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Non-Additive Genetic Effect of Upgrading the West African Dwarf Goat with French Alpine Goat on Birth Weight of the crossbreds

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The study was undertaken to examine the effect of non-additive genetic variance revealed by heterosis on the birth weight of crossbred kids of the West African Dwarf and French Alpine goats as compared to the West African Dwarf (WAD) kids. The aim was to make a case and justify the importation of the French Alpine goat for upgrading the WAD goat in Nigeria. Birth weight records of 65 kids comprising 32 West African Dwarf (WAD) and 33 WAD x French Alpine crosses reared on the teaching and research farm of the University of Ibadan, Nigeria were analyzed. Mean birth weights of male and female WAD were 1.29 ± 0.29 kg and 1.51 ± 0.40kg respectively. Corresponding values for the crosses were 1.40 ± 0.33kg and 1.31 ± 0.30 kg. The female WAD kids appeared heavier than their male counterparts but for the crosses, the males were heavier than the females. The male crosses appeared heavier than their WAD counterparts, while the female WAD also appeared heavier than their crossbred counterparts. However, pooled values for the crosses were lower than WAD (1.38 ± 0.35 versus 1.42 ± 0.38 kg). Birth weight within groups was homogenous with coefficient of variation of 0.27and 0.25 for WAD and crosses respectively. Birth weight of both groups were not significantly different (P<0.05). Male and females were also not significantly (P>0.05) different within groups. Heterosis was negative probably due to the segregation pattern which contributed to dominance and epistatic variance in the hybrid. The negative heterosis is probably due to the segregation pattern which contributed to dominance and epistatic variance in the hybrid. Adaptive and fitness defects due to the environment suffered by the French Alpine and small sample size could have contributed to the effects observed. Other possibilities are discussed.

Keywords: Crossbreeding, West African Dwarf, French Alpine, birth weight, heterosis.

Introduction

Genetic improvement through crossbreeding is one of the most widely used interventions for increasing livestock productivity. The aim is to combine the desirable qualities of two out-crossing breeds in a hybrid especially for traits of low heritability. Heterosis is an increase in animal performance above the average of the parents derived through the practice of crossbreeding. For many decades this has been adopted in developing countries and the tropics in general through the use of imported stocks to cross the local varieties. These exotic strains are reputed for high productivity in their own environment and they could also boost the production of local/indigenous strains that are known for low productivity. However, the indigenous stocks have their own merits. Terrill (1979) has noted that failure to find heterosis in breed crosses is associated with very good conditions of husbandry and feeding, leading to high production levels or where the purebreds are well adapted to the prevailing conditions. A further complication arises when one of the parent breed is unsuited to the environment in which the comparison is being made and thus produces at low level. Sharp (1987) speculated that heterosis achieved in a cross is directly related to the genetic distance between the populations utilized. Different approaches to genetic improvement now include predictions from molecular data and it is thought to be more precise with an advantage of avoiding wastage through trial crosses. This has become an active area of research.

In order to upgrade herds and obtain defined improved breed in goats, it is common practice in Mexico as in other developing countries to introduce Anglo-Nubian, French Alpine, Saanen and Toggenburg sires for crossing with local goats. Among local goats, Granadina-like goats are commonly observed and selection towards the standards of this Spanish breed from local goats has also been conducted (Sanchez, *et al*., 1994). Results on milk yield and litter size in these upgraded goats are published elsewhere (Montaldo *et al*., l98l; Ricordeau l98l).

French alpine goats were imported into Nigeria in the seventies in order to upgrade the genetic merits of the indigenous goat varieties, especially the West African Dwarf. They are hardy, adaptable animals that thrive in any climate while maintaining good health and excellent production. The hair is medium to short, the face is straight and it takes to any climate. (www. dairygoatjournal.com, 2012) On the other hand, the WAD goat is found in the West African regions and especially along the coastal strips where they are well adapted. Their size has contributed to their hardiness and efficiency. In Nigeria (where they are known as Nigerian Dwarf goat) and some other West African states, they are not particularly used as dairy goats but as meat animals apart from their use for traditional purposes and festivals and religious ditty. The difference between these two goats, i.e. dairy and meat respectively informed their importation to Nigeria with the expectation that the milk production of the WAD goat in Nigeria would get a boost. The birth weight of an animal acts as a guide to predict postnatal development and as a pointer to mortality rate, growth rate and size of the adult (Sempho, 1985). An Peischel (2001) reported that birth weight is 30 – 40% heritable in goats. Ahuya *et al.* (2004) has published birth weight figures for some pure and crossbred goats. It has been reported that the value of birth weight as a predictor of future performance accounts for less than 25% of the variation in any postnatal growth performance. In this study therefore, the effect of the French alpine introgression on the birth weight of the West African Dwarf goat in Nigeria is investigated to unveil the non additive gene play in the breeds for that trait.

Materials and methods

The study site is the University of Ibadan; Ibadan is located in the humid Southwest Nigeria at an elevation of 200m above sea level and lies about $7^{o}30'$N and $3^{o}54'$E. It falls under low land rain forest with a dry season of 4-5 months between November and March marked by retarded vegetation which is registered in the growth pattern of animals inhabiting this location. There is little temperature variation throughout the year.

Management and breeding of animals:
The parent stock of WAD and the imported French alpine goats were reared semi intensively to maturity at the University of Ibadan teaching and research farm. They were kept in separate pens to avoid unplanned mating. The females of both breeds, which reached sexual maturity at about six months of age, were not bred until they reached fifteen months of age to avoid interference of active growth with reproductive phase. In this study which lasted over eight months, goats were housed on a cemented floor within a solid wall of 100cm high, completed with wire netting to the roof. WAD rams were used to mate the females of the two breeds so that the offspring were either WAD or crosses. After gestation and parturition, kids were allowed to suckle their dam from birth to 3 weeks of life, and then cow milk was introduced for 8 weeks. Concentrate feed containing 71% maize and 29% groundnut cake was offered as supplement. The concentrate was later boosted with 15% fish meal and 2% blood meal. In addition, fresh water, grass and salt lick were provided. They were also allowed to graze between 9.00am and 11.00am daily occasionally when grass was not wet to avoid worm infestation.

Measurement of live weight:
After parturition, each kid was put in a small jute sack that has been previously weighed and the sack suspended on a hanging scale. The weight was quickly read and kid released to avoid suffocation. X=weight of kid + sack and Y=weight of sack only. The weight of the kid was then taken as: X-Y. Sixty-five birth weights were recorded in the experiment. These included 29 males and 36 females comprising 32 WAD and 33 crosses.

Statistical analysis:
Least square means, standard deviation (SD) and coefficient of variation (CV) were computed for birth weight using the Procmeans of the SAS (1989) package. Next, the fixed effects of genotype and sex were tested using the Analysis of Variance (ANOVA) procedure. The following model was used:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + e_{ijk}$$

Where
Y_{ijk} = Individual observation of birth weights
μ = Population mean which is assumed fixed parameter to be estimated
α_i = Fixed effect of breed on birth weight (i= 1,2)
β_j = Fixed effect of sex on birth weight (j=1,2)
e_{ijk}= random experimental error, assumed NID~ $(0,\sigma_e^2)$

Results

Sample statistics of the birth weight records is presented in table 1. It showed that the mean birth weight of male and female WAD were 1.29 ± 0.29 and 1.51 ± 0.40kg respectively. Those for the crosses were 1.40 ± 0.33 and 1.31 ± 0.30kg for males and females respectively. Pooled values for the WAD and crosses were 1.42 ± 0.38 and 1.38 ± 0.35kg respectively. Levene's test showed that sample variances were homogenous (P>0.05).

Table 1 Least square means, standard deviation and coefficient of variation of birth weight of WAD and crossbred goats.

Genotype	N	Sex	Mean ±SD	CV%	Pooled	CV%
WAD	13	Male	1.29±0.29	22	-	-
	19	Female	1.51±0.40	26	-	-
	32	Total	1.42±0.38		1.42±0.38	27
Crosses	16	Male	1.40±0.33	24	-	-
	17	Female	1.31±0.33	23	-	-
	33	Total	1.38±0.35		1.38±0.35	25

CV= Coefficient of variation; SD= Standard deviation;

Table 2 presents the result of the analysis of variance. It showed that breed, sex and interaction were not significant (P>0.05).

Table 2 Analysis of variance of birth weight showing the effect of sex and genotype

Source of Variation	df	Mean square	P>0.001
Genotype	1	3.367E-02	0.59
Sex	1	7.429E-02	0.43
Genotype **x** Sex	1	0.399	0.07

Discussion

Mean values obtained for birth weight in this study falls within the ranges reported in literature: Sumberg and Mack (1985) reported a mean birth weight of 1.57 kg while reports from other researchers (Ngere *et al*., 1979; ILCA, 1982) ranged from 1.16 to 1.70 kg for WAD goats. Marete *et al.* (2011) reported a range of 1.50 - 3.40 kg (CV=17.3%) in Kenyan French Alpine goats while Sanchez *et al*. (1994) reported 3.2 and 3.3 kg in backcrosses of Mexican local goats with Alpine goats.

The apparent inferiority of the WAD x French alpine crosses as compared to that of WAD might be due to the inability of the cross to overcome environmental stresses experienced during gestation. The observation that the WAD kids appeared heavier than the crossbred kids is therefore not surprising though another investigator has reported that crossbreds were heavier (Ruvuna *et al.,* 1992). Ahuya *et al*. (2004) reported that the birth weight of the hybrids of Toggenburg x East African goat were superior being 4.42 ± 0.04 kg, while that of Toggenburg x Galla was 3.56 ± 0.06 kg. From theoretical consideration, it is understood that adverse environmental conditions could easily obscure potential heterosis as they may affect crossbreds more than the local parental types. Okeyo *et al*. (1985) and Baker (1988) showed that the indigenous East African goats (as is expected with the WAD goat of Nigeria) are more tolerant and resilient to the local disease and gastrointestinal parasite and birth weight could therefore be potentially heavier than that for crossbreds. Birth weight has also showed little to no heterosis among the crosses of Boer, Kiko, and Spanish goats. Preweaning average daily gain shows 5.52% heterosis between Boer and Spanish, 2.22% heterosis between Boer and Kiko, and no heterosis was expressed in the cross of Kiko and Spanish. For

weaning weight, Boer and Spanish generated 6.42% heterosis, Boer and Kiko expressed 3.16% heterosis and no heterosis again was shown between Kiko and Spanish. The first year of data indicates that levels of heterosis vary among meat goat breed crosses (William *et al*., 2011). The Boer kids recorded 3.23 ± 0.76 kg for birth weight - higher than the 1.47 kg reported for Bengal kids by Verma *et al*., (1991).Ahuya *et al*. (1987) reported that Toggenburg kids were superior to all the other genotypes for all growth traits monitored while the East African kids' performance level was the least for all the traits, with the F_1 kids, as expected being mid-way between their parental means for birth and 60-day weight. . The twinning observed in the crosses might also account for the lower value since birth weight of twins is always smaller than those of single born. Mishra *et al* (1976) reported 1.03% heterosis for Alpine x Beetal crosses and even negative heterosis for Angora x Gadi hybrid. This agrees with the result of this study though reciprocal crosses was not tested. Genetic principles have shown that by nature, non-additive generic variation of dominant and epistatic types are unstable and can be verified experimentally.

The similarity between the birth weights of the WAD and French alpine genotypes reported in this study agrees with the report of Barhorst *et al*. (1998) that there were no significant differences between purebred Yorkshires and any other breed combination tested. Furthermore, Adu *et al.* (1978) did not observed sexual dimorphism between goats at birth. In comparison, mean birth weight of 3.31 ± 0.87 kg for Tswana lambs was higher than the 2.44 kg reported for Djallonké x Sahelian crossbred lambs by Kabuga and Akowuah (1991) showed that in some cases pure breds could be superior to crosses as it was obtained in this work. Le *et al.* (1988) reported that the Body weight (BW) changes and daily weight gain of the F_1 (Bachthaot x Co) crossbred goats increased with age, and that the BW of males were higher than that for females. From the genetic view point, there are a number of factors which could influence decision in choosing crossbreeding plans for genetic improvement: (i) the average genetic differences between the breeds constituting the crosss (ii) The choice of traits, as all traits do not respond equally to vigor and (iii) the recombination effects in gametes produced by the crossbred parents. It refers to the breaking up of the epistatic combinations fixed in the parental breeds. With regards to size of breed difference between the parental breeds upon which the size of heterosis theoretically depends, this has neither been objectively measured and documented nor assessed under different environmental conditions.

The findings in this investigation are only preliminary and the reports should be subjected to further investigations using larger samples and reciprocal mating. It will be more informative to first measure genetic similarity/dissimilarity and genetic distance between the WAD and the French Alpine goat from morphological, structural loci and DNA standpoint using systematic studies in order to provide a more objective outlook on the possibility of sustainable upgrading of the WAD through crossbreeding with French alpine which was not obtained in this investigation.

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