

Heterosis for Prewaning Litter Characteristics in Nigerian Rabbit Crosses

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Abstract

The study investigated heterosis effects for preweaning litter characteristics using three Nigerian local rabbits (Local White LW, Local Brown Tail LBT, Local Black LB). The percent heterosis for litter size in LW x LB crossbred kits was positive at the 7th, 14th and 21st day postpartum (+24.20%, +31.63% and +22.94%, respectively). Direct heterosis and percent heterosis were negative for litter size in LW x LBT and LBT x LB crosses from birth to 21-day post-partum. A positive percent heterosis of 19% was recorded for litter size in LW x LB crossbred kits from birth to 21-day post-partum. Mortality within litter in LW x LBT and LBT x LB crossbred kits was reduced by 159% and 125%, respectively. Heterosis effect for litter weight (birth to 21-day postpartum) was 11% for LW x LB crossbred kits. Estimates of direct heterosis (and percent heterosis) for average kit birth weights were favourable for crossbred kits in this study. The potential of crossbreeding to tap the non-additive genes for reproductive performance was confirmed in the present study. Crossing LW with LB resulted in positive heterosis for postbirth litter size and litter weight while LW x LBT and LBT x LB helped to improve preweaning mortality and average kits' weight.

Key words: *Heterosis, Prewaning, Postweaning, Rabbit crosses*

1. Introduction

Growth traits in growing rabbits are important because heavier marketable bodyweight promotes the economics of rabbit production (Rashwan *et al.*, 1997). Crossbreeding is one of the fast tools offered to breeders to improve many traits in farm animals (Oseni *et al.*, 1997). One major basis for crossbreeding lies in the fact that the crossbred animals often manifest heterosis due to good interbreeding or nicking ability. Heterosis usually occur where the populations crossed differ genetically. Positive heterosis is the superiority of the heterozygous above the average value for the two parents. The percent superiority depends on the magnitude of non-additive genetic variation in the trait under consideration (Nagpure *et al.*, 1991).

Breed complementation for growth and carcass traits by crossing animals of different genotypes has generated a lot of interest among rabbit breeders (Carregal and Liu, 1984, Panic *et al.*, 1985, Lebas *et al.*, 1986, Ozimba and Lukefahr 1991, Rashwan and Marai, 2000, Iraqi *et al.*, 2008). For instance, breed complementarity was achieved by crossing the fast growing indigenous Sinar Gabali breed with the imported prolific V rabbit line (Iraqi *et al.*, 2008). The needed information on breed complementarity which should precede commercial trend is much less documented in developing countries of Africa. This study aimed to estimate heterosis in prewean-

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ing growth traits using three Nigerian domestic rabbits.

2. Materials and Methods

The Breeding bucks and does used for this experiment were raised in Nigeria tropical environments. The annual rainfall, relative humidity, and temperature were 600-1416mm per annum, 57.9-84.0% and 19.7-37.0°C, respectively. Animals were housed in hutches measuring about 72 cm x 62 cm x 52 cm. Kits and does were fed mash diet containing 46.59% rice bran, 25.00% palm kernel cake, 15.50% rice offal, 1.50% Oyster shell, 0.55% bone meal and 0.50% salt. The mash diet was supplemented with available local forages. The bioeconomic traits considered in this investigation were: Litter Size at Birth, LSB; Mortality within Litter group, MRL; Litter Birth Weight, LBW; Mean kit Birth Weight, KBW; Weekly litter size; Weekly within litter mortality; Weekly Litter Weight, LWT; Weekly Mean Kit Weight, MKW; and Weekly Growth Rate, GR. Estimates of direct heterosis were obtained as follow (Dickerson, 1992):

$$H' [LW \times LBT] = [LW \times LBT + LBT \times LW] - [LW \times LW + LBT \times LBT]$$

$$H' [LW \times LB] = [LW \times LB + LB \times LW] - [LW \times LW + LB \times LB]$$

$$H' [LB \times LBT] = [LB \times LBT + LBT \times LB] - [LB \times LB + LBT \times LBT]$$

LW, LBT and LB represented the Local White, Local Brown Tail and the Local Black rabbit, respectively. The percent heterosis was calculated as follows:

$$\frac{H'[\text{units}]}{\text{Means of purebreds}} \times 100$$

H' = Estimate of direct heterosis in unit. The statistical model used in this study was as follows:

$$y_{ij} = \mu + B_i + e_{ij},$$

Where y_{ij} = Record of the j th individual or litter belonging to the i th strain of local rabbit, μ = Random mean, B_i = Effect of the i th breed, e_{ij} = Error residual.

3. Results and Discussion

Prewaning and Weaning Litter and Kit Characteristics

Data on litter size at birth, litter birth weight, kit birth weight, litter mortality at birth, as well as litter size, litter weight, kit weight, litter mortality and growth rate at 7th, 14th and 21st Day post-partum were presented in Table 1. Mean litter size at birth varied from 3.20 (LBT x LB) to 4.82 (LB x LB) while the litter size at 21 days post-partum was 1.00 to 4.29 kits per litter. Litter size at birth was (on the average) higher in purebred than in crossbred rabbits. There was no significant difference ($p > 0.05$) in kits weight at birth but crossbred kits were heavier at 7th, 14th and 21st Day post-partum. LBT x LB crossbred kits had the highest mortality in the first week postpartum. Survivability in the first week postpartum was highest in LBT x LBT (Table 1). Nigerian rabbits used in the present study were better in litter and kit birth weights than Sudanese local rabbit that was reported by Elamin and Yousif (2011). Litter size at birth in the present study was similar to that reported by Elamin and Yousif (2011) for Sudanese local rabbit but lower compared with litter size at birth in Egyptian and exotic rabbits (Yamani, 1990, Rashwan *et al.*, 1997). Crossbred kits in this study were heavier than the purebred kits due to the smaller litters in which they were raised. Previous studies by Rashwan *et al.* (1997) and Ouyed and Brun (2008) showed that kit weight at birth, weaning, and post weaning liveweight and market age were significantly higher for crossbred strains of rabbit. The present result agrees with the report of El-Bayomi *et al.* (2012) who observed a decline in growth rate with advancing kits' age in their work on the New Zealand White, Californian and Gray Giant Flander breeds.

Neonatal mortality in the present study was lower compared with 5-7% of still born reported for highly prolific does in modern French rabbitries (Lebas *et al.*, 1986). The present study also agrees with the submission of Rashwan and Marai (2000) who observed that about 94% of preweaning losses occurred within the first two weeks of life.

Table 1Mean ($\pm$ SD) of productive and Reproductive traits in Nigerian local rabbits and their crosses

Litter Birth	Trait	PUREBRED			CROSSBRED		Total
		LWxLW	LBTxLBT	LBxLB	LBTxLW	LBTxLB	
		27 (128)	8(38)	22(106)	6(23)	6(19)	79(314)
	LSB	4.74 $\pm$ 1.23	4.75 $\pm$ 1.49	4.82 $\pm$ 1.68	3.67 $\pm$ 2.52	3.20 $\pm$ 1.48	4.52 $\pm$ 1.52
	MRL	2.30 $\pm$ 6.71	2.13 $\pm$ 6.01	3.05 $\pm$ 11.09	0.00 $\pm$ 0.00	18.20 $\pm$ 16.93	3.87 $\pm$ 10.55
	LWT	210 $\pm$ 46	209 $\pm$ 69	234 $\pm$ 81	158 $\pm$ 95	112 $\pm$ 46	200 $\pm$ 70
	KBW	46.16 $\pm$ 8.90	45.88 $\pm$ 11.24	48.71 $\pm$ 6.72	46.33 $\pm$ 7.09	47.00 $\pm$ 13.38	46.42 $\pm$ 8.72
7 th Day	LS	4.30 $\pm$ 1.30	4.29 $\pm$ 1.60	4.30 $\pm$ 2.65	3.00 $\pm$ 2.65	1.80 $\pm$ 0.84	3.96 $\pm$ 1.70
	MRL	7.04 $\pm$ 13.50	5.71 $\pm$ 15.12	10.65 $\pm$ 21.37	16.67 $\pm$ 28.87	21.40 $\pm$ 30.82	10.35 $\pm$ 18.21
	LWT	394 $\pm$ 119	488 $\pm$ 177	474 $\pm$ 227	236 $\pm$ 0	206 $\pm$ 89	376 $\pm$ 173
	MKW	91.12 $\pm$ 20.09	112.00 $\pm$ 21.12	105.21 $\pm$ 21.52	118 $\pm$ 0	125.75 $\pm$ 31.82	97.27 $\pm$ 24.29
	GR	123 $\pm$ 71	153 $\pm$ 50	112 $\pm$ 24	162 $\pm$ 0	177 $\pm$ 108	121 $\pm$ 56
14 th Day	LS	4.32 $\pm$ 1.38	4.29 $\pm$ 1.38	4.25 $\pm$ 1.81	3.00 $\pm$ 2.65	1.50 $\pm$ 0.58	3.85 $\pm$ 1.62
	MRL	5.63 $\pm$ 12.88	0.00 $\pm$ 0.00	5.19 $\pm$ 12.13	0.00 $\pm$ 0.00	5.00 $\pm$ 10.00	4.31 $\pm$ 11.22
	LWT	610 $\pm$ 187	675 $\pm$ 346	649 $\pm$ 284	684 $\pm$ 341	241 $\pm$ 53	557 $\pm$ 241
	MKW	143.22 $\pm$ 28.14	133.00 $\pm$ 35.50	158.41 $\pm$ 20.96	188.00 $\pm$ 48.08	171.75 $\pm$ 44.58	148.42 $\pm$ 33.57
	GR	63 $\pm$ 34	33 $\pm$ 8	61 $\pm$ 26	88 $\pm$ 0	75 $\pm$ 24	60 $\pm$ 11
21 st Day	LS	4.11 $\pm$ 1.45	4.29 $\pm$ 1.60	4.25 $\pm$ 1.81	3.00 $\pm$ 2.65	1.00 $\pm$ 0.00	3.73 $\pm$ 1.65
	MRL	1.05 $\pm$ 4.59	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	1.16 $\pm$ 5.71
	LWT	788 $\pm$ 263	773 $\pm$ 496	973 $\pm$ 329	707 $\pm$ 489	280 $\pm$ 29	734 $\pm$ 337
	MKW	201.44 $\pm$ 51.80	195.60 $\pm$ 81.47	216.92 $\pm$ 37.61	264.67 $\pm$ 49.57	280 $\pm$ 29	207.39 $\pm$ 52.53
	GR	34 $\pm$ 11	44 $\pm$ 33	38 $\pm$ 13	32 $\pm$ 5	51 $\pm$ 31	36 $\pm$ 17

LW, LBT, LB represent Local White, Local Brown Tail, Local Black, respectively. LSB, LS, MRL, LBW, LWT, KBW, MKW and GR represent Litter Size at Birth, Weekly Litter Size, Weekly within Litter Mortality, Litter Birth Weight, Weekly Litter Weight, Kit Birth Weight, Weekly Mean Kit Weight,; and Weekly Growth Rate.

Heterosis for Prewaning Litter Size

The percent heterosis effects for litter size were positive in LW x LB crossbred kits at the 7th, 14th and 21st day postpartum [+24.20%, +31.63% and +22.94%, respectively]. Direct heterosis and % heterosis were negative for litter size in LW x LBT and LBT x LB crossbred kits at the 7th, 14th and 21st postpartum (Table 2). A positive percent heterosis of 19% was recorded for LW x LB from birth to 21-day postpartum. The differences in heterosis effect for litter size among breed crosses in this study is in line with previous studies on New Zealand White and local Egyptian rabbits (Tag-El-Din *et al.*, 1992; Rashwan *et al.*, 1997). Breed combination to improve litter size is becoming increasingly important in rabbit breeding. For instance, a new line named *APRI* (produced by Youssef *et al.*, 2008) showed a direct heterosis of 24 and 28 percent for litter size at birth and at weaning. The new line was produced using Spanish V-line and Egyptian Baladi Red rabbits in a four years crossing scheme. In a contemporary study, Abdel-Azeem *et al.* (2007) observed a

positive heterosis for litter size at birth and at weaning in their four-breed crosses under Egyptian rearing conditions. Al-Saef *et al.*, (2008) evaluated traits such as litter size at birth and at weaning in Spanish V line x Saudi Gabali rabbits and reported that direct heterosis varied from 5.3% to 27.5% among the investigated production traits. However, the crossing of Sinai Gabali breed with the Spanish V-line did not give a significant individual heterosis for litter size at birth and at weaning (Iraqi *et al.*, 2010). The findings in Cuba by Garcia *et al.* (2012) suggested that California breed when used as a component of the maternal breed helped to improve total births and total born alive.

Heterosis for Litter Mortality

Crossbreeding helped to reduce within litter mortality in LW x LBT and LBT x LB crosses by 159% and 125%, respectively. On the other hand it increased mortality in LW x LB crossbred kits (Table 2). The present report agrees with earlier findings (Rashwan *et al.*, 1997, Al-Saef *et al.*, 2008).

Table 2

Estimates of direct and percent heterosis for preweaning litter characteristics in domestic rabbit

AGE	Crossbred		LS	MRL	LWT	KWT	GR
BIRTH	LW x LBT	H'	-2.56	-0.05	-51.00	+13.00	-
		%H'	-56.51	-200.00	-28.00	+30.00	-
	LW x LB	H'	-0.21	-11.00	-11.00	-5.00	-
		%H'	-4.77	-6.43	-6.00	+13.00	-
	LBT x LB	H'	-2.50	-11.00	-11.00	+6.00	-
		%H'	-57.14	-60.82	-61.00	+15.00	-
7 TH DAY POSTPARTUM	LW x LBT	H'	-1.95	-15.00	-15.00	+34.00	+0.00
		%H'	-52.35	-37.40	-41.00	+140.00	+8.00
	LW x LB	H'	+0.79	-1.07	+73.00	+3.00	+0.00
		%H'	+24.20	-83.59	+29.00	+3.00	-2.00
	LBT x LB	H'	-1.67	-1.67	-54.00	+35.00	+0.00
		%H'	-53.53	-125.09	-17.00	+41.00	+35.00
14 TH DAY POSTPARTUM	LW x LBT	H'	-1.80	-0.13	+136.00	+108.00	+0.00
		%H'	-49.32	-200.00	+32.00	+87.00	+77.00
	LW x LB	H'	+0.93	+0.48	+77.00	-12.00	+0.00
		%H'	+31.63	+739.00	+19.00	-8.00	-13.00
	LBT x LB	H'	-2.42	+1.25	-281.00	+14.00	+0.00
		%H'	-81.76	-74.00	+10.00	+10.00	-52.00
21 ST DAY POSTPARTUM	LW x LBT	H'	-1.50	-0.11	+86.00	+76.00	+0.00
		%H'	-42.86	-17.00	+41.00	+41.00	-41.00
	LW x LB	H'	+0.64	-200.00	+4.00	-5.00	+0.00
		%H'	+22.94	+0.47	+1.00	-3.00	+33.00
	LBT x LB	H'	-2.93	+8.55	-277.00	+65.00	+0.00
		%H'	-98.65	+0.33	-62.00	+34.00	+44.00
BIRTH-21 ST DAY POSTPARTUM	LW x LBT	%H'	-50±5	-159±81	-5±35	49±25	15±
	LW x LB	%H'	19±16	463±463	11±16	1±9	9±53
	LBT x LB	%H'	-73±21	-125±0	-53±25	25±15	10±42
	Population	%H'	-35±43	94±411	-16±37	26±26	

For legend, see Table 1

For instance, Rashwan *et al.* (1997) reported that preweaning mortality was reduced when New Zealand rabbit was crossed with local Egyptian rabbit in a crossbreeding programme.

The superiority of the crossbred over the purebred in this study suggests that there exist substantial non-additive genetic effects to improve kits livability especially in LW x LBT and LBT x LB crossbred rabbits (Nagpure *et al.*, 1991).

Heterosis for Litter Weight and Kits Weight

Estimates of direct heterosis (and percent heterosis) for kit birth weights were favourable for the crossbred kits in this study (Table 2). Heterosis effect for litter weight (birth to 21-day postpartum) was 11% for LW x LB crossbred kits. There were fluctuations in weekly heterosis effect for litter and kit weights among the rabbit crosses. Crossbreeding was unfavourable for growth rate in LW x LBT

crossbred kits during the third week postpartum (Table 2). On the average, crossbreeding helped to improve growth rate of crossbred rabbit by 9.8% of the parental mean from birth to 21-day postpartum. Many studies (Brun and Ouhayoun, 1989; Medellin and Lukefahr, 2001; Abdel-Azeem *et al.* 2007) revealed significant heterosis for growth rate and body weight, but at values generally lower than 5% of the parental mean. Al-Saef *et al.*, (2008) evaluated traits such as litter weight at birth, litter weight at 21 day and litter weight at weaning in Spanish V line x Saudi Gabali rabbits, showed that direct heterosis varied from 5.3% to 27.5% for all the investigated traits except litter weight at birth. Youssef *et al.* (2009) observed that estimates of direct heterosis were positive and ranged from 4.9 to 16.7% for bodyweight and 14.4 to 29.5% for rate of gain, but the estimates for maternal heterosis were, in most cases, significantly negative (-4.5 to -15.2% for body weight

and 20.6 to -36.9% for rate of gain). In another report, Eman (2011) obtained a high positive heterosis % for rate of growth at 10-12 weeks of age (40.21 %) in Californian x Bouscat rabbits. Estimates of heterosis effect obtained by El-Bayomi *et al.* (2012) for body weight, average daily gain and relative growth rate in postweaned New Zealand White, Californian and Flander crossbred rabbits were generally negative. On the other hand, a high positive heterosis effect (42.27 %) for rate of growth at 10-12 weeks of age was observed in Californian x Flander rabbits. One major advantage of crossbreeding is breed complementarity. This was demonstrated in a synthetic breed (named *APRI*) which combined the adaptability of Egyptian Baladi Red with prolificacy and mothering ability of the Spanish V-line. The synthetic breed showed a direct heterosis of 28

percent for litter weight (Youssef *et al.*, 2008). A study by Afifi *et al.* (2011) showed a less successful result ((2.5% to 5.0% for total gain and 0.7% to 9.5% for daily gain) in the local Baladi Red x New Zealand White crossbred kits.

4. Conclusion

The potentials of crossbreeding to tap the non-additive genes for improving reproductive performance is confirmed in the present study. LW x LB crossbred kits had a positive heterosis for postbirth litter size and litter weight. While LW x LBT and LBT x LB were superior in preweaning mortality and average kits' weight.

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