International Journal of Zoology Studies
www.zoologyjournals.com
ISSN: 2455-7269
Received: 26-01-2023, Accepted: 10-02-2023, Published: 28-02-2023
Volume 8, Issue 1, 2023, Page No. 21-26

Phenotypic and morphometric comparison in four lineages of ladoum sheep in Senegal

Pape Madiop Sembène, Pape Mbacké Sembène*
Genomic Laboratory, Département of Animal Biology, Cheikh Anta Diop University, Dakar, Senegal

Abstract
The process of creating the Ladoum breed, which in its early days was driven by passion and prestige, is now of great importance on the national economic and scientific level. In the breeders' jargon, there are several lineages within this breed, each headed by a male whose reproductive performance has been confirmed by his phenotypic criteria and the performance of his offspring. The aim of this study was to compare the morphometric characters of the four lineages of Ladoum in order to better highlight the qualities of each of them. The shape of the muzzle was appreciated. A series of four (4) morphometric measurements were taken. The height at the withers (HG) was measured using a measuring stick. A tape measure was used for occipito-ischial length (LOI) and chest circumference (TP). Weight (PDS) was assessed using a scale. Each parameter was measured three times by the members of the jury; the mean of each variable was calculated. The data obtained has been collected since 2014 during several fairs such as those organized in Rufisque and Dakar. Multivariate analyzes were performed on the quantitative data using Principal Component Analyses and Discriminant Factor Analysis; correlations were sought between the variables. The muzzle shapes most appreciated by breeders are found in the "Birahim" and "Tyson" lineages. No significant difference between HG, LOI, TP was observed between the four lineages. However, descendants of 'Tyson', 'Gorgui' and 'Birahim' show better performance for measurements of chest circumference and weight. These parameters are strongly correlated. Occipito-ischial length and live weight also show a fairly strong association. Thus, the chest circumference and weight variables made it possible to discriminate the descendants of “Tyson” and “Gorgui” from those of “Batling” and “Birahim”. AFD discriminates "Birahim" from other lineages.

Keywords: morphometry, sheep, ladoum, lineages, breeders, chamfer

Introduction
Livestock is a key driver for the sustainable development of agriculture and accounts for 40% of global agricultural production. Thus, it is directly or indirectly linked to each of the Development Goals (FAO, 2018) [6]. In Senegal, it is one of the priority sectors of the Emerging Senegal Plan (PSE). In 2019, the livestock sector contributed 4.3% to real GDP and 28.5% to added value (ANSD, 2020) [2]. It plays an essential role in supporting mixed crop-livestock production systems, particularly in traction, fertilization and adaptation to climatic problems. Thus, the sale of animals is one of the main strategies adopted by agropastoralists to cope with difficult times (ANSD, 2015) [1]. The value of animal genetic resources goes far beyond their current use, as they provide options for the future and it is possible that a breed or population of minimal importance today will prove extremely valuable to the future (BIP, 2010) [3]. In addition to the wealth it constitutes for most of the most vulnerable sections of the rural world, it also provides several services within the ecosystems of which it is a part. A great diversity of sheep breeds exists in different agro-ecological zones according to various management methods. Indeed, depending on the area, the most suitable breeds are favored by breeders. On the outskirts and inside the big cities, what is known as intensive farming (Sadio, 2010; Ousseini, 2011), mainly involving Ladoum sheep (Sall, 2008) [11], is practiced. he advent of urban breeding and the craze for the Ladoum sheep, several associations have been created for the promotion and development of this breed. The process of creating the Ladoum breed which, in its beginnings, was led by passion and prestige, is today of great importance on the national economic level (improvement of the local herd and self-sufficiency in sheep meat), but also on the scientific level (standardization and homologation of the breed, genetic study). This work, which today has resulted in this beautiful and large breed of sheep that is the Ladoum, was done empirically and did not follow the conventional process of creating a breed. Thus, animals achieving weight performance and morphometric measurements never before reported in sheep are presented and are the subject of competitions under the watchful eye of veterinarians and specialists in the field. Indeed, the Ladoum sheep presented can reach a height at the withers of around 1.20 m and weights of 175 kg. Despite these performances, speculation around the origin of the Ladoum sheep remains persistent (Sy *et al*. 2022) [12]. In addition, there are in the jargon of breeders several lineages within this breed with at the head of each line a male whose performance in terms of reproduction has been confirmed by his phenotypic criteria appreciated and measured during competitions organized annually by breeders' associations (mainly SALADAM, SALADEL) but also by the performance of its offspring. Among these lineages, we can cite those called "Batling", "Birahim", "Gorgui" and "Tyson". Each line has one or more intrinsic and phenotypic characteristics that distinguish it from the others. Faced with its phenotype and performance differences, breeders are trying controlled matings to improve offspring from one generation to another.

As part of a study of phenotypic and genotypic discrimination between the four main Ladoum lineages, this chapter attempts a morphometric comparison based on measurements of landmarks meeting a number of criteria to enable appropriate comparisons. These are unique points of interest such as height at withers (HG), occipito-ischial length (LOI), chest circumference (TP) and weight (PDS). morphometric analysis is, among the different methods us to characterize populations, the one that is the easiest to access.

Material and method

1. Study site and choice of animals.

The study was conducted in the Dakar region where all the "lineages" of Ladoum converge during fairs. Located on the Cap Vert peninsula, the Dakar region covers an area of 550 km², or 0.28% of the national territory. It is between 17° 10 and 17° 32 West longitude and 14° 53 and 14° 35 North latitude. Sheep farming practiced in this area is intensive and mainly concerns house sheep (Mfoukou-Ntsakala, 2000; Sall, 2008) [7, 11]. The animals are raised in enclosures in front of the houses or indoors on the terraces in stables. A total of 57 Ladoum sheep were studied, including 11 from the "Batling" lineage, 18 from the "Birahim" lineage, 13 from the "Gorgui" lineage and 15 from the "Tyson" lineage. The values used were obtained within the framework of measurements taken by juries composed of veterinarians, professionals and experienced people rigorously selected at fairs (SALADAM, SALADEL, etc.).

2. Phenotypic characterization criteria and data collection

FAO (2018) [6] defines phenotypic characterization of animal genetic resources as the identification of different breeds and the description of their external and production characteristics in a given environment and management setting, taking into account the socio-economic factors that affect them. The phenotypic characterization including the morphological description and the morphometric measurements of the Ladoum sheep involved fifty-seven (57) animals. The shape of the muzzle (appreciated (+), well appreciated (++) and very well appreciated (+++)) was described following direct observation of each animal with the help of the breeders. On this same number, a series of four (4) morphometric measurements (quantitative characters) were taken. The height at the withers (HG) was measured using a measuring stick. A tape measure was used for occipito-ischial length (LOI) and chest circumference (TP). Weight (PDS) was assessed using a scale. Each parameter was measured three times by the members of the jury; the mean of each variable was calculated. The data obtained has been collected since 2014 during several fairs such as those organized in Rufisque and Dakar.

3. Statistical analyzes

The data collected was entered into the Microsoft Excel spreadsheet and analyzed with R software version 4.2.2 (2022-10-31 ucrt). Qualitative variables were expressed as a percentage and quantitative variables as the mean plus or minus the standard deviation.

Fisher's test was used to see the distribution of chamfer according to lineage. Comparisons were made with a significance level of 5%. Concerning the data relating to the morphometric measurements, the variables were subjected to the Shapiro-Wilk normality test. All variables were expressed as the mean with the corresponding standard error. To detect differences that may exist between different groups, analysis of variance (ANOVA) was used. The means of these normally distributed variables by population pairs were compared using Student's t test. The significance threshold was set at 5% for all the comparison tests.

4. Correlation analyzes

Correlation analysis is a bivariate statistical method of measuring the strength of the linear relationship between two variables and calculating their relationship. Using correlation analysis, relationships, patterns, meaningful connections, and trends between two variables or data sets can be determined. Thus, the Pearson correlation coefficient represented by "r", measuring the strength of the linear association between the variable height of the withers and circumference of the chest was calculated.

5. Principal Component Analyzes (PCA)

It is an analysis method particularly suited to quantitative variables (Xj quantitative), continuous, a priori correlated with each other. It seeks to represent large sets of data with few variables. In other words, it looks for the relevant dimensions of these data in order to represent the selected variables in the most synthetic and explicit way. Once the data are represented in different planes, the proximities between variables are interpreted in terms of correlation, while the proximities between individuals are interpreted in terms of overall similarities of the observed values.

6. Discriminant Factor Analysis (DFA)

Discriminant factor analysis (DFA) combines analysis of variance and principal component analysis (PCA). It makes it possible to separate several groups as well as possible using several variables by discriminating between the populations defined a priori, but also to assign an individual whose origin is unknown to a given population, provided that the latter has been previously characterized by the same method.

Results

1. Chamfer and morphometric values

The muzzle shapes (Table I) most appreciated by breeders are found in "Birahim" and "Tyson" lineages with respective numbers of 5 and 3 individuals. The intermediate form is predominant in "Birahim" lineage where 11 individuals described present this character while the less marked convex form is encountered in the descendants of "Batling" and "Tyson" with 11 individuals each. The differences in shape of the muzzle according to the lineages are highly significant ($p<0.001$). Taken two by two, these differences are more marked between the "Batling" and "Birahim" lineages ($p = 2.3e-5$); and between "Birahim" and Tyson ($p=00016$).

Table 1: Distribution of the different chamfer shapes

	Lignée			
	"Birahim"	"Gorgui"	"Tyson"	"Batling"
+	2 (3.70%)	6 (11.11%)	11 (20.37%)	11 (20.37%)
++	11 (20.37%)	4 (7.40%)	1 (1.85%)	0 (0.00)
+++	5 (9.26%)	0 (0.00%)	3 (5.56%)	0 (0.00%)

Legend: appreciated (+); well appreciated (++); very well appreciated (+++)

The measurements of the height at the withers varied between 104 cm and 120 cm; 142 cm and 170 cm for the occipito-ischial length ; 120 cm and 151 cm for the chest circumference ; 119.1 cm and 181.5 cm for weight with respective averages of 111.8 cm; 156.3cm; 133.6 cm and 146 cm (Table II).

If we consider the lineages, the descendants of "Batling" present a slightly higher height at the withers and an occipito-ischial length compared to the other lineages; however, the differences are not significant ($p>0.05$).

Although the differences are not significant (p>0.05), the descendants of "Tyson", "Gorgui" and "Birahim" present in higher absolute values with regard to chest circumference and weight.

Table 2: Comparative parameters between the four lineages

	Lineages			
	"Birahim" (n=18)	**"Gorgui" (n=13)**	**"Tyson" (n=15)**	**"Batling" (n=11)**
	Moyenne ± Ecart-type	Moyenne ± Ecart-type	Moyenne ± Ecart-type	Moyenne ± Ecart-type
HG (cm)	111.306 ± 3.638[a]	111.008 ± 2.523[a]	111.587 ± 2.961[a]	113.864 ± 3.694[a]
LOI (cm)	157.417 ± 5.614[a]	157.231 ± 4.437[a]	152.780 ± 5.000[a]	158.300 ± 6.079[a]
TP (cm)	133.556 ± 6.171[a]	134.175 ± 5.431[a]	134.207 ± 7.734[a]	132.364 ± 5.278[a]
PDS (kg)	148.083 ± 16.336[a]	147.758 ± 14.078[a]	146.907 ± 15.951[a]	139.345 ± 12.875[a]

HG: Height at the withers; LOI: Occipito-ischial length; TP: Chest circumference; PDS: Weight.

2. Correlation between variables

The study of the link between body measurements in four lineages of Ladoum from Senegal revealed (Figure 1) a positive and significant association (p < 0.001) between weight and chest circumference commonly called thoracic circumference with a correlation coefficient of 0.8. Blue coloring indicates positive correlations. The darker the coloring, the higher the value of the coefficient. In addition, a significant association was found on the one hand between occipito-ischial length and height at the withers (p<0.01) and on the other hand between occipito-ischial length and weight (p<0. 05). Nevertheless, the connection between these pairs of variables is weak, as illustrated by their respective correlation coefficients of 0.36 and 0.33.

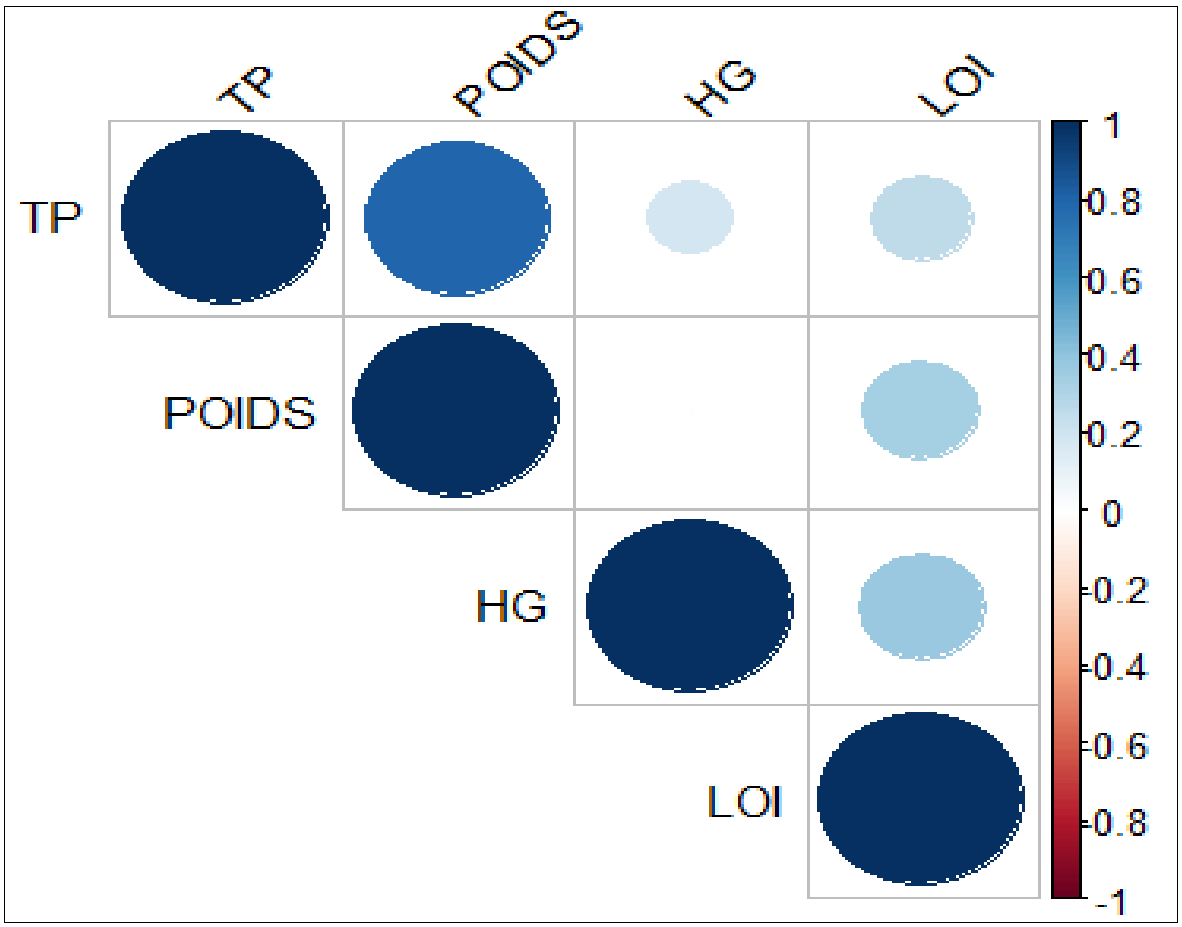

Fig 1: Matrice de corrélation des mensurations entre lignées de Ladoum du Sénégal. HG: Height at the withers; LOI: Occipito-ischial length; TP: Chest circumference

3. Principal Component Analyzes (PCA)

The multidimensional descriptive analysis by the method of principal components showed (Figure 2) a first factorial axis representing 51.1% of the total inertia (80.2%), while the second factorial axis concentrates 29.1% of this inertia. The chest circumference and weight variables mainly contributed to the first factorial axis with respective frequencies of 37.71 and 36.82%. These two variables make it possible to discriminate the descendants of "Tyson" and "Gorgui" from those of "Batling" and "Birahim", which themselves seem closer and are grouped by the height at the withers and the occipito-ischial length. The latter, HG and LOI, presented respective contributions of 55.77% and 22.38% to the formation of the second factorial axis

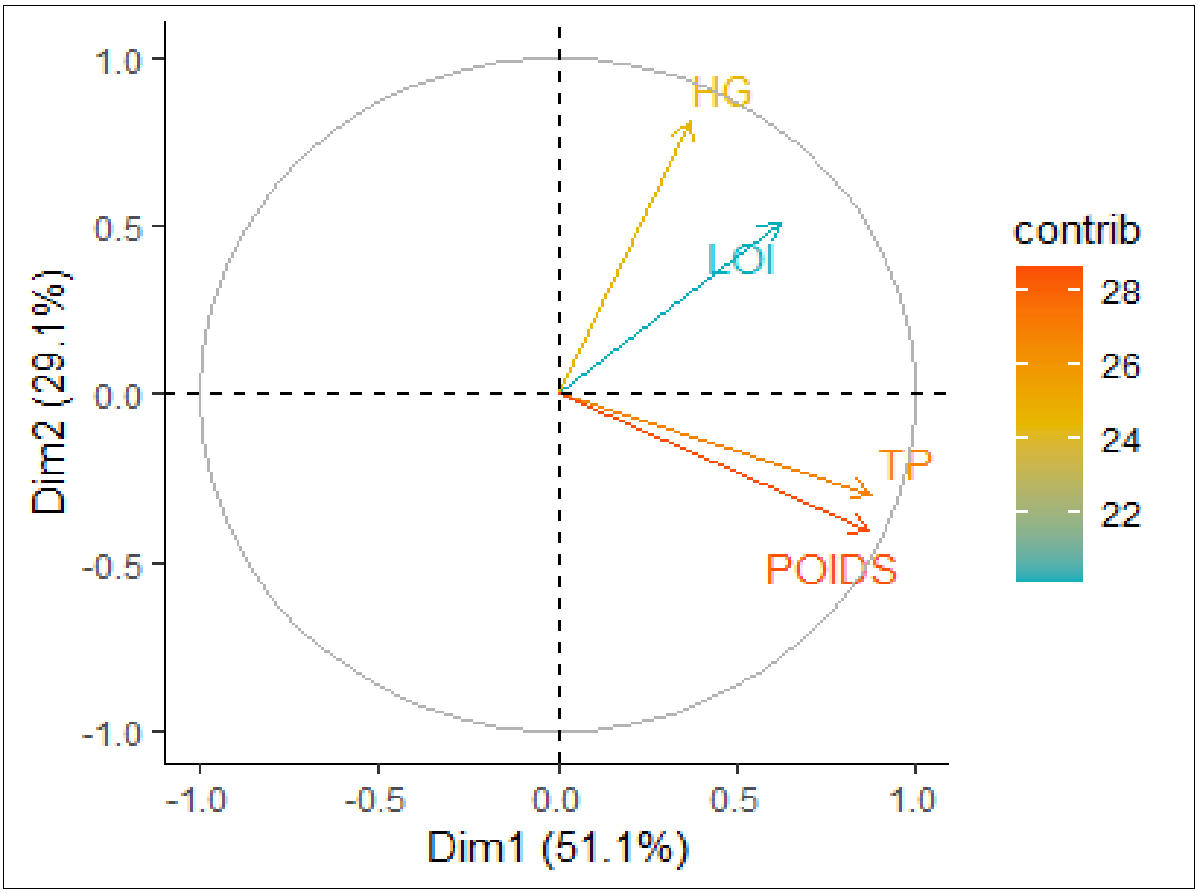

Fig 2: Correlation circle and contribution of variables

The PCA of the individuals (Figure 3) does not show any structuring between the lineages of the Ladoum sheep. However, if we refer to the multivariate analysis, we realize that the descendants of "Tyson" and "Gorgui" have started to regroup.

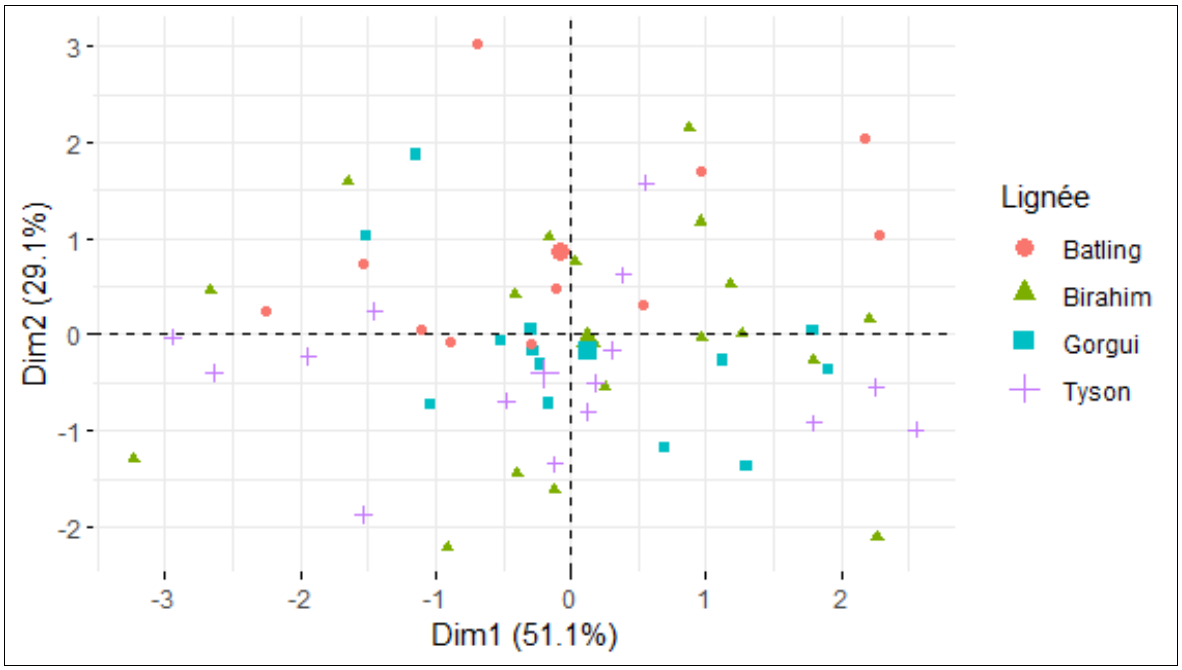

Fig 3: Principal component analysis of variables

The results of the discriminant factor analysis is well resolved. Two groups are distinguished. One where the majority of the individuals are and another grouping together the majority of the individuals of the lineages

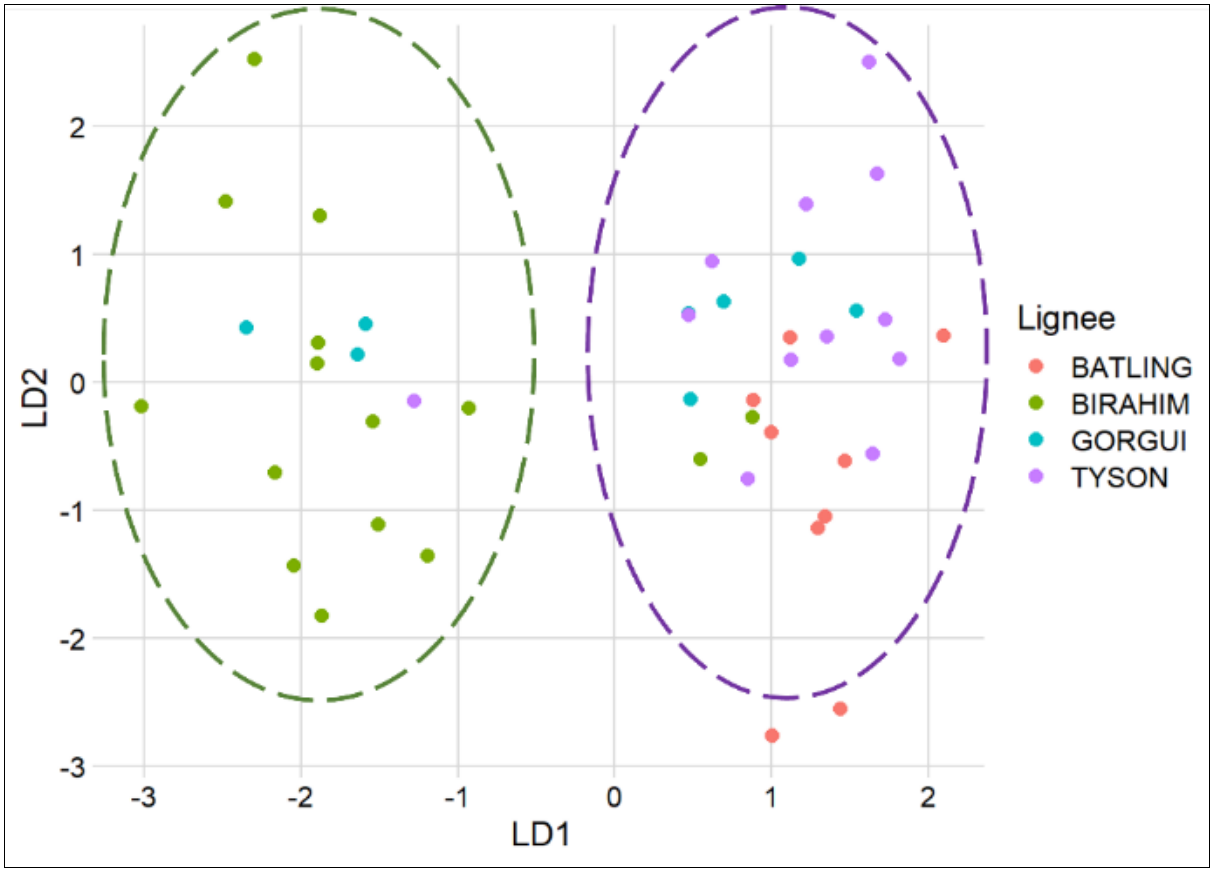

Fig 4: Discriminant Factor Analysis of individuals

Discussion

In biology, morphometry consists in determining morphometric data by the measurements of a specimen. It is therefore part of the scientific study of the morphology of an organism. The quantification of morphometric parameters, formerly long and tedious, limited to a few indicators, has been given a whole new efficiency thanks to the extraordinary computing power of computers. The Ladoum breed is a real star in sheep farming in the Sahel.

The results of this study showed a highly significant difference ($p<0.001$) in muzzle shape depending on the lineages. The muzzle shapes most appreciated by breeders are found in the "Birahim" and "Tyson" lineages. Although Ladoum sheep have the particularity of having a very convex and well appreciated nose (Sall, 2008) [11], the “Birahim” and “Tyson” lineages seem to hold in their descendants this criterion of choice for breeders. Associated with the weight, the shape of the chamfer becomes an essential criterion of choice during sales. Even if there remains a discriminative difference in the shape of the head, the quantitative measurements, namely the HG, LOI, TP do not show, overall, any significant difference. The intense improvement of this breed by crossbreeding between lineages in order to generate a trait favorable to the descendants seems to homogenize the criteria of this new breed. Also, their weights vary between 139 Kg to 149 Kg, which is not significantly different. It should be noted, however, that the descendants of “Tyson”, “Gorgui” and “Birahim” show better performance for measurements of chest circumference and weight. These differences could have a genetic basis because neither the type of breeding nor the type of diet can be discriminating criteria between the Ladoum lineages (Sy *et al*., 2022) [12]. A positive and significant correlation ($p<0.001$) between weight and chest circumference commonly called thoracic circumference with a correlation coefficient of 0.8 is observed between these variables. This same finding has been observed in Moroccan cattle (Minvielle, 1975) [8], but also in pigs (Eastwood & Smith, 2020). In addition, a significant association was found on the one hand between occipito-ischial length and height at the withers ($p<0.01$) and on the other hand between occipito-ischial length and weight ($p<0.05$). Indeed, the occipito-ischial length represents the longitudinal gait of the animal, which also depends on the height of the withers.

All of these anatomical parts directly influence the weight of the animal. The weight, in addition to the satisfaction provided, is a source of income generation (Diack *et al*., 2021) [4]. The chest circumference and weight variables make it possible to discriminate the descendants of "Tyson" and "Gorgui" from those of "Batling" and "Birahim", which themselves seem closer and are grouped by the height at the withers and the occipital- ischial length. This resemblance presupposes a preference during the crosses made by the breeders of descent (Touré & Seck, 2005) [13]. Indeed, some breeders will prefer high-legged animals and a long flank, which was revealed by the grouping of the descendants of "Tyson" and "Gorgui", while others will focus on the character such as the weight of the animal.

The overall results of this study remain relatively mixed even if morphometry is an indisputable tool in the phenotypic characterization of natural populations. This method allows intuitive visualization of differences in shapes, representing them as distortions leading from one shape to another, rather than as a series of different shapes as other statistical methods do. This visualization is done through two-dimensional “distortion grids”.

Conclusion

The aim of this study was to compare the morphometric characters of the four lineages of Ladoum in order to better highlight the qualities of each of them. The muzzle shapes most appreciated by breeders are found in the "Birahim" and "Tyson" lineages. No significant difference between HG, LOI, TP was observed between the four lineages. However, descendants of 'Tyson', 'Gorgui' and 'Birahim' show better performance for measurements of chest circumference and weight. These parameters are strongly correlated. Occipito-ischial length and live weight also show a fairly strong association. Thus, the chest circumference and weight variables made it possible to discriminate the descendants of "Tyson" and "Gorgui" from those of "Batling" and "Birahim".

Acknowledgements

The authors would like to thank Senegalese breeders or their excellent work in improving the Ladoum breed.

References

1. ANSD. Rapport projection de la population du Sénégal,2015:157:2013-2063.
2. ANSD. Situation économique et sociale du Sénégal en 2017-2018. Agence Nationale de la Statistique et de la Démographie, 2020, 12.
3. BIP. Genetic Diversity of Terrestrial Domesticated Animals. Biodiversity Indicators,2010:2181-188.
4. Diack F, Traore EH, Thior EHY, Gueye C, Sembène M, Seck M. Etude de quelques caractéristiques morphobiométriques de la race Ladoum du Sénégal. *Int. J. Adv. Res.*,2021:9(6):315-323.
5. Eastwood L, Smith J. Comment calculer la taille des porcs de finition, des cochettes et des truies ?, Fiche technique, 2020.
6. FAO. La situation mondiale de l'alimentation et l'agriculture. Le point sur l'élevage, 2018.
7. Mfoukou-Ntsakala L. Contribution à l'étude de l'élevage des petits ruminants en milieux urbain et périurbain de Brazzaville, Congo, Thèse de M.Sc., IMTA, N° 89, 2000, 89.
8. Minvielle F. L'estimation du poids vif de bovins marocains par barymétrie. *Hommes, Terres et Eaux*,1975:*4*:41-46.
9. Ousseini L. Analyse socioéconomique des élevages du mouton Laloum dans la commune de Thiès / Sénégal. Mémoire N°6 EISMV Dakar, 2011, 43.
10. Sadio M. C. Caractérisation génétique des races ovines Sahéliennes: Etude du Ladoum et du Touabire. Mémoire: Master II en Biologie animale, Dakar (UCAD), 2010.
11. Sall MS. Le mouton Ladoum: étude du système d'élevage et caractérisation morphologique. Mémoire ISFAR (ex ENCR) Bambey Sénégal, 2008, 55.
12. Sy D, Ndiaye B, Sembène M. Contribution à la caractérisation génétique des ovins du Sénégal: cas des races Ladoum et Touabire, 2022, Afrique SCIENCE,2022:20(3):85-93.
13. Toure O. et Seck SM. Exploitations familiales et entreprises agricoles dans la zone des Niayes au Sénégal. *International Institute for Environnement & Development*, *Dossier*,2005:6(133): 20-26.