J. Agric. Sci. Mansoura Univ., 27(2): 979 - 990, 2002.

ESTIMATION OF DOE BREEDING VALUES FOR LITTER TRAITS OF NEW ZEALAND WHITE AND CALIFORNIAN RABBITS RAISED UNDER EGYPTIAN DESERT CONDITIONS USING ANIMAL MODEL

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ABSTRACT

A total of 382 litters produced from 38 New Zealand White does (NN) and 46 Californian (CC) ones were used in the present study during the period 1998 to 2000, to evaluate genetically doe litter traits. The litter traits studied were litter size at birth (LSB), litter size at weaning (LSW), litter weight at birth (LWB), litter weight at weaning (LWW), mean bunny weight at birth (MBWB), mean bunny weight at weaning (MBWW) and litter gain at weaning (LGW). Estimates of doe variance components for litter traits were moderate. These estimates were higher in NN rabbits than in CC ones for most traits. Repeatability estimates were moderate and ranged in NN rabbits from 0.26 to 0.40. While, they ranged from 0.23 to 0.42 in CC ones. The range in estimates of doe breeding values (DBV) were higher in (NN) than those of (CC) rabbits. The range of DBV's in (NN) rabbits vs. (CC) were 3.22 vs. 2.58 bunnies, 2.1 vs. 1.12 bunnies, 128.7 vs 169.5 g, 581.1 vs 454.9 g, 7.65 vs 16.9 g, 11.7 vs 126.0 g and 424.9 vs 293.2 g for LSB, LSW, LWB, LWW, MBWB, MBWW and LGW, respectively. The percentages of does having positive estimates of DBV ranged from 43.5 to 57.9 for all does in the two breeds used in this study.

Keywords: Doe variance components, repeatability, doe breeding values.

INTRODUCTION

Two standard breeds viz., New Zealand White and Californian rabbits were introduced to Egypt and were used in large-scale commercial production in Egypt. Genetic improvement is mainly dependent on the genetic parameters obtained (heritability, repeatability) of the traits. Recently, genetic evaluation for litter and growth traits performed using the methodology of animal model requires accurate and good estimates of variance and covariance components (Baselga *et al.*, 1992, Ferraz *et al.*, 1992, Ferraz and Eler 1994, El-Raffa *et al.*, 1997). The objectives of the present study are to estimate (1) doe variance components and repeatabilities for litter traits, (2) the doe breeding values using a single- trait animal model.

MATERIALS AND METHODS

The present study was carried out at Maryout Research Station, Desert Research Center for two consecutive years started in Sep. 1998. Two standard breeds, New Zealand White (NN) and Californian (CC) rabbits were used. Data collected of 382 litters produced from 38 (NN) does and 46 (CC) ones. Females within each breed were randomly grouped into groups of 3 to 5 does according to the available numbers. Each buck from the same breed was mated to a group of does chosen at random avoiding parent- offspring and sib mating. Does were palpated ten days thereafter to determine pregnancy and those failed to conceive were remated every other day thereafter with the same buck until a service was observed. After kindling, does were mated one day after parturition. Young rabbits were weaned at 28 days after birth. Litters were recorded for size and weight at birth and weaning. Rabbits were fed *ad-libitum* on a commercial pelleted ration contained 16% crude protein, 12% crude fiber and 2500 Kcal/kg.

Litter traits studied were litter size at birth (LSB) and at weaning (LSW), litter weight at birth (LBW) and at weaning (LWW), mean bunny weight at birth (MBWB), mean bunny weight at weaning (MBWW) and gain in litter from birth to weaning (LGW). No of dose and litters born are shown in Table 1.

Table 1. Distribution of records collected according to breed of kindling.

Item	New Zealand White (NN)		Californian (CC)	
	1st year	2nd year	1st year	2nd year
No. of does used	25	38	35	46
No. of litters born	84	106	99	93

Models of analysis:

Doe litters traits studied were analyzed for each breed separately using the following mixed model (Harvey, 1990).

$$y_{ijklm} = \mu + D_i + ye_j + S_k + P_l + e_{ijklm} \quad \text{(Model 1)}$$

where:

y_{ijklm} = the observation on the ijklm th doe rabbit

μ = overall mean

D_i = random effect of I th doe

ye_j = fixed effect of j th year of kindling (j =1, 2),

S_k = fixed effect of K^{th} season of kindling (k=1, ..,3)

P_l = fixed effect of L^{th} parity of the doe (l=1,...6)and

$e_{ijkl\,m}$ = random error.

The minimum variance normal quadratic unbiased estimates (MINQUE) for doe variance components (σ^2 d) and error variance components (σ^2 e) as described by Handerson (1984) were obtained from the doe model (Harvey, 1990).

Repeatability estimates for each trait was calculated as the doe intra-class correlation (t_d), i.e. $t_d = \sigma^2 d / (\sigma^2 d + \sigma^2 e)$, where σ^2 d and σ^2 e are the variance components for doe and error estimated by REML procedure respectively, according to the formula described by Abdel-Raouf (1993) and Farid (1998) .

Doe breeding values (DBV):

The single traits animal model program written by Misztal (1990) was used in estimating the doe breeding values (DBV). Variance (Co) components obtained by model 1 were used as starting values in the animal model to obtain the doe breeding values. The animal model (in matrix rotation) used was:

$$Y = X\beta + Z_a A + e$$

where:

Y = vector of observation of doe traits,

X = incidence matrix for fixed effects,

β = vector of fixed effects (year of kindling, season of kindling and parity),

Z_a = incidence matrix for random effects (direct genetic effects),

A = vector of random effect (direct addi‥e genetic value) associated with the incidence matrix Z_a, i.e. doe bree‥ing values and

e = vector of random errors, normally and independently distributed with (0) mean and σ^2 e variance.

RESULTS AND DISCUSSION

Means and variation of uncorrected records:

Actual means, standard deviation (SD) and percentages of variation (V%) for litter traits in NN and CC rabbits are shown in Table 1. Means obtained in the present study are generally within the range of those reported in the Egyptian studies. Means of all traits in NN rabbits were higher than those in CC. Similar findings were reported by many Egyptian authors for LSB LWB and LWW (e.g. Farghaly and El- Drawany 1994, Farghaly 1996 and Farid *et al.*, 2000) and for MBWW (Oudah 1990 and Farid *et al.*, 2000). Percentages of variation (V%) for doe litter traits in NN and CC rabbits (Table 2) ranged from 25.4 to 40.3 % for litter size traits, from 31.6 to 42.4% for litter weight traits, from 23 to 33.6 % for mean bunny weight traits and from 26.2 to 27.8% for LGW. These authors are within those reported by some Egyptian studies (Afifi *et al.*, 1992, Yamani *et al.*, 1994, Ahmed 1997 and Farid *et al.*, 2000). The estimates of V% are given in Table 2. Indicate that the phenotypic variation of litter traits at birth were high and increased thereafter with the advance of litter's age. Blasco *et al.* (1992) attributed yhe high variation in litter traits at birth to the high variation in ovulation rate, embryo and fetal survival and uterine capacity.

Table 2. Actual means, standard deviation (SD) and percetages of variation (V%) for litter traits in New Zealand White and Californian rabbits.

Traits	New Zealand White Mean±SD	(V%)	Californian Mean±SD	(V%)*
Litter size at birth (LSB	7.77±2.55	33.3	6.6±2.33	32.0
Litter size at weaning (LSW)	5.50±1.80	36.5	5.2±1.6	30.0
Litter weight at birth (LWB), g	468.8±120.6	29.1	395.0±130	26.3
Litter weight at weaning (LWW), g	3000.9±1100	38.0	2981.0±1010	35.2
Mean bunny weight at birth (MBWB), g	60.5±9.5	14.9	54.2±10.5	15.3
Mean bunny weight at weaning (MBWW), g	469.3±92.3	19.0	400.3±100.9	22.5
Litter gain weight (LGW), g	2550±905	36.1	2250±840	37.5

*** V% = square root (MSE)/ actual mean x 100.**

Results of Lukefahr *et al.* (1990), Youssef (1992) and Khalil (1993) confirmed this concept. The percentages of variation increased with advancement of age of litter from birth up to weaning. This trend may caused by differences in their genotypes and the variation in milk production of their dams during the suckling period (Afifi *et al.* 1992, Khalil 1994 and Farid *et al.* 2000).

Non- genetic aspects:

Parity:

Parity effects were found to be non-significant differences on litter size traits (LSB and LSW) in the two breeds (Table 3). Ahmed (1997) noted that differences in litter traits (litter size, litter weight, mean bunny weight per litter and gain in litter weight at different ages) caused by year-season may be due to variations in climatic conditions and milk yield of the doe from one year-season to another. The non-significant parity effects were found in different breed groups of rabbits on LSB and LSW (Khalil and Mansour 1987, Hassan, 1988 and Hilmy, 1991). On the contrary, parity effects were found to be significant on LSB (Afifi *et al.*, 1982 and Khalil 1993). Also no significant effect for parity on litter weight at birth and at weaning was found in the present study. The same results were reported by Hilmy, (1991).

Year of kindling:

Effect of year of kindling was not significant in litter size at birth and at weaning (Table 3). These results agree with (Hilmy 1991, Youssef, 1992 and Hassan, 1995). Significant differences in litter size at birth due to year of kindling were reported by (Khalil and Mansour, 1987). The effects of year of kindling on litter weight at birth and at weaning are shown in Table 2. There were no significant differences in litter weight due to year of kindling. Similarly, some investigators (Afifi and Emara 1984, Hassan, 1988 and Hilmy 1991) found a non-significant effect of year of kindling on litter weights.

Season of kindling:

Effect of season of kindling was highly significant ($P<0.01$) on most of litter traits (Table 3). Ahmed (1997) noted that differences in litter traits (litter size, litter weight, mean bunny weight per litter and gain in litter weight at different ages) caused by year-season may be due to variations in climatic conditions and milk yield of the doe from one year-season to another. Californian breed had non-significant differences due to season of kindling. Abd El- Raouf (1993) confirmed this concern and attributed this evidence to that litter traits measured during preweaning period are more greatly affected by season than at birth.

Doe- Variance components:

Differences in litter size at birth and at weaning due to effects of doe were highly significant (Table 4).

Table 3. Least square means of litter traits in New Zealand White (NN) and Californian (CC) rabbits for parities, year and season of kindling

Item	LSB	LSW	LWB	LWW	MBWB	MBWW	LGW
New Zealand White breed							
Parity							
1st	7.8±.19	3.7±.11	466.2±10.0	1677.9±30.5	60.2±.92	466.9±13.6	1211.6±25.4
2nd	7.8±.19	3.7±.11	463.1±10.0	1697.2±30.6	59.6±.92	468.5±13.6	1234.1±25.4
3rd	7.4±.19	3.6±.11	453.5±10.0	1637.6±30.5	60.9±.92	459.9±13.6	1184.0±25.3
4th	7.6±.19	3.6±.11	452.8±10.0	1630.5±30.6	59.9±.92	460.9±13.6	1177.7±25.4
5th	7.5±.23	3.5±.13	460.3±11.6	1672.9±35.8	61.1±1.1	492.3±16.5	1212.6±30.4
6th	7.7±.28	3.8±.16	462.9±14.1	1680.9±44.2	60.6±1.3	460.0±20.9	1217.9±38.2
Year							
1st	7.7±.17	3.7±.09	456.3±8.9	1678.8±26.8	59.3±.80	469.6±11.5	1222.5±21.8
2nd	7.6±.17	3.6±.09	463.4±8.6	1653.5±25.9	61.4±.77	466.6±11.1	1190.1±20.9
Season							
Autumn	7.3±.19 b	3.5±.11 b	420.6±9.9 c	1522.9±30.3 c	57.5±.91 b	454.1±13.5 b	1102.3±25.1 c
Winter	8.5±.18 a	4.0±.09 a	524.8±9.2 a	1902.9±27.6 a	61.9±.82 a	485.5±12.0 a	1378.0±22.6 a
Spring	7.1±.21 b	3.5±.11 b	424.1±10.4 b	1572.6±32.1 b	61.7±.96 a	464.9±14.4 a	1138.6±26.8 b
Californian breed							
Parity							
1st	6.8±.26	3.2±.14	365.2±11.0	1299.9±32.4	54.4±.64	417.5±11.1	934.7±29.5
2nd	6.7±.26	3.4±.14	360.9±11.1	1313.0±32.8	54.5±.65	399.0±11.2	952.1±29.5
3rd	6.5±.26	3.2±.14	355.3±11.2	1278.4±33.0	54.9±.65	414.0±11.2	923.2±29.7
4th	6.6±.28	3.3±.15	355.4±12.0	1275.5±35.5	54.7±.70	395.5±12.1	920.2±32.3
5th	6.6±.37	3.6±.19	361.9±15.7	1370.8±47.5	55.6±.93	388.1±16.3	1008.8±44.0
6th	6.5±.48	3.3±.25	357.1±20.5	1227.5±62.3	55.1±1.2	388.9±21.4	870.4±58.4
Year							
1st	6.7±.29	3.3±.13	362.5±10.5	1266.6±30.6	54.7±.60	398.4±10.4	904.1±27.3
2nd	6.6±.24	3.4±.13	356.1±10.1	1321.8±29.6	55.1±.58	402.6±10.4	965.7±26.2
Season							
Autumn	6.3±.30 b	3.3±.16 ab	342.7±12.8 b	1193.0±38.1 c	54.8±.75 a	364.1±13.0 b	850.3±34.8 b
Winter	6.9±.29 a	3.7±.16 a	377.1±12.5 a	1453.5±37.3 a	55.1±.73 a	416.2±12.7 a	1076.4±34.0 a
Spring	6.7±.29 a	3.0±.16 b	358.1±12.3 a	1236.1±36.6 b	54.7±.72 a	421.2±12.4 a	877.9±33.2 b

Similar, results were obtained in the study of Khalil *et al.* (1988). Lukefahr *et al.* (1990) showed that doe contributes strongly to the phenotypic variation of her product not only because due to transmission of genes to her litter but also due to her maternal environmental effects on them. However, Khalil and Mansour (1987) reported non-significant effect for doe on the same traits.

Doe variance components (σ^2 d) and their percentages (v %) for litter traits in NN and CC rabbits are presented in Table 4. The percentages of doe variance components in NN rabbits for litter size traits ranged from 38.6 to 40.3 %, from 31.6 to 36.5% for litter weight traits, from 31.2 to 33.6% for mean bunny weight traits and 26.2 for litter gain at weaning. The corresponding estimates in CC rabbits for litter size traits ranged fróm 25.4 to 37.5%, from 37.2 to 42.4 % for litter weight traits, from 23.0 to 33.3% for mean bunny weight traits and 27.8% for litter gain at weaning. NN and from 25.4 to 37.5 % for CC, from 31.6 to 42.4 % for litter weight traits, from 23.0 to 33.6% for mean bunny weight traits and from 26.2 to 27.8 % for litter gain at weaning. Similar findings of El- Raffa (1994) and Farid *et al.* (2000) showed wide variation in percentages of doe variance components for litter traits. In general, (NN) does showed higher percentages of doe variance components than that of (CC) does. The same results were reported by Farid *et al.* (2000). High maternity of lactation in (NN) rabbits may be responsible for high estimates (v%) for litter traits. Khalil (1994) stated that the genetic and environmental differences in pre- and postnatal maternal influence could be added as another cause in this respect.

Table 4. Doe (σ^2 d) and error (σ^2 e) variance components, percentages (V%) and repeatabilites (t) and standard error (SE) obtained by REML method for litter traits in New Zealand White and Californian rabbits.

Traits+	New Zealand White					Californian				
	Doe		Remainder		Repeatability	Doe		Remainder		Repeatability
	Σ^2 d	V%	σ^2 e	V%	t±SE	σ^2 d	V%	σ^2 e	V%	t±SE
LSB	0.880***	38.6	1.4	61.4	0.38±.08	0.503***	37.5	0.84	62.5	0.38±.09
LSW	0.256***	40.3	0.38	59.7	0.40±.09	0.109***	25.4	0.32	74.6	0.25±.08
LWB	1504***	36.5	2619	63.5	0.36±.08	1461***	42.4	1984	57.6	0.42±.09
LWW	11309***	31.6	24454	68.4	0.32±.08	12045***	37.2	20314	62.8	0.37±.08
MBWB	4.699***	33.6	9.3	66.4	0.34±.08	9.5***	33.3	19.0	66.7	0.33±.07
MBWW	1327***	31.2	2928	68.8	0.31±.08	1483***	23.0	4953	77.0	0.23±.08
LGW	7845***	26.2	22147	73.8	0.26± .07	6236***	27.8	16231	72.2	0.28±.09

+ Traits are defined previously in Table 2.
*** = P< .0001

Repeatability:

Estimates of repeatability for doe litter traits (Table 4) were moderate. They were slightly higher in (NN) rabbits than those of (CC) in most of litter traits, they ranged from 0.26 to 0.40 in (NN), and from 0.23 to 0.42 in (CC). New Zealand White rabbits had high estimates for litter size and mean bunny weight traits than Californian rabbits. On the other hand, Californian rabbits had high estimates for litter weight and gain traits. Lukefahr *et al.* 1983 and Abdel- Raouf, 1993) reported that the high repeatability for litter traits in (NN) may be an indication of the considerable additive genetic variation for these characters. The estimates obtained of the present study agreed with some studies (Lukefahr *et al.*, 1983 and Lukefahr *et al.*, 1984).

Doe breeding values (DBV):

For single- traits animal model, the number of iterations attained in evaluation of doe litter traits in (NN) and (CC) rabbits are presented in Table 5. For (NN) does, the number of iterations recorded for litter size traits ranged from 114 to 133 iterations, for litter weight traits from 108 to 125 iterations, for mean bunny weight traits from 119 to 157 iterations and 128 iterations for litter gain at weaning. The corresponding figures recorded by (CC) does for litter size traits ranged from 85 to 105 iterations, for litter weight traits from 114 to 134 iterations, for mean bunny weight traits from 133 to 137 iterations, and 88 iterations for litter gain at weaning. Similar figures were observed by Farid *et al.* (2000). For most cases, these figures of the present study indicate that data of (CC) does required less iteration compared to (NN) to reach adequate convergence criteria. Ducrocq *et al.* (1990) reported that number of rounds of iterations required to reach adequate convergence criteria may not be before 100 or more iterations.

The minimum, maximum and range (i.e. the difference between the maximum and minimum) for doe breeding values are shown in Table 6. The ranges were higher in (NN) does than (CC) for litter size traits, litter weight at weaning and litter gain at weaning (LGW). Whereas (CC) does recorded higher ranges for litter weight at birth (LWB) and mean bunny weight at birth (MBWB) and at weaning (MBWW). Farid *et al.* (2000) confirmed this concerning in (NN) and Bouscat breeds., For litter weight traits, DBV increased with advance of age of the litter from birth up to weaning in NN does. Khalil *et al.* (2001) with New Zealand White reported that ranges estimated of (PBV) for total number (TNB), total number born alive (TNBA) and total number weaned (TNW) were 8.2, 9.8 and 11.8 bunnies when using single-trait animal model. Farid *et al.* (2000) reported that (NN) does recorded higher ranges of breeding values fore doe litter traits than those of (CC) does. Thus, improvement of these traits might be more effective in (NN) than in (CC) rabbits. Ranges in DBV for litter size traits of both breeds used in the present study decreased with the advance of age of the litter from birth up to weaning. Farid *et al.* (2000) attained the same trend of the present study of NN for litter weight traits in the three breeds used in their study (Bouscat, NN and CC). For litter weight traits and mean bunny weight traits were found to increase with advance of age of the litter from birth up to weaning in both breeds.

Table 5. Number of iterations recorded by single-trait animal model (SAM) for doe litter traits in New Zealand White and Californian rabbits.

Traits+	New Zealand White	Californian
LSB	133	105
LSW	114	85
LWB	108	134
LWW	125	114
MBWB	157	133
MBWW	119	137
LGW	128	88

+ Traits are defined previously in Table 2.

Table 6. Minimum, Maximum and ranges of doe breeding values (DBV) estimated by single-trait animal model (SAM) for litter traits in New Zealand White and Californian.

Traits+	New Zealand White			Californian		
	Minimum.	Maximum	Range	Minimum	Maximum	Range
LSB	-1.57	1.66	3.22	-1.43	1.16	2.58
LSW	-0.91	1.16	2.1	-0.56	0.56	1.12
LWB	-66.7	62.04	128.7	-112.63	56.90	169.5
LWW	-303.6	277.51	581.1	-271.13	183.83	454.9
MBWB	-3.8	3.91	7.65	-6.88	10.05	16.9
MBWW	-67.8	48.7	11.7	-51.21	74.84	126.0
LGW	-231.7	198.24	424.9	-142.65	150.52	293.2

+ Traits are defined previously in Table 2.

Farid *et al.* (2000) reported this trend in New Zealand White and Bouscat rabbits.He attributed these results due to that the expression of the genotype is clearer at weaning than at earlier ages. Thus, selection for a composite trait at weaning might be more effective to improve many traits than selection for a simple trait at birth or at weaning. The numbers and percentages of does with positive breeding values (Table 7) indicated that in general, does having positive estimates of breeding values were about 50% of all does in both breeds used (ie. NN and CC). Farid *et al.* (2000) reported that does having positive estimates of breeding values were less than 50% of all does in their study.

Table 7. Numbers and percentages of does having positive estimates of breeding values (DBV) and their percentages (%) recorded by single trait animal model (SAM) in New Zealand and Californian rabbits.

Traits+	New Zealand White		Californian	
	Number	(%)	Number	(%)
LSB	19	50.2	20	43.5
LSW	18	47.4	23	50.0
LWB	22	57.9	23	50.0
LWW	20	52.6	24	52.6
MBWB	20	52.6	25	54.4
MBWW	18	47.4	23	50.0
LGW	19	50.0	21	45.7

+ Traits are defined previously in Table 2.

CONCLUSION

New Zealand White (NN) recorded better performance in litter traits than in Californian (CC). Many authors also declared this concept. This is due to superiority of NN does in their potential maternal abilities (in terms of milk production, maternal behavior, caring ability...etc) than CC. Therefore, NN could be used as a dam breed in crossbreeding strategies in Egypt.

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تقدير القيم التربوية لإناث الأرنب النيوزيلندي الأبيض و الكاليفورنيا لصفات البطن تحت ظروف الصحراء المصرية باستخدام نموذج الحيوان

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استخدمت بيانات٣٨٢ بطن من ٣٨ أم نيوزيلندي ابيض , ٤٦ أم كاليفورنيا لتقييم صفات البطن وراثيا مرباة تحت ظروف الصحراء بمحطة بحوث مريوط التابعة لمركز بحوث الصحراء و كانت صفات البطن المدروسة هي عدد خلفة البطن عند الميلاد, عدد خلفة البطن عند الفطام, وزن خلفة البطن عند الميلاد, وزن خلفة البطن عند الفطام, متوسط وزن الأرنب عند الميلاد, متوسط وزن الأرنب عند الفطام, الزيادة الوزنية في وزن خلفة البطن من الميلاد حتى الفطام. كانت قيم مكونات التباين المتحصل عليها للأمهات متوسط في كلا السلالتين و كانت هذه القيم مرتفعة نسبيا لأرانب النيوزيلندي الأبيض عنها في أرانب الكاليفورنيا. و كانت قيم المعامل التكراري لصفات البطن متوسطة في كلا من السلالتين وتراوحت هذه القيم من ٢٦, و ٤٠, في الأرانب النيوزيلندي الأبيض بينما تراوحت هذه القيم في أرانب الكاليفورنيا من ٢٣, و ٤٢, . كان المدى للقيم التربوية لسلالة النيوزيلندي الأبيض أعلى منها في سلالة الكاليفورنيا. كانت هذه القيم لسلالة النيوزيلندي الأبيض لصفات عدد خلفة البطن عند الميلاد, عدد خلفة البطن عند الفطام , وزن خلفة البطن عند الميلاد, وزن خلفة البطن عند الفطام, متوسط وزن الأرنب عند الميلاد, متوسط وزن الأرنب عند الفطام, الزيادة في وزن خلفة البطن من الميلاد حتى الفطام هي ٣،٢٢ أرنب, ٢,١ أرنب, ١٢٨,٧ جم , ٥٨١,١ جم , ٧،٦٥ جم , ١١،٧ , ٤٢٤،٩ جم على التوالي مقابل ٢,٥٨ أرنب , ١,١٢ أرنب, ١٦٩,٥ جم , ٤٥٤,٩ جم , ١٦,٩ جم , ١٢٦،٠٤ جم , ٢٩٣,٢ جم لنفس الصفات على الترتيب لسلالة الكاليفورنيا . تراوحت نسبة الامهات ذات القيم التربوية الموجبة من ٤٣،٥ الى ٥٧،٩ فى كلا السلالتين.