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Phenotypic and genetic categorization of qualitative traits in extensively managed local goat (*Capra aegagrus*) population of Niger State, Nigeria

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Abstract

A study on the distribution and frequencies of coat colour, wattle, beard, horn, and hair type using 375 extensively managed local goats was carried out in the three administrative zones of Niger state, Nigeria. The animals were scored for coat colour pigmentation pattern, presence or absence of wattle, beard, horn, hair type and extra teat. The study showed that light brown is the predominant colour in zones A (43.24%) and zone C (47.57%). Dark brown colour was predominant in zone B (37.82%) followed by light brown (31.09%). The observed frequencies for wattle (Wa^w) and extra teat (Et^e) were above ($p < 0.01$) the expected Mendelian value of 75% for a dominant gene in all the zones (90.34, 86.55, 87.39 percent for wattle and 91.73, 96.64, 98.21, percent for extra teat in zones A, B, and C, respectively). The gene frequency for beard (Br^b) were significantly lower ($p < 0.01$) than the expected Mendelian value of 75% for a dominant gene in zone A (66.20%) and zone B (55.46%), but was higher in zone C (83.78%). The gene frequency for polledness (Po^p) was 0.00% for all the zones. The gene frequency for soft hair.

was more than ($p < 0.01$) the expected Mendelian value of 75% for dominant genes in zone C (87.33%) but fell short in zone A (60.69%) and zone B (43.70%), respectively. It was concluded that coat colour variation exist in local goats reared extensively in Niger state.

Keywords: Expansively; Inherent; Indigenous goat; Physical; Traits

1. Introduction

The domestic goat (*Capra aegagrus*) is a subspecies of goat domesticated from the wild goat of southwest Asia and Eastern Europe. Goats have variety of coat colours ranging from pure white, cream, to red, black or gray sprinkled or pied, gray, brown or black [14]. Naturally they have two horns of various shapes and sizes which depend on the breed [4]. Like other ruminants goat are even-toed and the females have udders consisting of two teats [25]. Both male and female goats have beards, and many breeds of goat may have wattles. Goat tails are short and usually point upward which makes it different from that of sheep which usually hang down and are usually longer and bigger [2].

Goats have unique adaptive features that enable them fit into their environment. In drought prone regions, goats survive on thorny vegetation and even browse on three tops. This explains why goats survive in most arid areas under such conditions where cattle and sheep start dying in numbers. They can trek for long distances and require less frequent watering than sheep and cattle [2]. The expression of various qualitative traits may represent some adaptive mechanism developed for adaptation and survival in different ecological zones of the country [18]. This agrees with the report of Odubote [17] on the influence of certain qualitative traits on the genetic potential of the Nigerian goats. The conservation of these unique genes for the present and future use has therefore become very important. Since characterization of a breed is the first approach to a sustainable use of its animal genetic resource, more studies on diversity and variability between indigenous goat breeds on the basis of quantitative and qualitative evaluation needs to be carried out in the

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Northern parts of Nigeria since the vast majority of indigenous goats are concentrated in this axis [27].

The objective of the study was to evaluate the distribution and frequencies (phenotypic and gene) of some qualitative traits in local goats extensively managed in Niger state.

2. Materials and methods

2.1. Location of study

The study was carried out in the three administrative zones of Niger state (zones A, B and C). The local governments that made up Zone A include: *Agaie*, *Bida*, *Edati*, *Gbako*, *Katcha*, *Lapai*, *Lavun* and *Mokwa*. Local governments in zone B include: *Bosso*, *Chanchaga*, *Gurara*, *Munya*, *Paikoro*, *Rafi*, *Shiroro*, *Suleja* and *Tafa* while those in zone C include: *Agwara*, *Borgu*, *Kontagora*, *Magama*, *Mariga*, *Mashegu*, *Rijau* and *Wushishi*. Niger state is located between latitude 9^0 31′ and 9^0 42′ North and longitude 6° 29′ and 6^0 41′ East of the equator. The mean annual rainfall is between 1200 mm and 1300 mm, with average highest temperature in the month of March and lowest temperature in the month of August. The mean annual temperature is between 38 and 42 °C. Niger state is located within the guinea savannah vegetation belt of Nigeria and has two distinct seasons; wet from March to October and dry from November to March [16].

2.2. Experimental animals and sampling technique

Three hundred and seventy five goats reared extensively were sampled from the three administrative zones of Niger State. The sampling technique used was as described by Cameroon [7]. All the local governments in the three zones were numbered and the first three with even numbers were selected. A total of nine local government areas were therefore selected for the study. This includes *Bida*, *Lavun* and *Katcha* (zone A), *Chanchaga*, *Suleja* and *Gurara* (Zone B), while *Kontagora*, *Wushishi* and *Mariga* local government areas were selected from zone C. Houses with goats were identified and ten percent of the identified household flock in each of the selected local government areas were selected by randomization technique. Each household (farmer's) flock in the selected local government areas were given a number written on cards. The cards were shuffled and the card equivalents to ten percent of the households with goats in each local government area were randomly picked. Within each household, the systematic sampling technique as described by Puff et al. [20] was used.

2.3. Data collection

Data were collected on qualitative traits (coat colour pigmentation, hair type, extra teat, wattle and beard).

The coat colour pattern described by Lauvergne [11] and Machado et al. [13] were used as guideline. This include black colour, dark brown, light brown, red cheek, eumelanic and tan, badger face, wild, anterior mantlet, posterior mantlet and Phaeomelanic.

2.4. Data analysis

Phenotypic frequencies were computed by direct count. The proportions (%) of individuals carrying the various traits were determined as follows:

$$= \frac{\text{Number of individual having the trait}}{\text{Total number of individual sampled}} \times 100$$

Hardy–Weinberg principle [9] was used to estimate gene frequency as given below:

$$q = \sqrt{\mathrm{m/t}}$$

where q = frequency of the recessive or dominant gene, m = observed number of animals exhibiting the particular recessive or dominant trait and t = total number of animals sampled. Chi-square statistics was employed to test the observed number of goats having a trait against the expected Mendelian value (25 and 75%).

3. Results

Coat pigmentation pattern for goats in Niger state is presented in Table 1. The common pigments observed in the population sampled are black, dark brown, light brown, Barger face and white. The most common pigment in zones A and C was light brown (43.24 and 47.57%, respectively) followed by dark brown (21.62%). The most predominant pigment in zone B was dark brown (37.82%). The least observed pigmentation across the three zones was Barger face (0.90, 4.20 and 0% for zone A, B and C, respectively). Table 2 shows the phenotypic and gene frequency of wattle in goats in Niger state. The presence of wattle is low across the three zones with phenotypic and gene frequency of 9.66% and 0.05 (zone A), 13.45% and 0.07 (zone B) and, 12.61% and 0.07 (zone C).

Table 3 shows the phenotypic and gene frequency of beard in goats in Niger state. The presence of beard was low across the three zones with phenotypic and gene frequency of 33.80% and 0.19 (zone A), 44.54% and 0.26 (zone B) and 16.22% and 0.06 (zone C).

Table 4 shows that all goats in Niger state possessed horn with phenotypic and gene frequency of 100% and 1.00 in zones A, B, and C. Soft hair predominates in zones A and C (Table 5), the phenotypic and gene frequencies are 60.69% and 0.78 and 87.33% and 0.93, respectively while coarse hair predominates only in zone B with phenotypic and gene frequencies of 56.30% and 0.75, respectively. The occurrence of extra teat is low in the three Zones (A, B and C, Table 6). The phenotypic and gene frequencies for the occurrence is 8.27% and 0.04 (Zones A), 3.36% and 0.02 (Zone B) and 1.80% and 0.1 (Zone C). Goats without Extra teat were predominant with phenotypic and gene frequency of 91.73% and 0.96 (Zone A), 96.64% and 0.98 (Zone B) and 98.21% and 0.99 (zone C).

Table 1
Coat pigmentation pattern of goats in Niger State.

Colour	Zone A		Zone B		Zone C		Total	
	Number	Frequency %	Number	Frequency %	Number	Frequency %	Number	Frequency %
Black	18	16.22	19	15.97	20	13.79	57	15.2
Dark brown	24	21.62	45	37.82	46	31.72	115	30.67
Light brown	48	43.24	37	31.09	69	47.57	154	41.07
Barger face	1	0.90	5	4.20	_	_	6	1.6
White	20	18.02	13	10.92	10	6.92	43	11.46
Total	111	100.00	119	100.00	145	100.00	375	100.00

4. Discussions

The predomination of Brown coat pigmentation in Niger state is in agreement with Wamagi et al. [26] who reported that brown colour is the commonest in the Southern part of Kaduna state, Nigeria. The result however, is not in agreement with the findings of Yakubu et al. [27] who reported red colour to be the most frequent in Red Sokotogoat breed compared to either black or chocolate brown colours in Northern Nigeria. Odubote [17] and Oseni et al. [18] however, reported on the preponderance of black or dark pigmentation in West African Dwarf goat in Southern Nigeria. The higher percentage of brown colour (a gene masking black colouration) in Niger state agrees with the report of [26] that, brown colour is due to transition or crossing between the Red Sokotogoat of North western Nigerian and the West African Dwarf goat of the Rain forest region of Southern Nigeria. According to Oseni et al. [18]; the expression of various qualitative traits represents some adaptive mechanism developed for adaptation and survival in the different ecological zones of the country. For example, in the cold season, it is believed that dark pigmented animals (those with more melanin pigment) warm up easily and more quickly than their light coloured counterparts (with lower levels of melanin).

The observed frequency for goats without wattle were higher than the expected Mendelian value of 25% for recessive genes while those with wattle were lower than the expected value of 75% for dominant genes in zones A, B and C. This is in agreement with the work of Adebayo and Chineke [1] who observed that 63.5% of goats sampled in south western part of the country do not possessed wattle while 36.5% of the goats possessed wattle. The results obtained in the present study however is not in line with the findings of Yakubu et al. [27] who reported gene frequencies for absence of wattle (Wa^{w}) in WAD and Red Sokoto goats to be 17.16 and 2.61%, respectively, while the frequencies for presence of wattle (Wa^{+}) were 82.84 and 97.39%, respectively. Odubote [17] reported that goats without wattle constitute only about 35.70% of goat population in the south west of Nigeria. Vilson et al. [24] reported that the most frequent allele of wattle in Albanian goat populations is Wa^{+}. The low occurrence of wattle in Niger State as observed in the present study could be attributed to the associated taboo. The non-wattled animals are normally used for idolatory sacrifices which according to Yakubu et al. [27] is typical of the rural populace.

The gene frequencies for the presence of beard and for its absence were similar to those reported by Vilson et al. [24] for allele Br^{b} in all Albania goat breeds; they observed a high frequency. Adebayo and Chineke [1] reported the absence of beard to be 79% and the occurrence of beard to be 21% in goats in south western part of Nigeria. The result is however not in line with the findings of Yakubu et al. [27] who observed a high frequency for the presence of beard in both

Table 2
Phenotypic and gene frequency of wattle in goats of Niger State.

	Genotype	Number	Observed frequency (%)	Expected frequency (%)	Calculated gene frequency	Expected gene frequency
Zone A	Wa^{+}	14	9.66	75	0.05^{b}	0.25
	Wa^{w}	131	90.34	25	0.95^{a}	0.75
	Total	145				
Zone B	Wa^{+}	16	13.45	75	0.07^{b}	0.25
	Wa^{w}	103	86.55	25	0.93^{a}	0.75
	Total	119				
Zone C	Wa^{+}	14	12.61	75	0.07^{b}	0.25
	Wa^{w}	97	87.39	25	0.93^{a}	0.75
	Total	111				
Total	Wa^{+}	45	12	75	0.06^{b}	0.25
	Wa^{w}	330	88	25	0.94^{a}	0.75
	Total	375				

[ab]Means in the same column without common letter are different at $p < 0.01$.
Wa^{+} = presence of wattle; Wa^{w} = absence of wattle.

Table 3
Phenotypic and gene frequency of beard in goats of Niger State.

	Genotype	Number	Observed frequency (%)	Expected frequency (%)	Calculated gene frequency	Expected gene frequency
Zone A	Br^+	49	33.80	25	0.19^b	0.25
	Br^b	96	66.20	75	0.81^a	0.75
	Total	145				
Zone B	Br^+	53	44.54	25	0.26^b	0.25
	Br^b	66	55.46	75	0.74^a	0.75
	Total	119				
Zone C	Br^+	18	16.22	25	0.06^b	0.25
	Br^b	93	83.78	75	0.94^a	0.75
	Total	111				
Total	Br^+	120	32	25	0.18^b	0.25
	Br^b	255	68	75	0.82^a	0.75
	Total	375				

[ab]Means in the same column without common letter are different at $p < 0.01$.
Br^+ = presence of beard; Br^b = absence of beard.

WAD and Red Sokoto goat breeds (89.55 and 78.44%) and 10.45 and 21.56% for their absence, respectively. Ozoje [19] reported that 75% of goats studied in the south western part of Nigeria have beard while 25% have no beard. The low occurrence of beard in Niger state was because more females were available for sampling. Asdell and Buchanan-Smith [5] revealed that beard is a trait controlled by an autosomal gene and depended on sex. Lauvergne et al. [12] stated that beard is a trait dominant in males and recessive in females. Yakubu et al. [27] also observed sexual dimorphism in the distribution of beard as more males exhibited the trait than females.

The gene frequency for horned goats was 100%. This is not unexpected as Adebayo and Chineke [1] reported the presence of horn in all goats sampled in South Western Nigeria in respective of sex. Yakubu et al. [27] also reported 100% presence of horn in goats they sampled in Northern Nigeria. Kharel et al. [10] also reported that the gene frequency of horned condition was higher (98.96%) than polled in Nepalese hill goats. The presence of horn was also reported to be very high (>90%) in all Albanian goat breeds [12]. Ozoje [19] however reported a fairly low frequency of pollness (13%) for West African Dwarf goats. Rodero et al. [22] found very high frequencies of both populations (horned and polled) in Blanca Serrana breeds. Nafti et al. [15] observed lower values for the presence of horn in Tunisian goats. The possession of horns (which is said to be dominant in male) by both male and female goats in Niger state is of advantage since temperature could get to the extremes. Horns are superficial areas with a major drainage of blood through the cavernous sinus which according to Robert-Shaw [21]; is used as a control mechanism for thermal homeostasis.

The gene frequencies observed for soft hair and coarse hair falls within the range reported by Yakubu et al. [27]. They reported high frequencies of soft hair in WAD and Red Sokoto goats (79.85 and 88.15%, respectively). Ozoje [19] observed soft hair to be the predominant hair type in WAD goat in South Western Nigeria though the percentage was not stated. The dominance of smooth hair structure in Niger state is of 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

Table 4
Phenotypic and gene frequency of horn in goats of Niger State.

	Genotype	Number	Observed frequency (%)	Expected frequency (%)	Calculated gene frequency	Expected gene frequency
Zone A	Ho^+	145	100.00	25	1.00^a	0.25
	Ho^p	0	0.00	75	0.00^b	0.75
	Total	145				
Zone B	Ho^+	119	100.00	25	1.00^a	0.25
	Ho^p	0	0.00	75	0.00^b	0.75
	Total	119				
Zone C	Ho^+	111	100.00	25	1.00^a	0.25
	Ho^p	0	0.00	75	0.00^b	0.75
	Total	111				
Total	Ho^+	375	100.00	25	1.00^a	0.25
	Ho^p	0	0.00	75	0.00^b	0.75
	Total	375				

[ab]Means in the same column without common letter are different at $p < 0.01$.
Ho^+ = presence of horn; Ho^p = absence of horn.

Table 5
Phenotypic and gene frequency of hair type in goats of Niger State.

	Genotype	Number	Observed frequency (%)	Expected frequency (%)	Calculated gene frequency	Expected gene frequency
Zone A	Soft	88	60.69	75	0.78[a]	0.75
	Coarse	57	39.31	25	0.22[b]	0.25
	Total	145				
Zone B	Soft	52	43.70	75	0.25[b]	0.75
	Coarse	67	56.30	25	0.75[a]	0.25
	Total	119				
Zone C	Soft	97	87.33	75	0.93[a]	0.75
	Coarse	14	12.67	25	0.07[b]	0.25
	Total	111				
Total	Soft	236	62.93	75	0.79[a]	0.75
	Coarse	139	37.07	25	0.21[b]	0.25
	Total	375				

[ab]Means in the same column without common letter are different at $p < 0.01$.

play in the adaptability of animals to different ecological zones [6].

The gene frequency for the presence of extra teat is far below the expected value for recessive gene (25%) while the value for the absence of the trait is far above the expected value of 75% for dominant gene. The result is in conformity with the findings of Salako [23] who reported similar results while working with WAD and the Yankasa breeds of sheep in South Western Nigeria. The author discovered 0.00% occurrence of supernumerary nipples in both breeds. The results of Oseni et al. [18] however did not agree with the current findings as they discovered that 64.30% of goat's possessed extra teat in the Southern part of Nigeria. In a similar work Adebayo and Chineke [1] reported the presence of extra teat in 95% of goats sampled in the South Western part of Nigeria. The low frequency of goats with extra teat observed in the present study confirms the report of Amao et al. [3] who reported that presence of supernumerary teat constitute a major udder abnormality in WAD goats. Calfology.com [8] reported that extra teat is a predisposing factor that causes mastitis and can interfere with milking process.

5. Conclusion

The results obtained from the present study showed that light brown is the predominant colour in zones A and C while dark brown colour is predominant in zone B. The observed gene frequencies for wattle (Wa^w) and extra teat (Et^e) were above the expected Mendelian value of 75% in all the zones. The observed gene frequency for beard (Br^b) was not up to the expected Mendelian values of 75% in zones A and B, but was higher in zone C. The observed gene frequency for polledness (Po^p) was 0.00%. Soft hair is the predominant hair type in zone C but fewer in zones A and B.

6. Recommendation

Further research to investigate the genetic characterization based on proteins and molecular assessment within and between the indigenous goats breeds in Nigeria especially in Northern states should be carried out. This will strengthen the understanding of the diversity within and between indigenous goat breeds and help to conserve their genetic make-up.

Table 6
Phenotypic and gene frequency of extra teat in goats of Niger State.

	Genotype	Number	Observed frequency (%)	Expected frequency (%)	Calculated gene frequency	Expected gene frequency
Zone A	Et^+	12	8.27	25	0.04[b]	0.25
	Et^e	133	91.73	75	0.96[a]	0.75
	Total	145				
Zone B	Et^+	4	3.36	25	0.02[b]	0.25
	Et^e	115	96.64	75	0.98[a]	0.75
	Total	119				
Zone C	Et^+	2	1.80	25	0.1[b]	0.25
	Et^e	109	98.21	75	0.99[a]	0.75
	Total	111				
Total	Et^+	18	4.53	25	0.02[b]	0.25
	Et^e	357	95.47	75	0.98[a]	0.75
	Total	375				

[ab]Means in the same column without common letter are different at $p < 0.01$.
Et^+ = presence of extra teat; Et^e = absence of extra teat.

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