

## SIRE'S STRAIN INFLUENCE ON LIVABILITY AND GROWTH TRAITS IN A DIALLEL CROSSED RABBITS

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### ABSTRACT

*The study was conducted to evaluate sire's strain influence on livability and productivity traits using four rabbit strains; ; the New Zealand White (NZW), the Chinchilla (CHL), New Zealand Red (NZR) and the FCEABK- $\alpha$  (K- $\alpha$ ); a newly developed rabbit strains through di-allele crossbreeding experiment that generated 16 genotypes involving 4 straight bred and 12 crossbreds respectively. The performance of these rabbit strains was monitored to evaluate sire's strain effect on livability, growth traits and mortality at birth, pre-weaning (21 days), weaning (42 days) and post-weaning age of 84 days respectively. The results indicated that kindling to weaning livability and growth traits varied among the rabbit genetic groups due to differences in their genetic makeup. Chinchilla and K- $\alpha$  improved strain and their crosses performed better relative to other strains studied due to heterotic effect. Recommendations were therefore made that variations that existed in this rabbit population should be thoroughly exploited through crossbreeding and selection programmes. This is desirable in order to take advantage of heterosis in enhancing numerical doe's reproductive efficiency. The study therefore underscored the importance of sire's strain influence on livability and growth traits in rabbits, which is a better tool of improving animal agriculture for economic development in Nigeria.*

**Key Words:** Breeding, Diallel analysis, Livability, Humid environment, Sire's strain.

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### INTRODUCTION

Essentially, agriculture is the propeller for economic growth in emerging economies, and foreign trade through animal agriculture can be a propeller of economic growth, especially in developing countries like Nigeria (Sertoğlu *et al.*, 2017; Farahane and Heshmati 2020). This implies that animal agriculture is of huge importance to any economy of the world due to the ability of the sector to provide food for households, raw materials for firms and foreign exchange for the government. Rabbit production and consumption in Nigeria as a livestock specie, is fast gaining importance and popularity in the sub-humid zone. An important point in favour of domestic rabbit is that it compares favourably with other meat-producing farm animals in its efficient conversion of feed into meat for human consumption and, taking a long look at the industry, this characteristic would suggest the probability that the domestic rabbit will become more important in furnishing the meat supply of this country, especially as the human population continues to increase and competes to a greater extent with the meat-producing animals for the cereal grains (FAO,2020). The importance of the domestic rabbit for supplying meat for human consumption in thickly populated countries like Nigeria could be illustrated by the number of rabbits raised (Akanni *et al.*, 2012; North *et al.*, 2018).

However, due to the poor global economic status information on the genetic diversity, variability and potentials in terms of the sire's strain influence on the nature of growth, productive and reproductive indices of rabbits, is of paramount importance especially in tropical areas, where environmental factors are known to influence growth and reproduction tremendously. Therefore, this study attempts to provide such information by determining the genetic basis for sire's strain influence on livability and growth potentials in rabbit breeds and crosses in the humid tropics, as a panacea for improving animal agriculture for sustainable economic development in Nigeria.

### MATERIALS AND METHODS

The research was carried out at the Rabbitry Unit of the Department of Agricultural Education, School of Secondary Education (Vocational and Technical), Federal College of Education, Osiele, Abeokuta, Nigeria. Osiele (7°10'N and 3°2'E) is in Odeda Local Government Area, Ogun State, Nigeria. The experiment was conducted using 16 does and 2 bucks from each of the pure line and their crosses. These animals were raised between February 2022 and January 2023 in an experiment that lasted for 52 weeks.

### Management of the experimental animals

The experimental rabbits comprised 20 each of four pure breeds; the New Zealand White (NZW) and the American Standard Chinchilla (CHL), New Zealand Red (NZR) and the FCEABK-ALPHA (K- $\alpha$ ), a newly TETFund funded developed rabbit line were used for the study. These rabbit strains were sourced from the TETFund funded Rabbit Breeding and Multiplication research farm, Federal College of Education, Abeokuta, Ogun State. Twelve lines inclusive of straight and reciprocal crosses were generated from the 4 x 4 di-allele crossing of these rabbit strains. The pure line served as the control line to all the crosses. A total of 25 growing rabbits per strain averaging 10 weeks in age and 850g – 950g in body weight were reared till 20 weeks of age when the average body weight reaches 1450g) and used as parents.

Bucks and does from each genetic group were properly identified by ear tagging. The rabbits were housed in hutches. Each hutch has the following dimensions. Length – 144cm; width – 24cm / 48cm and height – 36 cm for both growers and breeder hutches. The hutches were raised on both wooden and metal stands about 24cm above the ground. The rabbits in hutches were placed inside a low walled house built with wooden material and corrugated iron sheets as roofing material. The wooden hutches were covered to some extent with mesh that would permit inspection, ventilation and dropping of rabbit faeces and urine to the floor. Kindling boxes, feeding and watering troughs, made from concrete and clay respectively were provided inside the hutches. The rabbit and its surroundings were kept clean.

### Data Collection

Data on litter weight and mortality at birth, pre-weaning (21 days), weaning (42 days) and post-weaning age of 84 days respectively in all the genetic groups were pooled together and average recorded on weekly basis. These were arc-transformed into percentages and used to compute and generate kindling to weaning livability and mortality.

### Statistical analysis

The effect of sire's strain on livability and growth traits of rabbit strains was estimated from two-way analysis of variance with sub samples using General Linear Model of SAS (2019). This further generated significant differences among the means using the model:  $Y_{ij} = \mu + T_i + \Sigma_{ij}$ . Where;

$Y_{ij}$  = Observed value of the dependent variable (productive traits)

$\mu$  = Population means

$T_i$  = Effect of  $i^{\text{th}}$  strain ( $i = 1- 16$ )

$\Sigma_{ij}$  = Random residual error.

Significant differences among means were also separated. Correlations were computed using Statistical Analysis System (SAS, 2019). All effects except error terms were fixed.

## RESULTS

### Sire's strain influence on growth traits, livability and mortality

The least squares means  $\pm$ SEM of litter weight at pre-weaning (21 days), weaning (42 days) and post-weaning age of 84 days are presented in Table 1. Litter weight was significantly ( $P < 0.05$ ) affected by sire's strain in all the ages. The litter weight increased with increase in age of the rabbits in all the genetic groups studied. Litter weight in K- $\alpha$ , New Zealand White, Chinchilla X K- $\alpha$ , K- $\alpha$  X Chinchilla were significantly ( $P < 0.05$ ) higher than other genetic groups in all the ages. The mean weight ranged from 1533.54 $\pm$ 10.21g, 1533.54 $\pm$ 12.06g, 1531.71 $\pm$ 13.23g, 1519.92 $\pm$ 15.24g and 1506.45 $\pm$ 15.20g while New Zealand Red X Chinchilla and K- $\alpha$  X New Zealand Red statistically had the least values of 1258.80 $\pm$ 10.17g and 1263.53 $\pm$ 10.26g respectively at pre-weaning. Mean weaning weight also followed similar trend as observed in pre-weaning weight across the genetic groups. Higher weights were recorded in Chinchilla X K- $\alpha$ , K- $\alpha$  pure line and K- $\alpha$  X Chinchilla respectively. At post-weaning age, the New Zealand White statistically had the highest weight of 4098.37 $\pm$ 25.45g and 4008.11 $\pm$ 19.56g closely followed by Chinchilla X K- $\alpha$  (3924.88 $\pm$ 26.42g), K- $\alpha$  X Chinchilla (3917.56 $\pm$ 20.07g), and New Zealand White X K- $\alpha$  (3908.57 $\pm$ 26.14g) while New Zealand Red X New Zealand White had the value of 1521.68 $\pm$ 21.15g. Values for other genetic groups are presented in the Table.

Kindling to weaning livability (KWL %) was also significantly ( $P < 0.05$ ) affected by genotype. Higher livability values (96.00 $\pm$ 0.01%, 93.75 $\pm$ 0.05%, 93.52 $\pm$ 0.09% and 91.66 $\pm$ 0.00% were noticed in

Chinchilla pure line, Chinchilla X K- $\alpha$  cross, K- $\alpha$  pure line and K- $\alpha$  X Chinchilla cross while New Zealand Red X New Zealand White statistically had the least value in of 46.42 $\pm$ 21.32% (Table 1).

**Table 1: Least squares means  $\pm$  SEM of litter growth traits as affected by genotype**

| GENOTYPE          | N  | PWLWG21 (G)                       | ALWG42(G)                         | ALWG84 (G)                         | KWL (%)                         |
|-------------------|----|-----------------------------------|-----------------------------------|------------------------------------|---------------------------------|
| NZW               | 16 | 1531.71 $\pm$ 13.23 <sup>a</sup>  | 2179.51 $\pm$ 15.22 <sup>ab</sup> | 4098.37 $\pm$ 25.45 <sup>a</sup>   | 71.74 $\pm$ 11.02 <sup>b</sup>  |
| CHL               | 16 | 1521.09 $\pm$ 1.26 <sup>a</sup>   | 2219.82 $\pm$ 15.25 <sup>a</sup>  | 3685.69 $\pm$ 18.20 <sup>a</sup>   | 91.00 $\pm$ 0.01 <sup>a</sup>   |
| NZR               | 16 | 1310.71 $\pm$ 17.25 <sup>bc</sup> | 1904.59 $\pm$ 11.22 <sup>b</sup>  | 3037.71 $\pm$ 27.07 <sup>abc</sup> | 87.50 $\pm$ 7.97 <sup>ab</sup>  |
| K- $\alpha$       | 16 | 1533.54 $\pm$ 10.21 <sup>a</sup>  | 2474.90 $\pm$ 18.26 <sup>a</sup>  | 3778.91 $\pm$ 24.96 <sup>a</sup>   | 93.52 $\pm$ 0.09 <sup>a</sup>   |
| NZW X CHL         | 16 | 1468.8 $\pm$ 19.29 <sup>ab</sup>  | 2264.34 $\pm$ 17.28 <sup>a</sup>  | 3824.76 $\pm$ 24.96 <sup>b</sup>   | 74.72 $\pm$ 10.39 <sup>b</sup>  |
| NZW X NZR         | 16 | 1396.99 $\pm$ 18.17 <sup>b</sup>  | 1937.92 $\pm$ 15.25 <sup>b</sup>  | 3475.87 $\pm$ 24.64 <sup>b</sup>   | 75.35 $\pm$ 10.35 <sup>b</sup>  |
| NZW X K- $\alpha$ | 16 | 1496.59 $\pm$ 10.01 <sup>ab</sup> | 2386.78 $\pm$ 14.21 <sup>a</sup>  | 3908.57 $\pm$ 26.14 <sup>a</sup>   | 87.50 $\pm$ 12.50 <sup>ab</sup> |
| CHL X NZR         | 16 | 1437.54 $\pm$ 19.29 <sup>b</sup>  | 2001.27 $\pm$ 11.20 <sup>b</sup>  | 3509.97 $\pm$ 15.21 <sup>b</sup>   | 70.20 $\pm$ 14.76 <sup>b</sup>  |
| CHL X K- $\alpha$ | 16 | 1519.92 $\pm$ 15.24 <sup>a</sup>  | 2482.63 $\pm$ 19.27 <sup>a</sup>  | 3924.88 $\pm$ 26.42 <sup>a</sup>   | 93.75 $\pm$ 0.05 <sup>a</sup>   |
| CHL X NZW         | 16 | 1441.94 $\pm$ 16.28 <sup>b</sup>  | 2041.17 $\pm$ 18.25 <sup>b</sup>  | 1954.23 $\pm$ 23.99 <sup>c</sup>   | 83.33 $\pm$ 9.62 <sup>ab</sup>  |
| NZR X NZW         | 16 | 1358.86 $\pm$ 13.26 <sup>b</sup>  | 1381.67 $\pm$ 13.28 <sup>c</sup>  | 1521.68 $\pm$ 21.15 <sup>c</sup>   | 46.42 $\pm$ 21.32 <sup>c</sup>  |
| NZR X CHL         | 16 | 1258.80 $\pm$ 10.17 <sup>c</sup>  | 1442.09 $\pm$ 14.26 <sup>c</sup>  | 1907.56 $\pm$ 29.07 <sup>c</sup>   | 52.77 $\pm$ 20.97 <sup>bc</sup> |
| NZR X K- $\alpha$ | 16 | 1438.89 $\pm$ 16.17 <sup>b</sup>  | 1780.48 $\pm$ 10.22 <sup>bc</sup> | 2575.04 $\pm$ 28.44 <sup>bc</sup>  | 86.42 $\pm$ 3.57 <sup>ab</sup>  |
| K- $\alpha$ X NZW | 16 | 1641.00 $\pm$ 11.11 <sup>a</sup>  | 2543.12 $\pm$ 18.20 <sup>a</sup>  | 3554.23 $\pm$ 23.99 <sup>b</sup>   | 83.33 $\pm$ 9.62 <sup>ab</sup>  |
| K- $\alpha$ X CHL | 16 | 1506.45 $\pm$ 15.20 <sup>a</sup>  | 2476.83 $\pm$ 16.26 <sup>a</sup>  | 3917.56 $\pm$ 20.07 <sup>a</sup>   | 91.66 $\pm$ 00.00 <sup>a</sup>  |
| K- $\alpha$ X NZR | 16 | 1663.53 $\pm$ 10.26 <sup>a</sup>  | 2263.24 $\pm$ 17.24 <sup>a</sup>  | 2995.66 $\pm$ 24.62 <sup>abc</sup> | 66.66 $\pm$ 23.57 <sup>b</sup>  |

<sup>a,b,c</sup>: Means in the same column with different superscripts are significantly different (P<0.05).

PWLWG = Pre-weaning litter weight gain at day 21

ALWG42 = Average litter weight gain at day 42 ALWG84 =

Average litter weight gain at day 84

KWL = Kindling to weaning livability.

Strain significantly (P<0.05) affected rearing mortality from birth, pre-weaning, weaning and post weaning age. Results from Table 2 indicated that rearing mortality increased with increase in age of rabbits across the genetic groups studied Chinchilla X New Zealand White and New Zealand White pure line (8.33 $\pm$ 0.005 and 8.33 $\pm$ 0.03%) at birth, K- $\alpha$  X New Zealand Red (33.33 $\pm$ 2.57%) at pre-weaning, Chinchilla X New Zealand Red (46.66 $\pm$ 14.27%) at weaning and New Zealand White (58.25 $\pm$ 10.02%) respectively. K- $\alpha$  X Chinchilla had the least value in all the growing phases with no mortality at birth and corresponding values of 3.00 $\pm$ 0.00%, 2.50 $\pm$ 0.05% and 12.13 $\pm$ 5.00% at pre weaning, weaning and post weaning ages respectively (Table 2).

## DISCUSSION

Variation in pre-weaning litter weight, weaning and post weaning ages of 21, 42 and 84 days among the genetic groups is expected. This is a function of the differences in their genetic component. According to Castellini and Battaglini (1995), working on the significant effect of sire on most of the litter traits suggested that litter traits must be analyzed as traits of the sire that produced the sire or buck. Accordingly, the effect of sire that produced the litter must be considered in genetic analysis. He made the conclusion that selection of sires of those based on the doe performance for litter traits at weaning will be effective for genetic improvement of those traits. Several studies reviewed have shown that sire effect was significant for litter traits in some breeds and not in others. North *et al.* (2018) however, reported that sire affected significantly all the pre-weaning mortality in Bouscat, as well as litter size in Giza White purebred rabbits.

Better performance, as noticed in K- $\alpha$ , New Zealand White and Chinchilla showed that the breeds possess genetic potential for long term litter production (multiparous) which make the animals ideal litter producer. The wide differences in body weight at first parity naturally results in variation in individual productivity measured in terms of litter production traits. This showed vividly that productivity is a function of the breed which to a large extent depends on sire's body weight at maturity. Better performance in terms of kindling to weaning livability noticed in Chinchilla and K- $\alpha$  could be related to high degree of hardiness. The breeds were selected for dual purpose of high productivity, (meat and prolificacy) and good tolerance to tropical environment that is characterized

by disease and heat stress. According to Trocino *et al.* (2018) and Akanni and Ajayi (2023), stress usually comes as a result of variation in temperature, humidity and also nutrition.

**Table 2: Least squares means  $\pm$  SEM of sire's strain influence on rearing mortality (%) of rabbit genetic groups at different ages**

| Genotypes         | N  | Birth (%)                     | Pre-weaning (%)                 | Weaning (%)                    | Post Weaning (%)               |
|-------------------|----|-------------------------------|---------------------------------|--------------------------------|--------------------------------|
| NZW               | 16 | 8.33 $\pm$ 0.03 <sup>b</sup>  | 18.25 $\pm$ 1.02 <sup>abc</sup> | 30.00 $\pm$ 11.14 <sup>b</sup> | 56.85 $\pm$ 10.02 <sup>a</sup> |
| CHL               | 16 | 0.00 $\pm$ 0.00 <sup>c</sup>  | 0.00 $\pm$ 0.00 <sup>c</sup>    | 0.00 $\pm$ 0.00 <sup>c</sup>   | 20.00 $\pm$ 0.00 <sup>c</sup>  |
| NZR               | 16 | 3.00 $\pm$ 0.00 <sup>c</sup>  | 12.50 $\pm$ 2.97 <sup>b</sup>   | 12.50 $\pm$ 2.50 <sup>bc</sup> | 22.50 $\pm$ 0.97 <sup>bc</sup> |
| K- $\alpha$       | 16 | 0.03 $\pm$ 0.03 <sup>ab</sup> | 3.42 $\pm$ 1.98 <sup>c</sup>    | 2.50 $\pm$ 13.14 <sup>c</sup>  | 15.47 $\pm$ 0.98 <sup>c</sup>  |
| NZW X CHL         | 16 | 5.55 $\pm$ 0.05 <sup>b</sup>  | 5.27 $\pm$ 10.39 <sup>bc</sup>  | 31.66 $\pm$ 14.24 <sup>b</sup> | 15.27 $\pm$ 0.39 <sup>bc</sup> |
| NZW X NZR         | 16 | 0.00 $\pm$ 0.00 <sup>c</sup>  | 24.64 $\pm$ 0.35 <sup>ab</sup>  | 42.25 $\pm$ 21.25 <sup>a</sup> | 24.64 $\pm$ 0.35 <sup>bc</sup> |
| NZW X K- $\alpha$ | 16 | 3.37 $\pm$ 0.03 <sup>bc</sup> | 12.50 $\pm$ 1.25 <sup>b</sup>   | 6.25 $\pm$ 0.62 <sup>bc</sup>  | 22.50 $\pm$ 0.50 <sup>bc</sup> |
| CHL X NZR         | 16 | 0.00 $\pm$ 0.00 <sup>c</sup>  | 19.79 $\pm$ 1.76 <sup>b</sup>   | 46.66 $\pm$ 14.27 <sup>a</sup> | 19.79 $\pm$ 0.76 <sup>bc</sup> |
| CHL X K- $\alpha$ | 16 | 0.00 $\pm$ 0.00 <sup>c</sup>  | 6.25 $\pm$ 0.25 <sup>bc</sup>   | 8.33 $\pm$ 0.83 <sup>bc</sup>  | 16.25 $\pm$ 0.25 <sup>c</sup>  |
| CHL X NZW         | 16 | 8.33 $\pm$ 0.00 <sup>b</sup>  | 16.66 $\pm$ 2.62 <sup>b</sup>   | 12.50 $\pm$ 1.25 <sup>bc</sup> | 26.66 $\pm$ 0.96 <sup>bc</sup> |
| NZR X NZW         | 16 | 0.00 $\pm$ 0.00 <sup>b</sup>  | 13.27 $\pm$ 1.32 <sup>b</sup>   | 31.25 $\pm$ 8.96 <sup>ab</sup> | 53.57 $\pm$ 1.32 <sup>a</sup>  |
| NZR X CHL         | 16 | 5.56 $\pm$ 0.05 <sup>b</sup>  | 17.92 $\pm$ 2.97 <sup>abc</sup> | 31.25 $\pm$ 6.75 <sup>ab</sup> | 17.22 $\pm$ 2.97 <sup>b</sup>  |
| NZR X K- $\alpha$ | 16 | 0.00 $\pm$ 0.00 <sup>c</sup>  | 3.57 $\pm$ 0.35 <sup>c</sup>    | 4.16 $\pm$ 0.41 <sup>c</sup>   | 13.57 $\pm$ 0.35 <sup>c</sup>  |
| K- $\alpha$ X NZW | 16 | 0.03 $\pm$ 0.33 <sup>c</sup>  | 3.66 $\pm$ 0.96 <sup>c</sup>    | 2.50 $\pm$ 0.22 <sup>c</sup>   | 16.66 $\pm$ 0.96 <sup>c</sup>  |
| K- $\alpha$ X CHL | 16 | 0.00 $\pm$ 0.00 <sup>c</sup>  | 3.00 $\pm$ 0.00 <sup>c</sup>    | 2.50 $\pm$ 0.05 <sup>c</sup>   | 12.13 $\pm$ 5.00 <sup>c</sup>  |
| K- $\alpha$ X NZR | 16 | 0.36 $\pm$ 0.06 <sup>c</sup>  | 3.33 $\pm$ 2.57 <sup>a</sup>    | 4.16 $\pm$ 0.04 <sup>c</sup>   | 3.33 $\pm$ 3.57 <sup>b</sup>   |

a,b,c: Means in the same column with different superscripts are significantly different (P<0.05)

The differences in rearing mortality, in terms of number born, pre-weaning and post weaning deaths of litter/ kits among the genotypes were reported. Chinchilla and K- $\alpha$  and their crosses recorded next to zero mortality throughout the study except at post weaning ages. This is a breed that has long time been domesticated for rearing in tropical environment like Nigeria, and K- $\alpha$  being a new strain generated from 3-way crossbreeding experiments involving Chinchilla, New Zealand Red and Cinnamon. The high mortality recorded in New Zealand White could be due to environmental effect in terms of seasonal changes which could have had adverse effect in their reproductive activity, as a temperate breed possessing low tolerance to heat and stress characteristics of tropical climatic condition. According to Adejinmi *et al.*, (2005) cited by Akanni *et al.* (2023); North *et al.* (2018), extreme heat or cold, rain, wind or sudden changes in temperature and humidity usually have a temporary adverse effect on the reproductive activity of the doe causing physical discomfort, lowering vitality; reduce feed intake or restricting exercise and thereby resulting in reduced litter productivity (Adjahossou *et al.*, 2017. This could have informed the results obtained in this study.

## CONCLUSION

The differences observed in the Sire's strain effect on livability and productivity traits showed that the rabbit lines all exhibited different breed advantages. Sire's strain to a large extent is a function of breed characteristics. Dominance gene action favoured the productivity traits the cross breeds; this premised that standard selection procedures such as mass selection for sires with superior traits of economic importance should be highly considered for genetic improvement and better performance in rabbits.

## RECOMMENDATIONS

Variations that existed in this rabbit genetic groups studied should be thoroughly exploited through crossbreeding and selection programmes. This is desirable in order to take advantage of heterosis in enhancing numerical doe reproductive ability (measured through the number of weaned rabbits per doe per year) which is the key goal for improving animal agriculture for sustainable economic development in Nigeria.

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