GENETIC AND PHENOTYPIC PARAMETERS OF PRODUCTIVE AND REPRODUCTIVE TRAITS IN FIVE RABBIT BREEDS

By

A. M. Abdou, A. E. Khattab*, and A. E. Abou-Zeid*
Animal Production Department, Fac. of Agric., Cairo Univ., Giza, Egypt.
* Animal Production Dep., Faculty of Agric., Tanta, Tanta University

Received: **27/7/2006** Accepted: **16/8/2006**

ABSTRACT: *This experiment was carried out at Sakha experimental Farm, Kafr El-Sheikh, during the period from October 2000 to July 2003. Breeds used in this study were four foreign breeds, New Zealand White (NZW), California (Cal), Bauscat (Baus), and Flander (Flan), in addition to Baladi Black (BB) rabbit as a local breed. Studied traits are litter size at birth (LSB), litter weight at birth (LWB), bunny weight at weaning (WW) and marketing weight at 8 weeks (MW). The model used in the analysis included, the random effects of direct additive genetic, permanent environmental and residual. The fixed effects are month and year of kindling, parity and sex.*

Preliminary analysis of data, showed the significant effect of breed, month and year of kindling and parity (P<0.05 or P<0.01) for all traits that studied, while sex had no significant effect. Estimates of direct heritability for LSB were 0.63, 0.79, 0.60, 0.61 and 0.69 for NZW, Cal, Baus, Flan and BB, respectively. Heritability estimates for LWB, WW and MW were 0.56, 0.57 and 0.81 for NZW, 0.99, 0.85 and 0.79 for Cal, 0.59, 0.48 and 0.66 for Baus, 0.60, 0.46 and 0.63 for Flan and 0.70, 0.64 and 0.77 for BB, respectively.

Phenotypic correlations among litter size and litter weight at birth were positive and moderate. Also, phenotypic correlation between bunny weight at weaning and marketing weight were positive. However, estimates of phenotypic correlations between litter size at birth and both bunny weight at weaning and marketing weight were negative. Genetic correlations among all studied traits for each breed are similar in magnitude and their direction to the corresponding estimate of phenotypic correlations.

INTRODUCTION

The size and weight of litter at birth and at weaning are the most important economic components of meat production in prolific species such as pigs or rabbits. These traits are controlled by genetic and environmental factors. In development and evaluation of breeding programs, estimation of breeding values, genetic and non genetic parameters for the different productive and reproductive traits need to be evaluated accurately.

Genetic evaluation data of post-weaning growth traits was often performed using a sire model or animal model (Khalil, 1986; Khalil *et al*., 2000 and 2001, Afifi and Farid, 2001, Afifi *et al*., 2001; Anous, 2001, Sabra *et al*., 2001, Iraqi *et al*., 2002 and Kassab, 2004). Henderson (1988) stated that genetic evaluation using an animal model (where all relationships among all animals are considered) would be more accurate than evaluation based on sire model (which account only for relationship among sires).

The main objectives of the present study were to estimate phenotypic and genetic parameters for productive and reproductive traits (litter size at birth (LSB), litter weight at birth (LWB), bunny weight at weaning (WW) and marketing weight (MW)) for five breeds of rabbits; New Zealand White (NZW), California (Cal), Bauscat (Baus), Flander (Flan) and Baladi Black (BB) by using Multi - Trait Animal Model (MTAM).

MATERIALS AND METHODS

This experiment was carried out during the period from October, 2000 to July 2003. Four foreign breeds of rabbits were used in this study New Zealand White (NZW), California (Cal), Bauscat (Baus), and Flander (Flan) beside Baladi Black (BB) as native breed.

All animals included in this study were pedigreed. Females within each breed were randomly grouped at the beginning of the first breeding season, into groups having from 3 to 5 does and one buck according to the available numbers. Rabbits were fed diets according to the requirements of rabbits (NRC, 1994). A dry concentrated ration was provided in the morning and in the evening. In winter, barseem (*Trifolium alexandrinum*) was supplied at mid-day. During the summer months, clover hay and green maize plants (locally called drawa) were offered instead of barseem. The distributions of data, are presented in Table 1.

Statistical Analysis: Variance and covariance components and genetic parameters were estimated by using Multi-Trait Animal Model (MTAM) according to program of VCE 4 (Version 4.25) and PEST software, both are written by (Groeneveld et al., 1998). Studied traits are litter size at birth

(LSB), litter weight at weaning (LWB), bunny weight at weaning (WW) and marketing weight (MW). The MTAM which was used included the random effects of animal, permanent environmental and residual and the fixed effects of year of calving (from 2000 to 2003), month of calving (November to May), parity (1 to 4th) and sex. In addition, another model included the fixed effects of breed, month, year of kindling, parity and sex was also used.

RESULTS AND DISCUSSION

a- Unadjusted means:

Unadjusted means, standard deviations (SD) and coefficients of variability (CV%) for different traits studied for each breeds, are presented in Table 2. The means of litter size at birth (LSB) were 6.93, 7.25, 6.68, 8.37 and 6.79 for NZW, Cal, Baus, Flan and BB rabbits, respectively. The corresponding means of litter weight at birth (LWB) were 384, 349, 366, 395 and 335 g for the same breeds, respectively. The results showed that the Flander rabbits had the highest means of LSB and LWB than those of the other four breeds studied (Table 2).

Means of bunny weight at weaning at 4 weeks (WW) were 357, 295, 348, 292 and 312 gm for NZW, Cal, Baus, Flan and BB rabbits, respectively. Means of body weight at marketing 8 weeks (MW) were 868, 875, 868, 926 and 750 gm for the same breeds, respectively. The present results showed that Flander rabbits had higher body weight at weaning and at marketing than the other studied breeds. Also, the present means are little higher than those reported by Hassan *et al*. (1999), Khalil *et al*. (2000) and Afifi and Farid (2001). These differences may be due to, variation in ovulation rate and milking efficiency of the doe within each breed. Also, the environmental factors.

b- Non genetic effects:

The preliminarily analysis of data show that the effects of breed, month and year of kindling, parity were significant for all studied traits, while, the effect of sex was not significant (Table 3). The parity order or the year-season are the main factors affecting reproductive and productive traits. The first parity had a negative influence on litter size, litter weight at birth, bunny weaning weight and marketing body weight. In this respect, Khalil (1986) working on Bauscat and Giza White rabbits, found that pre weaning body weight and gain increased with advance of parity from 1st to 3rd and decreased thereafter. This may be due to the changes in the physiological efficiency of the dams, especially those associated with nourishment and intrauterine environment provided during pregnancy which occur with advance of parity. The significant effect of month and year of kindling (Table 3) can probably be attributed to fluctuation in weather, labor skill, feeding and health conditions.

c- Genetic parameters:

Direct heritability (h^2) for litter size at birth (LSB), litter weight at birth (LWB), bunny weight at weaning (WW) and marketing weight (MW) for the five breeds are presented in Table 4. Higher estimates of h^2 for different traits studied for each breed, indicated that direct additive variance is of considerable importance and consequently, litter size at birth, litter weight at birth, bunny weight at weaning and post weaning growth traits of five breeds of rabbits could be improved by selection of sires based on the performance of their progenies and also, selection for does and dams. In addition, higher estimates for LWB and WW (Table 4), suggested that selection for weaning weight will give greater improvement in body weight at marketing. Also, these substantial estimates indicated that importance to plan specialized selection programs of sires. The present estimates of h^2 for different traits studied are higher than those estimates reported by Khalil *et al*. (2001), Sabra *et al*. (2001) and Iraqi *et al*. (2001), who working on different breeds of rabbits in Egypt and using animal model.

d- Correlations:

Multi Trait Animal Model (MTAM) analysis of variance and covariance were performed on the data of the five rabbit breeds in order to derive estimates of direct additive genetic (r_g) and phenotypic (r_p) correlations among different traits studied.

Phenotypic correlations (r_p):

The phenotypic correlations among litter size at birth and litter weight at birth were positive and moderate for all breeds (Table 5). The present results showed an increase in litter weight at birth associated with increases in reproductive rates and consequently this trait can be improved. Khalil (1986) working on Bauscat and Giza White rabbits found that the phenotypic correlation between litter size at birth and litter weight at birth were positive and being 0.76 and 0.73 for Bauscat and Giza White rabbits, respectively. In addition, the estimates of most investigators (Sallam *et al*., 1999; Enab *et al*., 2000; Afifi *et al*., 2001; Zaky, 2001 and Kassab, 2004) working on different breeds groups of rabbits showed similar general trends indicating that litter size and litter weight traits from birth to weaning were positively phenotypically correlated.

Estimates of phenotypic correlations between litter size at birth and both bunny weight at weaning and marketing were negative and relatively low or moderate for the five breeds studied (Table 5). Our results indicate that the correlation coefficients decrease as the age of the bunny increased. These estimates show large-sized litters had higher mean bunny weight at weaning and at weaning than the small-sized litters. In this respect, Khalil (1986) working on Bauscat and Giza White rabbits, reported that the phenotypic correlation between litter size at birth and mean bunny weight at weaning were -0.47 and -0.34, respectively. The same author concluded that the negative phenotypic correlations may be due to that the mean bunny weight at weaning being influenced ($P < 0.001$) by litter size at birth.

The phenotypic correlations among litter weight at birth, bunny weight at weaning and at marketing were positive and high for the all breeds studied (Table 5). The present estimates are within the range from 0.59 to 0.85, which in agreement with those reported by (Khalil, 1986; Mohamed, 1993 and Enab *et al*., 2000).

Genetic correlation (r_g):

Genetic correlation between litter size at birth and litter weight at birth for the five breeds (Table 6), showed that most of these relationships were similar (in magnitude) and higher than phenotypic correlations. Similar results are reported by Sallam *et al*., (1999), Enab *et al.,* (2000), Afifi *et al*., (2001) and Zaky (2001) and ranged from 0.43 to 0.99.

Estimates of genetic correlations between litter size at birth and bunny weight at weaning and marketing for five breeds were negative (Table 6). This pattern indicated that genetic correlation coefficient decreases as the age of the bunny increases. In this respect, Khalil (1986) working on Bauscat and Giza White rabbits found that litter size at birth was negatively genetically correlated with the individual mean weight at weaning. The same author also, concluded that the maximum annual rate of direct genetic progress in rabbit herds selected solely for litter size and litter weight at weaning are 0.45 young (9.30%) and 445 g (22%) per litter per year, respectively. Consequently, the annual gain in mean bunny weight at weaning will be approximately 56 g (12.9%) and the expected direct selection gave greater improvement in litter weight at weaning and mean bunny weight at weaning than indirect selection.

Genetic correlations among litter weight at birth and both bunny weight at weaning and body weight at marketing were positive, and the correlation coefficients decreases as the age of the bunny advanced (Table 6). These results indicated that genes affecting litter weight at birth have also an effect the corresponding traits at weaning and marketing. Therefore, genetic correlations in this study are promising for rabbit breeders to select for litter weight at earlier ages. Selection for heavy litter weight at birth is usually associated with genetic improvement in the corresponding traits at weaning and marketing. Similar results were obtained by Khalil, 1986; Mohamed, 1993; Enab *et al*., 2000, Sqrensen *et al*., 2001 and Anous, 2001 working on different breeds of rabbits and ranged from 0.26 to 1.06. These results suggested a high and favorable genetic association between litter weight at birth and mean bunny weight at weaning and marketing. In addition, Rouvier *et al*., (1973) suggested that the growth rate of the average young rabbit during the pre weaning period depends less on prolificacy and more on litter weight.

Estimates of genetic correlation between weaning weight and marketing weight for all breeds studied are positive and highly significant (Table 6). The present results indicated that selection for higher body weight at weaning would cause a correlated increase in marketing body weight. In addition, the present results indicated the possibility of improving body weight of rabbits using early information of body weight.

Table 1. Number of records, does, sires, dams and animals, mixed model equations (MME) and number of iterations for the five studied breeds.

Item	Breed				
	NZW	Cal	Baus	Flan	BB
Record	616	162	628	217	97
Does	552	157	490	217	97
Sires	62	40	138	65	30
Dams	120	9	28	9	9
Animals	736	206	656	291	136
MME	5232	1512	4660	2096	980
Iterations	39	165	54	48	146

Table 2. Unadjusted means, standard deviations (SD) and coefficient of variations (CV%) for litter size at birth (LSB), litter weight at birth (LWB), bunny weight at weaning (WW) and marketing weight (MW) for the five studied breeds.

Trait	Breed														
	NZW			Cal			Baus			Flan			BB		
	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%
LSB	6.93	1.54	22.2	7.25	1.80	24.8	6.68	1.53	22.9	8.37	2.13	25.4	6.79	1.53	22.9
LWB (g)	384	121	35.5	349	92	26.4	366	86	23.5	395	120	30.4	335	65	19.4
WW (g)	357	118	33.1	295	101	34.2	348	111	31.9	292	102	34.8	312	108	34.6
MW (g)	868	240	27.7	875	199	22.7	868	271	31.2	926	208	22.4	750	251	33.5

Table (3). F- Value for factors affecting litter size at birth (LSB), litter weight at birth (LWB), Bunny weaning weight (WW) and marketing weight (MW) for the studied traits.

Source of variation	Trait							
	LSB		LWB		WW		MW	
	df	F-value	Df	F-value	df	F-value	df	F-value
Among breeds	4	** 493	4	** 26	4	** 9	4	** 10
Among months	8	** 15	8	** 32	8	** 14	8	** 22
Among years	3	** 16	3	** 44	3	** 25	3	** 73
Among parities	3	** 7	3	** 9	3	* 4	3	* 4
Between sex	1	0.03	1	0.30	1	0.11	1	0.31
Residual		1700		1300		900		753

* Significant at $p < 0.05$
** Significant at $p < 0.01$

Table 4. Estimates of heritability (h^2) ± SE of different traits studied for the five studied breeds.

Trait	Breed				
	NZW	Cal	Baus	Flan	BB
LSB	0.63 ± 0.02	0.79 ± 0.02	0.60 ± 0.02	0.61 ± 0.02	0.69 ± 0.03
LWB	0.56 ± 0.02	0.99 ± 0.01	0.59 ± 0.02	0.60 ± 0.02	0.70 ± 0.03
WW	0.57 ± 0.03	0.85 ± 0.02	0.48 ± 0.03	0.46 ± 0.04	0.61 ± 0.07
MW	0.81 ± 0.07	0.79 ± 0.02	0.66 ± 0.03	0.63 ± 0.07	0.77 ± 0.05

Table (5). Estimates of phenotypic correlation (r_p) among different traits studied for the five studied breeds.

Correlated Traits	Breed				
	NZW	Cal	Baus	Flan	BB
LSB x LWB	0.61	0.53	0.70	0.70	0.72
LSB x WW	0.32	0.57	- 0.35	- 0.36	- 0.26
LSB x MW	0.36	0.29	- 0.16	- 0.16	- 0.36
LWB x WW	0.20	0.35	0.21	0.22	0.24
LWB x MW	0.23	0.31	0.17	0.18	0.28
WW x MW	0.61	0.32	0.48	0.43	0.53

Table (6). Estimates of genetic correlation (r_g) ± SE among different traits studied for the five studied breeds.

Correlated Traits	Breed				
	NZW	Cal	Baus	Flan	BB
LSB x LWB	0.63±0.03	0.56±0.02	0.71±0.02	0.73±0.02	0.71±0.03
LSB x WW	- 0.31±0.04	- 0.55±0.08	- 0.39±0.03	- 0.41±0.03	- 0.28±0.07
LSB x MW	- 0.38±0.04	- 0.23±0.08	- 0.25±0.06	- 0.26±0.07	- 0.35±0.06
LWB x WW	0.30±0.05	0.36±0.06	0.13±0.05	0.15±0.06	0.26±0.09
LWB x MW	0.30±0.04	0.36±0.01	0.21±0.07	0.19±0.07	0.38±0.07
WW x MW	0.61±0.04	0.48±0.08	0.49±0.08	0.57±0.03	0.55±0.09

REFERENCES

Afifi, E. A.; and Farid, A. (2001). *Sire variance component and non genetic factors affecting weaning weight and post weaning growth traits in Bauscat and Baladi Red rabbits. 52nd Annual Meeting of the European Association for Animal Production, Budapest, 2001.*

Afifi, E. A.; Farid, A.; El-Mahy, M. R.; and Toson, M. A. (2001). *Doe traits as affecting by respiration rate, interval body temperature, rabbitry air temperature and some other non genetic factors in two breeds of rabbits. Egyptian J. of Rabbit Sci., 11: 57.*

Anous, R. M. (2001). *Selection indexes for imported weaning and marketing body weights of the Burundi local rabbits. Arch. Fur Tierzucht, 44: 561.*

Enab, A. A.; El-Weshahy. O. A.; and Abdou, F. H. (2000). *Genetic analysis of some economic traits in rabbits. Egyptian. J. of Rabbit Sci., 10: 327.*

Groeneveld, E.; Kovac, M.; and Wang, T. (1998). *PEST User Manual A software Package for multi- variate and estimation. Department of Animal Science, University of Illinois Germany pp80.*

Hassan, N. S.; Ahmed, E. G.; and Abd El-Ghany, A. M. (1999). *General combing and maternal abilities of post - weaning body weight traits of two native breeds on account of crossing. 1st International Conference on Indigenous Versus Acclimatized rabbits.*

Henderson, C.R. (1988). *Progress in statistical applied to quantitative genetic since 1976. 2nd congress of quantitative genetics, May, 1987.*

Iraqi, M. M.; Youssef, M. K.; El-Raffa, M. M.; and Khalil, M. H. (2001). *Genetic and environmental trend for post weaning body weight in New Zealand White and Z-Line rabbits using the animal model approach. 3rd Sci., Congress on rabbit production in hot climates, 89-101.*

Kassab, R. A. (2004). *A study of some economic traits on rabbits. M. Sc., Thesis, Faculty of Agric., Tanta, Tanta Univ., Egypt. PP162.*

Khalil, M. H. (1986). *Estimation of genetic and phenotypic parameters for some productive traits in rabbits. Ph.D., Thesis, Faculty of Agric., Moshtohor, Zagazig Univ., Egypt.*

Khalil, M. H.; Ibrahim, M. K.; Youssef, Y. M. K.; and Amira, S. El-Deighadi. (2000). *Estimation of sire transmitting abilities for post weaning growth traits in New Zealand White and Californian rabbits raised in adverse hot climate Egyptian conditions using Animal model. Egypt. Poultry Sci., 20: 65:90.*

Khalil, M. H.; Afifi, E. A.; Youssef, Y. M. K.; Raffa, A. M. E.; and Farid, A. (2001). *Estimation of breeding values for lifetime production traits using animal model in New Zealand White rabbits raised in high intensive system of production. Egyptian J. of Rabbit Sci., 11:93.*

Mohamed, H. (1993). *Genetic studies for some economic traits in rabbits. M.Sc., thesis, Faculty of Agric., Moshtohor, Zagazig Univ., Egypt.*

National Research Council, (1994). *Nutrient requirements of poultry. 9th ed. National Academy of Sci. Washington, D. C., USA.*

Rouvier, R. R.; Poujardien, and Vrillon, J. L. (1973). *Statistical analysis of the breeding Performance of female rabbits: environmental factors, correlations, repeatability. Ann. Genet. Sel Anim., 5: 83.*

Sabra, Z. A.; Khalil, M. H.; Hanafi, M.; and Gad, H. A. (2001). *Estimation of sire and paternal grand dams breeding values for growth traits in New Zealand White and Californian rabbits using the animal model. Egyptian. J. of Rabbit Sci., 11: 103.*

Sallam, M. T.; El-Feel, F. M. R.; Hassan, H. A.; and Ahmed, M.F. (1999). *Evaluation of litter performance and carcass traits of two and three way crosses of three breeds of rabbits. Egyptian. J. Anim. Prod. 29:287.*

Sqrensen, P. Kjaer, J.B. Brenqe, U. T. Sug. (2001). *Estimation of genetic parameters in Danish White rabbits using an animal model Litter traits. World Rabbit Sci., 9:33*

Zaky, H. I. (2001). *Effect of genetic and non genetic factors on litter traits in crosses of two rabbit strain under desert conditions. Egyp. Poult. Sci., 40: 61.*

الملخص العربي

المعايير الوراثية والمظهرية للصفات الإنتاجية والتناسلية في خمس من سلالات الأرانب

علاء الدين محمد.عبده ، عادل. خطاب *، و عادل أبو زيد*

قسم الإنتاج الحيواني، كلية الزراعة، جامعة القاهرة.
* قسم الإنتاج الحيواني، كلية الزراعة، جامعة طنطا.

أجريت هذه الدراسة في مزرعة تجارب سخا، بكفر الشيخ، أثناء الفترة من أكتوبر 2000 إلى يوليو 2003. و في هذة التجربة تم استخدام أربع سلالات أجنبية، نيو زيلاندي أبيض، كاليفورنيا، بوسكات، و فلاندر. بالإضافة إلى استخدام البلدي الأسود كسلالة محلية. الصفات التي تم دراستها هي حجم الخلفة عند الولادة، وزن الخلفة عند الولادة ، وزن الفطام ، و وزن التسويق عند 8 أسابيع. تم تحليل كل سلالة على حده و قد شمل النموذج المستخدم في التحليل، التأثيرات العشوائية للتأثير الوراثي التجمعي المباشر و البيئة المستديمة. أما التأثيرات الثابتة كانت هي شهر و سنة الميلاد، و الفصل، و الجنس.

وقد أظهرت النتائج وجود تأثير معنوي للسلالة، و شهر و سنة الميلاد، و الفصل، لكل الصفات تحت الدراسة، بينما لم يكن للجنس تأثير معنوي على أي من الصفات المدروسة.

العمق الوراثي لصفة حجم الخلفة عند الولادة كان 0.63، 0.79، 0.60، 0.61 و 0.69 لكل من النيوزيلاندي الأبيض، والكاليفورنيا، و البوسكات، و الفلاندر، والبلدي الأسود على التوالي. العمق الوراثي لصفات وزن الخلفة عند الولادة، و وزن الفطام، و وزن التسويق كان 0.56، 0.57، 0.81، على التوالي لسلالة النيوزيلاندي الأبيض، و كان 0.99، 0.85، و 0.79، على التوالي لسلالة الكالفورنيا، و كان 0.59، 0.48 و 0.66 على التوالي لسلالة البوسكات،و كان 0.60، و0.46، و 0.63 على التوالي لسلالة الفلاندر وكان 0.70، 0.64 و0.77، على التوالي للبلدي الأسود.

الارتباط المظهري بين حجم الخلفة عند الولادة ووزن الخلفة عند الولادة كان موجباً ومتوسط. وكذلك الارتباط المظهري بين وزن الفطام ووزن التسويق كان موجباً. أما تقديرات الارتباط المظهري بين حجم الخلفة عند الولادة وكل من وزن الفطام ووزن التسويق كانت سالبة. الارتباط الوراثي بين كل الصفات تحت الدراسة لكل سلالة أظهر نفس الاتجاه المتحصل عليه من الارتباط المظهري.