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Original Article

Morphological Characteristics of Indigenous Goats in the Coastal Savannah and Forest Eco-Zones of Ghana

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Abstract

A survey was carried out in two agro-ecological zones (coastal savannah and forest) of Ghana to describe the morphological characteristics of indigenous goat populations in those areas. Two districts each in the two zones were randomly selected and 15 villages with high concentrations of indigenous goats purposely selected from each of the districts. Information was collected on the visual appraisal of the indigenous goat types and their morphological description. The animals observed in the various households were put into homogenous classes according to their age based on dentition using the FAO breed descriptor guide which spelt out six age categories. The goats were also grouped according to their morphological characteristics. The distributions of the various traits were expressed in percentages and categorized according to sex and location. Apart from the qualitative traits, five (5) other morpho-biometrical characteristics or linear body measurements namely: body length, height at withers, horn length, tail length and ear length were taken on each animal in the morning before they were released for grazing. A total of 600 goats comprising 179 males and 421 females were observed during the survey. The result obtained from the study indicated that the highest percentage (28.3%) of indigenous goats sampled were less than 1 year old with those within the age range of 4-5 years being the least (9.7%). It was also observed that majority of the indigenous goats sampled were multi-coloured (35.0%) with colours ranging from white, brown, black and grey. The predominant hair type observed among the goats was the smooth type (64.5%) with the least hair type observed being curly (9.4%). It was observed that majority (75.5%) of the indigenous goats sampled were polled while 24.5% were horned. Again, it was realized that majority (72.6%) of the goat sampled had no wattles while 27.4% of them were wattled. The study also revealed that 17.4% of the indigenous goat populations were bearded while about 82.6% had no beard. There was a significant ($P<0.05$) age effects on linear body measurements. There was also a significant ($P<0.05$) sex and location effects with regard to body length and height at withers with the male goats being superior to the females.

Key words: Beard, hair colour, hair type, indigenous goats, morphological, wattle

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Introduction

Goats are multi functional animals and play a significant role in the economy and nutrition of landless, small and marginal farmers in most developing countries including Ghana (Khan *et al*., 2006). Goat rearing is an enterprise which has been practised by a large section of population in rural areas. Small ruminants especially goats can efficiently survive on available shrubs and trees in adverse harsh environment in low fertility lands where no other crop can be grown. They contribute to livestock industry in terms of milk, meat skin and hair. In spite of their continuous neglect and little or no attention given to them, they have, however, fulfilled a most useful task by way of supplying a part of humane population with milk, meat, hair, leather and other products. The ruminant industry of Ghana is composed largely of small-scale enterprises involved in the rearing of cattle, sheep, and goats. The ruminant livestock population stood at 1.5 million cattle, 3.8 million sheep and 4.9 million goats (MoFA, 2010).

Most goats in Ghana are of the indigenous West African Dwarf (WAD) breed, an achondro-plastic dwarf. The adult male weighs 20-25 kg and the female 18-22 kg. The breed is very prolific, precocious and trypano-tolerant and is found throughout the country. It is the broad genetic variability of the West African Dwarf breed that enables it to survive under stressful environmental conditions, including high disease incidence, poor nutrition and high temperatures. There are considerable numbers of the much larger and long-legged and exotic Sahelian as well as crosses between the WAD and the Sahelian goats in the north of the country and in the peri-urban areas (Oppong-Anane *et al*., 2008).

West African dwarf goat is the most prevalent in the southern part of Ghana. They are hardy, small, early maturing, prolific, non-seasonal breeder (Oppon-Anane *et al*., 2008) and plump, measuring less than 50cm in height and weighing between 20 – 25 kg (Ozoje, 2002) and they are trypanosome tolerant. West African dwarf goats possess the widest margin for adaptation amongst the ruminants (Oni, 2003) and have quite specific physiological properties that have made them acclimatize in the tropics easily. Their coat colour may vary from white, brown, black and sometimes various combinations of these colours. There could be presence or absence of wattle or beard in the breed. Majority of the studies on the West African dwarf goats in Ghana were conducted in herds maintained at research stations (Kintampo Goat Research Station). Even though the extensive system of husbandry is the commonest type, little effort has been made in a way of characterizing and determining the adaptive and productive potential of these West African dwarf goats under the system. Characterizing the indigenous goats phenotypically is one of the cheapest, indirect and alternative ways of improving their productivity (Odubote, 1994).

According to FAO (2008), phenotypic characterization of AnGR is the process of identifying distinct breed populations and describing their external and production characteristics in a given environment and under given management, taking into account the social and economic factors that affect them. The information provided by characterization studies is essential for planning the management of AnGR at local, national, regional and global levels. The close adaptation of the West African Dwarf goat to the hot and humid environment would suggest that until more is known of the characteristics, much emphasis should be placed on within-breed selection for genetic improvement. There is the need to study variations among local goat populations through breed characters to facilitate their efficient utilization (Salako and Ngere, 2002). The current study therefore sought to describe the morphological characteristics of indigenous West African Dwarf goats in the coastal savannah and the semi-deciduous zones of Ghana.

Materials and Methods

Description of the study areas

Sampling procedure and data collection

A multi-stage sampling approach was adopted by first making a reconnaissance study of the selected districts to find out the number of farmers involved in the goat rearing. An informal and formal field surveys were conducted on the selected household to explore the available knowledge about the type, distribution and utility of goat types in the districts. Information was collected on the visual appraisal the indigenous goat types and their

morphological description. After that ten villages involved in indigenous goat rearing were randomly selected from each of the four (4) districts with the help of the districts agricultural extension officers. The animals observed in the various households were put into homogenous classes according to their age. The age of the animals were estimated based on dentition using the FAO breed descriptor guide (2008) which spelt out six age categories; less than 1 year, which represents kids with 8 sharp incisors; 1-2 years, represents yearling stage where a central pair of permanent incisors appear; 2-3 years, which represents young adults with 2 pairs of permanent incisors; 3-4 years, which represent adult goats with 3 pairs of permanent incisors; 4-5 years, which represent mature goats with 4 pairs of permanent incisors and goats over 5years old are animals with missing teeth and in some cases without teeth.

Table 1: The climatic characteristics of the studied areas.

Climatic characteristics	Coastal Savanna		Forest	
	Mfantsiman	Efutu	Kwahu West	Birim South
Temperature	24-28°C	22-28°C	26-30°C	25.2-27.9°C
Humidity	70%	75%	75-80%	56-70%
Latitude	5° 07-5° 20 N	5° 20°" N	6°30°N 7°N	6°30°" N
Longitude	0° 44 - 1°11 W	0° 32° " E	0°30° W 1°W	0°30° " W
Vegetation	Coastal shrub in the upland interspersed with grasses	Coastal savannah grassland	Dense vegetation with major trees like odum, wawa.	Presence of tall trees interspersed with evergreen undergrowth
Rainfall	100-120mm	400-500mm	1,700-2000mm	1,500-2000mm
Relief	Land is undulating with about 60m above sea level	Low-lying with protruding granite rocks and isolated hills	Lies within the semi-deciduous forest zone	Undulating and hilly rising to about 61m above sea level
Population of goats	6,000	6,500	35,000	25,000
Major cash crops	Root and tubers, maize, pineapple and vegetables	Cassava, maize, and vegetables	Maize, root and tubers, oil palm, and vegetables, citrus, cocoa	Maize, root and tubers, oil palm, and vegetables, citrus, cocoa
Major livestock	Sheep, goat and pigs	Cattle, sheep, pigs, goats and poultry	Cattle, sheep, goats, grass cutter pigs and chicken rabbits	Cattle, pigs, snails, sheep, goats, grass cutter, poultry rabbits

Source: MoFA (2010)

Apart from the age categorization, the goats were also grouped according to other morphological traits like horn type (straight or curved); coat colour (grey, white, multiple, brown or black); hair type (straight, curly, glossy or smooth); hair pattern (plain, spotted or patchy); wattle (presence or absence); beard (presence or absence); horn (presence or absence); ear orientation (erect, pendulous or horizontal); horn orientation (lateral, backward or upward) and facial profile (straight or concave). The distributions of the various traits were expressed in percentages and categorized according to sex and location. All these were based on visual appraisal of the morphological characteristics of the animals observed in each household. In all, there were a total of 600 goats comprising 179 males and 421 females. Apart from the qualitative traits, other five morpho-biometrical characteristics were taken on each animal in the morning before they were released for grazing. The

measurements were restricted to only animals that appeared and those that conformed to the classification descriptions of the West African Dwarf. The body parts measured was as described by FAO descriptor tool (2008). They included body length (BL), measured as the distance between the anterior points of the shoulder to the posterior extremity of the pin bone; heart at withers (HW), measured from the highest point of the withers vertically to the ground with the animal standing with its feet placed squarely on the level ground; ear length (EL), distance from the point of attachment to the tip of the ear; tail length (TL), measured from the base of the tail to the end of the coccygeal vertebrae; and horn length (HL), measured from the temple of the head to the tip of the horn. The height measurement (cm) was performed using a graduated measuring rule while the length measurements (cm) were taken using a tailor's measuring tape. All measurements were carried out by the same person in order to avoid between-individual variations. Due to the absence of scale, the body weights could not be taken.

Statistical Analysis

The generalized linear modeling procedure of GenStat (Discovery Edition) was used to analyze the quantitative data, fitting the linear body measurements as independent variables and age category, location and sex of the goats as fixed factors. Where significant differences in means existed, means were separated using the lsd at 5% level significance. With regard to the qualitative traits, descriptive statistics was employed to classify the data into means and percentages. The morphological variables were recorded in different character states with some of them being recorded as a binomial variable (1 if present, 0 if absent). The binomial variables from records on qualitative morphological characters were analyzed for descriptive statistics using frequency procedures and percentages.

Results and Discussions

Generally, the study reveals that there were more female indigenous goats (421) sampled than male goats (179), representing 29.8% and 70.2% of male and females respectively (Table 2). These findings were similar to those observed by other researchers such as Katongole *et al*. (1996), who observed 69% females and 31% males from their study.

Table 2: Total number of indigenous goats sampled per sex and different age groups as estimated by dentition in the districts

Age (years)	Sex	Mfantsiman (n= 147)	Efutu (n= 119)	Birim-South (n= 202)	Kwahu West (n= 132)	Total n=600
< 1	Male	16	12	16	14	
	Female	21	16	52	23	170 (28.3)
1 – 2	Male	8	7	10	5	
	Female	20	17	22	19	108 (18.0)
2 – 3	Male	10	10	8	9	
	Female	18	6	30	12	103 (17.2)
3 – 4	Male	6	9	8	5	
	Female	10	13	27	15	93 (15.5)
4 – 5	Male	1	1	5	3	
	Female	11	8	10	19	58 (9.7)
Over 5 years	Male	8	5	2	1	
	Female	18	15	12	7	68 (11.3)

Age estimated based on dentition FAO breed descriptor guide, (2008). Numbers in brackets represent percentages

This flock structure is so because farmers have observed that to maintain a constant flock size they need to keep more reproductively active females longer in their flock than males. Again, more males were sold for income, given as gifts and used during rituals or sacrifices and more importantly

slaughtered for food more often. This confirms the report by Apori *et al*. (2011) that, keeping livestock, especially small ruminants, plays an important role as a safety net that enables households to get quick income to settle urgent financial needs such as buying food and farm inputs, settling hospital bills, school fees, expenses for funeral, marriage and the like. This might be the reason for the observed decreasing population of goat as they aged.

The present results on the predominance of dark pigmentation as far as coat colour is concerned (Table 3) are in consonance with previous works carried out in Southern Nigeria (Odubote 1994; Oseni *et al.,* 2006). Dark coat colour could be a form of adaptive mechanism because of the role it plays in temperature regulation especially in the cold season when dark pigmented animals warm up earlier and more quickly than their light-coloured counterparts.

Though there was diversity of colour observed for the indigenous goats sampled, majority of the goats surveyed were found to be darker (Table 3) as against lighter colours such as white and fawn. The white colouration could be an advantage in an intense radiant environment due to its reflectance property as reported by Hensen (1990) that animals with higher percentage of light colour offer a better resistance to heat in environment characterized by higher solar radiation.

Table 3: Percentage of indigenous goats showing the various morphological characteristics in the four districts

Category	Trait	Mfantsiman (n = 147)	Efutu (n = 119)	Birim-South (n = 202)	Kwahu West (n = 132)	Total (%)
Body Hair pattern	Plain	12.6	13.0	2.3	14.8	42.7
	Spotted	6.0	2.2	5.3	2.7	16.2
	Patchy	12.8	12.3	12.1	3.9	41.1
Body Hair Colour	Grey	1.0	1.1	1.1	0.2	3.4
	White	2.8	1.7	1.5	1.7	7.7
	Multiple	9.3	9.6	8.9	7.2	35.0
	Brown	10.3	5.4	8.7	2.1	26.5
	Black	10.1	7.7	2.8	6.8	27.4
Body hair type	Straight	4.8	1.1	1.8	6.0	13.7
	Curly	1.5	1.1	1.7	5.1	9.4
	Glossy	5.0	3.0	20.0	2.4	12.4
	Smooth	10.3	16.4	26.7	11.1	64.5
Horn	Presence	19.5	21.0	20.2	14.8	75.5
	Absence	0.5	7.6	9.8	6.6	24.5
Horn Type	Straight	14.6	29.8	26.3	18.8	89.5
	Curved	2.0	1.6	3.9	3.0	10.5

This makes light coloured goats more adaptable to the hot and humid environments hence making them more heat-stress tolerant. As reported by Odubote (1994) coat colour influences radiant heat loss exerting its effect on body weight and other productive adaptability factors in livestock species most especially in the tropical environment. Under intensive solar radiation, light coat colours such as white, grey and fawn influences radiant heat loss exerting its effects on body weight and other productive adaptability factors in livestock species (Peters *et al*., 1982). The relatively low proportion of light colour observed in the goat populations in the districts is an indication that indigenous goats in the region (which is relatively warm and humid during most parts of the year) were thermal stressed and their productivity could be compromised.

The variability in coat colour is an indication of indiscriminate crossing existing among indigenous goat populations. The variations in the morphological traits especially coat colour, pattern and hair type are reflections of the goats' adaptability to the various ecological zones they are raised, and also the vegetation and relief features pertaining in the ecological zones. The present results on the dominance of multiple coat colouration are in agreement with similar reports by Katongole *et al*. (1996) in Twasna goats. This provides an opportunity for more effective breeding strategy to be adopted to select towards specific

coat colour as according to Toth *et al*. (2006), there is a relationship between polygenic effects of coat colour and other traits of interest (for example, physiology, morphology and behaviour). Hair type is also an important economic trait in small ruminants. Smooth hair type is advantageous as it permits conventional heat loss from the animal surface and also ensure easy disposal of dirt as supposed to curly and rough (coarse) hair which harbour dirt and disease pathogens and consequently serve as a breeding ground for disease (Yakubu *et al.,* 2010). In this present study, it was observed that majority (64.5%) of the indigenous goats sampled had smooth hair. 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 adaptability of animals to different ecological zones (Banerji, 1984). Again, due to the high incidence of disease causing pathogens in the hot and humid environments, the smooth hair type provides the animals with easier means of disposing off the pathogens.

Presence of horns in indigenous goats is an important self-defensive mechanism. Majority of the goats sampled were horned (Table 3), an indication of their ability to defend themselves and survive the harsh environments in which they are reared. Also the presence of horn is an adaptive feature to fight predation especially in the tropical zones where production is characterized by extensive system (Katongole *et al.,* 1996), where animals had to fight competitors for feed and water and even for does during mating. The present result confirms the findings of Odubote (1994) and Adedeji *et al*. (2006) that there is a low occurrence of polledness in indigenous goat populations in southern Nigeria. Majority of indigenous goats' populations in the studied areas had no wattle (72.6%) and were not bearded (82.6%) despite the numerous benefits associated with the presence of wattles and beard in goats reared under hot and humid environments. Prominent among the benefits are the thermoregulatory functions of beard and wattle and the association of these traits with reproduction such as higher prolificacy, higher milk yield, higher litter size, fertility index and conception rate (Osinowo *et al.,* 1988 and Yakubu *et al.,* 2010).

The results on body length and height at withers of indigenous goats in this present study (Table 5) were better than previous findings from similar breeds of similar age groups in southern Nigeria as reported by Fajemilehin and Salako (2008). According to Cam *et al.* (2010) morphometric measurements and how they relate to one another can describe roughly the animal's production status and breed characteristics. According to Davendra and McLeroy (1982) goats are classified as large when they weigh between 20-60kg and with a height at withers above 65cm. On this basis, the indigenous goats observed in this present study could be classified as small-sized breeds. Results from the presents study showed that age significantly influenced ($P<0.05$) linear body measurement in the indigenous goats populations in the studied areas (Table 4) with consistent increases in all the linear body traits measured with age. This confirms the observation by Fajemilehin and Salako (2008) that the size and shape of the animal increases as the animal ages. There was however no difference in linear body characteristics of the indigenous goats within the age groups 3-4 years up to those above 5 years old. This is also in agreement with findings of Jeffery and Berg (1972) and Fajemilehin and Salako (2008) who observed that goats attain their full matured body characteristics at 3 years and above. The findings of the present study were in agreement with the work of Jeffery and Berg (1972) who reported that at maturity, linear body measurements are essentially constant**,** thereby reflecting heritable size of the skeleton. There was a consistent increase in body length and height at withers with increasing age, an indication of good body conditions and normal skeletal development. This is consistent with the report of Jeffery and Berg (1972) and Fajemilehin and Salako (2008) that the body length and height at withers at any given time reflects the animal**'**s skeletal size and body conditions.

As has already been stated, linear body measurements reflect breed characteristics and the management conditions under which the animals are kept. Therefore the significant ($P<0.05$) differences in body length and height at withers observed in the indigenous goats in the different ecological zones (Table 6) could be attributable to the differences in availability of feed resource base

(in terms of quantity and quality), availability of natural grazing field and the management conditions which the animals were subjected to (Cam *et al.*, 2010). The values obtained showed that the male goats were superior in terms of body length and height at withers to their female counterparts. This sex influenced differences in linear body measurements according to Frandson and Elmer (1981) might be partly due to hormonal effect, resulting in sexual dimorphism in goats. The results from the present study also confirm previous works by Devendra and Burns (1983), Ifut *et al.* (1991) and Akpa *et al.* (1998) that sex significantly influenced linear body measurements.

Table 4: Percent incidence of some of the morphological features of the indigenous goat populations in the districts

Category	Trait	Locations				Total,%
		Mfantsiman (n = 147)	Efutu (n = 119)	Birim-South (n = 202)	Kwahu West (n = 132)	
Horn Orientation	Lateral	10.0	5.0	5.0	1.7	21.7
	Backward	9.3	13.5	12.8	9.3	44.9
	Upward	9.9	7.5	7.4	8.6	33.4
Wattle	Presence	2.2	6.6	8.8	9.8	27.4
	Absence	19.2	22.0	21.2	10.2	72.6
Beard	Presence	6.0	5.5	1.5	4.7	17.4
	Absence	15.4	23.1	28.5	15.6	82.6
Ear Orientation	Erect	10.6	15.0	6.6	7.8	40.0
	Pendulous	1.1	6.0	1.1	3.9	12.1
	Horizontal	18.7	13.6	12.3	3.3	47.9
Facial profile	Straight	3.8	5.0	1.8	1.3	11.9
	Concave	27.6	23.6	21.2	15.7	88.1

Table 5: The linear body measurements of the various age groups of the indigenous goat populations in the districts

Trait	‹1 year	1-2 years	2-3 years	3-4 years	4-5 years	Over 5 years	SEM
BL	49.1^{c}	51.9^{b}	52.4^{b}	56.6^{a}	51.2^{b}	56.8^{a}	1.2
HW	43^{c}	43.8^{b}	43.7^{b}	46.6^{ab}	45.5^{ab}	48.3^{a}	1.5
HL	6.8^{c}	7.4^{bc}	8.3^{ab}	9.3^{a}	8.7^{ab}	8.5^{ab}	0.6
EL	9.1^{b}	9.4^{b}	10.1^{b}	11.4^{a}	11.7^{a}	11.5^{a}	0.6
TL	10^{b}	10.8^{b}	10.6^{b}	11.5^{a}	11.6^{a}	11.7^{a}	0.4

BL= Body length, HW= Height at wither, HL=Horn length, EL= Ear length and TL= Tail length
S.E.M: Standard error of means; means in the same row for each parameter with different superscripts are significantly different (P<0.05).

Table 6: The effects of location and sex on linear body measurements of the indigenous goat populations sampled

	Body length, cm	Height at withers, cm	Horn length, cm	Ear length, cm	Tail length, cm
Locations					
Mfantsiman	54.2^{a}	45.4^{a}	8.3	11.1	11.4
Efutu	50.4^{b}	45.7^{a}	8.5	11.4	11.6
Birim South	51.3^{b}	40.2^{b}	8.3	11.6	11.8
Kwahu West	51.5^{b}	40.1^{b}	8.2	11.0	11.6
SEM	1.2	1.4	0.5	0.5	0.6
Sex					
Male	54.8^{a}	45.4^{a}	8.3	11.1	11.4
Female	51.4^{b}	42.9^{b}	8.1	10.0	10.6
SEM	0.7	0.9	0.4	0.3	0.2

S.E.M: Standard error of means; means in the same column for each parameter with different superscripts are significantly different (P<0.05).

From Table 6 it could be seen that there was a significant ($P<0.05$) sex effect with regard to body length and height at withers with the male goats being superior to the females. There were however no significant ($P>0.05$) sex effect on horn length, ear length and tail length. It could be seen from Table 5 that body length of the sampled indigenous goat populations were significantly ($P<0.05$) different in the various locations with goats from Afram Plains district being significantly longer than their counterparts in the other districts. There were no significant differences ($P>0.05$) in horn length, ear length and tail length among goats in the various districts.

Conclusions

The relevance of phenotypic characterization of indigenous goat genetic resources cannot be over emphasized. The result revealed the presence of wide morphological and phenotypic variations within and among the indigenous goat populations in the various studied agro-ecological zones of Ghana. Due to the existence of varied ecological zones with their accompanying unique climate and vegetations, the goat populations in the studied areas have also developed varied morphologically adaptable characteristics to be able to survive and reproduce in those environments. Among the unique traits are the type of hair or coat, colour of the hair or coat, presence of wattle and beard. These rich adaptable morphological traits could be exploited for future goat breed improvement programmes. In spite of the wide variety of qualitative traits observed, traits like white colour and presence of wattle (which are good for adaptation in the hot and humid environment and also have positive impact on performance) were at the brink of extinction due to their low frequency and incidence in the goat populations studied. The results obtained also showed sex effects on linear body measurements, an indication of sexual dimorphism in the goat populations in the studied areas. There were also location effects on linear body measurements, an indication of influence of management and environments on the performance of the goat populations in the studied areas.

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