Trop. J. Anim. Sci. 5 (1): 205- 214 (2002)
ISSN: 1119 - 4308

# VARIABILITY OF THE EXTERNAL EAR OF THE WEST AFRICAN DWARF SHEEP OF NIGERIA

***SALAKO A. E. AND NGERE L.O.**

Animal Breeding and Genetics Unit, Department of Animal Science, University of Ibadan, Ibadan, Nigeria *E-mail: aesalak@yahoo.com

**Target Audience**: Livestock researchers,animal breeders.

## ABSTRACT

**491 individuals comprising rams and ewes belonging to the West African Dwarf sheep population sampled within the South-West Nigeria were investigated. These were stratified into six age groups determined by dentition. Five variables of the external ear including two zoometrical characters (ear length and ear width) and three visible traits (ear size, ear length and ear width) were investigated as appropriate for phenotypic and genetic variability. The ear was also classified.**

**The ear of the breed was between 8.82cm and 10.17cm in length the width was between 5.19 and 6.10cm. Phenotypic variability indicated by associated coefficient of variation was small for both measurements. There was no significant difference (P>0.05) between sexes within all age groups. Based on the linear function, regression of ear length and width on age were not significant (P>0.05), as was that of ear length on width (P>0.05). The discontinuous variation tested on three phenotypes: 'normal' 'shortened' and 'vestigeal' showed that the ear may be classified 'normal' overlapping the 'shortened' variation in size. In attitude, it is horizontal rather than erect or drooping. It is also pendant in consistency. The phenotypic profile indicated great uniformity for each visible trait in the breed. Allelic profile suggested that the breed is homozygous for the 'standard' allele in size and attitude with allelic constitution of EL*+ and EC*+ respectively. These suggested the absence of mutants EL* R and EC* P respectively at the locus controlling the traits, thus, both loci are monomorphic in the sheep. Using the scale of length and attitude, based on the idea that the oldest were closest to the wild ancestor, the breed is considered archaic.**

**Because of the small variability observed in the length (size) of the appendage, cross breeding with longer eared sheep (indigenous or exotic) rather than selection within the indigenous population is suggested to be the best option for improving the structure. The presence of mutants which increase the length of the ear is desirable in sheep productivity because of the positive association which has been established between the ear length and skin texture. Very few published works in sheep genetics deal with qualitative and quantitative examination of the ear. Further investigation is needed to exploit the genetic significance of the structure as regards increased productivity in the species**

**Key words:** Sheep, normal ear, variability, productivity.

## DESCRIPTION OF PROBLEM

Shape, size and carriage of the ear are determined genetically and are expressed in the conformation of the outer ear, namely its cartilage. The external ear comprises the auricle-a tunnel-like structure and the external meatus. The auricle is attached by its base round the external acoustic process in such a manner as to be freely movable on a cushion of fat. The framework of cartilages consists of the conchal or auricular cartilage that determines the shape of the ear, and the annular cartilage which forms the base (11).

Approximately 40 articles have been devoted to the biometry and hereditary determinism of ear characteristics of domestic sheep starting with (1, 8). These have used both Mendelian and population genetics methods to study the heredity of the appendage. The normal length of ear may vary between 7 and 21 cm with means between 9 and 17cm according to the breed. The mean width varied between 4.6 and 8.3cm (8). The literature covering more than 80years and some 20breeds and populations throughout 15 countries by 40 researchers of 35 different nationalities is lacking in certain basic information such as ear width (and its variation in proportion to length), which has been rarely measured biometrically (8). The size of the appendage may vary with the stage of body growth and this relationship has not been studied. Simple histograms of length are rare as the biometric comparison of the simple characters of length between populations. These studies are of great interest in sheep genetics. (7) studied correlations between ear skin, texture and fur quality on the one hand and birth and weight with curl size on the other. Several significant correlations were found, the main one being ear length: the skin. The skin of animals with the longest ears generally graded better than that of the others. Further, these studies can reveal the existence of variation that can be used to follow migration of ancient sheep populations by plotting visible genetic profiles. These can be used for comparisons among traditional populations (9). While other authors employed mainly genes of coat colors (10), others like (3) have shown that variation of the ears can also be used.

In this study, variation of length and width of the ear with the stage of body growth in proportion to length of the appendage and data on the biometry considering both continuous and discontinuous variations are investigated by population genetics method. Visible genetic and phenotypic profiles of the structure are also plotted for the breeds under investigation. This information is of value in providing genetic basis for targeting future development initiatives in sheep improvement.

## MATERIALS AND METHODS

### *Study Area*

The humid southwest Nigeria located between 7°20°N and 3°50°E was the

study location. The climate is humid, tropical, with an average annual rainfall of 1300mm bimodally distributed, and average relative humidity of about 80%.

***Animals and Management***

The predominant domestic livestock are sheep and goats, mainly the indigenous trypanotolerant Djallonke type. Over all, 90% of household in the area own small ruminants with herds of 3 to 5 animals, goats outnumbering sheep by about 3:1. Farmers preferred goats to sheep because to them, they are less troublesome than sheep to manage since they wander unless watched.

***The West African Dwarf sheep***

The breed is widely distributed in the area south of latitude 14°N within Nigeria. Also called southern forest sheep or Nigerian dwarf sheep suggesting its predominant occurrence in the study area. It is a small compact, hardy breed with a wide range of coat colors that may be all black, white or brown or spotted black or brown on a white coat. It has a smart appearance and a timid disposition thriving and breeding successfully in its area of occurrence, which is known to be heavily tsetse fly infested.

***Management***

The traditional free roaming management system, which allows year round breeding with minimal purchased inpute is most common. In the rural areas, most animals remain free but confinements are practiced at night in areas where theft is a problem. Traditional flocks are kept by small holders who keep them with crops. Here, crop production is of primary importance. These sheep browse roadside shrubs and leaves and when available subsist on kitchen wastes such as cassava, yam, potato and banana peels and or roots. Characteristically, mortality is fairly high since no particular health care is provided. Preventive treatment against the more common small ruminant disease such as Peste de Petit Ruminant (PPR) was not even administered in most cases. Selection is non-directional and records are virtually non existent.

***Sampling***

Gird cell system was employed for random selection of sampling areas within the study area. Animals/ flocks were then randomly selected. Over the period of 24 months the ears of 491 animals were measured biometrically and scored qualitatively. The breed was identified in selected animals by the use of primary breed marks earlier reported by (2). Selected animals were stratified by sex and age groups (determined by dentition) according to the method of (16).

***Data Collection***

***Ear Measurement (Continuous variables)***

Two biometric measurements were taken on the ear of each subject namely ear length and ear width. They were accomplished according to the method described earlier by Salako et al. (1999).

***Discontinuous Variables***

Ear size, Orientation (attitude) and consistency were scored using the method of (14). This recognized three distinct classes for each of the discrete variable. They are as follows:

Ear length (size): small, Average, large.

Ear Orientation (attitude): erect, horizontal, drooping.

Ear consistency: rigid, peduncular, dropping.

***Methodology for the determination of genetic profile***

***Ear Length***

(4) and (14) upheld the two allele hypothesis for the locus controlling this character namely, EL*R (reduced) and EL*+ (standard or wild type) related by autosomal semi-dominance or intermediate hereditary.

***Ear attitude***

Of the three classes of ear attitude adopted by (14), only one was encountered namely horizontal ear.

***Consistency***

(4) view that sheep ear could only be pendulous (EC*P) or standard/wild (E*+) with both alleles related by dominance (EC*P dominant over EC*+) was adopted.

***Statistical Analyses***

Means (x), standard deviation (s.d.) standard error(s.e)and coefficient of variation(c.v.) associated with each investigated metric character were accomplished using the means procedure of the statistical Analytical system (15). The PROCREG program of the same package was used to examine the relations among ear length, width and age of the animals.

For the discontinuous variables, phenotypic profile was calculated by direct count of the coded scores. On the other hand, genetic profile was obtained through the allelic frequencies of the variables. These were made possible because their genetic determinations were already defined. If this happened to correspond with heredity by co-dominance, the allelic frequencies were calculated by direct count. When heredity was by dominance, the frequencies were calculated supposing the population under investigation to be genetically at hardy-Weinberg's equilibrium.

## RESULTS AND DISCUSSION

Means, standard deviation, standard error and coefficient of variation associated with each biometric variable in each population are presented in Table 1. Mean ear length was observed to range from $8.82 \pm 1.17$cm in milk teeth individuals to 10.17 in the 6-teeth age group. Ear length of male were not consistently superior over those of females and when age groups were considered, no trend

**Table 1: Means (X) standard deviation (S.D.) standard error (S.E.) and coefficient of variation (C.V.) of ear length (EL) and ear width (EW) of WAD sheep.**

| | | WAD | | | | | |
|---|---|---|---|---|---|---|---|
| AGE | | MALE | | FEMALE | | TOTAL | |
| GROUP | | EL | EW | EL | EW | EL | EW |
| | N | 57 | 57 | 111 | 111 | 168 | 168 |
| Milk teeth | X | 8.83 | 5.52 | 8.82 | 5.02 | 8.82 | 5.2 |
| | S.D. | 0.80 | 0.94 | 1.33 | 0.65 | 1.17 | 0.79 |
| | S.E. | 0.10 | 0.12 | 0.12 | 0.06 | 0.09 | 0.06 |
| | C.V. | 9.10 | 17.2 | 5.10 | 12.9 | 13.33 | 15.4 |
| 2-Teeth | N | 36 | 36 | 61 | 61 | 97 | 97 |
| | X | 8.77 | 5.21 | 9.28 | 5.51 | 9.09 | 5.40 |
| | S.D. | 0.67 | 0.46 | 1.04 | 0.59 | 0.95 | 0.56 |
| | S.E. | 0.11 | 0.07 | 0.13 | 0.07 | 0.09 | 0.05 |
| | C.V. | 7.64 | 8.99 | 11.28 | 10.78 | 10.49 | 10.51 |
| 4-Teeth | N | 16 | 16 | 38 | 38 | 54 | 54 |
| | X | 9.1 | 5.36 | 8.8 | 5.23 | 8.89 | 5.27 |
| | S.D. | 0.52 | 0.38 | 0.16 | 0.84 | 0.60 | 0.74 |
| | S.E. | 0.13 | 0.09 | 0.10 | 0.13 | 0.8 | 0.10 |
| | C.V. | 5.73 | 7.09 | 7.01 | 16.22 | 6.78 | 14.03 |
| 6-Teeth | N | 18 | 18 | 32 | 32 | 50 | 50 |
| | X | 10.96 | 5.61 | 9.72 | 5.90 | 10.17 | 5.79 |
| | S.D. | 1.14 | 0.64 | 0.74 | 0.55 | 1.08 | 0.59 |
| | S.E. | 0.27 | 0.15 | 0.13 | 0.09 | 0.15 | 0.08 |
| | C.V. | 10.46 | 11.47 | 7.66 | 9.94 | 10.63 | 10.33 |
| 8-teeth | N | 10 | 10 | 34 | 34 | 44 | 44 |
| | X | 12.07 | 5.66 | 9.50 | 5.80 | 10.08 | 5.76 |
| | S.D. | 0.67 | 0.45 | 1.00 | 0.66 | 1.43 | 0.62 |
| | S.E. | 0.21 | 0.14 | 0.17 | 0.11 | 0.21 | 0.09 |
| | C.V. | 5.57 | 7.95 | 10.54 | 11.49 | 14.19 | 10.78 |
| Wom teeth | N | 17 | 17 | 61 | 61 | 78 | 78 |
| | X | 9.45 | 6.05 | 10.24 | 6.11 | 10.07 | 6.10 |
| | S.D. | 1.21 | 0.61 | 0.89 | 0.56 | 1.01 | 0.57 |
| | S.E. | 0.29 | 0.14 | 0.11 | 0.07 | 0.11 | 0.06 |
| | C.V. | 12.84 | 10.16 | 8.68 | 9.24 | 10.08 | 9.39 |

in particular was observed in the total for the breed, however, increase in ear length with age appeared to exist in the male but not among female animals. Standard errors and coefficient of variation associated with the measurement were generally small. Ear width measurements were slightly lower than the lengths with the range form 5.19±0.06cm for the milk teeth group to 6.10±0.06cm in the wom-teeth age bracket. Again, no particular increase in the measurement with age was observed when the total for the sexes was considered but the measurement appeared to increase with age in females. Standard errors and coefficient of variation were also small for the measurement (table 1). Sample sizes were not equal for all age groups.

### *Regressions*

As shown in table 2, regression of ear length and width on age were not significant ($P>0.05$) as that of ear width on ear length ($P>0.05$) this is further established by their associated coefficients of determination.

**Table 2. Estimates of Parameters of linear function with S.E. and $R^2$ in Ear length ear width and age relationship.**

| Y variable | X variable | Y = a + b x | S.E. | $R^2$ | SIGN. |
|---|---|---|---|---|---|
| | | Estimates of parameters of function | | | |
| Ear length | Age | Y = 8.33+0.30X | 0.05 | 0.27 | NS |
| Ear width | Age | Y = 5.26+0.10X | 0.03 | 0.45 | NS |
| Ear length | Ear width | Y = 8.23 + 0.54X | 0.01 | 0.74 | ** |

NS – not significant.

** Highly significant.

***Phenotypic Profile***

**Table 3. Presents the phenotypic profile of the ear of WAD sheep**

| Characters | (Classes) Phenotype | Code | Frequency | % |
|---|---|---|---|---|
| Ear size | Vestigeal | 0 | 0 | 0 |
| | Short | 1 | 0 | 0 |
| | Normal | 2 | 456 | 100 |
| Ear Attitude | Erect | 0 | 0 | 0 |
| | Horizontal | 1 | 458 | 100 |
| | Drooping | 2 | 0 | 0 |
| Ear Consistency | Rigid | 0 | 0 | 0 |
| | Pendant | 1 | 458 | 100 |
| | Drooping | 2 | 0 | 0 |

The breed appears monomorphic for all the phenotypic variables examined since it has 100% in a single class.

***Genetic Profile***

**Table 4: Genetic Profile of Ear Character of the WAD SHEEP**

| **Locus** | | **allele** | | | |
|---|---|---|---|---|---|
| Name. | Symbol | Name | Symbol | N | q |
| Ear size | EL | Reduced | EL*R | 0 | 0 |
| | | Standard | EL*+ | 458 | 1.000 |
| Ear Attitude | EC | Pendulous | EC*P | 0 | 0 |
| | | Standard | EC*+ | 458 | 1.00 |

Gene frequencies of each character were 1.000 in a single class indicating homogeneity.

q= gene frequency

N= No of animal samples

The mean ear length of 8.82±0.09cm reported in this study for the WAD sheep at milk-teeth age is similar to the 8.05±0.15cm obtained by (17) while

the 10.17±0.15cm reported here is slightly higher than 9.10±0.29cm reported by the same author for 6-teeth group of the same breed. (6) figure, 10cm for the adult Djallonke sheep agree with this report as also the 10cm average reported by (8) for the wild ancestor which ear they described as moderately long. This suggests that the WAD sheep of Nigeria resemble the ancient sheep in this regard. Again, the range of values reported for ear length here (8.82-10.17cm) showed that the sheep is similar to some modern breeds such as the karakul of Spain, 7-11cm, mean 8.89cm (12), Rambouillet of Austria, 9-10cm, (1) and traditional breeds such as the North short tail of USSR, 9-10cm (18), Splaesau of Norway, 8.5-10.5cm, (19) and the Karakachan of Bulgaria 7.75-13.0cm, mean 10.4cm (5).

All the above sizes were described by the corresponding authors as 'normal' ear, only (6) referred to the same size (10cm) as short while describing the Djallonke sheep and African breeds in general. While the later considered the classification as either short or long, the former considered three classes, small, average and long, which correspond to 'vestigeal' (Earless), 'short' and 'normal' respectively when description is extended to include European breeds.

Perhaps the criteria of classification vary with authors and breeds being described in different regions. (13) described three phenotypes in sheep. The two-allele hypothesis, that only two alleles are present at the locus controlling the size and these are related by intermediate heredity or autosomal semi-dominance where the heterozygote is considered to have 'reduced' ear due to the mutant and the hmozygote ear is classified as 'vestigeal' for the mutant allele. These agree with (1) who analyzed data on crosses of $20F_1$, karakul (External ear length 14.25cm) X Rambouillet Merino (ear length 9cm). The mean ear length for the crosses was 12.4cm. The average length of $10F_2$ was 13.2cm while the ear sizes of back crosses of karakul were 'rather long'. He concluded that there was a 'polymeric' or quantitative inheritance. Results of this mendelian method was also conformed by (18) who using the population approach measured 460 Karakul ewe as done in this study. He showed that there is a high intra and inter breed polynomial variability.

Of the three phenotypes, only one was encountered in this study showing that there is a sharp distinction/division between the earless and the short eared condition, the short eared class frequently overlapping the 'normal' in length but can easily be distinguished by the fact that the ear is pointed rather than broad and flat as in the large-as outlined by (13). The classification of the WAD sheep's ear under investigation may be confusing when using the scale of length and shape. This is because a particular ear may be short in length but large when shape is considered and vice versa. All these criteria need to be harmonized into a single scale for uniformity and ease of description across the global regions

whether the breed is considered 'standard' or traditional.

It is shown from this investigation that the ear of WAD sheep is 'normal' when the review of (8) is upheld that the 'normal' ear length varies between 9 and 17cm according to breed. The ear cannot be considered 'shortened' because shortened ear individuals are regarded as heterozygotes (4) and if this is so, segregation at the locus should have given rise to different proportions of both homozygotes in the population over the years. But in contrast, observations show a fair homogeneity and since the ear is pointed rather than broad it cannot be classified as large. It is therefore vestigeal because of its size. It is clear that (6) description of the Djallonke ear as short considered only the criteria of two phenotypes, short and long which were restricted to their description of African and west African sheep and not extended to include European populations. In order to adopt the three-phenotype hypothesis upheld by (4) in the two-allele hypothesis, which is more generally acceptable, we classify the ear of WAD sheep as 'normal'. Even the wild species described by (3) as small and erect measuring up to 10-11cm disagree with that of (8) that the same wild species measuring 10cm is moderately long.

Using a scale of length and attitude to determine the disagree archaism based on the idea that the oldest were closest to the wild species which has moderately long (10-11cm) erect ears, the ear of WAD being studied in considerably close to that of the mouflon in length but not in attitude. The observed departure of the attitude from the 'erect' to 'pendant' may be attributed to age and adaptation due to migration from the center of domestication in the Middle East. This is further established by the example of evolution of fat tails from thin as energy store in response to desert environmental need for long treks although it is not clear what environmental need the ear may be modified to meet.

The several significant correlations found in sheep between ear length and skin texture by (7) suggesting that the skin of the animals with the longest ears generally graded better than others probably explains the low skin quality and consequent low utilization and productivity of the skin of WAD Sheep of Nigeria. This probably also may well be the reason why the skin of northern Nigerian sheep with relatively long ears (Balami, Uda and Yankasa) are useful in tanning and leather industries. No wonder these industries are also located in the northern part where the varieties are most commonly found. The presence of mutants that is responsible for increase in the length of ears is therefore also desirable for increased sheep productivity. In order to improve the ear length of the WAD sheep, it is suggested that response to selection will be poor since the coefficient of variation for the trait is small. A better alternative that will also take advantage of operations at genetic level will be cross breeding since the inheritance in simply Mendelian.

Crossing of the WAD sheep under investigation and those of the Northern Nigeria for the purpose of increasing the productivity of WAD sheepskin will be a good attempt. Otherwise, crossing with exotic, modern 'normal' eared sheep will be desirable.

Since polymorphism was not implied at the locus controlling ear length, the sheep in regarded as monomorphic for the studied characters.

There seem to be a relation between length and attitude. As the ear goes longer, it tends to be drooping assuming the conchal contilage type is same throughout life. Age also tends to affect attitude.

***Relationships among studied ear characters.***

The measured continuous variables presented in table 3 suggest that age has played no role in the prediction of ear length and width. However, length depends on width. The regression equation implied that the rate of growth of length is higher than that of width.

Since the outer ear is essentially cartilage the rate at which it grows with age is so little as also do other parameters that could be measured on the head such as head width.

It seems that there is a relationship between ear length and attitude. Assuming a consistent texture of the ear regardless of age, attitude appeared to change from horizontal or straight to pendant and then dropping if the ear size continues to increase.

## CONCLUSIONS AND APPLICATIONS

The classification of the ear of WAD sheep of Nigeria as 'Normal with a range of 8.81-10-17cm according for this investigation and the existence of other sheep ear sizes that are more than the above range within the 'normal range showed that improvement through crossbreeding is possible in the studied sheep. This will be a desirable indirect effort to improve the skin texture of the breed. It will be interesting to know the result of crossing this sheep with either exotic of indigenous sheep which has relatively longer ears in order to assess the extent of improvement that can be harvested in the hybrid. The ear of the WAD sheep expresses great homogeneity.

## REFERENCES

1. **Adametz L. (1917)** Studeen Uber die MendelsChe Vererbung der Wichtigsten Rassenmerkmale de karakul schafe bei Reinzucht und Kreuzung mi t Raambouillets. Bibliot. Genet 1.1-2558.
2. **Adu I. F.and Ngere L. O. (1979).** The indigenous sheep of Nigeria. World review of Anim.Prod. Vol. 15, No 3, 51-62.
3. **Bonacini, I, Lauvergne J.J. Succi, G. and Rognomi G. (1982).** Etude du profil genetique des orins de l'Arc Alpin italien a L'aide de Marquevers

genetiques a effects visible (A study of the genetic profile of sheep in the Italian Alps with the help of genetic markers with visible effects). Ann. Genet. Sel. Anim 14:355-371

4. **Committee on Genetic Nomenclature of sheep and Goats (COGNOSAG, 1987).** Workshop atelier Proceedings of the COGNOSAG workshop Gontard Mauosque France. July 21-26, 1987.
5. **Djorbineva M.K. Aleksieva, S. A. and Lauvergue J.J. (1985).** hereditary shortening of external ear in the Karakachan sheep of Bulgainia) Rec. Med. Vet. 161:57-58.
6. **FAO (1991).** Food and Agriculture Organization.vol.39
7. **Hardy J.L and Simmons, V. L., (1943).** Measurments in relation to pelt thickness and for Characteristics of Karakul lambs. J. Anim Sci., 2:146-151.
8. **Lauvergne J. J. Djorbineua N. K. and Aleksieva S. A. (1988).** Hereditary determinism of Form and, attitude of the external ear of sheep. A review small ruminant Research, 237-248.
9. **Lauvergne J.J. (1982).** Genetica en poblacione amimales despies de la domestication: Consecuencias para la conservacion de la las razas (Genetics of Animal populations since their domestication, result for the conservation of breeds). 2nd world Congr. Genel. Appl. Livest. Prod., Marid, 6:77-87.
10. **Lauvergne J. J. (1979).** Visible genetic marlers in domestic sheep and their ansestors. In W.C. Foote and T.D. Bunch: The domestication of sheep, international sheep and goat institute, Logan, Utah, pp 21-23.
11. **Millar P. (1988).** Loci with visible effect in the goat. In J.J. Lawergne: Proc, COGNOSAG Workshop 1986. Bureau des Resources Genetiques, Paris, 41-51.
12. **Panos Marti, Palancar, F, Tur, M. and Martinez G. (1963)** Determination of the character ear length in the Spanish karakul and its significance as a hereditary character Rev. Patron, Biol. Anim, Madvid, 7:49-53.
13. **Rae A. L. (1956).** the genetics of the sheep. In Advances in genetics vol. VIII pp 189-252.
14. **Rodero E. de la Haba M.R., Rodero A. y Herreva M. (1996).** Genetic and phenotypic profiles of Endangered Audalusian sheep and goat breeds. F.A.O Health paper No pg 77-95.
15. **SAS (1989)** SAS User's guide. Statistical Analysis system institute, Inc, Cary NC.
16. **Starke J. S. and Pretorius A. G (1955):** Fmg in S. Africa, 30,53.
17. **Umoren E.P. (1994):** Live weight prediction of Extensively managed west African Dwarf Goats and sheep using conventional and non conventional Body measurements.
18. **Wassin B. N. (1928).** Ohrlosigkeit bei schafeu and Ziegen, Earlessness in sheep and goats) Z. Indukt. Abstamm, Verer bungsl. 49: 95-104.
19. **Wriedt C. (1928).** Segregation ratio of erless and short ear sheep and heredity of these types in Norway). Z Indukt. Abstamm. Verer bungsl 49: 430-437.