for the study. Two farmers in two villages whose goats were kept in enclosures were selected. As for the 18 other villages, one (1) farmer was also chosen for the study to reduce the risk of sampling related animals, given that the livestock are free-ranging. A total of 30 farmers were included in this study.

A total of 90 goats (06 bucks and 84 does) with a minimum age of one year in five sites were sampled, with a maximum of four animals in each herd used for body measurements to avoid issues in the two provinces. The age of the goats was estimated using their teeth. Eight quantitatives and nine qualitatives traits were assessed per herd, with a maximum of four animals per herd, following the FAO/ISAG guidelines for goat characterization [9] (**Figure 2**).

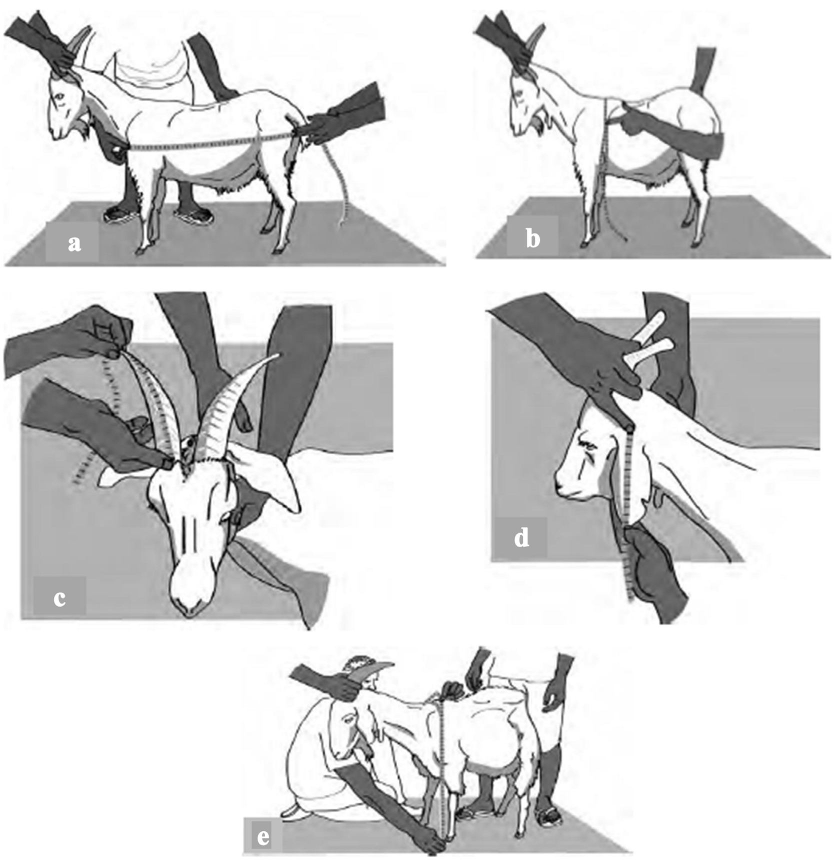

Figure 2. Schematic representations of methods for measuring goat morphometric traits (FAO, 2012). a = body length; b = chest circumference; c = horn length; d = ear length; e = height at the withers.

2.3. Data Processing and Statistical Analysis

The collected data were recorded in a Microsoft Excel spreadsheet and analyzed using R-3.6.2 software. Normality of the distribution of values and similarity of variances for quantitative variables in the goat subpopulations were verified using the Shapiro-Wilk and Bartlett tests. Various representing morphobiometric characteristics were analyzed using multivariate analysis of variance (ANOVA) to assess their combined influence on the separation of goat subpopulations. Subsequent ANOVA tests were then conducted to examine the effect of each individual characteristic on subpopulation differentiation. A t-test was then used to compare the mean values of male and female goat subpopulations respectively in urban and rural environments. Pearson's correlation coefficients were estimated between morphometric parameters. The significance threshold for all statistical tests was set for 5%. The structure of the morphological diversity of goats was assessed by Principal Component Analysis (PCA) using the FactomineR and Factoextra packages. The prevalence of qualitative variables was expressed in terms of percentages. These proportions were compared using the chi-square test. The structure of the morphological diversity of goats linked to qualitative traits was assessed using MCA with the factomineR, ggplot2, and Ade4 packages. This analysis was performed by turning the 10 qualitative traits' data matrix into hclust objects. The fastcluster package was used to determine the optimal group number.

3. RESULTS

3.1. Qualitative Traits

The piebald coat is really in most of the goats sampled in this study. It was observed in 77.78% in the whole-breed with 66.67% of males and 78.57% of females exhibiting this coat pattern. Only 22.22% of the study breed had a solid coat. Males with this pattern represent 33.33% of the breed studied and females 21.43%. The predominant solid coat is the wild coat, which is present in 6.67% of the breed studied, with frequencies of 16.67% in males and 5.95% in females. The wild coat is followed by the black coat, which appears in 5.56% of all individuals studied, with 16.67% of males and 4.77% of females exhibiting this phenotype. Black, tan, fawn, and buff coats were not observed in males. The most common coats in the studied breed were black and fawn piebald, which were observed in 27.78% of the individuals. Black and fawn piebald coats had frequencies of 16.67% and 33.33% in males, respectively.

These coats were present, respectively at frequencies of 28.57% and 27.38% for black and fawn piebald coats, respectively. The wild piebald coat was the most commonly observed coat among the goats studied after the black piebald and chamois piebald coats, with a frequency of 16.67% and 8.33% among male and female individuals, respectively. The coat, front mantle, black and tan piebald, and diluted buff piebald were not observed in male goats. All male goats had curved horns, compared with 94.05% females. Straight horns were not observed in males. Only 5.95% of the females had straight horns. Almost all the goats studied had short hair (96.67%). Only 3.33% of the study breed had medium-length hair. Regarding the nose bridge, 83.33% of the males in this study had a straight nose bridge, compared with 94.05% of the females. A concave nose bridge was observed in 6.67% of the animals studied, with 16.67% of males and 5.95% of females exhibiting this phenotype (**Table 1**; **Figure 3**).

Table 1. Characteristics of coat pattern, coat color, horn shape, coat type, and muzzle type of dwarf goats in Man department according to sex.

	Sex		
	Male (n = 6)	Female (n = 84)	Total Population (n = 90)
Coat pattern			
Uniform	33.33% (n = 2)	21.43% (n = 18)	22.22% (n = 20)
Variegated/Pie	66.67% (n = 4)	78.57% (n = 66)	77.78% (n = 70)
Color of coat			
Black	16.67% (n = 1)	4.77% (n = 4)	5.56% (n = 5)
Black and tan	0% (n = 0)	2.38% (n = 2)	2.22% (n = 2)

Continued

Fawn	0% (n = 0)	2.38% (n = 2)	2.22% (n = 2)
Chamois	0% (n = 0)	4.77% (n = 4)	4.44% (n = 4)
Wild	16.67% (n = 1)	5.95% (n = 5)	6.67% (n = 6)
Black pied	16.67% (n = 1)	28.57% (n = 24)	27.78% (n = 25)
Red pied	0% (n = 0)	3.57% (n = 3)	3.33% (n = 3)
Fawn pied	0% (n = 0)	7.14% (n = 6)	6.67% (n = 6)
Chamois pied	33.33% (n = 2)	27.38% (n = 23)	27.78% (n = 25)
Wild pied	16.67% (n = 1)	8.33% (n = 7)	8.89% (n = 8)
Front mantle	0% (n = 0)	1.19% (n = 1)	1.11% (n = 1)
Black and tan pied	0% (n = 0)	2.38% (n = 2)	2.22% (n = 2)
Diluted chamois pied	0% (n = 0)	1.19% (n = 1)	1.11% (n = 1)
Horn shape			
Curved	100% (n = 6)	94.05% (n = 79)	94.44% (n = 85)
Straight	0% (n = 0)	5.95% (n = 5)	5.56% (n = 5)
Hair type			
Medium length	16.67% (n = 1)	2.38% (n = 2)	3.33% (n = 3)
Short	83.33% (n = 5)	97.62% (n = 82)	96.67% (n = 87)
Chamfer type			
Concave	16.67% (n = 1)	5.95% (n = 5)	6.67% (n = 6)
Straight	83.33% (n = 5)	94.05% (n = 79)	93.33% (n = 84)

The numbers in parentheses indicate the test frequencies. The values in parentheses represent the number of individuals characterized.

All male individuals in this study had beards, compared with 86.91% of females which did not. Goatees were observed in females (4.76%). All males studied have manes. As for females, 76.19% had one, compared with 23.81% which did not. Only 38.89% of the animals sampled had a dorsal stripe, with 66.67% in males and 36.90% in females (Table 2).

Table 2. Dewlap, dorsal line, mane and beard appearance of dwarf goats from the Man department according to sex.

	Sex		
	Male (n = 6)	Female (n = 84)	Total Population **(n = 90)**
Appearance of beard			
Absent	0% (n = 0)	86.91% (n = 73)	81.11% (n = 73)
Goatee	0% (n = 0)	4.76% (n = 4)	4.44% (n = 4)
Beard	100% (n = 6)	8.33% (n = 7)	14.45% (n = 13)
Pampille			
Absent	100% (n = 6)	100% (n = 84)	100% (n = 90)

Continued

Dorsal line			
Absent	33.33% (n = 2)	63.10% (n = 53)	61.11% (n = 55)
Present	66.67% (n = 4)	36.90% (n = 31)	38.89% (n = 35)
Mane			
Absent	0% (n = 0)	23.81% (n = 20)	22.22% (n = 20)
Present	100% (n = 6)	76.19% (n = 64)	77.78% (n = 70)

The numbers in parentheses indicate the test frequencies. Values in parentheses represent the number of individuals characterized.

Figure 3. Diversity in coat colours of goats in the study area.

3.2. Morphobiometric Characterization

Table 3 shows the results of the analyses of the eight quantitative parameters aimed at highlighting the environmental effect. A comparison of the averages for goats raised in urban and rural environments revealed no significant differences between the two variables. These were the horn length and ear length variables. However, at the 5% threshold, the six variables showed significant differences. These were height at the withers, for which individuals raised in urban areas had an average of 49.52 ± 4.12 cm and those raised in rural areas had an average of 47.43 ± 3.14 cm. The average head lengths measured 14.56 ± 1.27 cm in urban settings and 13.86 ± 1.55 cm in rural settings. The average scapulo-ischial lengths were 55.54 ± 6.13 cm for goats bred in urban areas and 52.37 ± 5.81 cm for those bred in rural areas. For chest circumference (thoracic perimeter), individuals raised in urban areas had an average of 73.96 ± 7.47 cm, whereas those raised in rural areas had an average of 68.84 ± 8.31 cm. Finally, for the weight variable, goats reared in urban areas showed an average of 28.82 ± 6.86 cm, whereas those reared in rural areas showed an average of 23.36 ± 7.56 cm. Overall, goats raised in urban areas had higher averages on the six variables than those raised in rural areas (Table 3).

Table 3. Comparison of the morphobiometric characteristics of dwarf goats in rural and urban area.

Variable	Urban area	Rural area	Significance
Height at withers (cm)	49.52 ± 4.12[a]	47.43 ± 3.14[b]	S*
Head length (cm)	14.56 ± 1.27[a]	13.86 ± 1.55[b]	S*
Horn length (cm)	10.80 ± 3.22	10.58 ± 3.68	NS
Neck length (cm)	14.83 ± 1.91[a]	13.79 ± 1.62[b]	S*
Ear length (cm)	10.72 ± 1.22	10.32 ± 0.84	NS
Scapulo-ischial length (cm)	55.54 ± 6.13[a]	52.37 ± 5.81[b]	S*
Chest circumference (cm)	73.96 ± 7.47[a]	68.84 ± 8.31[b]	S**
Weight (kg)	28.82 ± 6.86[a]	23.36 ± 7.56[b]	S**

Multivariate Analysis

1) Correlation matrix

Figure 4 shows the pearson correlation matrix for all morphobiometric traits. Only correlations with a significant p-value at the 5% threshold were introduced in the figure. This matrix indicates that all correlations were positive. The majority of correlations between the different variables are medium. They ranged from 0.4 to 0.6. The correlations between ear length on the one hand and weight, scapulo-ischial length and head length on the other, and between neck length on the one side and head length and chest circumference on the other, have values of 0.30. Strong correlations were observed between weight and chest circumference (0.95), scapulo-ischial length and chest circumference (0.77), scapulo-ischial length and weight (0.83), total length and chest circumference (0.69) and head length and weight (0.68).

2) Principal component analysis

Figures 5-7 show the PCA results for the entire sample. They were based on eight morphometric measurements of the study area's animals. The first three axes in the sample have an 82.4% cumulative variance. The first axis explains 59.5% of the total variability, whereas the second explains only 12.7%. The third axis explains 10.2% of the total variability (Figure 5). The variables that contribute most to the formation of the factorial plane consisting of axes 1 and 2 are: ear length (EL), weight (W), height at the withers (HW), and SL. Factorial plane 2 formed by axes 2 and 3 is mainly formed by LCU and LO variables. Generally, active individuals contribute an average amount to the formation of the first three axes, with the exception of two individuals, one from the northern zone and the other from the southern zone, as shown in Figure 6. Most of the individuals which contributed to axis 3's formation came from the southern zone. No discrimination in the population was found by PCA, regardless of the plane (Figure 7).

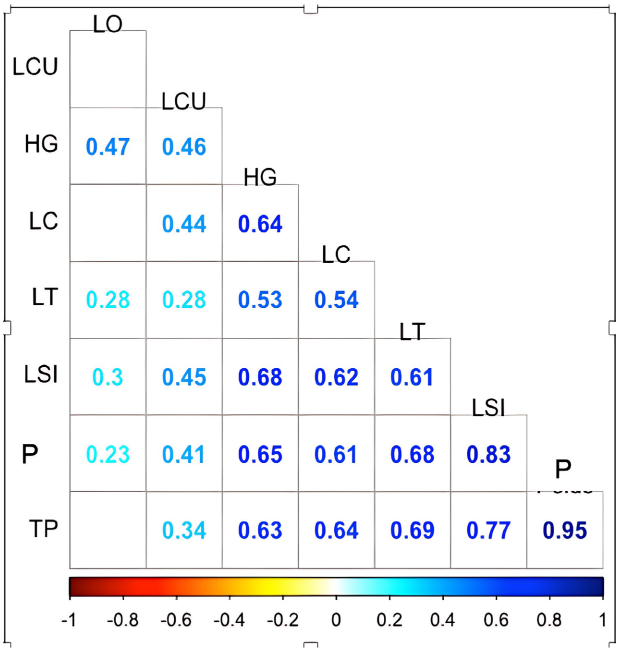

Figure 4. Pearson correlation matrix for all morphometric traits. (HG) height at withers; (LT) total length; (LC) horn length; (LCU) neck length; (LO) ear length; (LSI) scapulo-ischial length; (TP) chest circumference; (P) weight.

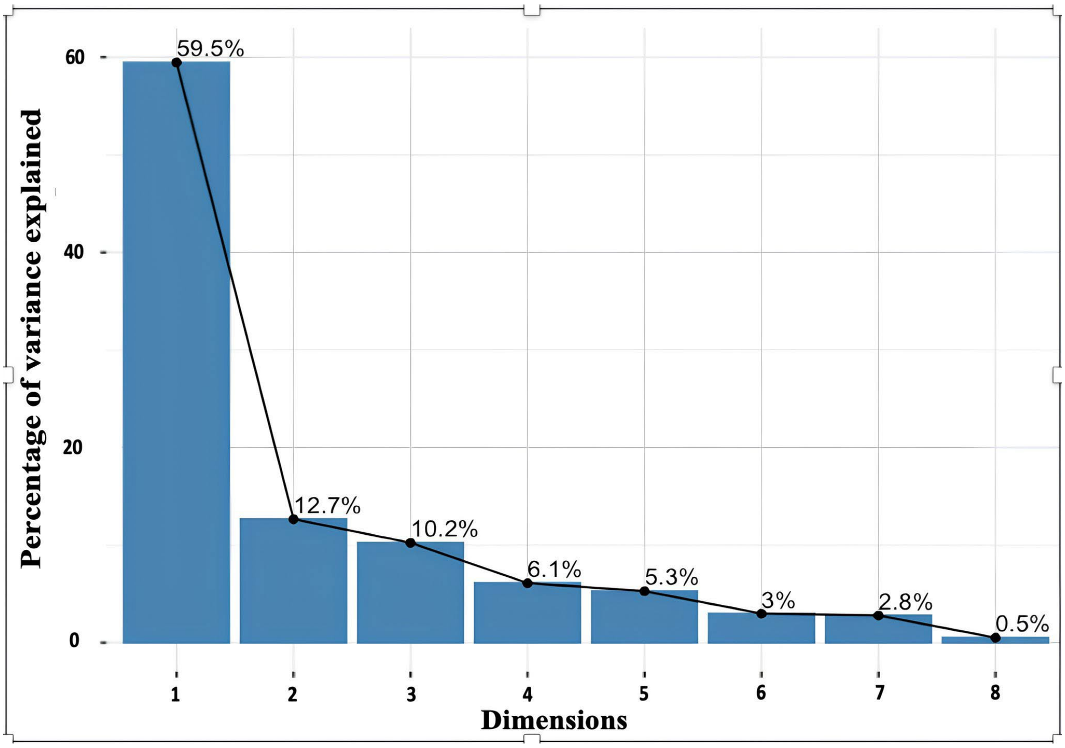

Figure 5. ACP scree graph for the entire sample.

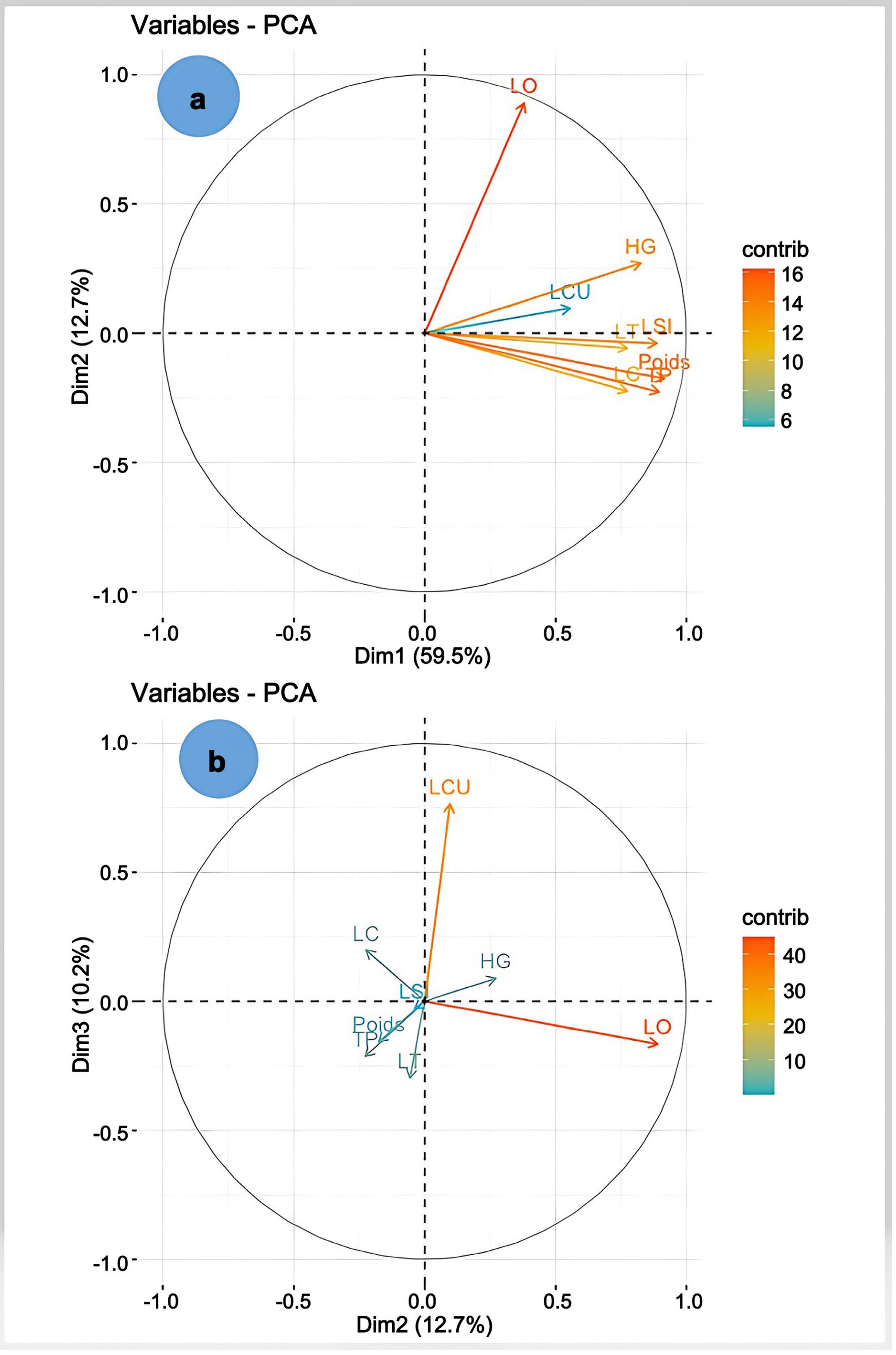

Figure 6. Projection of all variables in the correlation circles formed by axes 1 and 2 (A) and the plane formed by axes 2 and 3 (B). (HG) height at withers; (LT) total length; (LC) horn length; (LCU) neck length; (LO) ear length; (LSI) scapulo-ischial length; (TP) chest circumference; (P) weight.

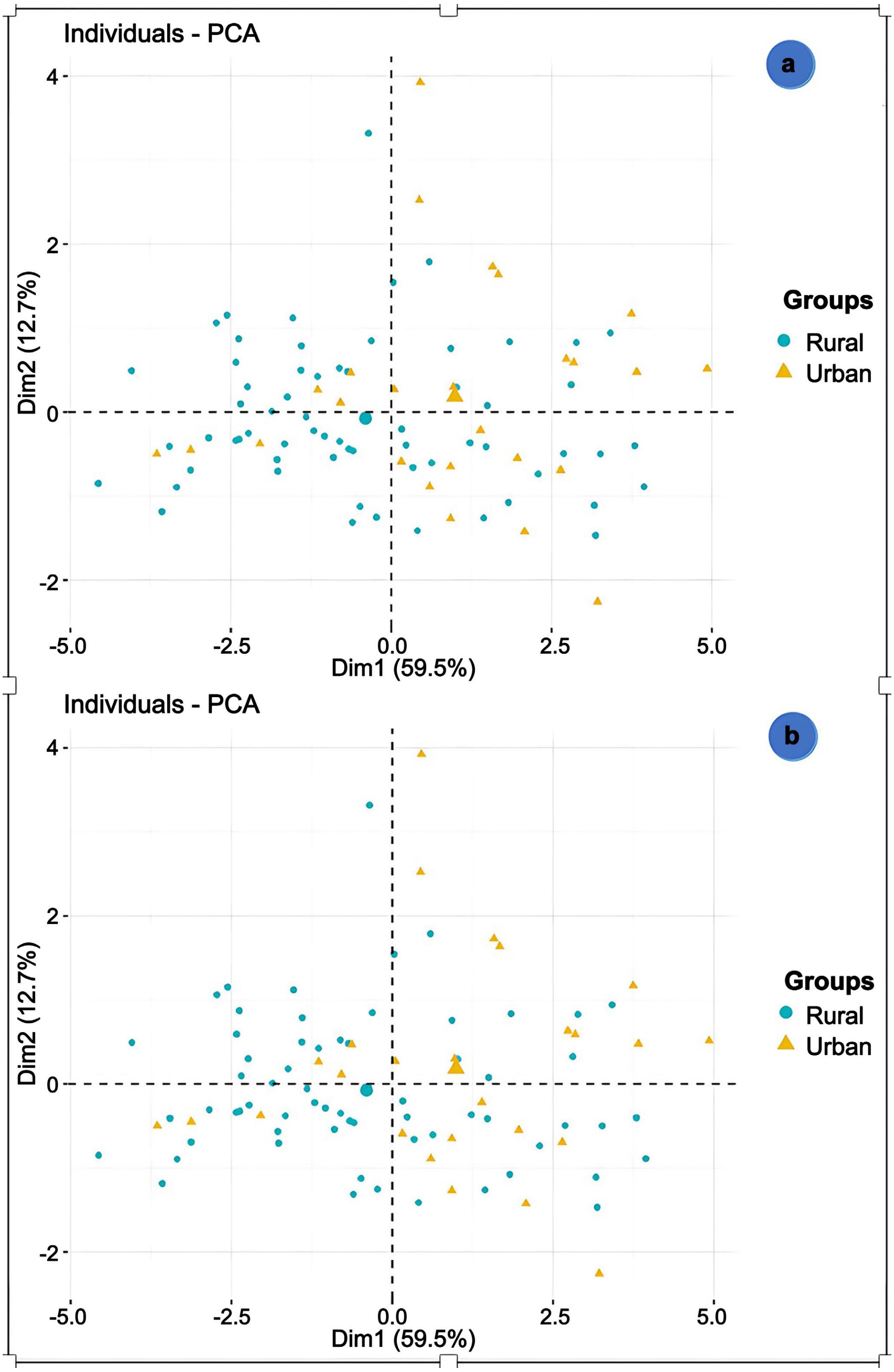

Figure 7. Projection of all individuals in the plane formed by (A) axes 1 and 2 and (B) axes 2 and 3.

3) Multiple component analysis

The discrimination between the different classes was performed using a partitioning algorithm based on the HI loss criteria. Figure 8 shows the inertia jumps obtained by transforming the qualitative variable matrix into the crust class objects. The analysis of this figure allows us to distinguish the optimum number of groups, which is two. Individuals in our sample are represented as points in two-factor multiple component analysis planes. It consists in factors 1 and 2. The second plane includes factor axes 2 and 3. The two colours observed represent the two groups obtained from the partitioning method. The red and blue individuals represent, respectively individuals in groups 1 and 2, respectively (Figure 9). The first factorial plane representation of individuals clearly divides the studied population into two distinct subgroups. Group 1 consists of 21 individuals, 15 of whose come from urban areas and 6 from rural areas. They are characterised by plain coat patterns and colours (Table 4). The second group consisted in 49 and 20 individuals from urban areas and 20 individuals from rural areas. This group is characterised by a variegated coat pattern and coats of varying colours.

Table 4. Composition of different groups and main discriminating factors.

	Group I (n = 21)	Group II (n = 69)
Area		
Urban	71.43% (n = 15)	71.01% (n = 49)
Farmer	28.57% (n = 6)	28.99% (n = 20)
Coat pattern		
Variegated/Pie	4.76% (n = 1)	100% (n = 69)
Uniform	95.24% (n = 20)	0% (n = 0)
Coat color		
plain	95.24% (n = 20)	0% (n = 0)
Compound	4.76% (n = 1)	100% (n = 69)

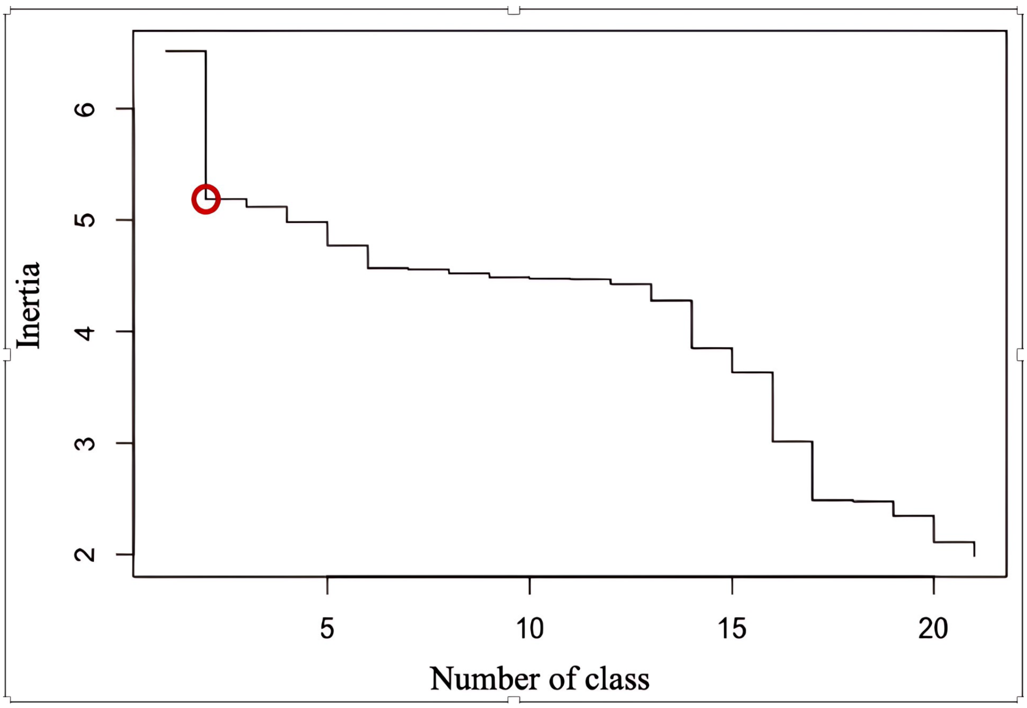

Figure 8. Optimal number of groups.

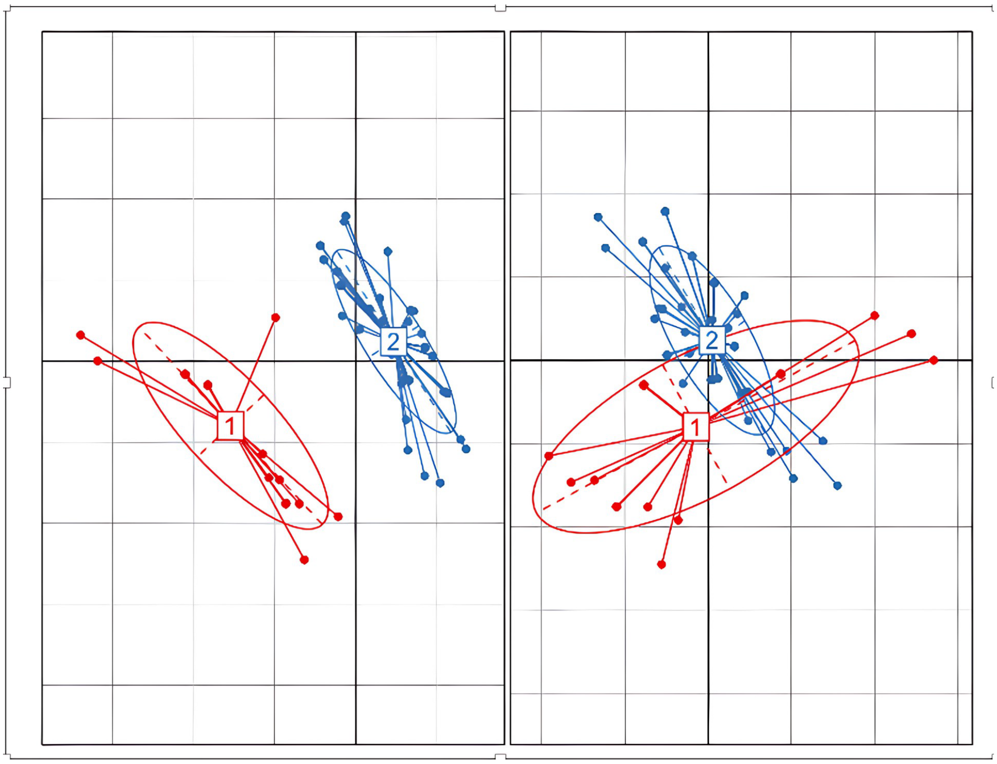

Figure 9. **Presentation of the different groups using the ACM method.**

4. DISCUSSION

Multivariate analysis of variance (MANOVA) considering the sex of the individuals sampled in the study area yielded a non-significant p value of 0.07 at the 5% threshold. The results suggest that there is minimal sexual dimorphism in goats in the Man department or that is nonexistent in terms of morphometric characteristics. This trend was also observed in Niger goat herds, as reported by [10]. However, these results differ from those obtained by [11]. The existence of sexual dimorphism was demonstrated by these authors in both Sokoto Red goats and goats with WAD in Nigeria. This difference can be explained by the impossibility of finding sufficient older males during our studies, as they are most often sold. This non-significance can be explained by the higher number of females compared with males in our study. [12] observed a significant effect of age on live weight and other body measurements in Ethiopian goats. Multivariate analysis of variance (MANOVA) considering the environment as a factor revealed the existence of a significant difference. This difference was localised at the level of six variables using ANOVA. The t-test also revealed superiority in these six parameters at the 5% threshold for goats from urban areas compared with those from rural areas. This difference can be explained by possible blood introgression from Sahelian goats. Indeed, Côte d'Ivoire imports goats, sheep, and cattle from the Sahelian countries [13]. In this study, the height at the withers were 47.43 ± 3.14 cm in rural areas and 49.52 ± 4.12 cm in urban areas. These results are lower than those reported by [14]. This author obtained an average of 54.86 ± 0.09 cm, which is higher than the values obtained for all parameters by Djagba *et al.* (2019) in Togo. The average height at the withers of 41.56 ± 3.66 cm, and the average weight of 17.51 ± 4.43 kg. In a study conducted on red goats in Maradi, Niger, [15] obtained a value of 53.68 ± 0.45 cm for chest circumference. These values are lower than those in this study, which are 73.96 ± 7.47 cm in urban areas and 68.84 ± 8.31 cm in rural areas. These results suggest a possible genetic superiority in dwarf goat conformation from the Man area over the Sahelian breeds studied by the aforementioned authors.

The ears of all animals were horizontally erect in this study. These results differ from those obtained by [10]. Approximately 60% of the ears were drooping and 33% were pedunculate. Similar findings have been reported for Sahel goats in Burkina Faso and Chad ([16, 17]). According to [16], when folded forward, the ears of the Chadian Sahelian goat are long, wide, and extend beyond the muzzle. Horizontally erect ears are the unique form found in the Man area. The presence of another form in this population could be a phenotypic indicator of blood introgression from another breed, particularly from the Sahel.

In our study, the dominant coat colours were piebald and black-footed. These observations are consistent with those reported by [18] for Djallonke goats from the slaughterhouse in Abidjan. The black-and-white colour, which is preferentially found in rural areas in our study, is also very common among Mossi goats in Burkina Faso [17]. It is also the dominant colour in Liberian goat herds, with a frequency of 40% [19]. The Pearson correlation matrix for all morphobiometric characteristics indicated positive correlations. Most correlations between the different variables were moderate. The correlation between weight and chest circumference was 0.95. Several studies have reported a strong positive and significant correlation between these two parameters ([20, 21]). The correlation between weight and SL was 0.83. These results are consistent with those of [21] and [22], who obtained values of 0.9 and 0.75, respectively. These two parameters are excellent weight estimators in goats in general and dwarf goats in particular. By establishing a barometric formula, they can be used to get values that are very close to the actual weight. Barometric formulas exist for Azawak, Abyssinian, and Kapsiki cattle ([23, 24]). Barometric formulas have also been developed for the Koundoum sheep breed in Niger and the Tazegzawth sheep breed in Algeria ([25, 26]). [27] used these measurements to establish barometric formulas for the body weight of goats. PCA revealed no trends. This result indicates that even if introgression existed in urban goats, this phenomenon is fairly localised and not sufficiently pronounced to cause discrimination between the two populations detectable by PCA.

The distinction between the different classes allowed the subdivision of goats from Man region into two groups. The MCA also allowed us to evaluate the individuals' projection and the two groups' discriminating variables. [28] used this method in Ndama cattle. These variations are mainly related to coat colour and patterns. Other parameters show variability. This configuration of variability does not permit distinguishing between individuals. Individual variability is typically observed at the individual rather than group level. Therefore, we were able to discriminate the population based on coat colour and patterns, following the observations of [29]. A link was also discovered between the breeding environment and the various groups. These data are crucial for genetic enhancement, allowing the development of genetically modified animals with a striking visual appearance that differs from current physical characteristics.

5. CONCLUSION

This study aimed at phenotypically characterize dwarf goats in the Department of Man, assuming that phenotypic diversity exists within the department's dwarf goat breed. The results obtained for quantitative traits revealed the heterogeneity of goats in the study area. In fact, goats in urban areas have higher quantitative parameters than those in rural areas. The goat breed studied is clearly multicolored. The frequency of variegation was high, resulting in a high proportion of piebald coats (black, red, fawn, buff, wild, tan, and diluted buff). All animals of both sexes have curved horns. All males had beards; however, only 8.33% of females had beards. The goatee is found only on females, at a frequency of 4.76%. Both sexes are free of the pendulum. The coat is predominantly short, with almost straight chamfers. The ears are all erect and horizontal. The multivariate analyses showed no specificity according to the environment. Therefore, dwarf goats from the Man department were superior to Sahelian goats in terms of conformation and carcass yield. The dwarf goat is generally recognized for its hardiness and good adaptation to its native environment. However, its intrinsic potential has not yet been revealed in terms of the mechanisms it has developed to resist and adapt to an environment that is naturally hostile to Sahelian goats. Therefore, this genetic resource must be carefully considered before any attempt is made to improve it, either by crossing with exotic breeds or by selection.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

ACKNOWLEDGEMENTS

The authors would also like to thank the local animal extension agents, researchers, and private farmers for their cooperation during data collection.

REFERENCES

1. Missohou, A., Nahimana, G., Ayssiwede, S.B. and Sembene, M. (2016) Élevage caprin en Afrique de l'Ouest: Une synthèse. *Revue d'élevage et de médecine vétérinaire des pays tropicaux*, **69**, 3-18. https://doi.org/10.19182/remvt.31167
2. MIRAH (2014) Strategic Development Plan for Livestock, Fisheries, and Aquaculture in Côte d'Ivoire (PSDEPA 2014-2020). Volume I: Diagnosis-Development Strategy—Guidelines. MIRAH, 102 p. https://faolex.fao.org/docs/pdf/ivc146471.pdf
3. Alexandre, G., Arquet, R., Fleury, J., Troupé, W., Boval, M., Archimède, H., *et al.* (2012) Systèmes d'élevage caprins en zone tropicale: Analyse des fonctions et des performances. *INRAE Productions Animales*, **25**, 305-316. https://doi.org/10.20870/productions-animales.2012.25.3.3218
4. Escareño, L., Salinas-Gonzalez, H., Wurzinger, M., Iñiguez, L., Sölkner, J. and Meza-Herrera, C. (2012) Dairy Goat Production Systems: Status Quo, Perspectives and Challenges. *Tropical Animal Health and Production*, **45**, 17-34. https://doi.org/10.1007/s11250-012-0246-6
5. Bassossa, B.A.M. (2012) Phenotypic and Zootechnical Characterisation of Dwarf Goats in the Bachelor's Thesis in Animal and Fisheries Production Science and Technology. Option: Animal and Fisheries Production, 46 p.
6. Laouadi, M., Tennah, S., Kafidi, N., Antoine-Moussiaux, N. and Moula, N. (2018) A Basic Characterization of Small-Holders' Goat Production Systems in Laghouat Area, Algeria. *Pastoralism*, **8**, Article No. 24. https://doi.org/10.1186/s13570-018-0131-7
7. RGPH (2014) Locality Directory: TONKPI Region. INS, 62 p. https://ins.ci/documents/rgph/TONKPI.pdf
8. Sodexam (2018) Rainfall Data from the Man Weather Station. https://sodexam.com/
9. FAO (2012) Phenotypic Characterization of Animal Genetic Resources. FAO Animal Production and Health Guidelines No. 11. https://www.fao.org/4/i2686e/i2686e00.pdf
10. Mani, M., Marichatou, H., Mouiche, M.M.M., Issa, M., Chaïbou, I., Sow, A., *et al.* (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. https://doi.org/10.1017/s2078633614000046
11. Alphonsus, C., Akpa, G.N., Barje, P.P., Nwagu, B.I., Orunmuyi, M., Sam, I.M., *et al.* (2024) Sexual Dimorphism in Morphological Characteristics of Two Nigerian Indigenous Goat Breeds. *Nigerian Journal of Animal Production*, 94-96. https://doi.org/10.51791/njap.vi.7196
12. Mekasha, Y. (2007) Reproductive Traits in Ethiopian Male Goats. With Special Reference to Breed and Nutrition. Doctoral Thesis, Swedish University of Agricultural Science, 56 p. https://pub.epsilon.slu.se/1494/1/Thesis_Combined_Final.pdf
13. FAO (2003) The State of Food Insecurity in the World 2003. Monitoring Progress towards the World Food Summit and Millennium Development Goals. FAO, 36 p. https://www.fao.org/4/j0083e/j0083e00.pdf
14. Traore, A., Tamboura, H.H., Kabore, A., Royo, L.J., Fernandez, I., Alvarez, I., *et al.* (2008) Multivariate Analyses on Morphological Traits of Goats in Burkina Faso. *Archives Animal Breeding*, **51**, 588-600. https://doi.org/10.5194/aab-51-588-2008
15. Marichatou, H., Karimou, B., Issa, M., Chaibou, M., Banoin, M., Yénikoye, A., *et al.* (2012) Caractérisation morphologique de la chèvre rousse du Niger. *Animal Genetic Resources*, **51**, 89-97. https://doi.org/10.1017/s2078633612000458

16. Dumas, R. (1980) Contribution to the Study of Small Ruminants. *Journal of Animal Husbandry and Veterinary Medicine in Tropical Countries*, **33**, 215-233.

17. Traoré, A., Tamboura, H.H., Kaboré, A., Yaméogo, N., Bayala, B. and Zaré, I. (2006) Caractérisation morphologique des petits ruminants (ovins et caprins) de race locale "Mossi" au Burkina Faso. *Animal Genetic Resources Information*, **39**, 39-50. https://doi.org/10.1017/s1014233900002121

18. Akaffou, Y., Komara, M., Van Dexter, B.I. and Dagnogo, K. (2024) The Phenotypic and Zootechnical Characteristics of Goats Slaughtered at the Port-Bouët Abattoir for Meat Production in Abidjan. *Iran International Journal of Innovation and Applied Studies*, **41**, 867-875. https://ijias.issr-journals.org/abstract.php?article=IJIAS-23-324-03#google_vignette

19. Arthur, B.K., Richard, O., Gregory, D., Arthur, W., Walter, T.W. and Paul, B. (2018) Phenotypic Characterization of the West Africa Dwarf Goats and the Production System in Liberia. *International Journal of Livestock Production*, **9**, 221-231. https://doi.org/10.5897/ijlp2018.0496

20. Gebreyesus, G., Haile, A. and Dessie, T. (2013) Breeding Scheme Based on Community-Based Participatory Analysis of Local Breeding Practices, Objectives and Constraints for Goats around Dire Dawa, Ethiopia. *Livestock Research for Rural Development*, **25**, Article No. 48. http://www.lrrd.cipav.org.co/lrrd25/3/grum25048.htm

21. Seid, A., Kebede, K. and Effa, K. (2016) Morphological Characterization of Indigenous Goats in Western Ethiopia: Implication for Community-Based Breeding Programmes. *Animal Genetic Resources*, **58**, 53-62. https://doi.org/10.1017/s2078633616000047

22. Sam, I.M. and Ekpo, J.S. (2023) Comparative Evaluation of Live Body Weight, Linear Body Measurement and Carcass Characteristics of West African Dwarf and Red Sokoto Goats in Abak Municipality, Akwa Ibom State. *Nigerian Journal of Animal Production*, **49**, 1-12. https://doi.org/10.51791/njap.v49i4.3697

23. Dineur, B. and Thys, E. (1998) Phanerozoic and Barometric Characteristics of Kapsiki. In: Christian, S., Ed., *Des taurins et des hommes*: *Cameroun*, *Nigéria*, Paris, 39-44. https://books.openedition.org/irdeditions/5378

24. Dodo, K., Pandey, V.S. and Illiassou, M.S. (2001) Utilisation de la barymétrie pour l'estimation du poids chez le zébu Azawak au Niger. *Revue d'élevage et de médecine vétérinaire des pays tropicaux*, **54**, 63-68. https://doi.org/10.19182/remvt.9808

25. Hamadou, I., Moula, N., Siddo, S., Marichatou, H., Issa, M., Leroy, P. and Antoine-Moussiaux, N. (2015) The Koundoum Sheep Breed in Niger: Morpho-Biometric Study and Description of the Production System. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, **116**, 49-58. http://nbn-resolving.de/urn:nbn:de:hebis:34-2015011347146

26. Moula, N. (2018) Caractérisation de la race ovine algérienne Tazegzawth. *Tropicultura*, **36**, 43-53. https://www.researchgate.net/publication/324043336

27. Atoui, A., Carabano, M.J., Lasoued, M., Laroussi, A., Abdennebi, M., Tlahig, S., *et al.* (2023) Prediction of Birth Weight Using Body Measurements of Local Caprine Population Kids Raised in a Low-Input Breeding Mode under Arid Environment. *Tropical Animal Health and Production*, **56**, 1-9. https://doi.org/10.1007/s11250-023-03865-0

28. Kanh, K.H.M., Soro, B., Kouassi, Y.J.M.P. and Sokouri, D.P. (2025) Phenotypic Characterization of Ndama Cattle Breed from the Kolda Region (Senegal) Based on Qualitative Parameters. *International Journal of Agriculture and Biosciences*, **14**, 94-99. http://dx.doi.org/10.47278/journal.ijab/2024.202

29. Adam Kade, M.G., Mani, M., Dayo, G. and Marichatou, H. (2019) Etude comparative des caractéristiques morphobiométriques des chèvres Rousse et Noire de Maradi au Niger: Analyse des paramètres quantitatifs et qualitatifs. *International Journal of Biological and Chemical Sciences*, **13**, 1431-1443. https://doi.org/10.4314/ijbcs.v13i3.18