Genetics and Biodiversity Journal

Journal homepage: http://ojs.univ-tlemcen.dz/index.php/GABJ

OPEN ACCESS

Original Research Paper

Phenotypic and genetic differentiation of qualitative traits in sheep ecotype from Cameroon Western Highlands

Djoufack Y T[1], Meutchieye F[1], Manjeli Y[1]

[1]*Department of Animal Science, Faculty of Agronomy and Agricultural Sciences, University of Dschang, PO Box 188 Dschang, Cameroon.*

Corresponding Author: Meutchieye F, University of Dschang, Cameroon. **Email**: fmeutchieye@gmail.com

Article history; Received: 7 March 2020 ; Revised: 25 March 2020***;*** Accepted: 2 May 2020

Abstract

This study was carried out in the highlands zone, west region of Cameroon to evaluate the distribution and frequency of sheep qualitative traits. Four hundred and three (403) adult sheep were randomly sampled in the study area. The qualitative traits observed were the presence or not of toggles, beard, horns and the sheep coat color (white, black, white-black and white-brown). The main results showed that the traits observed were variable according to the locality and sex of the animal. The sheep from the Bamboutos Division have the highest toggles frequency (21.69%) compared to those of the Noun Division whose frequency was the lowest (11.67%). Toggles were present in both sexes with higher frequency of 18.18% in females compared to the males (9.47%). Beard was almost non-existent in the two localities as well as in the two sexes. Horns were present in sheep of all the investigated localities and in both sexes, with higher frequency in males (90.53%) compared to females (8.12%). The action of the gene responsible for the color of the coat was variable as far as any locality was concerned. The predominant color observed was white. The gene frequencies recorded for the presence of the toggles (Waw), beard (Brb) and horns (HoP) were 0.06%, 0.00% and 0.35%, respectively. These values were far below the expected Mendelian value of 0.75. These low frequencies observed would indicate that the sheep populations of the highlands of the west region of Cameroon were variegated without proper actions of artificial selection, opening ways for genetic improvement.

Keywords: Phenotypes- Sheep – qualitative traits − gene frequencies – West Cameroon

Introduction

Sheep production is considered as an important economic activity for rural and peri urban populations in Sub-Sahara Africa. Sheep populations constitute in a context of low monetization and insecurity, a source of households' savings and contribute to the diversity of easy income and food resources (Mamadou, 2000; Kamuanga, 2002; Duteurtre et al., 2003; Boye et al., 2005; Gagara, 2008). Sub-Saharan native sheep populations display large adaptability: rusticity, resistance to hunger, thirst and trypanotolerance. They can be raised in all diverse agro-climatic areas (FAO, 2008). Despite the fact that sheep are widely distributed (Devendra and McLeroy, 1982), they are neglected and their key role in tropical agriculture has been misunderstood for some while (Wilson, 1983). In Cameroon, sheep production is found throughout the country with undeniable socio-economic importance (Tchouamo et al., 2005). The Ministry of Livestock, MINEPIA (2012) estimated the sheep flock around 3 million heads. This livestock species is represented by the West Africa dwarf sheep (Djallonké), Peulh or Pulfulli and Foulbé sheep, the Uda sheep with Balaami variety, the Kirdi sheep or Massa and the humid forest Black Belly sheep (Meka et al., 2019). According to Hall (1999), diversity of the genetic heritage, climatic conditions, free mating and natural selection could give rise to different local populations of sheep and consequently, to the development of differential adaptive behaviors that could be obvious in the morphology of animals. In the same vein, the findings of Oseni et al. (2006) show that, the diverse expressions of qualitative traits can have certain adaptive mechanisms linked to adaptation and survival in different ecological zones. This was supported by the report of Odubote (1994) on the influence of some qualitative traits on the genetic potential and adaptability of Nigerian goats. Hence, the necessity to keep these unique genes considering the fact that the high-level production of hybrids, does not behave well with low-input management typical of the smallholder production system (Rege and Gibson, 2003). Given that the characterization of a given breed is the first step of a long lasting of its genetic improvement, the aim of the present study was to provide information on the distribution or frequencies of some qualitative traits of West Cameroon highland sheep populations.

Material and methods

Area of study

The study was carried out between October 2014 and January 2015 in the Sudano-guinean zone of the western highlands of Cameroon (LN 3’5°, LE 8’20°). Elevation varies from 1400 to 2700 m (Figure 1). The climate that prevails is characterized as Cameroonian type, modified by the altitude. The temperature varies from 16 to 27°C; the relative humidity ranges from 49 to 97%. The average rainfall is about 2000 mm raging from 1700 to more than 2500 mm/year and divided into two seasons. The rainy season moves from half-March to half-November and the dry season , from half-November to half-March (Feukeng, 2005).

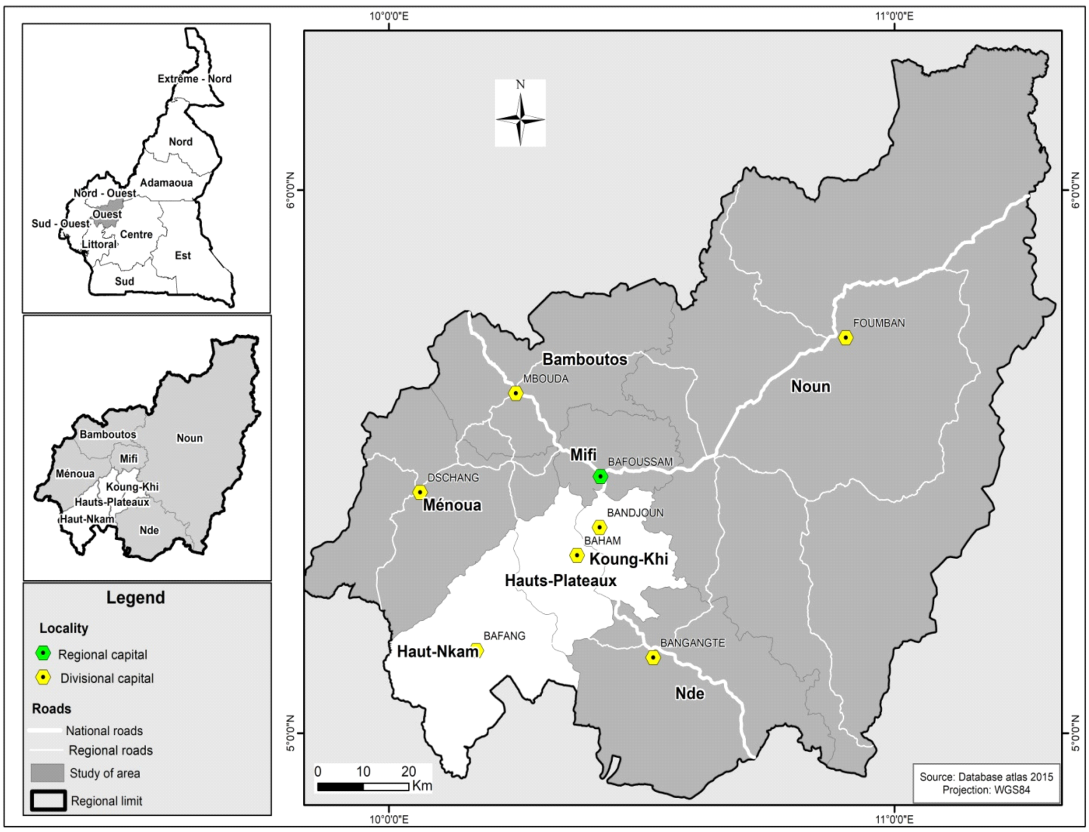

Figure 1: Map of study area for Cameroon West highlands Sheep

Data collection

Four hundred and three (403) sheep, including 308 females and 95 males divided in 5 of the 8 divisions that the region has, were sampled. Four qualitative traits (toggle, beard, horn and coat color) were used as variables of the classification of the population. From the presence or absence of the toggles, beard and horns, the sampled animals were observed as follows:

- (W_a^w) for presence and (W_a^+) for absence of toggles
- (B_r^b) for presence and (B_r^+) for absence of beard
- (H_o^+) for presence and (H_o^p) for absence of horns.

Concerning the coat pigmentation, the types of the color of fur observed have been classified in white (A^{wh}), black, white and black, white and brown and others (Sponenberg *et al*., 1988).

Data analysis

Descriptive statistics were used to describe the distribution of qualitative traits: coat color, horns' presence, toggles and beard. The distribution of the different qualitative traits were labeled in percentages and classified according to their locality and sex.

The frequencies of the recessive alleles (W_a^+, B_r^+ and H_o^+) were estimated using Hardy-Weinberg equilibrium (Falconer and Mackay, 1996) as indicated below:

$q = \sqrt{\frac{m}{M}}$; where,

q = frequency of the recessive gene

m = Number of animals observed with a particular recessive trait.

M = Total number of sampled animals

From q as mentioned above, the frequencies of the dominant alleles (W_a^w, B_r^b, H_o^P) were calculated as follows:

p = 1-q; where,

p = frequency of the particular dominant allele

The observed frequencies have been tested against the predictions of the Mendelian ratio of 3:1corresponding to values of 0.75 for the dominant allele and 0.25 for the recessive allele using Pearson chi-square test. The null hypothesis (NH) being the fact that is in the Mendelian proportions while the alternative hypothesis (AH), the population is not included in the Mendelian proportions.

Pearson's chi-square test for the state of well-being:

$$X^2 = \Sigma \frac{(\text{Observed - Expected})^2}{\text{Expected}}$$

The significance level of the test was examined at $\alpha<0.05$.

Results

The phenotypic frequencies of the different variables observed within the sheep population from the locality and sex perspective are indicated in Tables 1 and 2. All the investigated localities had sheep, which carried toggles, while horns were observed in all rams and also in some ewes (Figure 2). Sheep from the Bamboutos recorded higher frequency (21.69%), whereas those from the Noun had lowest frequency (11.67%). Similarly, toggles were present in both sexes with highest frequency (18.18%) in females compared to males (9.47%). With regard to beard, it was almost non-existent in all the localities and in both sexes. Horns were present in all sheep of the investigated localities. The sheep from the Bamboutos had the highest frequency (77.11%) whereas those of the Nde had the lowest (62.34%). Horns were present in both sexes of the sheep from the highlands of West Cameroon with highest frequency in males (90.53%) compared to females (8.12%).The action of the gene responsible for coat color was variable according to localities. The sheep were mainly white in the Bamboutos, Menoua and Noun localities (67.47%, 45.07% and 52.50%. respectively), whereas, those of the Mifi and Nde were mainly white and black (57.70% and 49.35%, respectively). The dominant color in both sexes was the white color (55.79% and 44.81%, respectively for rams and ewes).

A: Ram with horns B: Ewe with horns

Figure 2: Cameroon West Highland sheep bearing horns: (A: Ram and B: Ewe)

Table 1: Phenotypic frequencies (%) of qualitative traits in Cameroon West highlands sheep

Traits	**Alleles**	**Divisions (localities)**									
		Bamboutos		**Menoua**		**Mifi**		**Nde**		**Noun**	
		N	**F(%)**	**N**	**F(%)**	**N**	**F(%)**	**N**	**F(%)**	**N**	**F(%)**
Toggle	W_a^w	18	21.69	13	18.31	9	17.31	11	14.29	14	11.67
	W_a^+	65	78.31	8	81.69	43	82.69	66	85.71	106	83.33
Beard	B_r^b	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	B_r^+	83	100.00	71	100.00	52	100.00	77	100.00	120	100.00
Horn	H_o^P	64	77.11	50	70.42	39	75.00	48	62.34	91	75.83
	H_o^+	19	22.89	21	29.58	13	25.00	29	37.66	29	24.17
Coat Colour											
White	A^{wh}	56	67.47	32	45.07	11	21.15	29	37.66	63	52.50
Black	-	2	2.41	6	8.45	1	1.92	1	1.30	2	1.67
White-black	-	15	18.07	31	43.66	30	57.70	38	49.35	42	35.00
Brown	-	2	2.41	1	1.41	2	3.85	1	1.30	1	0.83
White-brown	-	5	6.02	0	0.00	7	13.46	5	6.49	7	5.83
Others	-	3	3.61	1	1.41	1	1.92	3	3.90	5	4.17

N = Size ; F = Phenotypic frequency

Table 2: Phenotypic frequencies (%) of qualitative traits in Cameroon West highlands sheep

Traits	Alleles	Sex		Phenotypic frequencies		
		Ram	Ewe	Ram	Ewe	Ram &Ewe
Toogle	W_a^w	9	56	9.47	18.18	16.13
	W_a^+	86	252	90.53	81.82	70.47
Beard	B_r^b	0	0	0.00	0.00	0.00
	B_r^+	95	308	100.00	100.00	100.00
Horn	H_o^P	9	283	9.47	91.88	72.46
	H_o^+	86	25	90.53	8.12	27.54
Coat Color						
White	A^{wh}	53	138	55.79	44.81	47.39
Black	-	0	12	0.00	3.90	2.98
White-black	-	31	125	32.63	40.58	38.71
Brown	-	0	7	0.00	2.27	1.74
White- brown	-	9	15	9.47	4.87	5.96
Others	-	2	11	2.11	3.57	3.23

The genetic frequencies of sampled qualitative traits of the sheep of the highlands of West Cameroon are indicated in Table 3. The frequencies were 0.06%, 0.00% and 0.35%, respectively for the W_a^w, B_r^b and H_o^P genes. These values were lower than the expected Mendelian value of 0.75%. These low frequencies observed would indicate that the sheep populations of the highlands of the west region of Cameroon were not purified by artificial selection.

Table 3: Gene frequencies of qualitative traits in Cameroon West highlands sheep

Traits	**Alleles**	**Expected value**	**Observed value**	**Gene frequencies**	**χ^2 test**
Toogle	W_a^w	302.25	65	0.06	*
	W_a^+	100.75	338	0.94	
Beard	B_r^b	302.25	0	0.00	*
	B_r^+	100.75	403	1.00	
Horn	H_o^P	302.25	292	0.35	*
	H_o^+	100.75	111	0.65	

*Significant at $p<0.05$

Discussion

In general, genetic frequencies of qualitative traits observed in sheep of the highlands of West Cameroon indicate phenotypic variability. Yakubu *et al*. (2010) showed higher toggles frequencies in females (36.63%) compared to males (11.45%) for *Yankassa* sheep breed in Nigeria. However, on *Uda* and *Balami* sheep, the same researchers found higher frequencies in males (10.26% and 19.59%) compared to females (1.59% and 13.59%). The total frequency of 16.13% is not in accordance with the 48% and 98.28% reported respectively by Ozoje and Kadri (2001) on West Africa Dwarf sheep and Rodero *et al*., (1996) on Lebrijan Churro sheep in Andalusia. Salako (2012) obtained toggles frequencies of 4.59% and 82.14%, respectively in the *Djallonké* sheep and in *Yankassa* sheep in Nigeria, which is therefore not comparable with our observations. The frequency of 0% observed corroborates with the observations of Yakubu et al. (2010) on *Balami*, *Yankassa* and *Uda* sheep in Nigeria.

Salako (2012) reported that the presence of horns in rams and ewes in the *Djallonké* and *Yankassa* sheep in Nigeria with a sexual dimorphism in favor of the males. According to Yakubu *et al*., (2010), the bearing of horns could be advantageous in the tropics where the temperature can easily reach the extremes due to the fact that they are the only specific areas with a major drainage of blood through the cavernous sinus, which, according to Robertshaw (2006), is involved in the control of the thermal homeostasis mechanisms. Yakubu *et al*., (2010) observed the predominance of white coat color in both rams and does in *Balami* sheep in Nigeria. According to Ozoje and Kadri (2001), in addition to relationship between white coloring and environment stress, there is also a morphostructural importance, for it affects the width of shoulders on sheep. Furthermore, Dyrmundsson and Adalsteinsson (1980), reported that allele A^{wh} responsible for the white coat colorplays a role in suppressing off-season reproduction; which is an advantage under harsh environmental conditions where the off-season reproduction with lambing in cold season, would lead to the high mortality of kids.

Yakubu *et al*., (2010) found the W_a^w allele frequencies ranging from 0.08%, 0.02% and 0.09% respectively in *Yankassa*, *Uda* and *Balami* sheep in Nigeria, whichare close to observations from this study. On the other hand, Ozoje and Kadri (2001) reported frequency of 0.39 % for the W_a^w allele, which is in contradiction with the observations on this sheep populations. According to Yakubu *et al*. (2010), such low frequency of the gene responsible for the presence of toggles is sign that it is subject to disappearance. Such observations should lead to appropriate decision making in order to ameliorate the understanding of diminishing mechanisms and potential impacts on current and future breeding programs.

Conclusion

From this study, the frequenciesof toggles, horns and coat color patterns in Cameroon West highlands sheep vary according to locality and sex. Dominant genes for all these traits were present but at very low frequencies. The sheep populations in the region were variegated without a directional selection. To foster sheep larger breeding efforts in the country, further investigations should be intensified both for other qualitative studies and in connection with quantitative aspects that could enable sheep production.

References

Boye CM. Gueye E-HF. Missohou A. Sow RS 2005. La viande. In : Bilan de la recherche agricole et agroalimentaire au Sénégal. ISRA, ITA, *CIRAD*: pp321-344.

Devendra C. McLeroy GB 1982. Goat and Sheep Production in the Tropics. Longman group Longman House Burnt Mill, Hallow Essex. U.K

Duteurtre G. Corniaux C. Boutonnet JP 2003. Baisse de la consommation des produits laitiers en Afrique Subsaharienne : mythe ou réalité ? *Renc. Rech. Ruminant*. 10: 323-326.

Dyrmundsson OR. Adalsteinsson S 1980. Coat-color gene suppresses sexual activity in Icelandic sheep. *J. Heredity*. 71: 363-364. DOI : 10.1093/oxfordjournals.jhered.a109389.

FAO 2008. L'état des ressources zoogénétiques pour l'alimentation et l'agriculture dans le monde: pp320-350.

Falconer DS. Mackay TFC 1996. Introduction to quantitative genetics. 4th ed. Longman, London. 464p.

Feukeng E 2005. La météo change. *ECOVOX* N°34, Juillet-Septembre 2005 : pp9-11.

Gagara HM 2008. La peste des petits ruminants au Niger: Enquête sérologique dans les régions de Niamey, Tahoua et Tillabéry.*Mémoire de fin d'étude* Université d'Adomey-Calvi, 88p.

Hall SJG 1991. Body dimensions of Nigerian cattle, sheep and goats. *Anim. Prod.* (UK). 53: 61-69. DOI : https://doi.org/10.1017/S0003356100005985

Kamuanga M 2002. Rôle de l'animal et de l'élevage dans les espaces et les systèmes agraires des savanes soudano-sahéliennes. *In: jamin J. Y., Seiny Boukar L., Floret C* ; (eds.), savanes Africaines, des espaces en mutation, des acteurs face à des nouveaux défis. Actes du colloque, mai 2002, Garoua, Cameroun, PRASAC, Céderom. pp77−94

Mamadou SB 2000. Communication des résultats de l'étude sur la socio-économie de l'élevage ovin périurbain (SECOVILLE) en Guinée. *In: Symposium technique T1*. «*Bilan et perspectives de programmes européens sur les petits ruminants en Afrique*». *CIRAD-EMVT*, 20 mai 2000 à Poitiers, pp59-83.

MINEPIA 2012. Annuaire statistique du Cameroun. Chapitre 15, pp266-281.

Meka Zibi II MA. Meutchieye F. Ntsoli J. Tadakeng Y. Fonteh F 2019. Factors affecting the global diffusion of an African animal genetic resource: the case study of the Cameroon *Blackbelly*. *PKFokam Journal of Applied Science and Technology*, Inaugural issue June 2019 : 21-29. URL: http://www.pkfokam-cap.org/en/pkf-jast/

Odubote IK 1994. Characterisation of West African Dwarf goats for certain qualitative traits. *Nig. J. Anim. Prod.* 21: 37-41. http://doi.org/10.1155/2015/728210

Oseni S. Sonaiya B. Omitogun G. Ajayi A. Muritala I 2006. West African Dwarf goat production under village conditions: I. Characterization and the establishment of breed standards. Conference on International Agricultural Research for Development, University of Bonn, Tropentag. 11-13 October.

Ozoje MO. Kadri OA 2001. Effects of coat color and wattle genes on body measurement traits in the West African Dwarf sheep. *Trop. Agric.* (Trinidad). 78: 118- 122. DOI:
JSAER2018-05-10-155-161

Robertshaw D 2006. Mechanisms for the control of respiratory evaporative heat loss in panting animals. *Journal of Applied Physiology* 101: 664-668. DOI : japplphysiol.01380.2005

Rege JEO. Gibson JP. 2003. Animal genetic resources and economic development: Issues in relation to economic valuation. *Ecological Economics* 45: 319-330. DOI: https://dx.doi.org/10.1016/S0921-8009(03)00087-9

Rodero E. de la Haba MR. Rodero AY. Herrera M 1996. Genetic and phenotypic profile of endangered Andalusian sheep and goat breeds. FAO Health paper. 88: 77-97.

Salako AE 2012. Genetic and phenotypic profiles of West African dwarf and Yankasa sheep breeds in Nigeria. *International Journal of Biodiversity and Conservation* Vol. **5**(2):47-53. DOI:10.5897/IJBC11.012

Sponenberg DP.Shosuke I. Wakamatsu K. Eng LA 1998. Pigment Types in Sheep, Goats, and Llamas. Pigment Cell Research1:414-418. DOI: 10.1111/j.1600-0749.1988.tb00145.x

Tchouamo IR. TchoumbouéJ. Thibault L 2005. Caractéristiques socio-économique et techniques de l'élevage de petits ruminants dans la province de l'ouest Cameroun. *Tropicultura* **23** (4): 201-211.

Yakubu A. Raji AO and Omeje JN 2010. Genetic and phenotypic differentiation of qualitative traits in Nigerian indigenous goat and sheep populations. ARPN Journal of Agricultural and Biological Science Vol. **5**(2):58-66. DOI: 10.1.1610.3565.

Wilson RT 1983. Husbandry, nutrition and productivity of goats in subtropical Africa. In: Joint IFS/ILCA Workshop on Small Ruminant Research in the Tropics. IFS Provisional Report14, International Foundation for Science, Stockholm, pp. 19-34.