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Genetic Parameters for Pre-Weaning Litter Traits in Heterogeneous Population of Rabbits (*Oryctolagus cuniculus*) Raised in the Humid Tropics

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ABSTRACT

Data from 302 progeny in a heterogeneous population of rabbits were used to estimate the heritability and correlations (phenotypic and genetic) of pre-weaning litter traits (litter size at birth LSB, litter size at weaning LSW, litter weight birth LWB, litter weight at weaning LWW, kit weight birth KWB, and kit weight weaning KWW). Heritability estimates for litter size ranged from 0.16 (LSW) to 0.22 (LSB). LWB and LWW were more highly heritable (0.52 and 0.55 respectively) than KWB and KWW (0.36 and 0.25 respectively). The genetic (r_G) and phenotypic (r_P) correlations between litter size and litter weight at birth and weaning were 0.69 to 0.88 (r_G) and 0.28 to 0.88 (r_P). Generally, litter traits gave higher estimates than individual kit traits implying that selection criteria based on litter performance rather than on individual kit performance should be applied in genetic improvement of pre-weaning traits in rabbits raised in derived savanna zone.

Key words: Heritability, Litter traits, Phenotypic correlations, Genetic correlations, Rabbits.

INTRODUCTION

Rabbit production is becoming an important sector in livestock production in Nigeria. Inherent characteristics such as early sexual maturity, high conception rate/prolificacy, short gestation interval, high feed conversion efficiency (forages/roughage to meat) and production of meat with high quality protein and low levels of low density lipoproteins have made it an acceptable source of animal protein (Okoro *et al.,* 2012). Major selection criterion of litter traits evaluated in artificial selection for improvement of any strain or development of new lines in rabbits include litter size and litter weight at birth and weaning. Both traits reflect the contribution of fertility, maternal behavior and attributes, pre-weaning growth performance and survivability.

Genetic studies on these traits in the humid tropics compared to studies in temperate regions appear to be not only limited but diverse (Rastogi *et al.,* 2000). Akanno *et al.* (2004) and Kabir *et al.* (2006) emphasized that accurate genetic evaluation is essential for the purpose of upgrading or improvement. The knowledge of genetic parameter estimates, with respect to (co) variances of relatives using heritability, as well as genetic and phenotypic correlation between traits will, thus, provide considerable information which could be harnessed in multi-trait selection and genetic improvement of litter traits in available rabbits population in the country The aim of the present study was to estimate heritability, genetic and phenotypic correlations in a heterogeneous population of rabbits raised in humid tropical zone of Nigeria.

MATERIALS AND METHODS

Study location, experimental animals and procedures

The heterogeneous population used for the study consisted of a random-bred population of rabbits comprising the chinchilla, Dutch and New Zealand white breeds maintained at the Teaching and Research Farm of Ebonyi State University, Abakaliki. Abakaliki lies within latitudes 06°4¹N and longitude 08°65¹E in the derived guinea savanna zone of south eastern Nigeria.

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At seven months of age, nine sires and twenty-seven does were randomly selected from the population and mated using a mating ratio of 1 buck to 3 does. The bucks were kept in separate wooden cages (breeding cages) two weeks before mating. Mating was done in the morning by taking each doe to a buck assigned to it; each doe was assigned to a particular buck for the period of study. This breeding scheme was adopted to avoid inbreeding (Ragab *et al.,* 2014). Pregnancy diagnosis was done 14 days after mating as described by Onifade *et al.* (1999). Non-pregnant does were re-mated immediately. Does were gently introduced to individual nursing cage having a nest box on day 26 of gestation. Parturition was monitored from day 30-31 of gestation. A total number of 302 kits were kindled over three parities. The kits were introduced to pelleted feed (16%CP) from four weeks of age and weaned totally at eight weeks of age. All animals were raised under the same environmental (climatic, nutrition, medication, biosecurity, *etc*.) conditions.

Traits measured and statistical analysis

Litter traits measured include litters size at birth (LSB) and weaning (LSW), litters weight at birth (LWB) and weaning (LWW) and litter (kit) weight at birth (KWB) and weaning (KWW). Individual body weights were obtained using an electronic sensitive weighing balance.

To estimate the observable (co)variance components for litter traits, data obtained were subjected to paternal half-sib analysis by applying the following model:

$$Y_{ij} = \mu + S_i + E_{ij}$$

Where: Y_{ij} = observation on the jth progeny of the ith sire μ= overall mean; S_i= random effect of ith sire on the trait; E_{ij} = random error, assumed to be independently and identically normally distributed with zero mean and constant variance.

Heritability for the litter traits studied was estimated as described in Becker (1996).

$$h^2 = \frac{4\sigma^2_s}{\sigma^2_s + \sigma^2_e}$$

Where; h^2 = heritability estimate
σ^2_s = variance component due to sire
σ^2_e = variance component due to error

All statistical analyses were done using least square maximum likelihood software of Harvey (1990).

RESULTS AND DISCUSSION

Descriptive statistics

Table 1 shows the descriptive statistics (phenotypic mean, standard deviation, range and coefficient of variation) of litter traits studied. The mean value of litter size at birth (LSB) (5.22±1.07) obtained in the present study compared favourably with the result reported by El-Rahman *et al.* (2012) for NZW (5.63) but higher than 4.07 ±1.43 obtained by Okoro *et al.* (2012) in a similar population. Sorhue *et al.* (2013) asserted that differences exist in LSB among rabbits but this may be due to disparity in conception rate and maternal effect usually determined by the number of mature fertilized and established ova. Result of litter size at weaning (LSW) is higher than results (3.06±0.4 for CHI and 2.21±0.74 for NZW) of Oke and Iheanacho (2011) but lower than range of 6.31±0.08 - 6.47±0.08 reported by Abdel-Azeem *et al.* (2007) in Baladi red, Chinchilla giganta, French grant Papillion and Simenwar rabbits. The differences observed may be attributed to different genotype (e.g. milk production, mothering ability) of the dam and management during rearing.

Litter weight at birth (241.81±50.34g) obtained in the present study is heavier than the reports of Kabir *et al.* (2012) and Onifade *et al.* (1999). Abdel-kafy *et al.* (2012) reported a higher weight of 276g from a Baladi black rabbit population. Our findings on litter weight at weaning (1937.02g) was higher than 1795.10g and 1881.95g recorded for chinchilla and New Zealand white breeds respectively by Oke and Iheanacho (2011). Kit weight at birth (KWB) for heterogeneous rabbit population (46.45±3.67g) was in agreement with the findings of Oludayo (2012) and Onifade *et al.* (1999) who reported respective 46.34g in Hyla (NZW X NZW) rabbits and 35-45g in an unselected rabbit population of Nigeria respectively. Kabir *et al* (2012) worked on Chinchilla, New Zealand White and California white rabbits and reported lower mean kit weight at birth of 27.05, 21.16 and 21.27g respectively. Kit weight at weaning in the present study differs from the reports of Obike and Ibe (2010)

Table 1: Descriptive statistics (phenotypic mean, standard deviation, range and coefficient of variation) for litter traits studied.

Litter traits	Mean	SD	Range		CV (%)
			Minimum	Maximum	
LSB	5.22	1.07	3.00	7.00	20.49
LSW	4.09	0.77	3.00	6.00	18.83
LWB (g)	241.81	50.34	129.99	350.00	20.81
LWW (g)	1937.02	495.89	1235.01	3210.00	25.60
KWB (g)	46.45	3.67	38.00	55.71	7.90
KWW (g)	469.54	53.95	328.75	642.00	11.49
PWM (%)	20.92	12.52	0.00	50.00	59.85

LSB = Litter size at birth; LSW = Litter size at weaning; LWB = Litter weight at birth; LWW = Litter weight at weaning; KWB= Kit weight at birth; KWW = Kit weight at weaning; PWM = Pre-weaning mortality; SD = Standard deviation for the mean; CV= Coefficient of variation.

Table 2: Variance component estimates due to additive genetic, environmental and phenotypic effects and heritability estimates for the litter traits.

Litter traits	σ^2_S	σ^2_e	σ^2_P	h^2
LSB	0.044	0.742	0.786	0.22
LSW	0.124	2.935	3.059	0.16
LWB (g)	330.292	2231.670	2561.962	0.52
LWW (g)	34462.100	215183.210	249645.310	0.55
KWB (g)	1.242	12.357	13.599	0.36
KWW (g)	186.192	2744.941	2931.133	0.25

LSB = Litter size at birth; LSW = Litter size at weaning; LWB = Litter weight at birth; LWW = Litter weight at weaning; KWB= Kit weight at birth; KWW= Kit weight at weaning; h^2 = heritability estimate; σ^2_s = variance component due to sire; σ^2_e = variance component due to error; σ^2_P = Phenotypic variance.

Table 3: Phenotypic (below diagonal) and genetic (above diagonal) correlations between litter traits in the heterogeneous rabbit population.

Litter traits	LSB	LSW	LWB	LWW	KWB	KWW
LSB		0.39	0.69	0.28	-0.52	-0.01
LSW	0.47		0.69	0.88	0.29	0.33
LWB	0.93	0.53		0.71	0.23	0.43
LWW	0.39	0.89	0.49		0.46	0.72
KWB	-0.20	0.19	0.17	0.29		0.50
KWW	0.11	0.37	0.22	0.74	0.31	

LSB = Litter size at birth; LSW = Litter size at weaning; LWB = Litter weight at birth; LWW = Litter weight at weaning; KWB= Kit weight at birth; KWW= Kit weight at weaning.

for chinchilla (741.00g), Dutch (524.29g) and New Zealand white breeds (658.38g). The disparity between the findings in our study and those of other authors could be attributed to varied factor such as genetic constitution of the population of study, management and breeding systems, mothering ability of individual dam (number of kits reared to weaning age), number of parity and environmental factors prevailing at a particular period of investigation.

Pre-weaning mortality (PWM)

Pre-weaning mortality obtained in the present study is similar to that reported by Kabir *et al.* (2012) but contrary to that of Onifade *et al.* (1999) who reported a range of 30 to 40% PWM in an unselected population of rabbits in Nigeria.

Genetic parameter estimates

Table 2 reveals the heritability estimates of the litter traits in the heterogeneous population of rabbits. The heritability estimates of litter weight at birth and weaning were high (0.52 and 0.55 respectively) while the estimates for litter size at birth, KWB and KWW were moderate. Such result indicates strong influence of additive genetic effects on these traits, implying that there is possibility of achieving genetic gain in these traits through selection. The higher estimates of heritability for litter weight at birth and weaning compared with the estimates obtained for individual kits may be due to collective sum (as a litter group) in maternal and additive effects. The present findings affirm the reports of previous studies (Akanno and Ibe, 2005; Iraqi *et al.* 2006; Okoro *et al.,* 2012). Rastogi *et al.* (2000) however, reported lower heritability estimates (as low as 0.1) for litter traits. The discrepancies may be attributed perhaps to the nature and number of population studied.

Phenotypic and genetic correlations

Phenotypic and genetic correlations coefficients estimated from litter traits studied are presented in Table 3. The genetic (r_G) and phenotypic (r_P) correlations between litter size and litter weight at birth and weaning were medium to very strong (0.69 to 0.88 (r_G) and 0.28 to 0.88 (r_P). The genetic correlations between litters traits studied are in agreement with the results of Enab *et al.* (2000) and El-Deghadi (2005). Iraqi *et al.* (2007) reported genetic correlation from sire component as 0.98 between LSB and LWB and 0.97 between LSW and LWW. Afifi *et al.* (1992) asserted that high genetic correlations between litter traits indicates possibility of positive correlated response such that selection for litter size at birth could improve litter size and litter weight at weaning. Iraqi (2007) reported positive phenotypic correlations among litter traits at birth and weaning of mixed and Gabali population. Phenotypic correlation between litter traits and individual kit traits ranged from -0.52 to 0.72. (2001). Orunmuyi *et al.* (2006) made similar observation for litter traits and pre-weaning productive traits in Danish and non-descript population respectively.

CONCLUSION

Moderate to high heritability estimate for pre-weaning body weight indicates the usefulness of these traits as a guide to selection in any programme aimed at genetic improvement of rabbits. The phenotypic and genetic correlations that existed between LSB and LWB and LSW and LWW indicate possible improvement in litter size and litter weight at weaning through genetic selection of these traits at birth. The higher estimates of heritability for litter weight at birth and weaning compared with the estimates obtained for individual kits indicates that selection criteria based on litter performance rather than on individual kit performance should be applied in genetic improvement of pre-weaning traits in rabbits raised in derived savanna zone.

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