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Qualitative characteristics of small ruminant skins from Niger: comparative study of Maradi goats (Red and Black) *vs* Sahel goat and sheep (Oudah and Balami)

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ABSTRACT

The objectiveof this study was to compare qualitative and quantitative post-mortem characteristics of Maradi Red and Black goats' skins to those of Sahel goats, Oudah and Balami sheep, all of which were subjected to traditional tanning in Niger, in order to determine the relationship between animal live weight and skin weight parameters, as well as to assess texture, resistance, solidity, suppleness, and smoothness under independent qualitative rating by 8 locals. Sheep skin has much more texture than goat skin ($p = 0.000$), according to statistical analyses. The texture of Red and Black goat skins does not change significantly ($p = 0.856$).

The skin resistance of Red and Black goats was higher than that of Sahelian goats and sheep. A significant difference between breeds was discovered using analysis of variances ($p = 0.001$). According to the Scheffe post hoc test, the difference between the Black goat and the Oudah sheep was not significant, but it was significant between the Red goat and the Balami sheep ($p = 0.013$) and the Sahelian goat ($p = 0.016$).

Except for Black goat (p = 0.272), the skin of Red goats was significantly stronger than that of the other breeds (Red vs Sahel, p = 0.001; vs Oudah, p = 0.027, and vs Balami, p = 0.001).
The difference in skin suppleness between Black and Red goats (p = 0.390) was not significant, however it was significant between these two goat groups and Sahel goat (p = 0.000) and Black goat and Oudah sheep (p = 0.001).
The following classification was noticed in decreasing order based on skin fineness: Black, Sahelian, Red, Balami, and Oudah. According to ANOVA and the Scheffe post hoc test, the difference between the Black goat and the Oudah sheep was significant (p = 0.000).
For all breeds and species studied together, principal component analysis of skin's quantitative parameters (weight after skinning, trimming, drying, and tanning) revealed a substantial positive connection between these and animal live weight (R^2 = 0.851; 0.838; 0.788; and 0.854).
Despite phenotypic differences, Red and Black Maradi goats performed similarly in all qualitative and quantitative skin metrics evaluated, and had benefits over Balami and Oudah sheep and Sahelian goats. (*Abstract*).

Keywords*—qualitative parameters, quantitative parameters, Maradi Red goat, Maradi Black goat, Sahelian goat, Oudah sheep, Balami sheep, Niger (key words)*

RESUME

L'objectif de ce travailétait de comparer les caractérisques qualitatives et quantitatives *post-mortem* des peaux de chèvres Rousse et Noire de Maradi entre elles puis avec celles du Sahel et des moutons Oudah et Balami, toutes soumises au tannage traditionnel au Nigerpour mettre en évidence la relation entre le poids vif et les paramètres pondéraux de la peau et apprécier la texture, la résistance, la solidité, la souplesse et la finesse grâce à une notation qualitative indépendante par 8 cordonniers traditionnels expérimentés locaux.
L'analyse statistique a ressorti que la peau des ovins a significativement plus de texture que celle des caprins (p=0,000). Il n'y avait pas de différence significative de texture entre les peaux de chèvres Rousse et Noire (p=0,856).
La résistance de la peau a été plus importante chez les caprins Roux et Noirs que la chèvre du Sahel et les ovins. L'analyse de variances a montré une différence significative entre races (p = 0,001). Suivant le test post hoc de Scheffe, cette différence n'a pas été significative entre la Noire et le Oudah avec toutes les autres races; elle l'est seulement qu'entre la Rousse avec le Balami (p = 0,013) et la chèvre du Sahel (p = 0,016).
L'analyse des variances à un facteur et le test post hoc de Scheffe ont montré que la peau de la chèvre Rousse est statistiquement plus solide que celles de toutes les autres races (Rousse vs Sahel, p = 0,001; vs Oudah p = 0,027 et vs Balami p = 0,001) à l'exception de la chèvre Noire (p = 0,272).
Il est ressorti que la différence de souplesse de la peau n'a pas été significative entre la Noire et la Rousse (p=0,390) mais plutôt entre ces 2 groupes caprins et celle du Sahel (p=0,000) et entre la chèvre Noire et le mouton Oudah (p=0,001).
En matière de finesse de peau, il a été noté le classement par ordre décroissant suivant: Noire, Sahel, Rousse, Balami etOudah. Cette différence selon l'ANOVA suivi du test post hoc de Scheffe a été significative entre la chèvre Noire et le mouton Oudah (p=0,000).
L'Analyse en Composantes Principales des paramètres quantitatifs de la peau (poids après dépouille, rognage, séchage et tannage), toutes races et espèces étudiées confondues a établi une corrélation positive significative entre ceux-ci et le poids vif (respectivement R^2= 0,851; 0,838; 0,788 et 0,854).
En dépit de différence de phénotypes, les chèvres Rousse et Noire de Maradi ont occupé une position très similaire pour l'ensemble des paramètres qualitatifs et quantitatifs étudiés de la peau et ont présenté des avantages comparatifs devant celles des moutons Balami, Oudah et chèvre du Sahel.(*Abstract*)

Mots-clés*: caractéristiques, peaux, chèvre Rousse de Maradi, chèvre Noire de Maradi, chèvre du Sahel, mouton Oudah, mouton Balami, Niger. (key words)*

I. INTRODUCTION

Because of the quantity of its livestock and the amount of butchering that occurs each year, Niger is a major supplier of hides and skins. According to [1], goats are the top producers of hides and skins. The evident features of red goat skin make it a popular choice. According to [2], Maradi Red goat skin is supple, fine, and has a wonderful solidity, which is highly valued in leather goods and luxury gloves. In a similar vein, [3] reported that leather and skin experts in Paris, London, Hamburg, and New York

ranked Red goat skin from Niger first among all competitors for its remarkable attributes in gloves, luxury footwear, and women's clothes.
Red goats share the same biotope with their black counterparts, whose skin quality is unknown.
Comparative data on the quality of hides and skins of different types or breeds of goats in Niger is essentially non-existent, according to [4]. The goal of this study was to compare post-mortem qualitative characteristics of skins from Maradi Red and Black goats with those from Sahel goats and Oudah and Balami sheep, all of which were exposed to traditional tanning in Niger.

II. MATERIALSAND METHODS

A. Study location

The study took place in the Urban Community of Maradi, capital of region of the same name (Fig. 1).

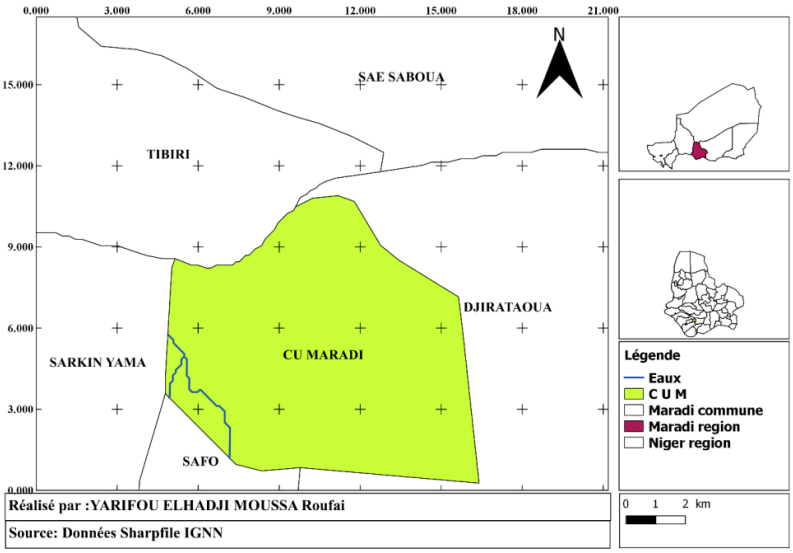

Fig. 1: Location of Urban Community of Maradi.*(figure caption)*

Maradi is essentially an agro-pastoral region. The livestock industry plays a vital role in the socioeconomic life of the inhabitants. It is the second most important activity in the region, after agriculture, and it affects more than 89 percent of the people. The region is experiencing changes in agro-sylvo-pastoral production practices as a result of intensification of agricultural production, which is experiencing significant growth, use of harnessed and mechanical cultivation, development of cattle and sheep fattening, popularization of the Azawak cattle breed and Red goat, and securing of land for breeders (TABLEI). It contributes a large amount to state and local budgets, which is why some extremely positive features for its development have been recognized, including, among others:

- presence of livestock management structures, in particular regional directorate with its annexes (1 refrigerated slaughterhouse, 2 livestock multiplication centers, 1 training center for livestock volunteers);
- presence of various development partners (projects, programs, NGOs and associations) working for development of livestock farming;
- existence of a vast pastoral zone (2,455,693 hectares), and 182 pastoral enclaves (157,162 hectares) in the agro-pastoral and agricultural zones which deserve to be preserved, developed and well managed;
- emergence of private initiatives in poultry and livestock farming.

TABLE I:EVOLUTION OF LIVESTOCK IN THE MARADI REGION FROM 2009 TO 2019.*(Table head)*

Year	Cattle	Sheep	Goats	Camels	Horses	Donkeys	Total
2009	1,430,255	1,745,090	2,327,891	264,184	17,031	197,553	5,982,003
2010	1,495,780	1,735,242	2,374,730	264,966	16,577	198,136	6,085,431
2011	1,585,527	1,795,975	2,469,719	268,411	16,743	202,099	6,338,474
2012	1,680,658	1,858,835	2,568,508	271,900	16,910	206,141	6,602,952
2013	1,781,498	1,923,894	2,671,248	275,435	17,079	210,264	6,879,417
2014	1,888,388	1,991,230	2,778,098	279,015	17,250	214,469	7,168,450
2015	2,001,691	2,060,923	2,889,222	282,642	17,423	218,758	7,470,659
2016	2,121,793	2,133,055	3,004,791	286,317	17,597	223,134	7,786,686
2017	2,249,100	2,207,712	3,124,982	290,039	17,773	227,596	8,117,203
2018	2,384,046	2,284,982	3,249,982	293,809	17,950	232,148	8,462,918
2019	2,527,089	2,364,957	3,379,981	297,629	18,130	236,791	8,824,576

Source: DS/MAG/EL, 2020. *(Table footnote)*

Economically, the proximity to Nigeria encourages favorable commercial links, especially in livestock, hides, and skins.

Pasteurellosis, sheep pox, and smuts are the most common animal diseases in the region during the wet season. Various public and private services vaccinate cattle on a regular basis each year.

Maradi City (the site of our research) is located at latitude 13°28'29.9N, longitude 7°8'38.1E, and elevation 384 m. The relief of the region is flat, with a non-functional hydrographic network, with the exception of the GoulbiN'Kaba and some of its tributaries, which present an ephemeral water flow during the rainy season, between July and September,[4].

With a long dry season and a short rainy season, the climate is tropical dry, semi-arid, or sahelian. Annual rainfall reaches 650 mm with substantial interannual fluctuation. The average monthly temperature is particularly high (with a maximum of 32.7°C in May and a minimum of 23.5°C in January). From May to September, the prevailing winds are from the south-west, with a direction of 240 to 210 degrees. They determine the rainy season since they come from the Atlantic Ocean and are humidified. From November to March, the prevailing wind comes from the north-east, with a fairly consistent 60-degree direction. Harmattan is a highly dry wind that originates in the Sahara (Tibesti - Bilma). It is occasionally coupled with sandstorms.

Maradi is the economic capital of Niger. Its economy is centered on trade (import-export), agriculture, particularly peanuts, for which it was a center of excellence, cowpeas, millet, and the breeding of cows, camels, and small ruminants, notably the famed Maradi Red goat [5].

In 2018, the population of Maradi's Urban Community was estimated to be 326,804 people[6]. Maradi Refrigerated Slaughterhouse slaughters agricultural animals every day to feed its rising population (TABLE II).

TABLE II:EVOLUTION OF CONTROLLED MEAT PRODUCTION AT MARADI REFRIGERATED SLAUGHTERHOUSE FROM 2010 TO 2019.*(Table head)*

Year	Meat production (tons)
2010	1,767.614
2011	2,314.372
2012	1,847.194
2013	1,856.148
2014	2,103.164
2015	2,176.596
2016	2,103.444
2017	1,981.260
2018	1,883.360
2019	1,511.570

Source:DREIA Maradi, 2020.*(Table footnote)*

B. Experimental materials

Used materials consist of:

- skins of small ruminants (Red and Black goats, Sahel goats, Balami and Oudah sheep);
- a 100 kg scale for weighing selected animals before slaughter;

- a load cell of 25 kg for weighing skins;
- markers for identification of weighed animals;
- a knife for fleshing and trimming hides.

C. Study sample

The sample was made up of 50 skins from small ruminants slaughtered at the Maradi Urban Community's Refrigerated Slaughterhouse. There were 40 goat skins, with 15 Black goats (7 females and 8 males), 15 Red goats (7 females and 8 males), and 10 Sahel goats (5 females and 5 males), as well as 10 sheep skins, with 6 Oudah (4 males and 2 females) and 4 Balami (3 females and 1 male). Animals belonged to people who decided to collaborate after their subjects were choosing. The skins of identified animals were purchased at prices negotiated with their owners in preparation for the next steps of the operation.

D. Data collection

Data of two types of parameters (quantitative and qualitative) were collected in different stages, starting with a live animal and ending with the utilization of skin. Each hide was identified (numbered) and tracked throughout the research process.

E. Animal identification

It was conducted on animals destined for slaughter at Maradi Refrigerated Slaughterhouse's stable yard after *ante-mortem* inspection. Animals that met typical phenotypic characteristics of different breeds were selected. Age of animals was determined using [7] scale. TABLEIII shows the characteristics that were used to make animal selections.

TABLEIII:CHARACTERISTIC TRAITS OF ANIMAL BREEDS SELECTED BEFORE SLAUGHTER.*(Table head)*

N°	Animalbreed	Head profile	Dresscolor	Bearing of goatee	Bearing of horns	Wearingears	Wearing pendants	Tail port
1	Red goat*	Fixed, domed forehead often covered with longer and darker hair in males than in females; rectilinear chamfer sometimes subconcave	Redorbrown	Constantly carried by males and often by older females	In ibex (lying backwards), rarely markhar type (vertically erect)	Short and erect	Absence	Short and upright
2	Black goat*	Fixed, domed forehead often covered with longer and darker hair in males than in females; rectilinear chamfer sometimes subconcave	Black	Constantly carried by males and often by older females	Mainly markhar and rarely ibex	Short and erect	Absence	Short and upright
3	Sahel goat**	Thin, flat-fronted triangular. In the adult male, the forehead bears a tuft of hair	Extremely variable: plain (black, chocolate, brown, white) and compound (grey, roan, pie-black, pie-red, black-pie or red-pie)	Can be carried by individuals of both sexes but always by the adult billy goat	Mostly ibex (lying backwards), sometimes markhar type (upright and diverging); fine in females, coarse and often twisted in males	Three types: Long and drooping; Medium and stalked; Short and erect	Worn by individuals of both sexes and most often by females	Short and upright
4	Oudahsheep***	Convexiline	Bicolor with constant white posteriorly and variability anteriorly: black-white, brown-white, fawn-white	Absence	Very developed and spiral horns in males, long and thin in females	Drooping	-	Goes down below the hocks
5	Balamisheep****	Big	White	Absence	Spiral horns	Long et wide	Presence	Big and long reaching below the hocks

Sources:*[8], ** [9],[10].*(Table footnote)*

- *Slaughtering, processing, preservation and tanning of hides*

Slaughtering, processing and preservation of hide were carried out at Maradi Regional Refrigerated Slaughterhouse. Tanning was done in traditional way by artisanal tanners of Maradi.

- *Collected data*

Quantitative data were: animal live weight, skin weights after skinning, trimming, drying and tanning. Load cells with capacities of 100 kg and 25 kg were used for weighing animals and skins respectively.
Qualitative data were: texture, resistance, solidity, flexibility and smoothness. Eight experienced local traditional shoemakers (at least ten years of activity) were identified in order to assess independently and qualitatively according to [11] (with 1=very bad, 2=poor, 3=average, 4 =good, 5=very good) on a sample of skins from each category of small ruminants (Red, Black and Sahel goats, Oudah and Balami sheep).

F. Data processing

All data collected was entered on an EXCEL 2010 spreadsheet model.
Statistical analysis were performed using SPSS 17.0, XLSTAT 2014 and MINITAB 14 software. Quantitative data were expressed as means, standard deviations and extrema, and qualitative data as their numbers and frequencies.
For quantitative parameters, Ryan Joiner's test made it possible to check normality of distribution, that of Levens was used to check equivalence of variances according to genetic types studied and Analysis of Variances was used for averages comparison (at 5% statistical threshold). Quantitative data were also subject of multivariate analysis using XLSTAT software, in particular Discriminant Factor Analysis and Simple Linear Regression in order to establish relationships between various weight parameters measured.
Regarding to qualitative parameters, Factorial Analysis of weightings by shoemakers on different studied genetic types was carried out using XLSTAT software and results presented in form of factorial maps. Analysis of Variances of average weightings assigned by shoemakers was also carried out to distinguish skin's qualities of studied different species and breeds.

III. RESULTS

A.Factorial analysis of hides weightings qualitative parameters

- *Texture*

It is the physical quality of skin that is perceptible by touch or sight.Fig. 2 shows factor map of shoemakers weightings on texture.

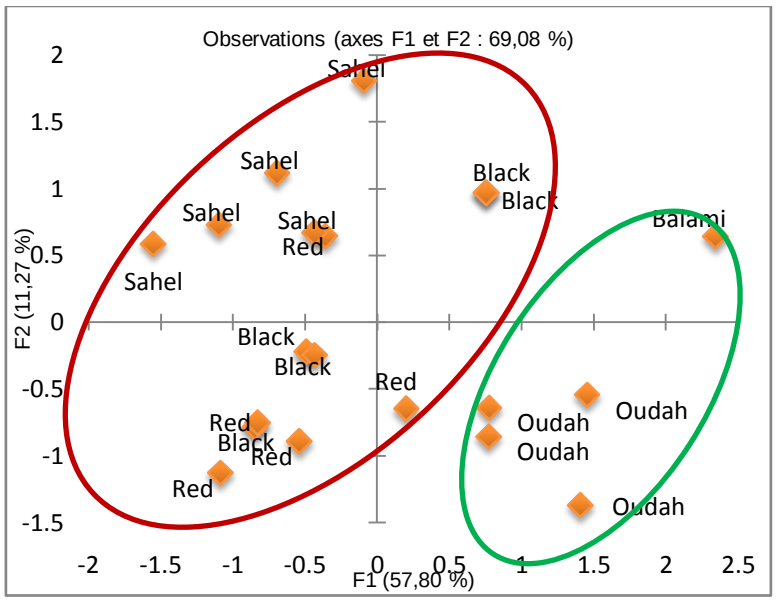

Fig.2: Factorial map of skin texture of studied differentgenetic types, all sexes combined.*(figure caption)*

It emerged globally that the skin texture of animals of the same species is similar. It is higher in sheep than goats, regardless of the gender of the animal. The Sahelian goat's texture is less prominent than that of the Red and Black goats (Fig. 2). Using one-way analysis of variance and Scheffe's post hoc test, the following results were obtained:

- Balami skin texture is statistically superior to that of 3 goat breeds (p values are 0.005; 0.000 and 0.000 respectively with Black, Red and Sahel);
- Oudah skin, statistically better than that of Red and Sahel (p = 0.003 and p = 0.000 respectively);
- there is no significant difference between skin of Black and Redhead (p = 0.856) and
- Sahelian goat skin texture is statistically weaker than that of Black, as well as 2 sheep breeds.

- *Resistance*

It refers to the skin's ability to withstand being injured or transformed by an external force. Fig. 3 shows a factorial map of goat and sheep skin resistance, split down by breed and sexes.

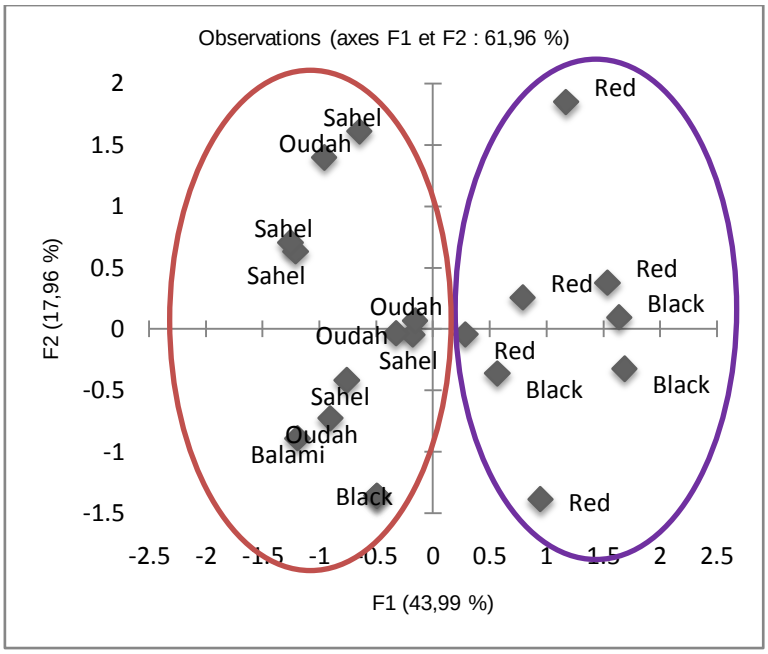

Fig. 3: Factorial map of skin resistance of different genetic types studied for all sexes combined.*(figure caption)*

Fig. 3 illustrates that depending on breed and species, skin resistance is higher in Red and Black goats than in Sahelian goats and sheep.Significant differences across breeds were observed using analysis of variances (p = 0.001). With all other breeds, Scheffe's post hoc test revealed that the difference between Black goat and Oudah sheep is not significant. While that of the Red goat with Balami sheep (p = 0.013) and the Sahel goat (p = 0.016) are significant.

- *Solidity*

Solidity, toughness, and durability are terms used to describe the ability of skin to survive time's wear and strain. Figure 4 summarizes shoemakers' perspectives on the solidity of the hides of the various breeds and species tested.

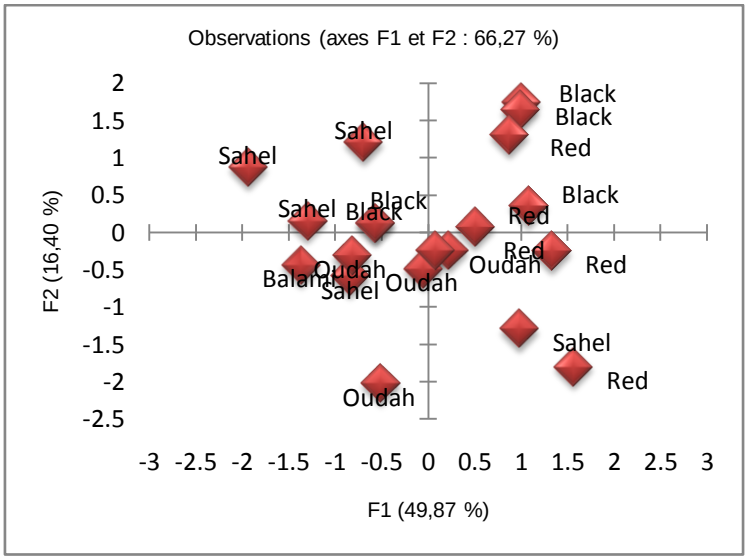

Fig.4: Factorial map of skin solidity of different studied genetic types for all sexes combined.*(figure caption)*

One-way analysis of variances and Scheffe's post hoc test show that Red goat skin is statistically stronger than that of all other breeds (Red vs Sahel, p = 0.001; vs Oudah, p = 0.027 and vs Balami, p = 0.001) except for Black goat (p = 0.272).

- *Suppleness or flexibility*

When skin is elastic or easily flexible, it is said to be supple or flexible. Fig. 5 presentsassessmentsanalysis of skin flexibility by shoemakers.

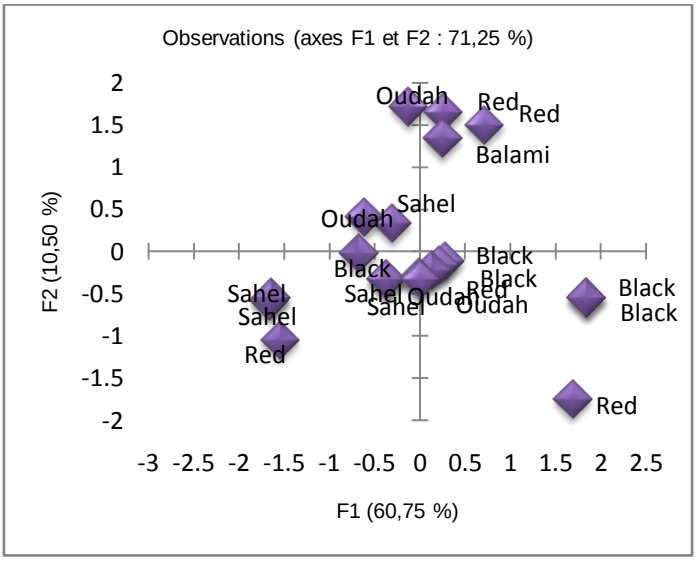

Fig.5: Factorial map of skin flexibility of different studiedgenetic types all sexes combined.*(figure caption)*

Fig. 5 shows that Black and Redgoats'skinis more supple than that of Sahelian goats and Oudah and Balami sheep. However, one-way analysis of variances shows that difference in flexibility between different genetic types is very significant (p=0.000). Scheffe's post hoc test made it possible to understand that difference in skin flexibility is not significant between Black and Red goats (p=0.390) but rather between these 2 goat groups and Sahel goat (p =0.000) and between Black goat and Oudah sheep (p=0.001).

- *Smoothness*

The term "smoothness" (thinness) refers to the skin's thinness, delicacy, or refinement in form and material. Fig. 6 shows a factorial analysis of scoring for this metric by breed and species.

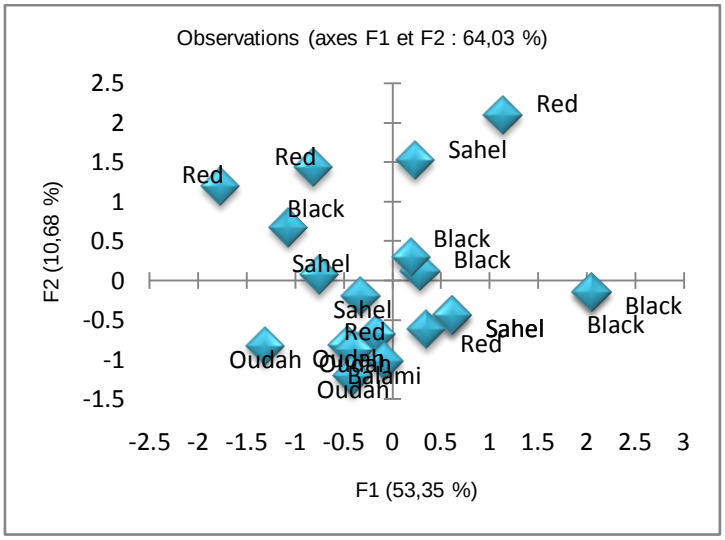

Fig.6: Factorial map of skin smoothness (thinness) of different studied genetic types all sexes combined.*(figure caption)*

The following breeds are classified in decreasing order of skin smoothness in Fig. 6: Black, Sahel, Red, Balami, and Oudah. According to the ANOVA and the Scheffe post hoc test, the difference between the Black goat and the Oudah sheep was significant (p=0.000).

B. Analysis of variation in hide weight from slaughter to tanning

Discriminant Factor Analysis (DFA) of skins weights of studied different genetic types from slaughter to tanning is presented in Fig. 7.

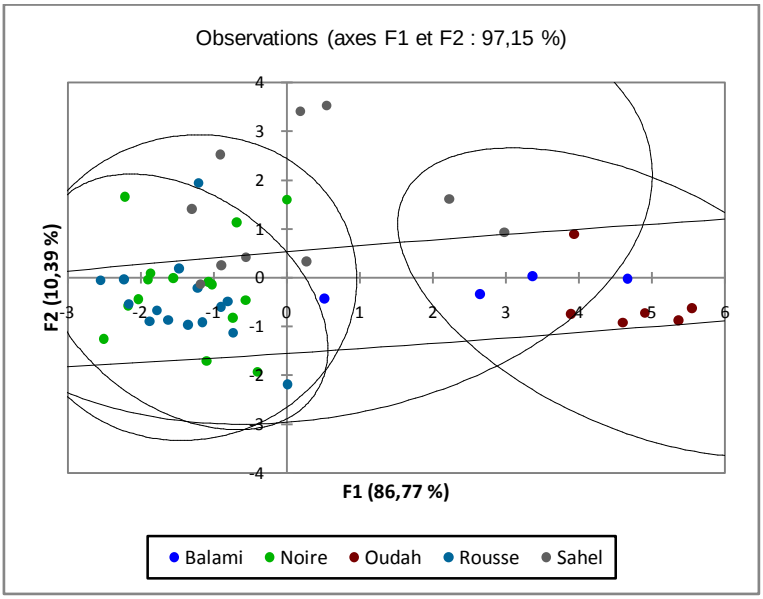

Fig.7: Discriminant Factor Analysis (DFA) of skins weights of studied different genetic types (Balami=Balami sheep, Noire=Black goat, Oudah=Oudah sheep, Rousse=Red goat, Sahel=Sahel goat).*(figure caption)*

At all levels of weighing, DFA highlights a similarity between the skins of Red and Black goats on one side and Oudah and Balami sheep on the other (live weight, weight after skinning, weight after trimming, dry weight and weight after tanning). The skin of the Sahelian goat, on the other hand, exhibits a mixture of traits.

Depending on sex in same breed, it appeared that at all weighing stages,skins weights of females are higher than those of males in all studied breeds with exception of Balami sheep (Fig. 8).

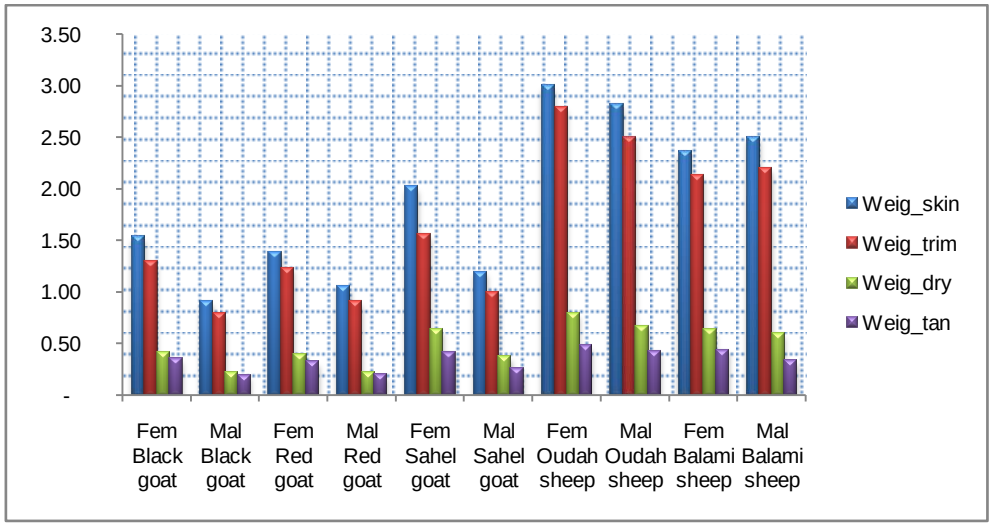

Fig.8: Variation in hide weight after skinning, trimming, dryingand tanning according to sex, breed and species of the animal.*(figure caption)*

All analyzed species and breeds combined demonstrated a substantial positive connection (TABLEIV) between weights at different stages of skin and animal living weight using Principal Component Analysis (PCA). The animal's age, live weight, and weights after skinning, cutting, drying, and tanning all had a strong positive connection (p=0.01).

TABLEIV: PEARSON CORRELATION MATRIX.*(Table head)*

	Age	**Live weight**	**Weightafterskinning**	**Weightaftertrimming**	**Weightafter drying**	**Weightaftertanning**
Age	**1**					
Live weight	0.590**	**1**				
Weightafterskinning	0.398**	0.922**	**1**			
Weightaftertrimming	0.391**	0.916**	0.983**	**1**		
Weightafter drying	0.465**	0.888**	0.893**	0.864**	**1**	
Weightaftertanning	0.617**	0.924**	0.851**	0.833**	0.930**	**1**

**. Correlation is significant at the 0.01 level (two-sided).*(Table footnote)*

TABLEV presents summary of results (R^2, Fisher's F probabilities and model equations) of simple regression of weights at different stages of skin as a function of animal live weight.

TABLE V:REGRESSION OF WEIGHT PARAMETERS OF SKIN ACCORDING TO THE ANIMAL LIVE WEIGHT. *(Table head)*

Types of régression	**R^2 Value**	**Fisher'sProbability F**	**Model equation**
Weights after skinning - Live weight	0.851	< 0.0001	WS = 0.01124+0.07757*LW
Weights after trimming - Live weight	0.838	< 0.0001	WTr = 0.08010+0.07141*LW
Weights after drying - Live weight	0.788	< 0.0001	WD = 0.00426+0.02126*LW
Weights after tanning - Live weight	0.854	< 0.0001	WTa = 0.04849+0.01334*LW

It emerges from TABLEV that R^2 values are all close to 1 and Fisher F are very significant.Fig. 9 (a, b, c and d) gives graphical representation of different regression models. It shows a good distribution of points around the regression line.

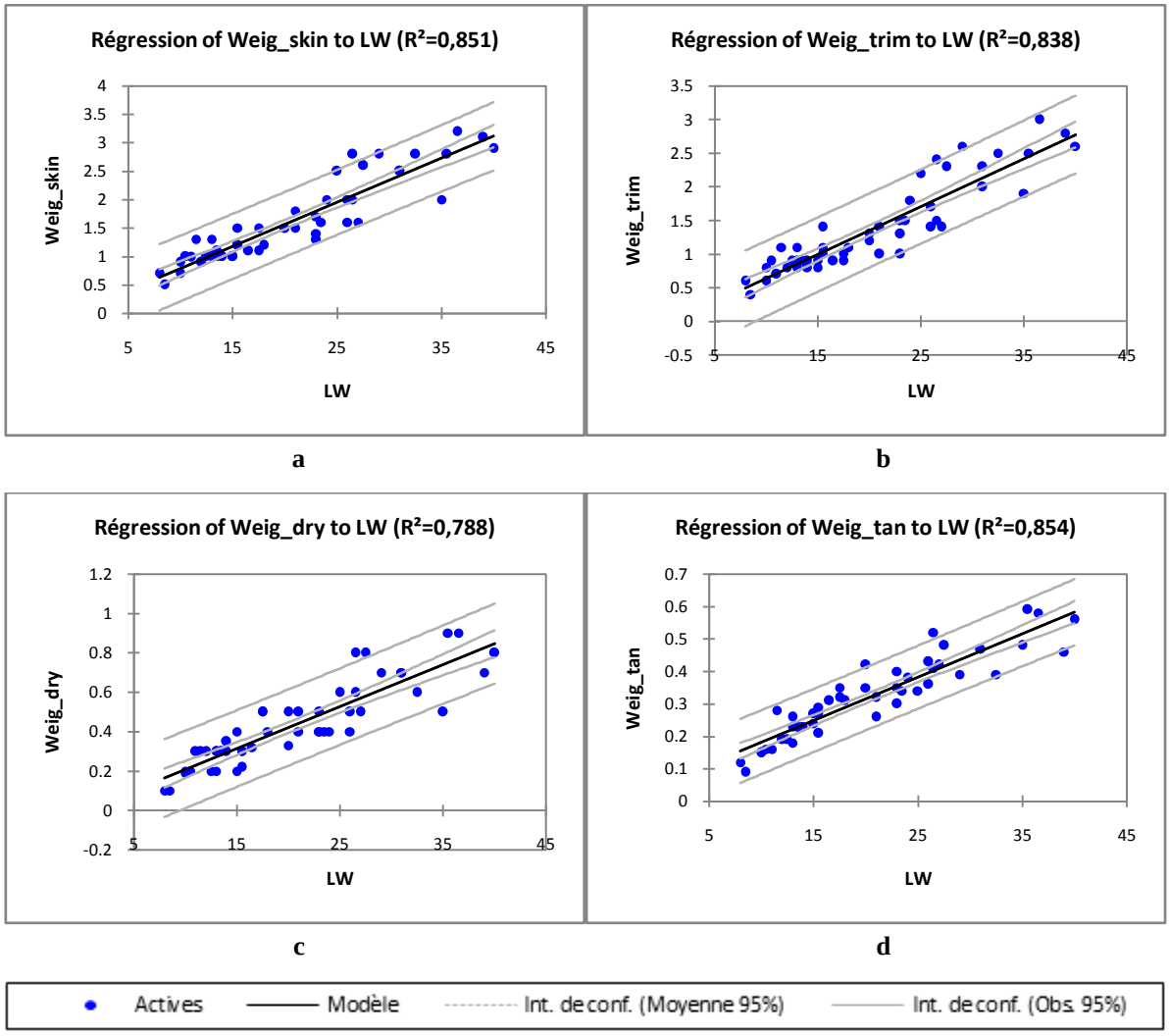

Fig. 9: Regression models of weights at different skin stages as a function of live weights for all studied genetic types.*(figure caption)*

Fig. 10 shows the normalized residuals distribution for several models (a, b, c and d). This figure shows that 88 percent, 94 percent, 94 percent, and 92 percent of observations of the model's weight after skinning, trimming, drying, and tanning were in the confidence interval] – 1.96; 1.96].

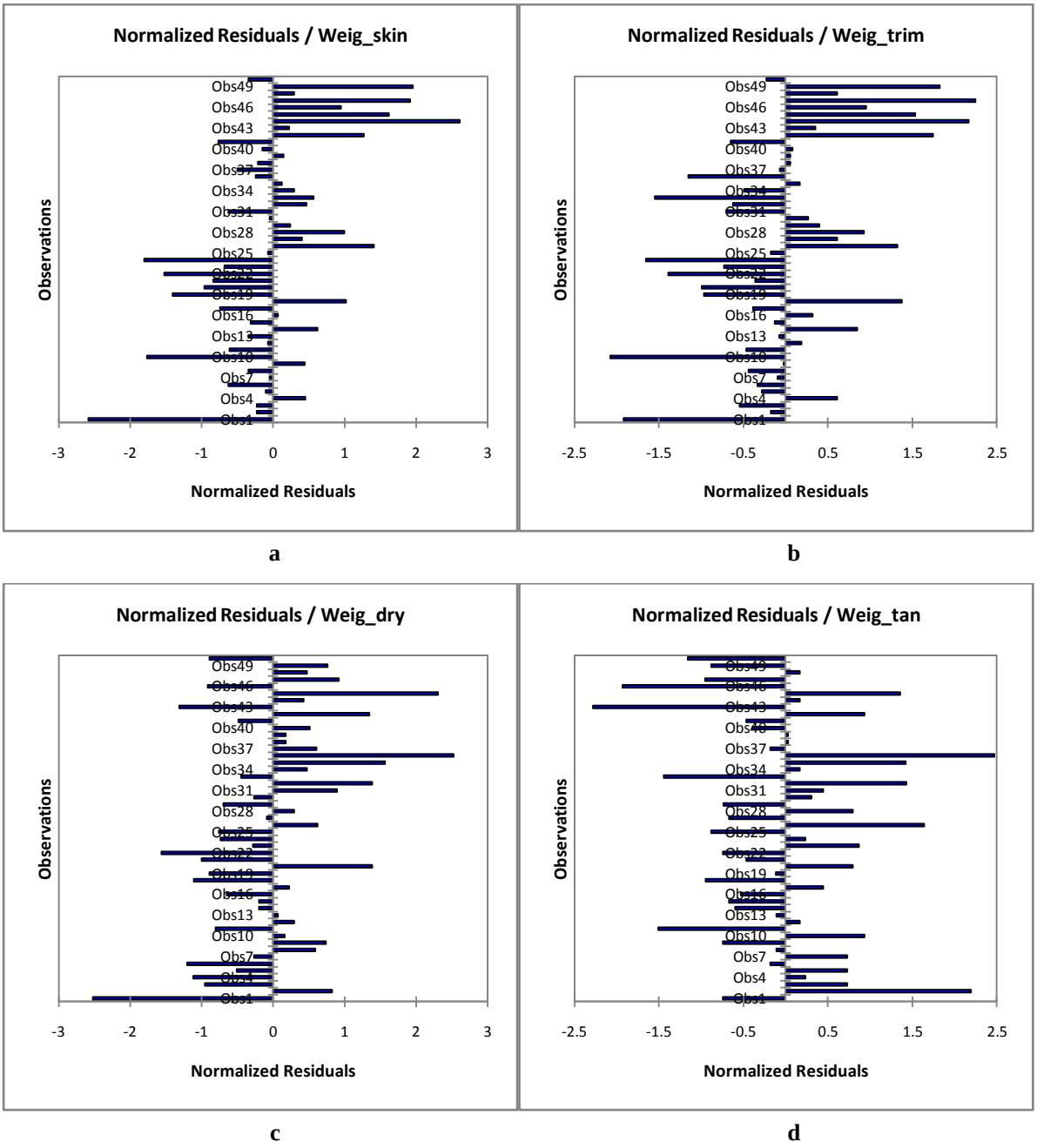

Fig.10:Observations of normalized residuals of regression models of skin weights at different stages as a function of live weights for all studied genetic types.*(figure caption)*

IV. Discussion

A. Qualitative parameters

Sheep (Oudah and Balami) have a much higher texture than goats (Rousse, Noire, and Sahel goats, in decreasing order) (p=0.000). In comparison to goatskin, sheepskin has a spongy structure and loose texture, according to [12]and [13]. The findings of this study agree with [14], who stated that "the intrinsic features of sheepskin (surface, thickness, loose yet resistant texture, low elasticity) are highly valued by the Nigerian customer for which it corresponds to various jobs."To the point where tanners compete directly with buyers of raw hides."

The skin resistance of Red and Black goats is higher than that of Sahelian goats and sheep. According to [15], goatskin has a structure that is comparable to that of calfskin in certain ways and similar to that of sheepskin in others, but its overall structure has unique properties. The blossom is resistant and the fibers are tighter than sheep's. However, this difference is not significant between the

Black and the Oudah with all other breeds; only the Redhead with the Balami (p = 0.013) and the Sahel goat (p = 0.016) are significant.

Analysis of shoemakers' opinions on skin solidity of different breeds and species shows that, with the exception of the Black goat (p = 0.272), the skin of Red goats is statistically stronger than that of all other breeds (Red vs Sahel, p = 0.001; vs Oudah, p = 0.027, and vs Balami, p = 0.001). This not only proves that the skins of Maradi's Red and Black goats are similar in terms of strength and that goat skin can be used raw as a lace or tie, but it also indicates that, due to its high plastic characteristics and strength, it should be tanned with caution[16].

Reference [17] observed that the difference in skin elasticity between Black and Red goats (p=0.390) is not significant, but rather between these two goat groups and Sahel goat (p=0.000) and Black goat and Oudah sheep (p=0.001). According to [14], goat skin has a deep and noticeable grain, and its dense and compact elastic fibers, which are not too oily, accept food and work effectively, resulting in a supple, nervous skin that is suitable for leather goods, gloves, bookbinding, and high-quality shoes.

Ranking the fineness of the skins of Black, Sahel, and Red goats, as well as Balami and Oudah sheep, in decreasing order, confirms the comparative study by unpublished [18], which concludes that Red and Black goats have a finer flower than particolored goats, even if the difference is only significant between Black goat and Oudah sheep (p=0.000). In comparison to sheep skin, goat skin has a finer and more flexible structure, according to [13], since the first has more elastic fibers, which are desirable in gloves and shoe uppers.

Reference [12] who adds age, sex, coat, climate, nutrition, and health state to our observations on variance in qualitative parameters of skin according to species and breeds, confirmed our findings. This was also [19]'s point of view, who related these components to breeding conditions. The comparative study by unpublished [18], which concludes that Red and Black goats have finer flowers than particolored goats, even if the difference is only significant between Black goat and Oudah sheep (p=0.000), confirms the fineness of the skins of Black, Sahel, and Red goats, as well as Balami and Oudah sheep, in decreasing order. According to [13], goat skin has a finer and more flexible structure than sheep skin, which has more elastic fibers, which are ideal in gloves and shoe uppers.

B. Quantitative parameters

Analysis of quantitative measures of small ruminant skin, such as weights at various stages from slaughter through tanning, revealed that those of sheep were higher than those of goats, owing to the texture of the former being more developed. According to [20], based on average weight, sheep fall into the "light" category (450-680 g) and goats fall into the "medium" category (300-680 g). According to [12],[18]and [19], the average of each quantitative parameter in females was higher than in males in both species of small ruminants, with the exception of Balami sheep, possibly due to the size of the test sample.

Within the same species, Oudah sheep had a heavier dry skin weight than Balami sheep, while in goats, the dried skin of Sahel weighed more than its sisters, Black and Red, which are fairly similar in this regard.

Principal Component Analysis of weights of all breeds and species aggregated at different phases of skin (weight after skinning, cutting, drying, and tanning) demonstrated a positive association with animal live weight. R^2 was close to 1 in a simple linear regression of these distinct weights as a function of animal live weight (R^2 between 0.788 and 0.854).

Given Fisher's F test is less than 0.0001, there is a risk of error of less than 0.01 % in concluding that animal live weight can provide considerable information about weights at various stages of hide from slaughter to tanning. Furthermore, the distribution of residuals according to animal live weight in confidence intervals of 88 %, 94 %, 94 %, and 92 % of Linear Regression Models of weight after skinning, weight after trimming, weight after drying, and weight after tanning in confidence intervals of 1.96; 1.96] strengthens this hypothesis.

V. CONCLUSIONS

For all skin qualitative parameters (texture, resistance, solidity, suppleness, and fineness) are quite comparable in Red and Black Maradi goats, more so than in Sahel goats, and they are different from sheep (Oudah and Balami), who have a higher texture.
Quantitative parameters, such as skin weights after each stage of the skinning, cutting, drying, and tanning process, all had a significant positive correlation (p=0.01) with animal live weight.
The skins of Maradi's Red and Black goats are extremely similar qualitatively and quantitatively, and they have some benefits over sheep and Sahel goat skins for use in traditional indigenous crafts in Niger.

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