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GENETIC AND PHENOTYPIC DIFFERENTIATION OF QUALITATIVE TRAITS IN NIGERIAN INDIGENOUS GOAT AND SHEEP POPULATIONS

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ABSTRACT

Data from smallholder flocks of adult West African Dwarf (WAD) and Red Sokoto goats (n = 824) and Yankasa, Uda and Balami sheep (n = 636) were utilized to investigate the distribution and frequencies of certain qualitative traits. The animals were randomly sampled in Northern parts of Nigeria. They were scored for the presence or absence of wattle, beard, horn, coat colour [Phaeomelanic standard pigmentation, Eumelanic Standard pigmentation and Brown Eumelanin (goats); White, White and Black and White and Brown (sheep)] and hair type (smooth or coarse). Breed-dependence and sexual dimorphism were observed in the qualitative variables considered. In both WAD and Red Sokoto goats, the dominant genes for wattle (Wa^w), beard (Br^b), and polledness (H_o^P) were found to segregate at low frequencies (0.09 vs. 0.02; 0.05 vs. 0.12 and 0.00 vs. 0.00). The values were also much lower than the expected Mendelian value of 0.75. However, a different trend was observed for phaeomelanic standard pigmentation (A^{wt}), where gene frequency was low in WAD (0.20); but high in Red Sokoto goats (0.63), conforming with the underlying assumption of complete dominance. Low gene frequencies were also recorded for wattle and beard in Yankasa, Uda and Balami sheep respectively (0.08, 0.02 and 0.09; 0.00, 0.00 and 0.00). Lower frequencies of wattle gene and variable coat colours obtained in both species are indicative of the fact that they have not been purified through artificial breeding. Estimates of genetic distance between WAD and Red Sokoto goats were, 0.005, 0.005 and 0.18 for wattle, beard and coat colour loci. In sheep, the estimates ranged from 0.0001 to 0.005 at the wattle locus. This shows that the two goat populations are more closely related at both the wattle and beard loci, thereby aiding in classical phylogenetic inference. The same is applicable to the sheep populations at the only estimated locus.

Keywords: goats, sheep, qualitative parameters, gene frequency, genetic distance.

INTRODUCTION

Small ruminants are important genetic resources in the tropics, where they play a predominant role in the sustenance of the livelihoods of impoverished families especially in the rural areas. In Nigeria, they represent about 63.70% of the total grazing domestic animals. The adaptive features of goats and sheep such as feeding behaviour, disease and heat tolerance and remarkable recovery capacity from drought enable them to cope effectively with a variety of stressful tropical environmental conditions.

The West African Dwarf (WAD) goat is widely distributed across the rainforest belt of Southern Nigeria. They are short-legged and small-bodied animals, weighing between 22 and 26kg. They also present variable coat colours, ranging from black, brown, gray, red and white, and sometimes combinations of these in a variety of patterns (Mourad *et al.*, 2000). For goats found in the Northern parts of the country, the major breed is the Maradi (Red Sokoto) followed by the long-legged Sahel goats (Borno White or Kyalla). The skin of Red Sokoto goats is reputed to be of high quality; therefore, it is used in the leather industry locally and internationally (Akpa *et al.*, 1998). Balami, Uda and Yankasa sheep are meat types and documented breeds native to the Northern parts of the country, while the West African Dwarf sheep are predominantly found within the rainforest, mangrove swamps and coastal regions in Southern Nigeria.

The diversity of gene pool, different climatic conditions within the country, free mating and natural selection have given rise to different local populations of goats and sheep. Therefore, one would expect much differential adaptive development to be reflected in the morphology (Hall, 1991). According to Oseni *et al.* (2006), varied expression of qualitative traits may represent some adaptive mechanisms related to adaptation and survival in different ecological zones in the country. This is substantiated by the report of Odubote (1994) on the influence of certain qualitative traits on the genetic potential or adaptability of Nigerian goats. Hence, the need for the conservation of these unique genes for present and future use. This becomes expedient in view of the fact that high-level production crossbreds do not perform under the low-input management typical of the smallholder production system (Rege and Gibson, 2003).

Since characterization of a breed is the first approach to a sustainable use of its animal genetic resource; studies on diversity and variability between indigenous goats as well as sheep breeds on the basis of quantitative (morphostructural) and qualitative (morphological) variables have been extensively carried out on-station and on-farm in Southern Nigeria (Orheruata *et al.*, 1997; Ozoje and Kadri 2001; Ozoje and Mgbere

2002). However, similar works especially on the qualitative traits of goats and sheep found in Northern parts of the country are scarce. This is inspite of the fact that vast majority of indigenous small ruminants are concentrated in the northern axis. Therefore, the present study aimed at providing information on the distribution and frequencies of some qualitative traits in indigenous goats and sheep traditionally managed in Northern Nigeria. It is part of a major characterization study involving the use of blood protein and molecular markers being undertaken by the same authors. This will eventually play a role in the prevention of rapid erosion of these zoogenetic resources, considering the fact that indiscriminate miscegenation, uncontrolled intermixing and geographical overlap are leading to the endangerment of breed purity; and potentially important caprine and ovine genetic materials are being put to risk.

MATERIALS AND METHODS

Location of study

The study was carried out in three states in Northern Nigeria; namely Nasarawa (North Central), Borno and Yobe (North east) states, respectively. Nasarawa State falls within the guinea savanna agro-ecological zone, and is found between latitudes $7^0 52'$N and $8^0 56'$N and longitudes $7^0 25'$E and $9^0 37'$E. It has two distinct seasons. The wet season lasts from about the beginning of May and ends in October. The dry season is experienced between November and April. Annual rainfall Figures range from 1100 to 2000mm. The mean monthly temperatures range between 20^0 and 34^0C. Borno State lies between latitudes 10^0N and 13^0N and longitudes 12^0E and 15^0E respectively. Three seasons have been identified in the state; the cool-dry (harmattan) season (October-March), hot-dry season (April-June) and rainy season (July-September). Temperatures are high all year round, with hot season temperatures ranging between 39^0C and 40^0C under the shade. The mean annual rainfall is over 800mm on the Biu Plateau but less than 500mm in extreme north around Lake Chad. Yobe state is hot and dry for most period of the year. The mean temperature for most stations in the state is about 37^0C. The highest temperature (about 42^0C) is normally experienced in April, while minimum temperatures (about 30^0C) are usually recorded in December. A wet season of only three to four months is usually experienced.

Livestock and their management

824 adult goats comprising 402 WAD (177 males and 225 females) and 422 Red Sokoto (237 males and 185 females) were sampled. Similarly, a total of 636 adult sheep comprising 232 Yankasa (131 males and 101 females), 204 Uda (78 males and 126 females) and 200 Balami (97 males and 103 females) were randomly surveyed. Although WAD goats are native to southern Nigeria, interestingly they are equally the predominant variety found in Nasarawa State, hence their inclusion in this investigation. Red Sokoto goats and Yankasa, Uda and Balami sheep were sampled in Borno and Yobe states respectively. The animals were managed in an extensive system, where they scavenged with their young on forages and on kitchen and food processing wastes. They returned to the homestead at dusk with little or no provision for shelter. The study lasted from March, 2006 to January, 2007.

Data collection

Five qualitative traits (Wattle, Beard, Horn, Coat colour and Hair type) were used as classification variables for both species. On the basis of incidence of wattles, animals were categorized into wattled (Wa^w) and non-wattled (Wa^+) goats and sheep respectively. They were also scored for the presence (Br^b) or absence (Br^+) of beard; and also for the presence (H_o^+) or absence (H_o^p) of horn. With regard to coat pigmentation, goats were assessed for Phaeomelanic standard pigmentation, Eumelanic standard pigmentation and Brown Eumelanin pigmentation as described by Lauvergne (1993) and Machado *et al.* (2000). This method was adopted for the purpose of clarity and simplicity, since it has been observed that the underlying genetics of pigmentation is complex, exhibiting quantitative as well as qualitative features (Klungland and Vage 2000). In the "Agouti (A) series" in the goat, the most dominant allele produces a goat with only phaeomelanin pigment and no eumelanin. Such a goat, depending on the rest of its genetic makeup, is entirely white, red, yellow, tan or cream (with or without white spots) the most recessive allele produces a goat with only eumelanin pigment and no phaeomelanin. Such a goat, depending on the rest of its genetic constitution is entirely black or chocolate brown and blue-gray (with or without white spots) The B or brown gene affects whether eumelanic (dark-pigmented) areas of the animal are black or chocolate-brown. It does not affect phaeomelanic areas. The brown colouration is found only in areas of the coat that would otherwise be black and that the brown is chocolate-brown, not yellow or red-brown (Waller 2006). For sheep, the observed coat colour types were classified into white (A^{wh}) White and Black and White and Brown respectively. Hair type was categorized into smooth and coarse for both species.

Statistical analyses

The distributions of the various traits were expressed in percentages and categorized according to sex. The frequencies of the recessive alleles (Wa^+, Br^+, H_o^+ and A^a) were estimated using Hardy-Weinberg equilibrium (Falconer and Mackay 1996) as shown below:

$$q = \sqrt{\frac{m}{M}}$$

Where,

q = frequency of the recessive gene
m = observed number of animals exhibiting the particular recessive trait.
M = total number of animals sampled.

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From q above, the frequencies of the dominant alleles (Wa^w, Br^b, H_o^P and A^{wt}) were calculated as follows:

p = 1-q

Where,

p = frequency of the particular dominant allele

The observed frequencies were tested against the expected Mendelian ratio of 3:1 corresponding to values of 0.75 for the dominant allele and 0.25 for the recessive allele using Pearson's chi-square test. The null hypothesis (HO) is that the population is in Mendelian proportions while the alternative hypothesis (HA) is that the population is not in Mendelian proportions.
Pearson's chi-square test for goodness of fit states:

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

The level of significance of the test was examined at p<0.05.

Genetic distance between the goats as well as the sheep breeds were estimated at the wattle (for both species), beard and coat colour (goats only) loci respectively using gene frequencies. The method of Bodmer and Cavalli-Sforza (1976) was adopted as follows:

$$d^2 = (P_1-P_2)^2$$

Where,

d^2 = genetic distance estimate between the two populations
P_1 = gene frequency of population 1
P_2 = gene frequency of population 2

RESULTS AND DISCUSSIONS

The phenotypic frequencies of qualitative variables in the various goat and sheep populations by sex are shown in Table-1 and Table-2, respectively. Both sexes of WAD and Red Sokoto goats were observed to have wattles (toggles). The wattled condition existed at a higher proportion in male (31.64%) than in female WAD goats (5.78). However, in Red Sokoto goats, relatively smaller percentage was recorded for male (1.69%) compared to the female population (3.78%). Comparatively, there was apparent variation in wattle incidence between the breeds, with WAD having an edge (17.16%) over Red Sokoto goats (2.61%). The present results obtained on WAD are not in conformity with the findings of earlier workers. Odubote (1994) and Oseni *et al.* (2006) reported frequencies of 69.10 and 64.30% respectively for the wattle gene in the rainforest zone of Southern Nigeria. Similarly, Adedeji *et al.* (2006) observed the prevalence of toggles (68.59%) in a derived savanna zone of Southern part of the country. This diversity or phenotypic differentiation might not be unconnected with territorial distribution and the historical and cultural context. WAD goats in the semi-humid tropics are believed to have migrated from the humid environments of the country. This indiscriminate flock movements and traditional livestock exchange might have affected wattle occurrence, a major gene already implicated in thermo-regulation (Odubote1994). In Yankasa sheep, toggles predominated in females with a frequency of 36.63% compared to 11.45% observed in males. However, lower proportions were observed in female Uda sheep (1.59%) than in males (10.26%). The frequency of incidence of wattles was also higher in male Balami sheep (19.59%) compared to their female counterparts (13.59%). The phenotypic frequencies (pooled) recorded for Balami (16.50%), Yankasa (14.66%) and Uda (4.90%) respectively are not in consonance with the 48% reported for WAD sheep (Ozoje and Kadri 2001), and 98.28% for Lebrijan Churro sheep in Andalusia (Rodero *et al.* 1996). The lower relative proportions of wattled condition could be attributed to the associated taboo. The non-wattled sheep are normally used for idolatory sacrifices typical of the rural populace.

Possession of beard was evident in both goat populations. However, there was sexual dimorphism in its distribution, as more males (33.33 for Red Sokoto and 18.64% for WAD goats) exhibited the trait than females (6.49 and 4.00% for Red Sokoto and WAD goats, respectively). The phenotypic frequency (pooled) was also higher in the former (21.56 vs. 10.45%). The sexual difference observed is not unexpected since the occurrence of beard is due to a locus which is dominant in males and recessive in females. It is a secondary sexual characteristic under male hormonal action; thus, females displaying the trait are likely to have threshold levels of androgenic hormone. The incidence of beard was found to be virtually non-existent (0%) in both sexes of the three sheep populations investigated.

There was species differentiation in the pattern of inheritance of horns. Both sexes of WAD and Red Sokoto goats were horned (100% in each case). However, in sheep, the horn condition only manifested in males, as the females were all polled. The phenotypic frequency (pooled) obtained in goats is not in agreement with the 75% reported for horn proportions in Twasna goats in Botswana (Katongole *et al.*, 1996). Inter-sexuality, which is a recessive trait associated with the dominant allele for polledness, could be responsible for the non-observation of polled goats in the survey agroecological zones. According to OMIA (2007), some XY goats that are homozygous for the polled allele, are sterile. Most XX goats that are homozygous for the polled allele show signs of inter-sexuality, ranging from almost normal female to almost male in external appearance and in the development of reproductive traits and organs. Vaiman *et al*. (1997) also showed an absence of Y chromosome DNA in these animals, thus rulling out Y-X translocation as a cause of the inter-sexuality. This might have led to the selection disadvantage of polled goats. It also implies that the frequency of polled trait as observed in WAD and Red Sokoto goats should not be taken as zero, but that it tends towards zero (odubote, 1994). The present result in sheep lent credence to the postulation that the inheritance of horns in this species is sex-influenced character (Khan and

Singh, 2002). The polled gene (PP) is epistatic to the gene for horns. However, it is incompletely dominant in rams, and completely dominant in ewes (Lauvergne *et al.*, 1996). While Nigerian indigenous sheep could be compared to Cheviots, Hampshires, Suffolk and Oxfords of the temperate region, they are different from Scottish Blackface, Jacobs and Icelandics where both rams and ewes exhibit substantial horn growth (p'p'). However, possession of horns could be advantageous in the tropics where temperature could get to the extremes. They are the only superficial areas with a major drainage of blood through the cavernous sinus, which, according to Robertshaw (2006), has been implicated in the control mechanism for thermal homeostasis.

There was diversity in coat colour pigmentation between the two goat populations. In WAD, the preponderant coat colour tended towards eumelanic standard pigmentation (dark-pigmented areas) and its frequency was higher in males (66.10%) than in females (57.78%). For goats with phaeomelanic standard pigmentation, the proportion for females (36.89%) was higher than for males (29.94%). The reverse was the case in Red Sokoto, where the distribution of goats with red colouration (phaeomelanic standard pigmentation) was greater (86.26%) than those with either black or chocolate brown colouration (eumelanic standard pigmentation). Marginal differences were observed between the sexes in both pigmentations. However, the occurrence of brown eumelanin, a gene masking black colouration was very low in WAD (4.73%) and conspicuously missing in Red Sokoto goats (0%). The present result on the preponderance of dark pigmentation in WAD concurs with previous works carried out on-station and on-farm in Southern Nigeria (Odubote 1994; Oseni *et al.,* 2006). This could be a form of adaptive mechanism bearing in mind its suggested role in temperature regulation especially in the cold season when dark pigmented animals warm up earlier and more quickly than their light-coloured counterparts. This is consolidated by a similar work on horses, where it was reported that melanin has a variety of functions including photo-protection, routing of the optic nerve tract, and possibly the scavenging of free radicals (Sturm *et al.,* 1988). Most of the Red Sokoto goats surveyed were found to be red (not due to the effect of recessive red of the extension locus (E^r)) which is a characteristic feature of the breed. However, the "A^{wt}" symbol was adopted for red and tan goats because they are genetically white. It is possible that homozygotes (goats possessing two copies of the A^{wt} gene) are white, while heterozygotes (goats possessing one copy only of the A^{wt} gene) are red or tan. The white colouration could be an advantage in an intense radiant environment due to its reflectance property. The apparent wide variation in coat colours is an indication that the goat populations have not been purified through impeccable selective breeding. Therefore, great opportunities exist for their improvement. This is concurrent with the report of Katongole *et al*. (1996) in Twasna goats. One of the possibilities as postulated by Toth *et al*. (2006), is to design selection towards specific coat colours putting into cognizance the relationship between polygenetic effects of coat colour and other traits of interest (for example, physiology, morphology and behaviour). The mode of gene action in coat colour distribution differed among the three breeds of sheep studied. Yankasas were predominantly white and black; with the black pigments found around the muzzle, face and hooves. The sexual difference observed in the breed was very low (97.03 and 95.42% for females and males respectively). In Uda sheep, the effect of A^{wh} allele was not completely dominant, as the sheep were either white and black (65.20%) or White and brown (34.80%); the black or brown colouration is found within the head region and forequarters, while the white pigment occupies the hindquarters. Similarly, Saldana-Munoz *et al.* (2004) reported that white and brown sheep are co-dominant and both dominant to spotted, blackbelly and black colours. The probable mechanism for Uda coat colour patterning could be the intensification of extensive spotting; while the depth of colour of the white areas is controlled by poorly-understood modifier genes separate from the colour patterning produced by the Agouti locus; there is also every tendency that the colouration of black areas is controlled by the Brown gene. Predominant solid white colour was observed in both sexes of Balami sheep. This is a distinguishing feature of the breed. The black and brown pigments in few ones were found as patches in minute parts of the breed. Apart from the relationship between white colouration and environmental stress, it is also of morphostructural importance as it affects the shoulder width of sheep (Ozoje and Kadri, 2001). Additionally, Dyrmundsson and Adalsteinsson (1980) reported that the allele, A^{wh} plays a role in the suppression of out-of-season breeding activity; which is an advantage under adverse environmental conditions where out-of-season breeding with lambing in the cold season, would result in extremely high lamb mortality.

Structurally, the hairs of female Red Sokoto and WAD goats (90.81 and 84.44%) were smoother than that of their opposite sex (86.08 and 74.01%, respectively). Similar patterns were observed sexually in coat hair type in the three breeds of sheep. The propensity towards smooth hair structure could be an advantage as it provides a medium for convectional heat loss from the animal surface. This is supported by the assertion that hair structures have an important role to play in the adaptability of animals to different ecological zones (Banerji, 1984).

The gene frequencies of certain qualitative traits of goats and sheep are shown in Table0-3. For goats, frequencies of the dominant alleles for both WAD and Red Sokoto goats were 0.09 and 0.02 (Wa^w); 0.05 and 0.12 (Br^b); 0.00 and 0.00 (Ho^p), and 0.20 and 0.63 (A^{wt}). These values were quite lower than the expected Mendelian value of 0.75, with the exception of A^{wt} of Red Sokoto goats which occurrence was not significantly ($p>0.05$) different from the Mendelian ratio of 3:1. However, higher frequencies were observed for the recessive alleles in both breeds except A^a in Red Sokoto goats. The present result concurs with the findings of Odubote (1994) and Adedeji

ARPN Journal of Agricultural and Biological Science

et al. (2006) on the low occurrence of beardedness and polledness; but contradicts their submission on the high incidence of wattle gene. In sheep, the observed frequencies (Wa^w) were 0.08, 0.02 and 0.09 for Yankasa, Uda and Balami respectively. Beards were virtually non-existent. The present finding on wattle occurrence is inconsistent with the earlier work of Ozoje and Kadri (2001), where the gene for wattle was estimated to have a frequency of 0.39. The present result on wattle in both species points to the fact that it is at the risk of extinction. Hence, the need to take appropriate measures to conserve this unique gene in order to enhance its utilization in present and future livestock development programmes.

The estimated genetic distance between WAD and Red Sokoto goats was 0.005, 0.005 and 0.18 at the wattle, beard and coat colour loci (Table-4). At the wattle locus, estimates ranging between 0.0001 and 0.005 were observed between pairs of sheep populations. Genetic distances make it possible to evaluate the degree of genetic similarity between two populations by measuring the probability of one or more characters appearing in one of the populations but not in the other (Sournia, 1991). The minuscule values obtained at the Wa and Br loci of goats are indications of phylogenetic relationship between the two breeds; while the seemingly higher value at the A^{wt} locus is indicative of genetic differentiation which could be used to classify the breeds into distinct populations. The same is applicable to sheep where the low values obtained show high similarity of alleles at the wattle locus.

Table-1. Frequency (%) of qualitative traits in Nigerian indigenous goats by sex.

Traits	Alleles	West African dwarf					Red sokoto				
		Phenotypic frequency					Phenotypic frequency				
		No. of male	No. of female	Male	Female	Pooled	No of male	No of female	Male	Female	Pooled
Wattle	Wa^w	56	13	31.64	5.78	17.16	4	7	1.69	3.78	2.61
	Wa^+	121	212	68.36	94.22	82.84	233	178	98.31	96.22	97.39
Beard	Br^b	33	9	18.64	4.00	10.45	79	12	33.33	6.49	21.56
	Br^+	144	216	81.36	96.00	89.55	158	173	66.67	93.51	78.44
Horn	H_o^P	0	0	0.00	0.00	0.00	0	0	0.00	0.00	0.00
	H_o^+	177	225	100.00	100.00	100.00	237	185	100.00	100.00	100.00
Coat colour											
Phaeomelanic standard pigmentation	A^{wt}	53	83	29.94	36.89	33.83	203	161	85.65	87.03	86.26
Eumelanic standard pigmentation	A^a	117	130	66.10	57.78	61.44	34	24	14.34	12.97	13.74
Brown eumelanin	B^{bI}	7	12	3.95	5.33	4.73	0	0	0.00	0.00	0.00
Hair type											
Smooth	-	131	190	74.01	84.44	79.85	204	168	86.08	90.81	88.15
Coarse	-	46	35	25.99	15.56	20.15	33	17	13.92	9.89	11.85

Table-2. Frequency (%) of qualitative traits in Nigerian indigenous sheep by sex.

Traits	Alleles	Yankasa					Uda					Balami				
				Phenotypic frequency					Phenotypic frequency					Phenotypic frequency		
		No. of male	No. of female	Male	Female	Pooled	No. of male	No. of female	Male	Female	Pooled	No. of male	No. of female	Male	Female	Pooled
Wattle	Wa^w	15	37	11.45	36.63	14.66	8	2	10.26	1.59	4.90	19	14	19.59	13.59	16.50
	Wa^+	116	64	88.55	63.37	85.34	70	124	89.74	98.41	95.10	78	89	80.41	86.41	83.50
Beard	Br^b	0	0	0.00	0.00	0.00	0	0	0.00	0.00	0.00	0	0	0.00	0.00	0.00
	Br^+	131	101	100.00	100.00	100.00	78	126	100.00	100.00	100.00	97	103	100.00	100.00	100.00
Horn	H_o^P	0	101	0.00	100.00	43.53	0	126	0.00	100.00	61.76	0	103	0.00	100.00	51.50
	H_o^+	131	0	100.00	0.00	56.47	78	0	100.00	0.00	38.24	97	0	100.00	0.00	48.50
Coat colour																
White	A^{wh}	6	3	4.58	2.97	3.88	0	0	0.00	0.00	0.00	92	100	94.85	97.09	96.00
White and black	-	125	98	95.42	97.03	96.12	48	85	61.54	67.46	65.20	3	1	3.09	0.97	2.00
White and brown	-	0	0	0.00	0.00	0.00	30	41	38.46	32.54	34.80	2	2	2.06	1.94	2.00
Hair type																
Smooth	-	107	84	81.68	83.17	82.33	62	104	79.49	82.54	81.37	79	86	81.44	83.50	82.50
Coarse	-	24	17	18.32	16.83	17.67	16	22	20.51	17.46	18.63	18	17	18.56	16.50	17.50

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Table-3. Gene frequencies of some qualitative traits in indigenous goats and sheep.

Goats

Traits	Alleles	West African dwarf				Red sokoto			
		Expected	Observed	Gene frequency	χ^2 test	Expected	Observed	Gene frequency	χ^2 test
Wattle	Wa^w Wa^+	301.5 100.5	69 333	0.09 0.91	*	316.5 105.5	11 411	0.02 0.98	*
Beard	Br^b Br^+	301.5 100.5	42 360	0.05 0.95	*	316.5 105.5	91 331	0.12 0.88	*
Horn	H_o^P H_o^+	301.5 100.5	0 402	0.00 1.00	*	316.5 105.5	0 422	0.00 1.00	*
Phaeomelanic standard pigmentation	A^{wt}	287.25	136	0.20	*	316.5	364	0.63	ns
Eumelanic standard pigmentation	A^a	95.75	247	0.80		105.5	58	0.37	

Sheep

Traits	Alleles	Yankasa				Uda				Balami			
		Expected	Observed	Gene frequency	χ^2 test	Expected	Observed	Gene frequency	χ^2 test	Expected	Observed	Gene frequency	χ^2 test
Wattle	Wa^w Wa^+	174 58	34 198	0.08 0.92	*	153 51	10 194	0.02 0.98	*	150 50	33 167	0.09 0.91	*
Beard	Br^b Br^+	174 58	0 232	0.00 1.00	*	153 51	0 204	0.00 1.00	*	150 50	0 200	0.00 1.00	*

*significant at p<0.05
Ns: not significant

Table-4. Matrix of genetic distances of goat and sheep populations.

Traits	WAD vs. red sokoto	Yankasa vs. Uda	Yankasa vs. Balami	Uda vs. Balami
Wattle	0.005	0.004	0.0001	0.005
Beard	0.005	-	-	-
Coat colour	0.18	-	-	-

CONCLUSIONS

This study has shown that the distribution and frequencies of wattle, beard, horn, coat colour and hair type in goats and sheep were influenced by the breed and sex of the animal. The dominant alleles in both species were found to segregate at lower frequencies with the exception of phaeomelanic standard pigmentation in Red Sokoto goats. Therefore, efforts should be intensified to preserve in particular, the wattle gene which is at the brink of extinction. Selection should also be geared towards specific coat colours. Estimates of genetic distance showed the closeness of WAD and Red Sokoto goats at both the wattle and beard loci and Yankasa, Uda and Balami sheep at the wattle locus. Current efforts on the genetic characterization of the two species using blood protein and microsatellite markers will consolidate classical understanding of these relationships, and also aid in in-situ and ex-situ conservation strategies.

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