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IMMUNOLOGICAL STUDIES IN ASSOCIATION WITH SOME PHYSIOLOGICAL AND REPRODUCTIVE TRAITS IN NEW ZEALAND WHITE AND CALIFORNIAN RABBITS

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ABSTRACT: *A total of healthy 144 purebred and 147 crossbred of both New Zealand White (NZW) and Californian (Cal) rabbits were used to study the association between high (HR) and low (LR) immune response to immunized bovine serum albumin (BSA) antigen and some physiological and reproductive traits in the purebred, NZW and Cal rabbits ad their crossbred progenies. Four crosses were formed from the mating types of {HR ♂ Cal x HR ♀ NZW (HCN), HR ♂ NZW x HR ♀ Cal (HNC), LR ♂ Cal x LR ♀ NZW (LCN) and LR ♂ NZW x LR ♀ Cal (LNC)}. Traits of antibody titers, plasma total protein (TP), albumin (Alb), globulin (Glob), A/G ratio, total white blood cells (TWBCs), immunoglobulin (total immunoglobulins Ig, IgA, IgM and IgG), kindling intervals (KI), days open (DO) daily milk consumed (DMC), litter size (LS21 and LWW), litter weight (LW21 and LWW) and mortality percentages were studied.*

The results showed that the HR-lines had the highest means of antibody titers, while the LR-lines had the lowest means and the control (CL) lines were intermediate in NZW and Cal purebred rabbits. The crossbred rabbits had higher means of antibody titers than their purebred parents. The primary antibody titers at 7d post immunization were 6.29 and 6.34 in HR-lines of NZW and Cal, respectively vs 7.11 and 6.89 in their crossbred progenies.

The traits of blood parameters (TP, Alb, Glob, A/G ratio, Hb and TWBCs) (immunoglobulins Ig and IgM), interval reproductive (KI), days open (DO), daily milk consumed (DMC), litter size (LS21 and LSW) and litter weight traits (LW21 and LWW) were associated positively and significantly with high immune response lines in both NZW and Cal purebred rabbits.

The remarkable results were the mortality percentages from birth to weaning, which were associated negatively and significantly with high immune

response lines. The mortality percentages were decreased from 72.4-85.9% in LR lines to 23.7-27.4% in HR lines of purebred parent rabbits. The crossbred rabbits achieved the lowest mortality percentages which ranged from 15.9 to 18.9% in HCN and HNC crosses. These results verified the important role of high immune response for improvement of physiological and reproductive traits either in purebred or crossbred rabbits.

INTRODUCTION

Immunity is one of the main goals for many livestock investigators. Early studied by Edward and Peters (1972) indicated that the immune response to immunized bovine serum albumin (BSA) antigen was strongly associated with some physiological parameters in rabbits and the strong reactions occurred in homologous antigen-antibody system. Moreover, the increased immunity in adult rabbits is an important factor for their resistance to several diseases and transmission of maternal milk antibody into serum of neonatal rabbits (Gennari et al, 1986).

Recently, Kelly et al., (2000) reported that communication between the immune system and other physiological system is extensive. Thus the immune system combats disease with an integrated physiological response involving different cells types.

On the other hand, crossbreeding has been stablished as an effective system to exploil the heterosis in animal breeding and could be successfully employed in rabbit breeding for increased productivity. Crossing does of New Zealand (NZW) breed with bucks of local breeds were genetically associated with heterotic effects on growth traits (Khalil and Afifi, 2000).

The present study, mainly aimed to shed more light on the possible effect of immunized BSA antigen as a result of selection for high (HR) and low (LR) immunity in both purebred parents and their progenies in relation to some physiological and reproductive traits in New Zealand White and Californian rabbits.

MATERIALS AND METHODS

The experimental work of this study was conducted for about two consecutive production years starting from September 2003 to June 2005 in Sakha Rabbit Farm, Experiment Station, Kafr El-Sheikh Governorate.

1. Experimental Rabbits:

A total number of healthy 96 does and 34 bucks of each of Californian (Cal) and New Zealand White (NZW) rabbits were used in haemagglutination test as a parent stock, which were obtained from the

flock of the rabbitary farm. The average body weight was 2258.1 ± 2.950 g for females and 2268.7 ± 2.721 g for males in both breeds. Each breed was kept in close population and random mating was applied.

2. Formation of purebred control and selected immune response lines:

At 20-wk of age, parent rabbits were individually immunized with bovine serum albumin (BSA) antigen as a primary immunization. The primary antibody titers to BSA were determined individually at 7, 14 and 21 d post-immunization. Rabbits were selected individually, based on the phenotypic of the primary antibody titers at 7 d post immunization. The established selected lines were as follows.

2.1. High immune response line (HR):

The highest 18 females and 6 males in the primary antibody titers were individually selected for reproducing in HR line in the next generation in each breed.

2.2. Low immune response line (LR):

The lowest 18 females and 6 males in the primary antibody titers were selected individually for reproducing the LR line in the next generation in each breed.

2.3. Control line (CL):

Eighteen females and 6 males were taken at random as parents for reproducing the CL line in the next generation in each breed. On all cases (HR, LR and CL), only three dams were assigned at random for each sire.

3. Stock management:

A total of 54 does and 18 sires which representing three lines (HR, LR and Cl lines) were housed individually in double flat galvanized wire batteries (40 X 30 X 25 cm) with fodder and automatic nipple drinkers. Each individual was given a metalic number which fixed in its ear and provided with kindling nest box for does. Feed was available *adlibitum* on commercial blanced peleted ration containing 17% crude protein, 12.91 crude fiber, and 2.13 either extract providing 2415 digestible energy (Kcal/kg feed).

4. Formation of crossbred progenies:

The mating was performed between two selected immune response lines (HR and LR) of both NZW and Cal. rabbits, where 6 bucks were mated with 18 does per each line to produce the first generation of crossbred progenies. The mating type was as follows:

Cross 1 – HR ♂ Cal x HR ♀ NZW (HC.N)

Cross 2 – HR ♂ NZW x HR ♀ Cal (HN.C)

Cross 3 – LR ♂ Cal x LR ♀ NZW (LC.N)

Cross 4 – LR ♂ NZW x LR ♀ Cal (LN.C)

5. Immunological and haematological determinations:

5.1. Antibody titers:

The primary antibody titers to BSA antigen with adjuvants of Freund's were determined at 7, 14 and 21d post-immunization according to Shaker (1997).

5.2. Blood parameters:

Total white blood cells (TWBCs) and its differentiation were microscopically counted after dilution with white blood cells diluting pipette (Coffin, 1955 and Schalm 1965), total protein (TP) concentration was determined by the colorimetric method according to Merk (1974), albumin according to Doumas et al., (1971), meanwhile, globulin was obtained by subtracting the value of albumin from the corresponding value of total protein.

5.3. Immunological determinations:

Total immunoglobulins (Ig) and its fractions (IgA, IgG and IgM) were determined in blood serum as given in the instructions with each appropriate kit according to Micini et al., (1965) at 7d post immunization.

6. Reproductive traits determinations:

Reproductive traits were recorded for both purebred and crossbred rabbits of both breeds. The traits determined included the following:

6.1. Kindling intervals (KI):

The period in days between two consecutive parturitions.

6.2. Days open (DO):

It is the interval from KI to next conception.

6.3. Daily milk consumed (DMC):

It was estimated from birth to 21 days of age using following equation:

DMC= LWG/0.56

Where LWG is a litter weight gain (kg) from birth to 21 days of age, and 0.56 is a constant calculated by Cowei, (1969).

6.4. Litter performance:

Determination of litter performance of both purebred and crossbred progenies including: Litter size at birth (LSB), number born alive (NBA), Litter size at 21-day (LS21) and litter size at weaning (LSW), litter weight at birth (LWB), litter weight at 21day (LW21) and litter weight at weaning (LWW) were determined.

7. Mortality rate:

Mortality rate of progenies was recorded from birth to 21days, 21days to weaning and birth to weaning.

8. Statistical analysis:

Data were statistically analyzed according to Snedecor and Cochran (1976) associated with SPSS program (1993). Percentage values were transformed to arcsine values before analyzed. The significance differences among the different lines were tested according to Duncan (1955).

RESULTS AND DISCUSSION

1. Antibody response in purebred and their crossbred progenies:

The primary antibody titers against BSA antigen at 7, 14 and 21d post-immunization of control and selected lines for high and low antibody titers in both NZW and Cal purebred and their crossbred progenies are given in Tables (1 and 2). The results show that means of antibody titers were increased gradually after the primary injection with BSA antigen, reached its maximum level at 7d post-immunization, then decreased gradually to reach the lowest level at 21d post-immunization for control and selected lines in both breeds. The HR line had naturally the highest means of antibody titers, while the LR line had the lowest means and CL line was intermediate (Table 1). The present results are in agreement with the results reported by Ferreira et al., (1986), Gebriel (1990) Wilkie and Mallard (1999), Klipper et al., (2000), Fusheng et al., (2002) and Saad (2006) who reported that the selected high immune response line had the highest means of antibody titers, while the low immune response line had the lowest means of antibody titers.

In regard to the crossbred progenies, the results showed that means of antibody titers in crossbred progenies had higher values than the purebred parents. The primary antibody means on the 7d post-immunization were

6.29 and 6.34 for HR line in NZW and Cal pure parents vs. 7.11 and 6.89 in their crossbred progenies. The means of antibody titers were 2.56 and 2.40 for LR line of NZW and Cal pure parents vs. 2.61 and 2.56 in LR cross progenies (Tables 1 and 2). These results demonstrated that the crossbred progenies had some superiority in antibody response over their purebred parents. These findings are in accordance with the results reported by Gennari et al., (1986) who found that the F1 hybrid rabbits showed significant differences in primary antibody response to BSA and a complete dominance in high immune response line to BSA.

2. Physiological traits:

Least-squares means (LSM ± SE) of haematological traits in serum of high and low antibody response lines to BSA antigen for purebred parental rabbits and their progenies are given in Tables (3 and 4). The results show that the high immune response rabbits (HR) line achieved superior values of total protein (TP), albumin (Alb), globulin (Gio), A/G ratio, haemoglobin (Hb) and total white blood cells (TWBCs) and its differentiation counted than the low immune response line of both NZW and Cal parental rabbits. The statistical differences between HR and LR lines were highly significant ($P \leq 0.01$) in most of the physiological traits studies in both breeds (Table3).

The present results are in agreement with Hanlon et al., (1997) and Kucharska et al., (1999) who reported that the high immune response had higher values of most haematological parameters as compared to the low immune response rabbits. In regard to the crossbred progenies, the results showed that HCN and HNC crossbred progenies produced from HR lines achieved superiority values of plasma total protein (TP), albumin (Alb), globulin (glo), A/G ratio and total white blood cells (TWBCs) and its differentiation than both LCN and LNC crossbred progenies produced from LR lines of both NZW and Cal breeds. The statistical differences among crossbred progenies were highly significant ($P \leq 0.01$). In addition, the crossbred progenies had higher means of all haematological parameters studied than their purebred parents. It could be concluded that differences in immune response between rabbit lines which expressed as antibodies and the maternal abilities effect of crossing may improve both humoral and cellular immunity, which led to the superiority of the crossbred progenies produced from high immune response parents in most of the haematological parameters.

3. Immunoglobulin traits:

Least-squares means (LSM ± SE) of total immunoglobulins (Ig), IgA, IgM and IgG (mg/dl) in serum of both purebred parental rabbits and their crossbred progenies on 7d post-immunization are given in Tables (5 and 6). The results showed that the HR-lines had higher means of total immunoglobulins (Ig) and (IgG) than the LR lines in both purebred parental NZW and Cal rabbits. In NZW rabbits, the Ig means were 915.35 vs 740.21 (mg/dl) in HR and LR lines, respectively. Similar trend was observed in Cal rabbits. The Ig means were 910.95 vs 730.01 (mg/dl) in HR and LR-lines, respectively. An oppiosite trend was observed in IgM antibodies. The LR-lines had higher values than HR-lines. The IgM means were 513.51 and 519.15 in LR-lines vs. 439.15 and 436.06 (mg/dl) in HR-lines in both, NZW and Cal, breeds, respectively. The statistical differences among lines in Ig, IgM, IgG were highly significant ($P \leq 0.01$). But the means of IgA antibodies were almost similar in HR and LR-lines of both, NZW and Cal, breeds.

In respect to immunoglobulins traits in crossbred progenies, the results showed that the IgA and IgG means were almost similar to the means of their purebred parents of both, NZW and Cal rabbits (Table 6). The statistical differences among crossbred progenies in Ig and IgG were highly significant ($P \leq 0.01$). The crossbred progenies achieved some superiority in IgM means than their purebred parents, produced from HR-lines or LR-lines of both, NZW and Cal breeds.

The present results demonstrate that increasing of Ig and IgG values in HR lines was indicator for high response of the immune system of rabbits line which induced humoral and cellular immunity as a result of immunization with BSA antigen (Helal and Mousa, 2005). Also, the superiority of HCN and HNC progenies produced from HR-lines than LCN and LNC produced from LR lines of both, NZW and Cal breeds in Ig and IgG may be due to the complete dominance of HR-lines genes than LR-lines genes due to an additive effect (Gennari et al., 1986 and Ferreira et al., 1986).

4. Reproductive traits:

Least squares means (LSM ± SE) of some reproductive traits for purebred parental rabbits are given in Table (7). In purebred rabbits, the interval reproductive traits (KI, DO and MDC), litter size (LS21 and LSW) and litter weight traits (LW21d and LWW) were associated positively and significantly, where the mortality percentages were associated negatively and significantly with high immune response to BSA antigen in both NZW and Cal breeds.

The litter size (LS21) ranged from 5.4 to 6.0 vs 3.2 to 3.5 in HR vs LR purebred lines of both NZW and Cal breeds. Also, the litter weight LW21d (g) ranged from 275.04 to 288.05 vs 105.00 to 157.00 (g), where the LWW ranged from 498.99 to 595.96 vs 418.00 to 426.00 (g) in HR vs LR purebred lines of both breeds. On the other hand, the mortality percentages from birth to weaning ranged from 23.7 to 27.4vs 72.4 to 85.9% in HR vs LR purebred lines of both breeds due to the differences in antibody titers.

In regard to the crossbred rabbits (Table 8), the results show that the HCN and HNC crossbred rabbits produced from the HR lines of both NZW and Cal breeds expressed superior values of all litter performance as compared to their purebred parents. The remarkable results were the mortality percentages from birth to weaning which decreased from 23.7-27.4% for purebred HR lines of both NZW and Cal breeds to 15.9-18.9% in their crossbred rabbits (Tables 7 and 8).

These results are in agreement with the findings reported by Khalil et al., (1995) and Khalil and Afify (2000) who found that the reciprocal crossing by two way of NZW and Cal rabbits had better values in Kl periods, DO, DMC and litter performance as compared to their parents rabbits due to the association with lactation and ability of females as well as her offspring young nursing and suckling till weaning.

The present results explained the important role of high immune response for improvement of physiological and reproductive performance either in purebred or crossbred rabbits.

Table (1): Least-square means (LSM ± SE) of primary antibody titers to BSA antigen at 7, 14 and 21d post-immunization in control and selected purebred parents rabbits.

Breed	***Line****	***No. of parents (M + F)***	***Primary antibody titers (LSM ± SE)***		
			7d	**14d**	**21d**
NZW	HR	6 + 18	6.29 ± 0.45	5.01 ± 0.39	1.17 ± 0.06
	CL	6 + 18	4.51 ± 0.68	2.55 ± 0.28	0.71 ± 0.08
	LR	6 + 18	2.56 ± 0.53	1.18 ± 0.12	0.60 ± 0.05
Cal	HR	6 + 18	6.34 ± 0.92	5.11 ± 0.62	1.27 ± 0.09
	CL	6 + 18	4.62 ± 0.81	1.96 ± 0.47	0.70 ± 0.08
	LR	6 + 18	2.40 ± 0.45	1.13 ± 0.32	0.53 ± 0.03

* HR= High immune response line.
CL= Control line.
LR= Low immune response line.

Table (2): Least-square means (LSM ± SE) of primary antibody titers to BSA antigen at 7, 14 and 21 d post-immunization in crossbred progenies.

Crossing type*	*No. of progenies*	*Primary antibody titers (LSM ± SE)*		
		7d	**14d**	**21d**
HCN	36	7.11 ± 0.83	5.26 ± 0.71	1.23 ± 0.09
HNC	30	6.89 ± 0.96	5.19 ± 0.82	1.27 ± 0.09
LCN	42	2.61 ± 0.81	1.28 ± 0.36	0.81 ± 0.06
LNC	39	2.56 ± 0.65	1.19 ± 0.28	0.72 ± 0.07

* HCN= High line ♂ Cal x HR ♀ NZW.
HNC= High line ♂ NZWX HR ♀ Cal.
LCN= Low line ♂ Cal x LR ♀ NZW.
LNC= Low line ♂ NZW x LR ♀ Cal.

Table (3): Least-square means (LSM ± SE) of haematological traits in serum of high and low antibody response to BSA antigen for purebred parent rabbits

Haematological traits	*NZW*		*Cal*	
	HR – line	**LR – line**	**HR – line**	**LR – line**
TP (g/dl)	7.61 ± 0.19^{a}	4.61 ± 0.44^{b}	6.96 ± 0.32^{a}	4.51 ± 0.46^{b}
Alb (g/dl)	4.14 ± 0.16^{a}	1.88 ± 0.18^{c}	3.17 ± 0.09^{b}	2.21 ± 0.08^{b}
Glob (g/dl)	3.70 ± 0.14^{a}	2.67 ± 0.22^{b}	2.93 ± 0.05^{b}	2.79 ± 0.11^{b}
A/G ratio	1.12	0.70	1.08	0.79
RBC (10^6 / mm^3)	5.51 ± 0.16^{a}	4.16 ± 0.13^{b}	4.23 ± 0.41^{b}	4.01 ± 0.23^{b}
Hb (g / dl)	10.95 ± 0.76^{a}	6.59 ± 0.94^{b}	9.11 ± 0.72^{a}	5.88 ± 0.51^{b}
TWBC (10^3 / mm^3)	12.59 ± 0.64^{a}	6.51 ± 0.35^{b}	11.46 ± 0.46^{a}	6.46 ± 0.22^{b}
Monocyte (10^3 / mm^3)	1.15 ± 0.04^{a}	0.40 ± 0.02^{b}	1.19 ± 0.06^{a}	0.41 ± 0.06^{b}
Lymphocyte (10^3 / mm^3)	3.05 ± 0.06^{a}	1.19 ± 0.09^{b}	3.36 ± 0.19^{a}	1.13 ± 0.15^{b}
Neutrophil (10^3 / mm^3)	5.01 ± 0.12^{a}	3.25 ± 0.21^{b}	5.46 ± 0.26^{a}	1.96 ± 0.18^{b}

^{a,b,c}= Means with different superscripts in the same raw are significant at ($P \leq 0.5$).

Table (4): Least-square means (LSM ± SE) of haematological traits of crossbred progen rabbits.

Haematological traits	*Crossing type **			
	HCN	**HNC**	**LCN**	**LNC**
TP (g/dl)	7.40 ± 0.07[a]	7.36 ± 0.28[a]	4.35 ± 0.46[b]	4.81 ± 0.21[b]
Alb (g/dl)	4.46 ± 0.19[a]	4.46 ± 0.16[a]	3.03 ± 0.12[b]	3.12 ± 0.12[b]
Glob (g/dl)	2.94 ± 0.53	2.90 ± 0.42	2.86 ± 0.30	2.93 ± 0.24
A/G ratio	1.56	1.61	0.65	0.56
RBC (10^6 / mm^3)	5.12 ± 0.02[a]	5.08 ± 0.91[a]	4.57 ± 0.15[b]	4.60 ± 0.79[b]
Hb (g / dl)	8.31 ± 0.27[a]	8.40 ± 0.19[a]	7.69 ± 0.02[b]	7.50 ± 0.31[b]
TWBC (10^3 / mm^3)	13.79 ± 0.08[a]	12.03 ± 0.35[a]	6.67 ± 0.22[b]	6.69 ± 0.21[b]
Monocyte (10^3 / mm^3)	1.45 ± 0.50[a]	1.35 ± 0.11[a]	0.87 ± 0.19[b]	0.93 ± 0.11[b]
Lymphocyte (10^3 / mm^3)	3.65 ± 0.14[a]	3.69 ± 0.73[a]	1.46 ± 0.65[b]	1.50 ± 0.96[b]
Neutrophil (10^3 / mm^3)	5.60 ± 0.66[a]	5.51 ± 0.32[a]	3.92 ± 0.51[b]	3.01 ± 0.22[b]

[a,b,c]= Means with different superscripts in the same raw are significant at ($P \leq 0.5$).
* HCN= High line ♂ Cal x HR ♀ NZW, LCN= Low line ♂ Cal x LR ♀ NZW,
HCN= High line ♂ NZW x HR ♀ Cal, LNC= Low lines ♂ NZW x LR ♀ Cal,

Table (5): Least-square means (LSM ± SE) of total immunoglobulins {Ig, IgA, IgM and IgG (mg/dl)} in serum of both NZW and Cal purebred rabbits.

Trait	*NZW*		*Cal*	
	HR – line	**LR – line**	**HR – line**	**LR – line**
Total Ig	915.35 ± 1.49[a]	740.21 ± 1.98[b]	910.95 ± 2.61[a]	730.01 ± 1.86[b]
IgA	19.11 ± 0.64	21.92 ± 0.14	18.89 ± 0.27	21.11 ± 0.65
IgM	439.15 ± 2.86[b]	513.51 ± 2.78[a]	436.06 ± 1.96[b]	519.15 ± 2.01a
IgG	435.90 ± 1.49[a]	161.03 ± 1.12[b]	433.81 ± 2.15[a]	159.95 ± 1.14[b]

[a,b,c]= Means with different superscripts in the same raw are significant at ($P \leq 0.5$).

Table (6): Least-square means (LSM ± SE) of total immunoglobulins {Ig, IgA, IgM and IgG (mg/dl)} in serum of crossbred progeny rabbits.

Trait	*Crossing type **			
	HCN	**HNC**	**LCN**	**LNC**
Total Ig	912.69 ± 1.38[a]	910.54 ± 1.65[a]	775.91 ± 3.16[b]	739.21 ± 1.24[b]
IgA	20.26 ± 0.64	19.92 ± 0.48	18.93 ± 0.73	20.91 ± 0.49
IgM	515.35 ± 2.81	510.41 ± 2.83	530.11 ± 1.98	526.37 ± 1.87
IgG	350.08 ± 1.92[a]	349.06 ± 1.88[a]	158.11 ± 1.03[b]	160.12 ± 1.14[b]

[a,b,c]= Means with different superscripts in the same raw are significant at ($P \leq 0.5$).
* HCN= High line ♂ Cal x HR ♀ NZW, LCN= Low line ♂ Cal x LR ♀ NZW,
HCN= High line ♂ NZW x HR ♀ Cal, LNC= Low lines ♂ NZW x LR ♀ Cal,

Table (7): Least-square means (LSM ± SE) of doe traits, litter performance and mortality percentages for purebred parents rabbits

Trait	*NZW*		*Cal*	
	HR – line	**LR – line**	**HR – line**	**LR – line**
No of Does	18	18	18	18
Doe Reproductive traits				
Kindling interval (KI)	84.00 ± 2.40[a]	80.00 ± 2.00[b]	83.00 ± 1.41[a]	83.00 ± 1.50[a]
Days open (DO)	64.00 ± 2.70[a]	56.00 ± 3.90[b]	64.00 ± 2.11[a]	51.00 ± 2.90[b]
Milk yield d DMC (g)	33.58 ± 0.71[a]	24.11 ± 0.14[b]	33.97 ± 0.14[b]	20.90 ± 0.19[c]
Litter size traits:				
Litter size at birth (LSB)	5.80 ± 0.38	5.99 ± 0.19	6.60 ± 0.39	6.15 ± 0.78
No. born alive (NBA)	5.70 ± 0.76	6.10 ± 0.19	6.00 ± 0.19	6.00 ± 0.73
Litter size at 21-day (LS21)	5.40 ± 0.11[a]	3.20 ± 0.20[b]	6.00 ± 0.20[a]	3.50 ± 0.19[b]
Litter size at weaning (LSW)	4.50 ± 0.20[a]	2.50 ± 0.11[b]	4.90 ± 0.11[a]	2.00 ± 0.10[b]
Litter weight traits (g)				
Litter weight at birth (LWB)	59.51 ± 0.80[b]	53.00 ± 0.34[b]	69.43 ± 0.87[a]	63.00 ± 0.85[a]
Litter weight at 21d (LW21)	288.05 ± 15.96[a]	105.00 ± 0.50[b]	275.04±0.32[a]	157.00±0.67[b]
Litter weight at weaning LWW	518.99 ± 0.964[a]	426.00± 0.14[b]	595.96±0.74[a]	418.00±0.12[b]
Mortality percentage				
From birth (B) to 21-day	7.0%	43.8%	9.1%	44.0%
21-day to weaning	16.7%	28.6%	18.3%	41.9%
birth to weaning	23.7[b]%	72.4%	27.4[b]%	85.9%

[a,b,c]= Means with different superscripts in the same raw are significant at ($P \leq 0.5$).

Table (8): Least-square means (LSM ± SE) of doe traits, litter performance and mortality percentages for crossbred progeny

Trait	*Crossing type **			
	HCN	**HNC**	**LCN**	**LNC**
No of Does	36	30	42	39
Doe Reproductive traits				
Kindling interval (KI)	86.00 ± 2.00^{a}	83.00 ± 1.40^{a}	80.00 ± 2.09^{b}	83.00 ± 1.59^{b}
Days open (DO)	64.00 ± 2.71^{a}	64.00 ± 2.11^{a}	58.00 ± 3.91^{b}	59.00 ± 2.90^{b}
Milk yield d DMC (g)	33.58 ± 0.71^{a}	33.97 ± 0.42	24.11 ± 0.14^{b}	20.90 ± 0.19^{c}
Litter size traits:				
Litter size at birth (LSB)	6.80 ± 0.38^{a}	6.60 ± 0.39^{a}	6.15 ± 0.19^{a}	5.15 ± 0.19^{b}
No. born alive (NBA)	6.00 ± 0.34^{a}	6.00 ± 0.19^{a}	5.00 ± 0.201^{b}	4.80 ± 0.73^{b}
Litter size at 21-day (LS21)	5.00 ± 0.11^{a}	5.00 ± 0.30^{a}	4.20 ± 0.20^{b}	3.00 ± 0.19^{c}
Litter size at weaning (LSW)	4.81 ± 0.20^{a}	4.70 ± 0.11^{a}	3.00 ± 0.11^{b}	2.00 ± 0.78^{c}
Litter weight traits (g)				
Litter weight at birth (LWB)	59.51 ± 0.80^{b}	59.43 ± 0.87^{a}	59.00 ± 0.21^{b}	63.00 ± 1.85^{a}
Litter weight at 21d (LW21)	288.05 ± 0.96^{a}	276.04 ± 0.32^{a}	135.00 ± 0.50^{b}	157.0 ± 1.67^{b}
Litter weight at weaning LWW	528.99 ± 0.140^{b}	611.00 ± 0.70^{a}	498.99 ± 0.96^{b}	495.00 ± 0.74^{b}
Mortality percentage				
From birth (B) to 21-day	4.7%	4.7%	25.9%	27.9%
21-day to weaning	11.2%	14.2%	25.4%	33.2%
birth to weaning	15.9^{b}%	18.9^{b}%	51.3^{a}%	61.1^{a}%

^{a,b,c}= Means with different superscripts in the same raw are significant at ($P \leq 0.5$).

* HCN= High line ♂ Cal x HR ♀ NZW.
HNC= High line ♂ NZW x HR ♀ Cal.
LCN= Low line ♂ Cal x LR ♀ NZW.
LNC= Low line ♂ NZW x LR ♀ Cal.

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الملخص العربى

دراسات مناعية وعلاقتها ببعض الصفات الفسيولوجية والتناسلية فى أرانب النيوزيلاندى الأبيض والكاليفورنيا

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استخدم فى هذه التجربة 144 أرنب نقى، 147 أرنب خليط من النيوزيلاندى الأبيض (NZW) والكاليفورنيا (Cal). وتهدف التجربة أساساً إلى دراسة العلاقة بين المناعة العالية (HR-line) والمناعة المنخفضة (LR-line) نتيجة التحصين بمصل البيومين البقر (BSA) وبعض الصفات الفسيولوجية والتناسلية فى الأرانب النقية والخليطة لكل من Cal و NZW . تم تكوين أربعة خلطات من الأرانب نتيجة تزواج ذكور Cal–HR x إناث NZW-HR (HCN)، تزاوج ذكور NZW – HR x إناث Cal-HR (HNC)، وتزاوج ذكور Cal–LR x إناث (LCN) NZW LR وأخيراً تزواج ذكور NZW– LR x إناث Cal– LR (LNC).

كانت الصفات المدروسة هى مستوى الأجسام المضادة وتركيزه، البروتين الكلى (TP)، الألبيومين (Alb)، الجلوبيولين (Glob)، نسبة الألبيومين إلى الجلوبيولين (A/G) والعدد الكلى لكرات الدم البيضاء (TWBCs)، الجلوبيولين المناعى الكلى وأنواعه (Ig, IgA, IgM and IgG)، فترات التناسل (الفترة على مدار بطنين متعاقبتين KI، الفترة من الولادة إلى الحمل التالى DO، كمية اللبن المستهلك للصغار DMC، حجم الخلفة (LSW, LS21)، ووزن الخلفة (LWW,LW21) ونسبة النفوق.

وقد أظهرت النتائج أن الخطوط عالية المناعة (HR-line) حصلت على أعلى مستوى من الأجسام المضادة، وحصلت الخطوط المنخفضة المناعة (LR-line) على أقل مستوى، بينما حصل خط المقارنة على قيمة متوسطة فى كل من أرانب النيوزيلاندى الأبيض والكاليفورنيا النقية. وقد حققت الأرانب الخليطة على متوسطات أعلى من الأجسام المضادة بمقارنتها بالأباء. كانت متوسطات الاستجابة الأولية للأجسام المضادة بعد 7 أيام من التحصين 6.29، 6.34 فى الخطوط عالية المناعة لكل من النيوزيلاندى الأبيض والكاليفورنيا، على التوالى، بينما زادت هذه المتوسطات إلى 7.11، 6.89 فى الأرانب الخليطة من هذه الأباء.

وقد وجدت علاقة إيجابية ومعنوية بين كل من قياسات الدم (TWBC, Hb, A/G, Glob, Alb, Tp)، والجلوبيولين المناعى بأنواعه (IgM and Ig) وفترات التناسل (DmC, DO) وحجم الخلفة (LSW, LS21) ووزن الخلفة (LWW, LW21) مع خطوط المناعة العالية (HR-line) فى كل من أرانب النيوزيلاندى الأبيض والكاليفورنيا النقية. وقد حققت الأرانب الخليطة الناتجة من خلط الخطوط العالية المناعة من النيوزيلاندى والكاليفورنيا (HCN, HNC) بعض التفوق فى معظم القياسات التى درست بمقارنتها بالأباء النقية.

وكانت أهم النتائج الواضحة هى أن نسبة النفوق من الولادة حتى عمر الفطام ذات علاقة سلبية ومعنوية مع الخطوط عالية الاستجابة للمناعة، حيث انخفضت نسبة النفوق من 72.4–85.9% فى الخطوط منخفضة الاستجابة للمناعة إلى 23.7–27.4% فى الخطوط عالية الاستجابة للمناعة فى الأرانب النقية، بينما حققت الأرانب الخليطة أقل نسبة نفوق حيث تتراوح من 15.9–18.9% فى الأرانب الخليطة الناتجة من خلط الأرانب العالية المناعة فى كلا النوعين (HCN, HNC).

نستخلص من هذه النتائج الدور المهم للإستجابة للمناعة العالية لتحسين الأداء الفسيولوجى والتناسلى فى كلاً من الأرانب النقية والخليطة.