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Genetic analysis of growth pattern in New Zealand White rabbit fed commercial grower mash

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Target Audience: Rabbit Farmers, Rabbit Breeders, Researchers

Abstract

Correlation coefficients of body weight at different ages were examined in this study. A total of forty-eight New Zealand White rabbit kittens were used for the genetic parameter estimation study. The rabbits were housed in wooden cages with wire mesh floor at four rabbits per cage and were fed ad libitum, solely on the commercial grower mash and fresh water. Individual weekly body weight of the rabbits was taken for 12 weeks using a sensitive scale with an accuracy of 0.1g. Heritability, genetic, phenotypic and environmental correlation coefficients of the body weight at different ages were estimated using the Restricted Maximum Likelihood (ReML) approach. The heritability estimates obtained ranged from moderate to low with higher estimates from the sire model. Heritability was highest at pre-weaning and few weeks post-weaning. The genetic, phenotypic and environmental correlations for weekly body weights showed positivity and ranged between 0.30 to 0.97, 0.79 to 0.99 and 0.33 to 0.99 respectively. The correlation coefficients estimates were highest at pre-weaning ages and later showed a decreasing trend at post-weaning from the 7th week. This implies that animal model selection can be practiced at the post-weaning age to reduce genetic-environmental interplay in the selection process.

Keywords: Rabbit, New Zealand White, heritability, genetic correlation, body weight

Description of Problem

Over the last three decades, information has it that, animal protein per capita in Nigeria according to UNDP (1) is less than the minimum recommended by the Food and Agricultural Organization (FAO). Increase in world population and high economic activities around the world contributed to the increasing demand for meat and meat products especially in developing countries like Nigeria. These have resulted in the inadequate intake, both in quality and quantity of protein-based diet by an average Nigerian. Of the 65-72 g of reference protein in the diet of the average Nigerian, 35 g is expected to come from animal products (2). However, only 8.4 g out of the 53.8 g of protein consumed per head per day in Nigeria comes from animal sources (3). In 1986, the average animal protein intake per capita per day was about 7.6 g, while only 13.2 g per day was estimated as the available animal protein for every Nigerian in the year 2000 (4).

In view of the above, it is expedient and inevitable to ensure sustainable and affordable animal protein supply through the production of fast-growing and efficient animals. Until now, the policy of Nigerian government over the years, laid more emphasis on increased production of large animal products like beef, pork, mutton, and chevon as well as poultry products while little or no attention on other farm animals such as rabbit (2). Increased rabbit production is the absolute way of improving animal protein deficiency in tropical countries like Nigeria (5). In recent years, micro-livestock production, like rabbit production, has been on the increase in a move to meet the protein demand of the populace. It has been reported that rabbit production is the most productive meat producing domesticated animal (6) because it possesses several important economic traits ranging from short gestation period to small rearing space area, prolificacy, high production potential, rapid growth rate, early maturing and efficient feed utilization (7). Rabbit meats contain high quality and quantity protein, less fat with a higher proportion of polyunsaturated linoleic and linolenic fatty acids (8), low cholesterol and richer in protein than beef, chicken, and pork (9). With so many researches on unconventional feedstuffs and their application to rabbit production, none has been able to attain acceptance with commercial feed producer. This has made conventional feeds the most acceptable and mainstay of livestock production in Nigeria because it delivers higher productivity and easily accessible to the farmers.

This research therefore aimed at analyzing the genetics of growth pattern in New Zealand White rabbit fed solely on conventional grower mash diet.

Materials and Methods

Experimental site

The research was carried out at the Rabbitory Unit of the Directorate of University Farms, Federal University of Agriculture, Abeokuta, Nigeria. The farm lies on the Latitude within the rain forest belt of Western Nigeria, Latitude $7^0$10´North, Longitude $3^0$2´East and altitude 76 masl. The climate is humid with a mean annual rainfall of 1,037mm, mean temperature of 34.7^{o}C and mean relative humidity of 82 %. The vegetation interplays between tropical rainforest and derived savannah.

Experimental animals and management

A total of forty-eight New Zealand White rabbits kittens were used for the genetic parameter estimation study. The kittens after birth were allowed to stay with their mother till 28 days before being weaned. After weaning, the rabbits were housed in wooden cages with wire mesh floor. Four rabbits were kept per cage. After two weeks of birth, the kittens were introduced to commercial grower mash (CGM) and lasted till the end of the research duration. The animals were fed solely on the commercial grower mash. Feed and water were given to the animal *ad libitum*. Routine management was observed and drugs were applied as when necessary.

Data collection and Statistical analysis

The body weight of individual rabbits was taken on a weekly basis with the aid of a sensitive scale with an accuracy of 0.1 g. At birth, extra care was taken in measuring the weight of the kittens. Weighing bowls used for the weighing were kept in the individual doe cage to mimic the peculiar odour existing within the cage to avoid the mother rejecting the kittens due to strange smell. The animals were weighed on a weekly basis for twelve weeks. The genetic, phenotypic and environmental correlations of the body weight at different ages were estimated using an animal model based on the Restricted Maximum Likelihood (ReML) approach of SAS (10) analytical package. The model used was of the form:

$Y_i = \mu + b_i + e_i$

Where Y_i = phenotypic record of the i^{th} individual.

μ = Overall mean of the observation

b_i = additive genetic value of the i^{th} individual.

e_i = residual effect associated with i^{th} observation.

Heritability estimate from sire and dam variance component were obtained using the formula below according to Becker (11);

Sire variance component: $h_s^2 = \frac{4\sigma_s^2}{\sigma_s^2+\sigma_d^2+\sigma_e^2}$

Dam variance component: $h_d^2 = \frac{4\sigma_d^2}{\sigma_s^2+\sigma_d^2+\sigma_e^2}$

Where; h^2 is the heritability estimate

$\sigma^2{}_s$ is the variance estimate for sire

$\sigma^2{}_d$ is the variance estimate for dam

$\sigma^2{}_e$ is the variance component for error

Using the procedure of CORR available in the SAS package (10) the Pearson product-moment correlation coefficient (*r*), simply called the correlation coefficient, was used to examine the linear relationship between the body weight at different ages. The correlation coefficient between the different weights are written as:

$$r = \frac{\sum XY}{\sqrt{\sum X \sum Y}} \qquad i = 1,\ldots,N$$

Where r = pearson correlation

X_i = first random variable of the ith body weight

Y_i = second random variable of the ith body weight

The Pearson correlation is defined between -1 and +1 ($-1 \leq r \leq 1$) where -1 indicates a perfect decreasing (negative) linear relationship, +1 indicates a perfect positive (increasing) linear relationship and some values between -1 and +1 in all other cases indicate the degree of linear relationship between the X and Y parameters.

Results and Discussion

Figure 1, presented the graph of weekly body weight gain pattern of rabbits over a period of 12 weeks. It could be seen from the graph that the growth was exponential though with a reducing rate of weekly growth performance difference of 30g. (12) in their study concluded that for better body weight (meat yield), the initial exponential growth phase should be given adequate attention for optimal performance. A reducing trend in weekly growth rate was recorded at interval of three weeks. The first three weeks recorded an average weekly growth rate of 158.5g per week while the last three weeks showed an average weekly weight gain of 131.25g per week higher than 100.1g reported by Abe (13).

Table 1 showed the heritability estimates of body weight at different ages for rabbit with respect to sire and dam components from 1 to 12 weeks. The results showed that the estimated heritability was generally low to moderate, ranging between 0.21 and 0.58. However, heritability estimates from sire components were higher with the lowest estimated value of 0.33 at the 12th week when compared to that of dam components where the highest estimated value of 0.48 was recorded in the 8^{th} week. This could be as a result of additive genetic variance effect as reported by (14) that heritability estimates from sire component are the most reliable because it contains variance due to additive gene effects. Variance between heritability estimates due to sire effect was ±0.25 while that due to dam effect was ±0.27. The table further showed that heritability estimates increased as the age increases up to around 7^{th} and 8^{th} week when it started fluctuating at a reducing rate. It was observed that after weaning at 4 weeks of age there was a slight drop in heritability at the 5^{th} week but later picked up at the 6^{th} week, which may be due to the environmental effect caused by the weaning process. Furthermore, there was a sharp drop in the heritability estimates for both sire and dam components at the 9^{th} week which persists till 12 weeks. This could be due to increased environmental influence on the trait before weaning indicating that individual selection for body weight should be more considered during this period as dam influence has been removed and body weight at this period will be more of genetic than environmental effect. The estimates of dam heritability were moderate and in the range of 0.21 to 0.48. These results were in agreement with the findings of (15) involving New Zealand White rabbit. However higher estimates were obtained by (16) in New Zealand White rabbits.

Table 2 presented the genetic correlation among the body weights of rabbit at different ages. The genetic correlations at the different ages were positive but ranged from low to high between 0.30 and 0.99. Higher and moderate genetic correlation was recorded between the body weights at earlier ages and fairly high to low correlations were recorded at older ages. This was in agreement with the results of (17). Generally, the genetic correlation varied from low to high (0.30 to 0.99). Furthermore, the result showed that the traits exhibit higher correlation at younger ages than older ages. The genetic correlations for pre-weaning body weight were high and ranged between 0.94-0.97. This indicates that selection for individual body weight at early ages i.e. at birth or during the pre-weaning period will lead to correlated responses in weight gain in the immediate age bracket (18). The reduction in genetic correlation as the animals advance in age could be attributed to the increased influence of environmental factor like change of diet from milk supplement feeding before weaning to solely grower mash diet after weaning. Selection in favour of heavy litter weight at birth has usually been associated with genetic improvement in the corresponding trait at subsequent ages (19).

The pattern of phenotypic correlation among body weights of rabbit at different ages is as presented in Table 3. The correlations were generally high and positive. The correlation among the body weight ranged between 0.33 and 0.99. These estimates are in agreement with the higher limits phenotypic correlation (0.79 – 0.98) reported by (20) while the lower limits (0.30 – 0.49) were similar to the findings of (17). The pattern of the correlation estimates showed an inverse relationship between body weight and age. Meaning that as the age of the rabbit increases the phenotypic correlation of the body weight decreases. The results showed that the closer the ages the strongly correlated they are, one to another. This indicates that selection for improvement in body weight at one age will lead to improvement in weight at the other ages.

Table 4 presented the environmental correlation among body weight of rabbit at different ages. The results of the study showed a high and positive environmental correlation coefficient for all ages. A similar result was obtained by (21) while lower estimates were reported by (22). The indication from the results of this study showed that pragmatic attention should be paid to environmental components of rabbit body weight at any age during production as this affect the phenotypic of the animal and resultant effect on body weight post-weaning.

Conclusion and Application

The following conclusion can be deduced from the study:

1. Heritability is strongly affected by environmental component post-weaning than pre-weaning.
2. There exist a strong genetic and phenotypic relationship between body

weight at pre-weaning and decreases as the animal advances in age.

3. Environmental component is a major factor in achieving good body weight in rabbit post-weaning.
4. There is the need for selection of superior breed as parents of the next generation and pay attention to factors that will allow for better profitability.

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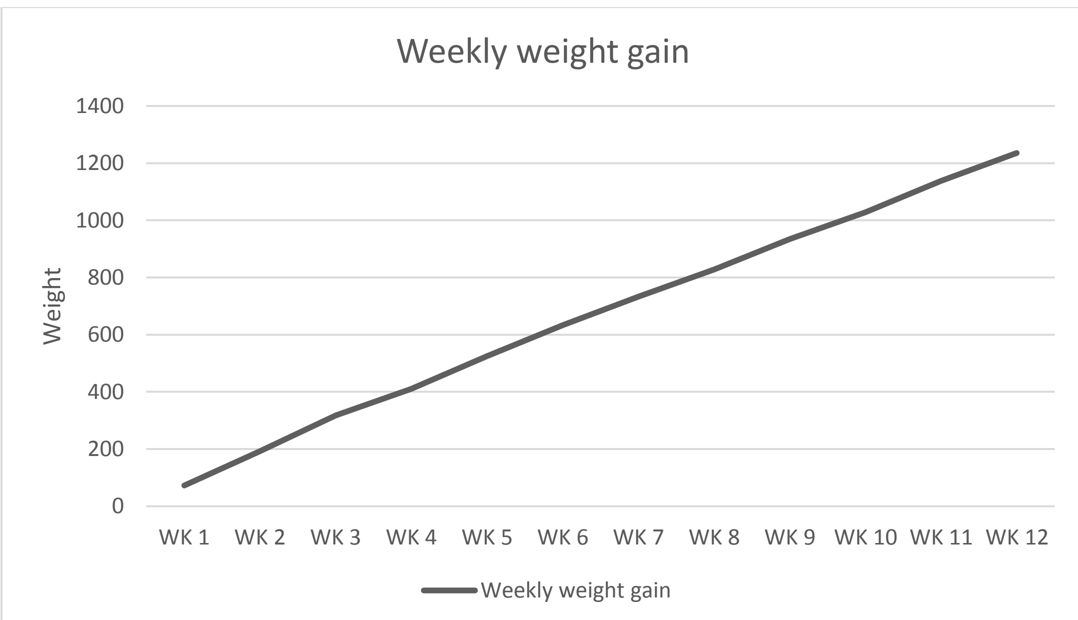

Figure 1. Weekly body weight pattern of New Zealand White rabbit

Table 1. Sire and dam heritability of body weight in rabbit at different ages

Age (days)	Sire model heritability	Dam model heritability
1	0.49 ± 0.13	0.21 ± 0.44
2	0.49 ± 0.12	0.30 ± 0.48
3	0.53 ± 0.12	0.30 ± 0.38
4	0.58 ± 0.14	0.32 ± 0.41
5	0.49 ± 0.14	0.30 ± 0.42
6	0.54 ± 0.13	0.43 ± 0.46
7	0.55 ± 0.13	0.45 ± 0.35
8	0.52 ± 0.13	0.48 ± 0.30
9	0.46 ± 0.14	0.22 ± 0.31
10	0.46 ± 0.12	0.28 ± 0.25
11	0.47 ± 0.12	0.25 ± 0.29
12	0.33 ± 0.12	0.22 ± 0.31

Table 2. Genetic correlations among body weight of rabbit at different ages

Age (days)	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	0.97											
3	0.94	0.94										
4	0.97	0.90	0.94									
5	0.95	0.82	0.91	0.91								
6	0.84	0.90	0.91	0.98	0.91							
7	0.76	0.80	0.97	0.92	0.95	0.94						
8	0.58	0.70	0.80	0.90	0.88	0.83	0.93					
9	0.84	0.63	0.70	0.89	0.95	0.86	0.83	0.85				
10	0.55	0.47	0.60	0.75	0.85	0.84	0.87	0.79	0.82			
11	0.54	0.40	0.33	0.61	0.60	0.74	0.83	0.89	0.79	0.84		
12	0.58	0.30	0.47	0.57	0.88	0.60	0.78	0.73	0.87	0.65	0.83	

Table 3. Phenotypic correlations among body weight of rabbit at different ages

Age (days)	1	2	3	4	5	6	7	8	9	10	11	12
1												
2	0.97											
3	0.99	0.90										
4	0.98	0.99	0.92									
5	0.87	0.94	0.98	0.99								
6	0.87	0.99	0.99	0.97	0.98							
7	0.79	0.88	0.87	0.89	0.82	0.91						
8	0.78	0.89	0.88	0.87	0.89	0.87	0.85					
9	0.79	0.69	0.77	0.71	0.72	0.78	0.81	0.79				
10	0.68	0.59	0.59	0.61	0.62	0.64	0.67	0.68	0.69			
11	0.61	0.52	0.55	0.58	0.57	0.55	0.55	0.52	0.64	0.59		
12	0.55	0.55	0.57	0.59	0.45	0.35	0.47	0.48	0.33	0.48	0.79	

Table 4. Environmental correlations of body weight at different ages

Age (days)	1	2	3	4	5	6	7	8	9	10	11	12
1												
2	0.94											
3	0.99	0.88										
4	0.95	0.87	0.94									
5	0.99	0.85	0.89	0.91								
6	0.98	0.82	0.89	0.95	0.99							
7	0.99	0.93	0.84	0.97	0.94	0.97						
8	0.95	0.88	0.87	0.87	0.89	0.94	0.98					
9	0.94	0.99	0.87	0.85	0.95	0.81	0.88	0.95				
10	0.89	0.95	0.88	0.86	0.89	0.91	0.92	0.94	0.96			
11	0.91	0.97	0.98	0.87	0.94	0.89	0.82	0.83	0.95	0.92		
12	0.88	0.87	0.89	0.95	0.94	0.90	0.92	0.84	0.88	0.79	0.84	