



*Full Length Research Paper*

# Genetic and phenotypic profiles of WAD and Yankasa indigenous sheep in Nigeria

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One thousand two hundred and seventeen (1217) traditionally managed sheep comprising 491 West African dwarf (WAD) (154 males and 337 females) and 97 Yankasa (29 males and 68 females) sampled over the Southwest Nigeria were used to assess allelic frequencies of qualitative trait loci based on defined genetic determinations in sheep. Traits investigated include wattles, ear size and attitude, eumelanin, coat spot, supernumerary nipples, head profile and horns. Results showed that WAD and Yankasa sheep were similar respectively with regards to erect ear attitude (0, 0%), small ear size (0, 0%), horn (78.5, 84.7%), coat pigment (93.67, 93.45%) and supernumerary nipples (0.00, 0.00%), absence of coat spot (0.00, 0.00%). Head profile was monomorphic (100%) but different in both breeds: straight in WAD and convex in Yankasa. WAD was standard for wattle,  $Wa^{*+}$ , ear attitude  $EC^{*+}$ , ear size  $EL^{*R}$  and head profile,  $Te^{*cx}$  (frequency=99.02). WAD exhibited higher degree of polymorphism than Yankasa especially for eumelanin type, and pigmentary pattern. However, the locus controlling head profile and ear attitude were monotypic; the frequency for a single class was higher than 75%.

**Key words:** Polymorphism, allelic frequency, genetic determination, WAD and Yankasa sheep.

## INTRODUCTION

Qualitative characters have been used for classification and identification of animal populations. Many improved breeds are monotypic for most visible traits and have therefore made quantitative assessment easy to monitor over time. Variation in ordinal traits such as coat color, ear size, ear attitude, eumelanin type, white design facial profile and nominal attributes such as presence and absence of wattles, horn and supernumerary nipples could be of tremendous assistance in generating racial interspecific variations among animal populations within the species. Standard procedures for the genetic assessment have been published by the Committee on Genetic Nomenclature of Sheep and Goat (COGNOSAG) for various breeds. These are regularly being updated as those for other breeds are being identified through complex mating systems and extensive field sampling and contributed to the visible trait bank via COGNOSAG. The West African dwarf (WAD) and Yankasa are important sheep in Nigeria. The WAD is most predominantly found in the Southwest and the Yankasa is the most widely distributed being found all over the

country (Adu and Ngere, 1979). Adu and Ngere (1979) described visible traits such as coat color and wattle status characteristic of the varieties. In this investigation, the genetic determinations of the visible traits of the two varieties are presented. Association of visible traits with important economic traits is perhaps the most important use to which this type of information can be put. The objective of this study is to determine and document genetic and phenotypic profiles of WAD and Yankasa indigenous sheep in Nigeria by generating the phenotypic and allelic frequencies of visible traits whose modes of inheritance are known. All visible traits that define a particular breed are considered in building the phenotypic profile while the genetic profile is obtained through the allelic frequencies of the characters.

## MATERIALS AND METHODS

One thousand two hundred and seventeen (1217) sheep comprising WAD (Figure 1) and Yankasa (Figure 2) were scored for the visible traits. The study and sampling area is the South west



**Figure 1.** The West African Dwarf rams (the roaming flock in Ibadan, Nigeria).



**Figure 2.** Yankasa rams (the flock in the University of Ibadan, Nigeria).

Nigeria as shown in Figure 3. A wide range of characters were used to produce the profile while each character was in turn split into corresponding specific external attributes. Genetic determination of the following traits was used.

#### Genetic determination of coded visible traits

##### Head profile

In line with Serra (1948), the existence of a 'Te' locus with two co-dominant alleles was adopted. The convex type (Te\*N) dominating

over upright and concave types (Te\*+).

##### Ear size

Two alleles, EL\*R and EL\*+ were established by Lauvergne (1988) and COGNOSAG (1988). These alleles are related by dominance with EL\*R (reduced ear length) dominating over EL\*+ (standard, normal, wild type long ear). The ear is vestigial in the homozygote but reduced in the heterozygote.

##### Ear attitude

COGNOSAG (1988) recognized only two alleles at this locus: EC\*P and EC\*+, controlling 'pendulous' and 'wild horizontal' type, respectively.

##### Horn

COGNOSAG (1987) method was employed. Three alleles controlling horn growth have been reported: Ho\*P (Polled), Ho\*+ (horned), and Ho\*hl (hornless). Ho\*P is completely dominant over the horned and hornless in rams, and but not completely dominant in ewes considering that the character is sex-influenced. Ho\*hl/Ho\*hl produces bone knobs or scurs in ewes and in males castrated at birth. In rams, it produces large horns that are not distinguishable from Ho\*+/Ho\*+ rams. Ho\*+/Ho\*+ produces horns in both sexes, large horn in rams and small in ewes and males castrated at birth. Ho\*P/Ho\*P rams and ewes have depressions in their frontal bone at the horn site. Rams may have very small bone knobs on this site.

##### Wattle

The method of COGNOSAG (1988) was adopted. A single locus with Wa\*+ (standard, wild) and WA\*w (wattled) were recognized to be related by dominance.

##### Agouti (coat pigmentary pattern)

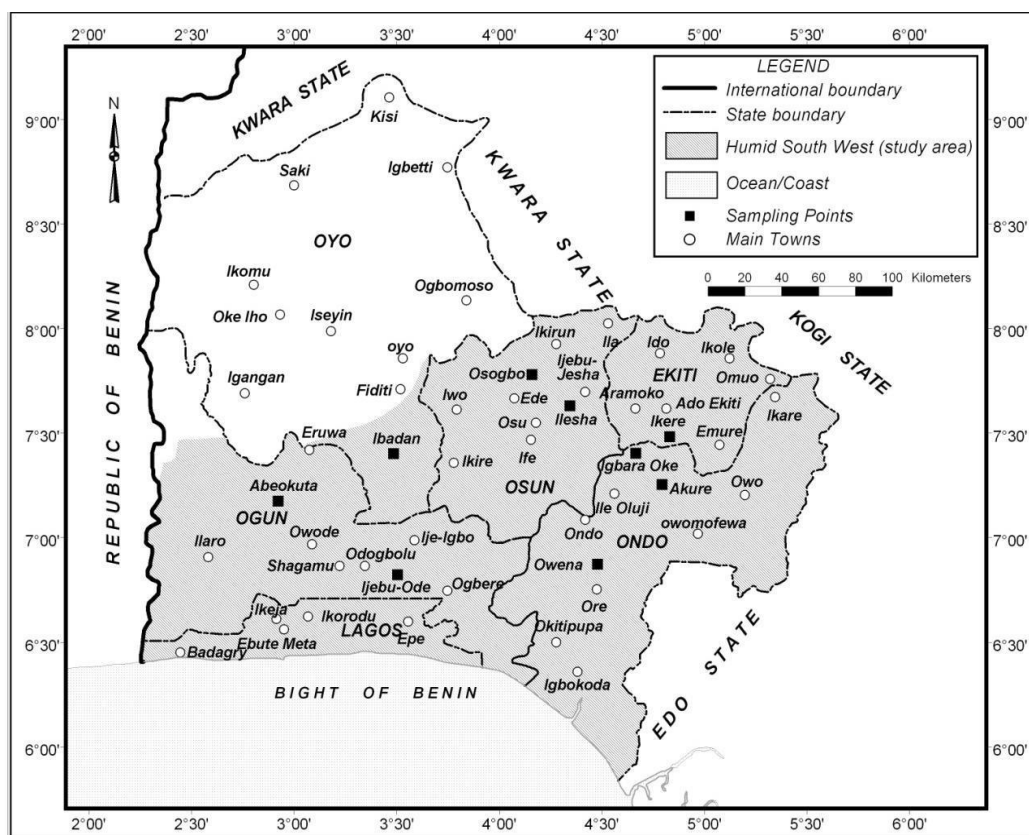
The frequency of the individual animals carrying different coat color patterns was determined using the six allele system reported and documented by COGNOSAG at this 'A' locus. It is the most polymorphic of all loci examined: A\*e (eumelanic), A\*s (grey), A\*t (bronze eumelanic), A\*b (badger face), A\*+ (wild) and A\*wh (phaeomelanic). Two extension loci have also been reported E and L, having E\*+ and E\*d (dominant) and L\*+ and L\*ak which is responsible for almost total depigmentation. A\*e produced two expressions: E\*+ expressing as black (wild) and E\*N expressing as brown color of differing shades. Alleles at agouti locus determine the arrangement of eumelanic and phaeomelanic areas over the body. This distribution over the body is designated 'white design' in line with the method of Snejena et al. (1986).

##### Supernumerary nipples

This trait has been recognized to be under the control of one locus with two alleles, 'P' (with supernumerary nipples) and 'p' (without supernumerary nipples) as also observed and contributed by Rodero et al. (1996) working with Andalusia caprine breeds.

##### Gene frequency

Frequency of Phenotypic traits for each genotype was calculated by direct counting. When heredity of a trait is by co dominance, direct



**Figure 3.** Map of Southwest Nigeria showing the study area.

counting was used but when it is by dominance, the frequencies were calculated by supposing that the populations were at Hardy-Weinberg's equilibrium genetically according to the method of Rodero et al. (1996). The fixing of the genotypes of coats in the breeds were facilitated by the work of Lauvergne (1975, 1976, 1978), Lauvergne and Adalsteisson (1976), Sponenberg (1990), Lauvergne and Hoogschansen (1978) and Nicholas (1987).

### Statistical analysis

The genetic profile of the sampled populations was obtained through qualitative characters whose genetic determinations were defined. If their heredity were by co-dominance, direct count was used to determine their gene frequency. When heredity was strictly by dominance, gene frequency was calculated by supposing that the population was genetically at Hardy-Weinberg's equilibrium. The analytical method of Serra (1948), Lauvergne (1986, 1996) and COGNOSAG (1988, 1993) were also used.

## RESULTS

Analysis of visible traits showed the varieties are monotypic for head profile, ear size, ear attitude and coat pigment. Respective frequencies were 98.03 for upright and 75.00% for subconvex in WAD and Yankasa. Ear size was observed to be medium for WAD and large for Yankasa sheep. WAD sheep had 100% ear attitude as

horizontal and 93% drooping in the Yankasa. The presence of wattle and horns as well as eumelanin type and coat spot were heterogenous: very few individuals of the WAD population had wattles (4.59) but it was absent in a small proportion of the Yankasa (82.14%). Three categories of the horn were observed: present, absent and knobs. Knobs are small protrusions from the head at the horn site and are usually not considered as true horns. Presence of horns was quite considerable in both breeds while the absence (2.8 and 3.4) and presence of knobs (18.8 and 11.8%) for the WAD and Yankasa are obviously low. Eumelanin presence showed a reciprocal mirror in the breeds with heavy presence and absence in WAD and Yankasa respectively as shown in Table 2. Table 3 is the summary of the generic profile of the investigated populations. It shows that the gene controlling head profile was standard for almost all WAD individuals and normal for the Yankasa. On the other hand, the EL\*R allele and EL\*+ allele were nil and 100% respectively for both varieties. Ear size and attitude, each of which is controlled by two co-dominant alleles shows 100% for the standard allele while attitude showed standard (EC\*) for WAD and majority 0.968 for pendulous in Yankasa. For the WAD the wattle locus both alleles were present on both breeds though appears that the allele that produces wattle is relatively more abundant in the Yankasa than in WAD: 0.821 and 0.045,



**Table 1.** Quantitative characters and common phenotypes in sheep.

Variable	Phenotype					
Code (locus)	0	1	2	3	4	5
Head profile	Upright	Convex	Sub-convex	Concave		
Ear size (EL)	Vestigeal	Shortened	Normal			
Ear attitude	Erect	Normal	drooping			
Wattle (Wa)	Present	Absent				
Horn (Ho)	present	Absent	Scur/knob			
Agouti (A)	Eumelanic	Grey	Bronze Eum.	Badger face	Wild	Phaeomelanic
Eumelanin (E)	Present		Absent			
Eum. Type	Brown	Black	Brown/black			
Coat spot	Present		Absent			
Super Nipple	Present		Absent			
White design						

Codes were assigned to phenotypes according to the above rules. Source: Rodero et al. (1996) and Snejena et al. (1986).

respectively. The alleles that produce horn (Ho\*+) is absent in the ewes of both sheep but are present in their rams as shown in the Table 1.

## DISCUSSION

The WAD and Yankasa sheep of Nigeria are very important not only because they are a source of quick revenue but also because their qualitative traits appear to possess selective properties which could serve as a reliable indicator when economic concerns mounts pressure on the variety for genetic improvement. A close look at the genetic and phenotypic profile including ordinal and nominal traits of the two sheep suggests that cephalic traits such as head profile, ear size and attitude and wattles fell off in opposite directions for the two sheep. For example, the head profile of the WAD and Yankasa are respectively upright and sub-convex. This may indicate complementary expressions of some metric traits that are correlated with them. However, the occurrence of horn in both sexes appears to be congruent though in size, sexual dimorphism was evident.

The phenotypic frequency of 0.95 and 0.18 reported for the absence of wattles in WAD and Yankasa respectively is similar to those reported in Grazalema Merino and Lebrijan Churro sheep of Andalusia (Rodero et al., 1996). The study of the primitive sheep showed that wattle evolved in the process of domestication when the wild allele 'Wa\*+' was gradually replaced with Wa\*w. Lydekker (1912) showed that the presence of the appendage is higher in primitive sheep implying from this investigation that Yankasa is more archaic than the WAD. Vasin (1939) show the possibility of its relationship with viability as Singh et al. (1970) attempted to relate it with

viability in Malpura ewes reporting that wattled individuals have low fertility. This may be the reason why Dettmers et al. (1983) reported that WAD sheep is more prolific than the Yankasa. Elimination of wattle gene could therefore have a desirable effect in sheep production. Thus there seems to then be an automatic elimination of the "W" gene due to reduced/impaired fertility and prolificacy with low viability in the homozygotes. However, Rae (1956) regarded the occurrence of the appendage as undesirable and abnormal and surprisingly, COGNOSAG (1993) expressed that no physiological function has been associated with it. Thus, if further research is focused on the incidence of the structure using larger samples and more populations, its significance might be finally established beyond preliminary conjectures and unfounded speculations. The literatures cited shows that this aspect of qualitative profiling and characterization have long time been neglected but more attention should be given to them because of their usefulness for instituting population boundaries.

The convex face profile in Yankasa and sub-convex in the WAD could be associated with archaism. The straight face profile characterized the wild sheep while the sub-convex resulted from the process of domestication. This argument is at variance with the previous speculation that Yankasa is closer to the ancient sheep than the WAD. We however can reconcile them by proposing that the different body shapes and evolution of appendages in the process of domestication were a response to the different management and natural and artificial selection pressures. Convex profile has been reported in some exotic sheep such as Timber valley of Italy and Cheviot. Other African sheep that have convex face profile are Sudan desert, Touabire, Peul peul, Mossi and the Black-head Persian breeds and all these have thin tails except

**Table 2.** Phenotypic profile of WAD and Yankasa sheep.

Character			WAD		Yankasa	
Genotype	Phenotype	Code	Freq.	%	Freq.	%
Head profile	Upright	0	449	98.03	0	0.00
	Convex	1	0	0.00	42	25.00
	Sub-convex	2	9	1.96	126	75.00
	Concave	3	0	0.00	0	0.00
Ear size	Small (vesti.)	0	0	0.00	0	0.00
	Medium (reduced)	1	456	100	0	0.00
	Large (norm)	2	0	0.00	168	100.00
Ear attitude	Erect	0	0	0.00	0	0.00
	Horizontal	1	458	100	11	6.55
	Drooping	2	0	0.00	157	93.45
Wattle	Present	0	21	4.59	138	82.14
	Absent	1	437	95.41	30	17.86
Horn (M)	Present	0	113	78.5	50	84.7
	Absent	1	4	2.8	2	3.4
	Scour/knob	2	27	18.8	7	11.8
Horn (F) present	Absent	1	246	84.2	94	90.3
	Scour/knob	2	41	14.0	10	9.6
Coat pigment	Eumelanic	0	429	93.67	157	93.45
	Grey	1	1	0.00	0	0.00
	Bronze(eum)	2	0	0.00	0	0.00
	Badger face	3	0	0.00	0	0.00
	Wild	4	0	0.00	0.00	0.00
	Phaeomelanic	5	29	6.33	11	6.54
Eumel. Type	Brown	0	45	9.82	0	0.00
	Black	1	397	86.68	156	100.00
	Brown/black	2	16	3.49	0	0.00
Coat Spot	Present	0	22	4.80	2	1.19
	Absent	1	436	95.19	166	98.80
Supper nipple present	Present	0	0	0.00	0	0.00
	Absent	1	456	100.00	168	0.00
Eumelanin	Present	0	429	93.67	11	6.54
	Absent	1	29	6.33	157	93.45

the black-head Persian sheep which have fat rump. The head profile of Macina and Red massai are slightly convex in the male but female Macina is upright as the WAD sheep under investigation. Rodero et al. (1996) reported both sub-convex and straight head profile in Grazalema merino and lebrijan Churro breeds of

Andalusia. While WAD is either heterozygous or homozygous recessive for the upright or concave allele, Yankasa is also either homozygous for the dominant allele or heterozygous. Since the primitive sheep has a straight face profile while the convex is considered a variant which only evolved in the process of domestication

**Table 3.** Genic profile of WAD and Yankasa sheep.

Locus		Allele		WAD		Yankasa	
Name	Symbol	Name	Symbol	n	q <sub>1</sub>	n	q <sub>2</sub>
Head profile	Te	Normal	Te*cx	9	0.0098	148	1.000
		Standard	Te*+	449	0.9902	0	0.000
Ear size	EL	Reduced	EL*R	0	0.000	0	0.000
		Standard	EL*+	458	1.000	168	1.000
Ear attitude	EC	Pendulous	EC*P	0	0.000	168	0.968
		Standards	EC*+	458	1.000	11	0.032
Wattle	Wa	Wattle	Wa*w	21	0.045	138	0.821
		Standard	Wa*+	437	0.954	30	0.178
Horn (M)	Ho	Polled	Ho*P	31	0.215	9	0.152
		Horned	Ho+	113	0.784	50	0.847
		Hornless	Ho*hl	113	0.784	50	0.847
Horn (F)	Ho	Polled	Ho*P	246	0.842	94	0.903
		Hornless	Ho*hl	46	0.157	10	0.096

N, Number of individuals; q<sub>1</sub>, gene frequency of WAD; q<sub>2</sub>, gene frequency of Yankasa; M, male; F, female.

through mutation, the WAD may be regarded as more archaic than the Yankasa.

Based on the distinction between normal shortened and earless condition described by Rae (1956) the WAD and Yankasa sheep have shortened ear, however, the ear biometry presented by Lauvergne et al. (1988) seems to describe both sheep as having normal ears. The wild ancestor had small erect ears of 10 to 11cm using the scale of length and attitude described by Zeuner (1963). Devendra et al. (1982) reported that the ear of the rain forest sheep is short like those of the WAD and that of indigenous sheep of Sri-lanka, whereas the ear of Yankasa is moderately long. The ears of WAD and Yankasa sheep resemble those of Karakul sheep of Germany and Spain, USA and USSR, Corinthian of Austria, Toposa of Sudan and Rambouillet of Austria as reported by Patrios et al. (1963); Lush (1930); Wasson (1928), Bishop (1951) and Adametz (1917). In Africa, both sheep also resemble the, Kufra sheep of Libya, Ronderib of South Africa and Somali sheep of Somalia (Epstein, 1971). Hardy and Simmons have associated ear size with grade of skin and this can be useful in selecting for skin quality among sheep populations because of their usefulness in the leather industry. Since actual breeding experiments agree that ear size is determined by single gene pair where the reduced ear length (EL\*R) is semi-dominant over the normal (EL\*+), the heterozygote produced reduced ears while it is normal/vestigial in the homozygote. Report on this investigation suggests that since the primitive / ancestral Mouflon is reported to possess normal ears

(COGNOSAG, 1987), the locus controlling the trait might have been intact (free from mutation) since domestication or migration. Other genetic factors may be responsible for the wide range between the frequencies of both sheep for this trait.

The frequency of knobs is similar but the males had more than the females in both WAD and Yankasa. From personal communications and interviews conducted during this study the frequency of hornedness in ewes might have been more than the 1.7% reported if they were monitored to adulthood. Generally horns in females were slender as is in the Vogan sheep of Togo where all the males have horns and only 5% of the ewes possess the structure but are different from Massai of Tanzania. Scours/knobs were frequently encountered though their occurrence was lower than that of horns. The Yankasa was monotypic for the eumelanin pigmentation since the frequency of the brown was zero against 100% black. This was true for the distribution of the eumelanin (black) found on the variety. Evidence from this investigation showed that the eumelanin patches on the ear, the hock, tail, eyes and the muzzle, which is characterizes the Yankasa is never brown but black type whereas for the WAD population, both eumelanin types were found. No association has been reported between the eumelanin types and any productivity trait except for the differentials usually observed in the manner in which the two colors take up dye in leather industry. A white design was evident in both sheep. Although, the profile is classificatory in the Yankasa, the variation is not predictable in the WAD sheep.

## Conclusion

Both sheep retain their primitive traits especially with regards to ear size and horns but the Yankasa is more archaic than WAD with regards to wattles, WAD is more archaic with regards to straight head profile where Yankasa showed a mutant variant. It will be of interest to know the pattern of distribution of the studied qualitative traits in other indigenous sheep in Nigeria namely Balami and Uda sheep. This could be a subject for further investigation.

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