Effect of Age, Parity, Breed and their Interactions on Litter Size in Nigerian Indigenous Goat Breeds

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Summary

The objective of this study was to investigate the effects of age, parity, breed and their interactions on litter size in Nigerian indigenous goat breeds. One hundred and eighty-five animal records: 87 West African Dwarf, 70 Red Sokoto and 28 Sahel goats from 2013 to 2019 collected on three farms were used for this study. Analysis of variance was used to analyse litter size variation in observed goat breeds. The average litter size for all studied indigenous breeds was 1.52. Breed and age significantly ($P < 0.05$) affected the litter size of goats, whereas parity did not significantly ($P > 0.05$) affect litter size. West African Dwarf and Red Sokoto breeds had a higher number of kids than Sahel breed. The results show a significant difference ($P < 0.05$) in litter size among does of different ages. Older does had larger litter sizes than younger does. With the findings of this study, it could be concluded that Nigerian indigenous goat breeds have good prolificacy and achieve high kidding rates. More conscious efforts should be made to include them in well-structured breeding programmes for conservation and multiplication purposes.

Key words

goat, litter size, indigenous, Red Sokoto, Sahel, West African Dwarf

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Introduction

Three indigenous Nigerian goat breeds (West African Dwarf (WAD), Red Sokoto (RS) and Sahel (SH)) were included in this comparative study. These breeds occur in two geographical regions (South and North) in Nigeria. The three goat breeds differ in productive, qualitative, reproductive traits such as hides and skins, milk, meat, immunocompetence and litter size (Tizhe et al., 2017). Of these goat breeds, the Red Sokoto goat (RS) is predominant and is found in the Northern Guinea Savanna zone (Okonkwo et al., 2011). This breed generally has a dark brown to reddish coat colour, and its skin has a remarkably high economic value in the local and international leather industry (Umar and Atabo, 2020).

The Sahel goat (SH), also referred to as the desert goat, is one of the meat breeds existing in Nigeria (Otoikhian and Orheruata, 2010). Mason (1951) describes that they are found in the hot semi-arid regions of the country where they are well-adapted. The Sahelian goat is a multipurpose goat breed raised mainly for meat and skin production (Adebambo, 2012). The West African Dwarf goat (WAD) is widely distributed in the rainforest belt of Southern Nigeria. They are short-legged and small-bodied animals, weighing between 20 and 36 kg (Ngere et al., 1984; Adebambo, 2012).

The profitability of goat farming is greatly affected by litter size, which determines the number of animals available for utilisation (feed, fur and manure). Therefore, it is necessary to improve reproductive traits in goats (Ahlawat et al., 2013). Increasing litter size depends on several factors, of which ovulation rate is particularly important. The number of mature oocytes released in a reproductive cycle is determined by a complex interplay between endocrine signaling, the pituitary gland, the ovary, paracrine and possibly autocrine signaling within ovarian follicles, and adjacent somatic cells (Durlinger et al., 2002; Knight and Glister, 2003).

Reproductive traits are of great interest to goat breeders as prolific breeds can increase productivity and provide a good profit (Shabir et al., 2013). One such trait is litter size (number of kids per birth cycle), which measures the fertility of an animal (Hafez, 2000). Reproductive traits such as litter size are sex-limited traits with heritability values between zero and one, low (0-0.19), moderate (0.2-0.39) and high (0.40-1.0), as described by Okafor (2012). Low to moderate heritability ranging from 0.08 to 0.37 was observed in different goat breeds (An et al., 2010; Notter, 2012; Okafor, 2012; Menezes et al., 2016; Zaibi et al., 2021). Litter size in a goat is influenced by the season of parturition (Karua, 1989).

Phenotypic value for litter size in goats has been shown to be highly dependent on genetic and non-genetic factors such as the age of a particular dam, nutrition, breed, season, body weight and parity (Assan, 2020). Therefore, the present study is aimed at investigating the effects of age, parity, breed and their interaction on litter size in indigenous goat breeds in Nigeria.

Materials and Methods

Experimental Site

The study included observations recorded on three farm locations, namely;

- Ipokia Local Government (Ipokia town).
- Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Alabata Road, Ogun State.
- National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria, Kaduna State. The geo-climatic characteristics of these regions are summarised in Table 1.

Experimental Animals and Data Collection

A total of 185 females of the three aforementioned Nigerian goat breeds, namely West African Dwarf goat (n=87), Red Sokoto goat (n=70), and Sahel goat (n=28) were used in the experiment. Each goat was identified with an ear tag number and corresponding litter size records (litter size, age of dam, breed and parity). Litter size data collected spanned six years, from 2013 to 2019. All goats were allowed to graze on a pasture consisting of *Panicum maximum*, *Gliricidia sepium*, and *Leucaena leucocephala* during the day and supplementary concentrate was provided in their pen in the evening. Water was provided *ad-libitum*.

Statistical Analysis

The collected data were loaded into an Excel spreadsheet for statistical analysis. Dataset values for age of does, parity, litter size, and breed were analysed with a general linear model (GLM) procedure using Statistical Analysis System (SAS, 2009) version 9.0 software.

The effects of age, parity, breed and interaction on litter size were tested by analysis of variance. Tukey's Studentised Range (HSD) test was used to determine the significant differences between means, with the significance level at $P < 0.05$.

Statistical model:

$$Y_{hijk} = \mu + A_h + B_i + P_j + (AB)_{hi} + (AP)_{hj} + (BP)_{ij} + \varepsilon_{hijk}$$

where:

Y_{hijk} = the trait of interest (litter size).
μ = the overall population mean.
A_h = fixed effect associated with hth age of dam (h =1-6)
B_i = fixed effect associated with ith breed (i = WAD, RS, and SH)
P_j = fixed effect associated with jth parity (j =1-5)
$(AB)_{hi}$ = interaction between hth age of dam and ith breed
$(AP)_{hj}$ = interaction between hth age of dam and jth parity
$(BP)_{ij}$ = interaction between ith breed and jth parity
ε_{hijk} = residual error.

Results

The effects of dam age, breed and parity on litter size of indigenous Nigerian goats are shown in Table 2. Breed and age significantly ($P < 0.05$) affected the litter size of goats, whereas parity did not significantly ($P > 0.05$) affect it.

Table 1. Geo-climatic characteristics of sampling locations

Location	Coordinate	Altitude (m)	Average Temperature (°C)	Annual rainfall (mm)	Climatic data
Ipokia	Latitude 6°31'29" N Longitude 2°50'17" E	11	26.5	1578	Tropical wet climate
DUFARMS	Latitude 7°14'37" N Longitude 3°20'35" E	136	26.3	1482	Tropical savanna climate
NAPRI	Latitude 11°12'16" N Longitude 7°33'39" E	669	24.9	863	Tropical savanna climate

Source: Google Earth and Cliamte-data.org

Table 2. Effects of age, breed and parity on litter size of Nigerian indigenous goats

Factors		N	Litter size
Age (years)	1 ≤ 2	81	1.35 ± 0.05^{b}
	3 ≤ 4	84	1.60 ± 0.04^{a}
	5 ≤ 6	20	1.57 ± 0.05^{a}
Breed	WAD	86	1.56 ± 0.05^{a}
	RS	72	1.52 ± 0.04^{a}
	SH	27	1.34 ± 0.06^{b}
Parity	1	185	1.47 ± 0.04^{ns}
	2	142	1.52 ± 0.05^{ns}
	3	103	1.57 ± 0.06^{ns}
	4	33	1.61 ± 0.11^{ns}
	5	7	1.43 ± 0.20^{ns}

Note: ^{a,b} - means within factors with different superscripts are significantly different ($P < 0.05$), N: number of observation, ns: not significant

The age of dams significantly ($P < 0.05$) affected litter size. Older does were reported to have larger litters than younger does. Breed also had a significant effect ($P < 0.05$) on litter size in this study. Litter size was the highest in the West African Dwarf breed (1.56 ± 0.05) and the lowest in the Sahel breed (1.34 ± 0.06).

Table 3 shows the interaction effect of age and breed on litter size of Nigerian indigenous goats. The interaction between age and breed showed significance ($P < 0.05$) with values ranging from 1.92 ± 0.04 to 1.00 ± 0.00. WAD goats in the age range of 3 ≤ 6 showed significantly higher values when compared to RS and SH breeds in this age range.

The interaction effect between age and parity on litter size of Nigerian native goats is shown in Table 4. The values of interaction effect on litter size ranged from 2.00 ± 0.23 to 1.00 ± 0.00.

Goats aged 3 ≤ 4 in 4th parity showed significantly higher value of litter size (2.00 ± 0.23) compared to goats aged 1 ≤ 2 in 4th and 5th parity.

Table 5 shows the interaction effect of breed and parity on litter size of Nigerian native goats. No significant effect ($P > 0.05$) was observed in the interaction between breed and parity. However, WAD had the highest litter (1.76 ± 0.13) in their third parity, while WAD and RS breeds had the smallest litters (1.00 ± 0.00) in the fifth parity.

Table 3. Interaction effect between age and breed on litter size of Nigerian indigenous goats

Age	Breed	Litter size
1≤2	WAD	1.41 ± 0.06^{bc}
1≤2	RS	1.15 ± 0.07^{cd}
1≤2	SH	1.00 ± 0.00^{d}
3≤4	WAD	1.82 ± 0.08^{a}
3≤4	RS	1.57 ± 0.05^{ab}
3≤4	SH	1.32 ± 0.08^{bc}
5≤6	WAD	1.92 ± 0.04^{b}
5≤6	RS	1.64 ± 0.06^{ab}
5≤6	SH	1.43 ± 0.10^{bc}

Note: ^{a,b,c,d} - means within factors with different superscript are significantly different ($P < 0.05$); WAD - West African Dwarf; RS - Red Sokoto; SH - Sahel

Table 4. Interaction effect between age and parity on litter size of Nigerian indigenous goats

Age	Parity	Litter size
1≤2	1	1.31±0.06^{ab}
1≤2	2	1.39±0.08^{ab}
1≤2	3	1.53±0.17^{ab}
3≤4	1	1.57±0.06^{ab}
3≤4	2	1.56±0.06^{ab}
3≤4	3	1.61±0.07^{ab}
3≤4	4	2.00±0.23^{a}
3≤4	5	1.84±0.19^{b}
5≤6	1	1.70±0.11^{ab}
5≤6	2	1.65±0.11^{ab}
5≤6	3	1.45±0.11^{ab}
5≤6	4	1.47±0.12^{ab}
5≤6	5	1.50±0.22^{ab}

^{a,b} - means within factors with different superscript are significantly different (P<0.05)

Table 5. Interaction effect between breed and parity on litter size of Nigerian indigenous goats

Breed	Parity	Litter size
WAD	1	1.45±0.07^{ns}
WAD	2	1.63±0.08^{ns}
WAD	3	1.76±0.13^{ns}
WAD	4	1.67±0.33^{ns}
WAD	5	1.00±0.00^{ns}
RS	1	1.51±0.07^{ns}
RS	2	1.52±0.07^{ns}
RS	3	1.56±0.07^{ns}
RS	4	1.62±0.15^{ns}
RS	5	1.60±0.24^{ns}
SH	1	1.41±0.10^{ns}
SH	2	1.25±0.10^{ns}
SH	3	1.29±0.13^{ns}
SH	4	1.50±0.22^{ns}
SH	5	1.00±0.00^{ns}

Note: ns: not significant; WAD - West African Dwarf; RS - Red Sokoto; SH - Sahel

Discussion

Variations in the evaluation of animal performance form the basis for selection and breeding in various domestic animals. In the present study, the effects of age and breed clearly showed significant differences in goats, which is consistent with Tizhe et al. (2017). These differences in litter size could be due to the different genetic makeup of goats.

Litter size in the present study ranged from 1 to 3 kids with a mean litter size of 1.52. Furthermore, litter size in this study for Nigerian goat breeds is similar to literature estimates for Nigerian breeds and other goat breeds, namely 1.8 (Pan et al., 2014).

WAD and RS have larger litters (1.56 and 1.52, respectively) than SH (1.34). The largest litter size observed in the West African Dwarf breed in the current study indicates that this breed is prolific and has a high kidding rate (Abdul-Rahman, 2017). This suggests that more deliberate efforts should be made to select within the breed and include them in well-structured breeding programmes to develop a standardised breed for reproduction.

A significant relationship was found between age and litter size. Older does had a better litter size. The increase in litter size with age could be due to improved ovulation rate and embryo survival, which is also confirmed by Tizhe et al. (2017). They reported that does aged ≥ 3 years had the highest number of ovarian profiles (mature ovarian follicles and corpora lutea) for both ovaries, the right and the left.

The effect of parity on litter size showed a gradual increase from the first parity to the fourth parity and then a decrease, which is consistent with Akpa et al. (2011). Therefore, the increase in litter size with increasing parity in this study could be related to physiological maturity and management of the doe. However, there was no significant difference in litter size among the goat breeds studied in terms of parity, which is consistent with a study on the Markhoz goat breed by Shokrollahi and Morammazi (2018). Also, this is in contrast to the findings of Akpa et al. (2011) who reported significant effects of parity on litter size.

Conclusion

This article attempted to determine the effects of age, parity, breed and their interaction on litter size in indigenous Nigerian goat breeds. The results showed that breed and age had significant influence on litter size of Nigerian goats. WAD and RS had larger litters (1.56 and 1.52) than the SH breed (1.34), and a higher maternal age (3 ≤ 6 years) was responsible for the difference in litter size. Interactions between age and breed and age and parity were also significant with larger litter sizes. WAD breed remarkably had a higher number of kids at age (3 ≤ 4 years), and significantly higher values were found for dams at higher age (3 ≤ 4) and higher parity (4th).

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