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EFFECTS OF INBREEDING ON DOE'S PERFORMANCE TRAITS IN CLOSED COMMERCIAL RABBIT POPULATIONS IN EGYPT

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ABSTRACT

Records of 5075 parturitions from three breeds: 2740 Bauscat (BAU), 1739 New Zealand White (NZW) and 596 Californian (CAL) after seven years of importation, were analyzed to investigate the pre-weaning productive and reproductive traits as affected by inbreeding coefficients (IC). The mixed effects model included, sire, dam within sire (as a random) year, season, parity (as a fixed) and IC of does (as a covariate) and two way interactions between fixed effects. Percentage of inbred does ranged between 55 and 60% after seven years of importation in the breeds studied. The linear regression coefficients of IC as covariant on pre-weaning performance were highly significant in BAU, NZW and CAL breeds. Inbreeding adversely affected litter size and mass at birth and weaning and pre-weaning mortality, while the positive linear regession of IC on bunny weight at birth and weaning was observed. Inbreeding in pre-weaning performance in close imported rabbit populations can be avoided by replacement selection based on performance of the dams and sire pedigree data.

INTRODUCTION

In isolated populations, there is always an increase in the level of inbreeding through mating systems designed (Richard, 1997). Inbreeding leads to greater homozygosity of individuals. The resulting inbreeding depression in performance is a function of the genetic properties of the population as well as the trait measured (Rastogi and Heyer, 1992). Inbreeding impairs physiological homeostasis and loss of genetic diversity, i.e. the ability of an individual to maintain its physiological norm against the impact of environmental influences (Lacy, 1993). The hypothesized causes of inbreeding depression fall into two categories: 1. Reduction of fitness in inbred animals due to homozygosity of deleterious recessive alleles that is thought to be a major cause of inbreeding depression in performance and fitness traits including growth rates, fertility and survival (Park *et al*., 1990 and Ferraz, *et al*. 1992). 2. loss of the general heterosis which is a fitness advantage of increased heterozygosity across the genome (Mitton, 1993).

In Egypt, the effect of inbreeding on preweaning performance of close imported rabbit populations has not been well studied and few papers on this topic are in the literature. The present work was carried out to estimate the effects of doe's inbreeding (as a covariate) on preweaning performance of subsequent generations of close imported rabbit populations.

MATERIAL AND METHODS

The study was carried out in San El-Hagar Agricultural Company Farm, San El-Hagar area, Sharkeya Governorate, Egypt. The data set included three commercial rabbit breeds: Californian (CAL), Bauscat (BAU) and New Zealand White (NZW). The rabbits were imported in 1989. The herd was closed from 1989 to 1996. During this period selection of replacement does was based on weaning weight and litter size of their dams. The animals were reared under similar environmental and managerial conditions. They were fed *ad lib.* on a commercial pelleted rabbit diet containing 180 g/kg crude protein and 140g/kg crude fibre, with 10.88 MJ/kg as digestible energy. Continuous access to freshwater was provided from automatic nipple drinkers.

The pedigree of each doe was traced back to the original imported stock and pedigree chart was prepared. The inbreeding coefficient of the stock, when imported was assumed to be zero. The coefficient of inbreeding (IC) for each doe was calculated according to Quass (1976). The data were analysed for each breed separately using General Linear Models (SAS, 1990) for the model including sire, dam within sire, year, season, parity, inbreeding coefficient (IC) as independent covariate, interactions among fixed effect and random residual effects. Logarithmic transformations were applied to each fitness measure prior to regression analysis. The following mathematical mixed model was used to describe the pre-weaning litter performance.

$Y_{bcijkl} = \mu + S_b + D_{bc} + A_i + M_j + P_k + AM_{ij} + AP_{ik} + M_{Pjk} + b_1X_1 + e_{bcijklm}$, where: Y_{bcijkl}= observed value of a given dependent variable: litter size at birth (LSB) and at weaning (LSW), litter mass at birth (LMB) and at weaning (LMW) and mean bunny weight at birth (BWB) and weaning (BWW), stillbirths (Sb%) and preweaning-mortality rate (MRW%); μ = overall mean; S_b= random effect associated with the b*th* sires of does; D_{bc}=random effect associated with the c*th* dam within sire; A_i= fixed effect of the i*th* year at delivery (i= 1 and 2); M_j= fixed effect of the j*th* season at delivery, j= 1,..4, (i.e. winter, spring, summer and autumn); P_k= fixed effect of the k*th* doe parity (k=1,..≥10); AM_{ij}=Interaction of i*th* year and j*th* season at delivery; AP_{ik}= Interaction of i*th* year and k*th* doe parity and MP_{jk}=Interactions of j*th* season at delivery with k*th* doe parity; b_1= the partial regression coefficients of Y_{bcijkl} on inbreeding coefficients (X_1) and e_{bcijkl}= random residual component.

RESULTS AND DISCUSSION

INBREEDING COEFFICIENT PERCENTAGES

Table 1. General frequency % of data according to breed and inbreeding coefficient (IC) levels.

Breeds	0	<0.25	0.25-0.50	>0.50
BAU	44.51	11.45	16.70	27.34
NZW	45.05	9.32	19.11	26.52
CAL	39.87	9.29	23.14	27.70

The general frequency of non-inbred and inbred does according to breed in the total data are shown in Table 1. The percentage of inbred does ranged between 55 and 60 % after seven years of importation in the total data. In general, inbreeding level is a reflection of the size of population, number of the two sexes, mating system, replacement and culling.

INBREEDING COEFFICIENTS AS A REGRESSION

The linear regression coefficients of IC as covariant on pre-weaning performance (Table 2) were highly significant (P<0.001) in BAU, NZW and CAL breeds, except Sb% in NZW and CAL breeds. These results show that each 1% increase in IC has resulted in an decrease of 6.4, 3.3, 6, 3.1 and 6.7, 3.2 % in LSB and LSW in BAU, NZW and CAL breeds, respectively. Chai (1969) and Poujardieu and Toure (1980) reported an adverse effect of inbreeding on LSB (a decrease of 0.7 kits born alive for an increase of 10% in IC of doe) and weaning (a decrease of 0.37 kits at weaning for an increase of 10% in IC of doe). LMB and LMW were decreased with increase of IC in three breeds. Similar to that reported by Bielanski *et al*., (1992) in NZW rabbits. Also, Park *et al*. (1990) analyzed the effect of inbreeding on weight of Angora and found inbred animals were lighter at 2 months of age when compared with non-inbred rabbits. In general, poor LSB, LSW, LMB and LMW during inbreeding might occur because inbred does suffer higher mortality at the embryonic, fetal and preweaning period. In addition to, inbred does provide poorer maternal care for their litters. Such effect was noted by Ralls *et al*, (1988) in mammals and by Lacy *et al*. (1996) in *Peromyscus Polionotus*.

Table 2. Linear regression analysis (b±se) for inbreeding coefficients (%) on performance traits in three commercial rabbit populations.

Traits	Breed		
	Bauscat	New Zealand White	Californian
Litter size at:			
Birth (LSB)	- 0.064±0.002***	- 0.060±0.001***	- 0.065±0.002***
Weaning (LSW)	- 0.033±0.004***	- 0.031±0.002***	- 0.032±0.004***
Litter mass at:			
Birth (LMB)	- 2.670±0.073***	- 2.300±0.093***	- 2.340±0.160***
Weaning (LMW)	-13.280±0.084***	-11.970±1.090***	-10.860±1.860***
Bunny weight at:			
Birth (BWB)	+ 0.176±0.012***	+ 0.195±0.013***	+ 0.201±0.020***
Weaning (BWW)	+ 1.563±0.116***	+ 1.460±0.219***	+ 2.510±0.677***
Mortality %			
Stillbirths (Sb%)	+ 0.029±0.010 **	+ 0.010±0.012 NS	+ 0.037±0.023 NS
At weaning (MRW%)	+ 0.258±0.021***	+ 0.260±0.023***	+ 0.257±0.035***

*** P<0.001, ** P<0.01, * P<0.05 and NS =Not significant.

The antagonism trends were observed for BWB and BWW in BAU, NZW and CAL breeds. The positive linear regression between IC and each of BWB and BWW in the present work confirms the above results. BWB is negatively correlated to LSB (Farghaly, 1996). These results were in agreement with that reported by Lacy, 1993 in *Callimico*. The linear regression coeifficents of IC on MRW% in three breeds were significant. Similar to that reported by Ralls *et al*, 1988 in mammals and Lacy, 1993 in *Callimico*. In general, probably the greater percent of MRW% was due to lowered resistance associated with inbreeding (Bielanski *et al*., 1992). Inbreeding can be a stress and it often causes greater mortality of Juveniles (Ralls *et al*. 1988). The linear regression of IC on Sb% in both NZW and CAL breeds were not significant. Similarly, Nunes and Polastre (1988) reported that inbreeding had no significant effect on Sb% in Norfolk rabbits.

CONCLUSIONS

The average effect of inbreeding was detrimental for pre-weaning performance. Inbreeding levels in close imported rabbit populations can be avoided by combining inbreeding levels with selection to purge a population of the genes that cause inbreeding depression, opening the population to outside sire and mating strategies are based not only on performance traits, but on pedigree data. Therefore, evaluating true value of doe's inbreeding depression for pre-weaning performance, adjustments might be made by gain of selection, under selection system of same population.

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