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Estimation of heritability and repeatability for pre-weaning body weights of domestic rabbits raised in derived savannah zone of Nigeria

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Abstract

Heritability and repeatability estimates are needed for genetic evaluation of livestock populations and consequently for the purpose of upgrading or improvement. Pooled data on 302 progeny from three consecutive parities of purebred rabbit breeds (Chinchilla, Dutch and New Zealand white) raised in Derived Savanna Zone of Nigeria were used to estimate heritability and repeatability for pre-weaning body weights between 1st and 8th week of age. Respective heritability estimates from the sire component (h^2_s) and repeatability (R) as intra-class correlations of repeated measurements from the three parities for Individual kit weight at birth (IKWB), 2nd week (IK2W), 4th week (IK4W), 6th week (IK6W) and 8th week (IK8W) are 0.59 ± 0.24, 0.55 ± 0.24, 0.93 ± 0.31, 0.28 ± 0.17, 0.64 ± 0.26 and 0.12 ± 0.14, 0.05 ± 0.14, 0.58 ± 0.02, 0.60 ± 0.11, 0.20 ± 0.14. Heritability and repeatability (except R for IKWB and IK2W) estimates are moderate to high. In conclusion, since pre-weaning body weights in the present study tended to be moderately to highly heritable and repeatable, improvement of rabbits raised in derived savanna zone can be realized through genetic selection criterions.

Keywords: Heritability**,** nested design, parity, pooled data, repeatability

Introduction

Genetic improvement remains a veritable option for the development of livestock industry in Nigeria. Ibe (1998) reported that genetic improvement of animals requires a good understanding of basic concepts of genetics and animal breeding and this includes information on genetic parameters of economic traits. Genetic parameters (e.g. heritability, repeatability, genetic and phenotypic correlations) are ratios of (co)variances and their estimates are needed for the genetic evaluation of livestock populations and consequently for the purpose of upgrading or improvement. Magnitude of heritability for important economic traits enables the rabbit breeder/farmer to decide on the type of selection that will lead to rapid genetic progress. Traits with high heritability may be improved by individual selection, while those with low heritability may be improved genetically by family selection. Obasiand Ibe (2008) opined that traits of low heritability can also be improved by exploiting heterosis through crossbreeding and non-genetically by improving the environment. Repeatability estimates also give useful information in determining Most Probable Producing Ability (MPPA) which adjusts the records of individuals to the same base for the purpose of ranking and selection.

The study therefore, attempt to address the dearth of information inheritability and repeatability estimates for pre-weaning body weight of rabbit raised in derived savanna zone of Nigeria

Materials and Methods

Study location and experimental animals: The study was conducted in the Rabbitry Unit of the Teaching and Research Farm of the Ebonyi State University, Abakaliki. Animals used in this study consisted of three (3) rabbit breeds [Dutch (DUT), Chinchilla (CHI) and New Zealand White (NZW)]. Three bucks and nine does (between 8 – 10 weeks of age) of each breed were used in the experiment. All animals were kept under the same management and climatic conditions.

Data collection: The kits were weighed at birth (IKWB); and at 2 weeks (IK2W); 4 weeks (IK4W); 6 weeks (IK6W) and 8 weeks (IK8W) of age. These were measured using sensitive Mettlertoled top pan weighing balance with 1000g capacity and 0.001g error. The measurements were taken while the animals were held in a standing position on top of the pan.

Data analysis: To estimate the observable (co)variance components for pre-weaning body weight, data obtained were subjected to Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) for unequal subclass numbers (unbalanced data) using Henderson's Method III (Henderson, 1984) of "fitting constants", as described in general m-stage nested procedures of SAS (SAS, 2013) Version 9.4 according to Montgomery (2001). The statistical model is as presented in expression (1).

$$Y_{ijklm} = \mu + P_i + B_{j(i)} + S_{k(ij)} + D_{l(ijk)} + \varepsilon_{ijklm} \quad . \ . \ . \quad (1)$$

Where: Parentheses denote which factor it's nested within; Y_{ijklm}=observation on the m[th] progeny of the l[th] doe mated to the k[th] sire and belonging to the `j[th] breed and i[th] parity; μ= overall mean; P_i = fixed effect of i[th] parity (i =1, 2, 3); B_j = fixed effect of j[th] breed (j=1, 2, 3)

$S_{k(ij)}$= random effect of k[th] sire; $D_{l(ijk)}$ = random effect of the l[th] dam mated to the k[th] sire; ε_{ijklm} = random error, assumed to be independently and identically normally distributed with zero mean and constant variance [iind (0, σ^2)]

By equating the mean square of each random effect to its expectation, variance component for sire (σ^2_s), dam (σ^2_d), and error (σ^2_e) were obtained. Similarly, by equating mean cross products for pairs of traits to their expectations, covariance components for sire (COV_s), dam (COV_d) and error (COV_e) were also obtained. These were used to estimate heritability and repeatability of pre-weaning body weight.

Heritability estimates due to sire, dam and sire and dam components were obtained with expressions (2), (3) and (4), respectively:

$$h^2_s = 4\sigma^2_s / \sigma^2_p \quad . \ . \ . \quad (2)$$

$$h^2_d = 4\sigma^2_d / \sigma^2_p \quad . \ . \ . \quad (3)$$

$$h^2_{s+d} = 2(\sigma^2_s + \sigma^2_d) / \sigma^2_p \quad . \ . \ . \quad (4)$$

where: h^2_s; h^2_d and h^2_{s+d} = respective heritability estimate from sire, demand sire and dam components

σ^2_p=total variance component ($\sigma^2_s + \sigma^2_d + \sigma^2_e$)and; σ^2_s; σ^2_d and σ^2_e. = respective sire, dam and error variance component.

Repeatability, R estimates were computed as intra-class correlations of repeated measurements for three parities on each doe.

Results and Discussion

Heritability estimates for pre-weaning body weight of rabbits: Heritability estimates for pre-weaning from sire component, dam component and both sire and dam components are presented in Tables 1. Except for moderate heritability estimates (0.21 ± 0.15 to 0.28 ± 0.17) obtained for IK6W, high estimates of heritability were observed in all pre-weaning body weight studied. Moderate to high heritability estimates (0.28±0.17 to 0.93±0.31) from the sire component for pre-weaning body weight are consistent with those estimates obtained in some studies in Egypt (Iraqi *et al ,* 2002), Spain (Estany *et al.,* 1992), Brazil (Fereaz and Eler, 1996) and Nigeria (Okoro *et al.,* 2011). The results obtained in the present study indicate the strong influence of additive factors in the expression of these traits and at the same time suggest possible improvement of the rabbits through individual selection method.

In contrast, Iraqi (2008) and Gad (2007) studied pre- weaning body weight in Gabali rabbits in North – western coast of Egypt and reported low heritability estimates of 0. 00, 0.05 and 0.07 for pre- weaning body weight at birth, 21 and 28 days using animal model and 0.11, 0.10 and 0.00 for body weight at 4, 8 and 12 weeks respectively. Nevertheless, the differences between heritability estimates of the present study and those reported in the literature could be attributed to the method of estimation/analysis, strain, environmental effects and sampling error due to a small data set or sample size. Higher heritability estimates (> unity) obtained from the dam and both sire and dam components for IKWB and IK2W in the present study may be attributed to inclusion of non-additive and environmental factors in the dam component.

Table 1: Heritability estimates for pre-weaning growth traits of rabbit.

Growth Traits	h^2_s	h^2_d	h^2_{s+d}
IKWB	0.59±0.24	1.56±1.31	1.07±0.23
IK2W	0.55±0.24	1.31±0.36	0.93±0.22
IK4W	0.93±0.31	0.86±0.30	0.90±0.22
IK6W	0.28±0.17	0.21±0.15	0.25±0.12
IK8W	0.64±0.26	0.48±0.23	0.56±0.17

h^2_s = heritability due fromsire component; h^2_d = heritability due fromdam component; h^2_{s+d} = heritability due from both sire and dam components; IKWB, IK2W, IK4W, IK6W and IK8W = Individual kit weight at birth, 2nd, 4th, 6th and 8th week respectively

Repeatability for pre-weaning body weight of rabbit; Estimates of repeatability (R) for pre-weaning body weight are presented in Table 2.Repeatability results obtained for pre-weaning body weight ranged from low (0.05±0.14) for IK2W to high (0.60±0.11) for IK6W.

Moderate to high repeatability estimates that were obtained for IK4W, IK6W and IK8W were similar to the reports of Chineke *et al.* (2001). Moderate to high repeatability required fewer (2 to 3 parities) records before selecting a doe for these traits. While, the low repeatability result implies that many measurements from several parities are needed to correctly evaluate the consistency of the doe's performance in any experimental population.

Table 2: Estimates of repeatability (R± SE) for pre-weaning body weight of rabbit

Pre-weaning body weight	R± SE
IKWB	0.12±0.14
IK2W	0.05±0.14
IK4W	0.58±0.02
IK6W	0.60±0.11
IK8W	0.20±0.14

IKWB, IK2W, IK4W, IK6W and IK8W = Individual Kit Weight at birth, 2nd, 4th, 6th and 8th week respectively; SE = Standard error for R

Conclusion

Moderate to high heritability estimate [$h^2_{(s)}$] for pre-weaning body weight indicates the usefulness of these traits as a guide to selection in any programme aiming at improvement of rabbits enterprise in the tropics. In the same vein, high repeatability estimates for IK4W and IK6W indicate that selection for improvement at these pre-weaning ages will result to increase in growth performance.

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