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HAEMATOLOGICAL AND BIOCHEMICAL OBSERVATIONS IN FOUR PURE BREEDS OF RABBITS AND THEIR CROSSES UNDER EGYPTIAN ENVIRONMENTAL CONDITIONS

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Abstract: The present study was conducted to evaluate 16 crosses between 4 breeds of rabbits from a physiological point of view. The breeds tested were Baladi Red (BR), Chinchilla Giganta (ChG), French Giant Papillon (FGP) and Simenwar (S). A total number of 6144 blood samples were collected to detect the effect of crossing, age of kits, month of kindling and sex effects. The traits evaluated were: haematological parameters; red blood cell count (RBCs), haemoglobin concentration (Hb), haematocrit value (Ht%), biochemical parameters of plasma; total protein (TP), albumin (Alb), globulin concentration (Glo), albumin/globulin ratio (Alb/Glo) and triglycerides (TG). BR or its crosses, using BR sires or BR dams, showed the highest value of RBCs, Hb and Ht%. Crossbred rabbits obtained from mating BR and FGP rabbits had the highest Glo values. Rabbits which were born in May-June months had the highest values of TP and its fractions (Alb and Glo). Age of kits had a highly significant effect (P<0.001) on RBCs, Hb, Ht%, TP and TG. Moreover, Glo and Alb/Glo ratio (P<0.01) and Alb (P<0.05) were also significantly affected. Sex had no significant effect on all studied parameters. Significant positive correlations were found between TP and each final body weight, total weight gain, total feed intake, carcass weight and dressing percentage, while significant negative correlation was found with feed conversion.

Key Words: rabbits, crossbreeding, haematological, biochemical, heterosis, superiority.

INTRODUCTION

Crossing between different breeds of rabbits plays an important role in increasing certain biochemical traits such as total protein and albumin (Nofal *et al*., 1999). However, Cazabon *et al*. (2000) reported no significant differences between New Zealand White and its crosses with Californian, Checkered Giant and Flemish Giant breeds for haemoglobin concentration, haematocrit value and plasma protein.

Accordingly, the present investigation studies the differences in some haematological and blood constituents of crossbred and purebred rabbits. Age of kits, month of kindling and sex were also considered.

MATERIALS AND METHODS

The experimental work in this study was carried out at Fayoum governorate, located about 100 km southwest of Cairo. Purebred and crossbred rabbits of three exotic breeds Chinchilla Giganta (ChG), French Giant Papillon (FGP) and Simenwar (S) and one local Egyptian breed, Baladi Red (BR) were used during the two production years of the study, which started in December 2003 and lasted until August 2005 (Table 1). Descriptions of the four breeds were reported by Abdel-Azeem (2006).

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Table 1: Work schedule.

Year	Starting dates	Kindling dates			
		1st	2nd	3rd	4th
1	December 2003	January 2004	March 2004	April 2004	May-June2004
2	December 2004	January 2005	March 2005	April 2005	May-June2005

A total of 256 does (64 does per breed) and 64 bucks (16 bucks per breed) were used. Does were allowed to kindle 4 parities per year. Kits were weaned at 32 d after birth, ear tagged by permanent marker and retagged each 20/30 d of age, sexed and housed in wire-netted hutches with suitable space in the second row of batteries along the rabbitry.

Pregnant and lactating does were fed *ad libitum* with commercial pellets. Pellet composition was 17.85% crude protein, 13.70% crude fibre and 3.10% ether extract. The young rabbits were fed *ad libitum* until 6 wk post weaning with a diet of commercial pellets composed of 16.77% crude protein, 13.85% crude fibre and 3.75% ether extract.

A total number of 6144 blood samples were collected from 2990 males and 3154 females. Blood samples were collected at 6 and 9 wk of age in 3 rabbits from each mating. Xylol was applied to increase blood flow (Hoppe *et al*., 1971) using heparin as anticoagulant.

Approximately half of each blood sample was centrifuged (15 min, 3000 rpm) and the obtained plasma was removed and frozen stored at −20C° until analysis. Blood samples were taken to determine red blood cells count (RBCs) and haematocrit value (Ht%) according to Bauer (1970) and haemoglobin (Hb) as stated by Singh (1983). Plasma total protein (TP), albumin (Alb), triglycerides (TG) were determined by using commercial kits. Globulin (Glo) concentration of plasma and albumin/globulin ratio (Alb/Glo) were calculated. Correlations were estimated between RBCs, Hb, Ht%, TP, Alb, Glo, Alb/Glo, TG and each of final body weight (FBW), total weight gain (TWG), total feed intake (TFI), feed conversion (FC), carcass weight and dressing percentage.

Analysis of variance using the General Linear Model (GLM) was used to calculate the least square means of the studied traits using SPSS (1997). The following model was used for blood traits.

$$Y_{ijkl}=\mu + A_i + M_j + Mo_k + S_l + e_{ijkl}$$

Where, Y_{ijkl}=the observation on the ijklth blood traits.

μ=overall mean;

A_i=the fixed effect of the ith age of kits (i= 1 and 2; 6 and 9 wk);

M_j=the fixed effect of the jth mating group (j=1, 2,.. and 16);

Mo_k=the fixed effect of the kth month of kindling (k=1, 2,..and 4);

S_l=the fixed effect of the lth sex (l=1 and 2; male and female);

e_{ijkl}=random error.

Heterosis and superiority percent of crossbreds

Heterosis was calculated as the difference between the mean of the F1 crossbred (MF1) and mean of the two parental populations (MP).

Heterosis (%)=$[(MF_1–MP)/MP]\times100$

Superiority was calculated as the difference between the mean of the F1 crossbred (MF1) and mean of the better parent value (BP).

Superiority (%)=[(MF_1 – BP)/BP]×100

RESULTS AND DISCUSSION

Haematological Parameters

RBCs, Hb and Ht% increased significantly (P<0.001) from 6 to 9 wk as shown in Table 2. This trend was reported by Meshreky *et al*. (2005) working on kits from 12 to 16 wk of age. This may be due to the positive relationship between blood volume and age advancement as indicated by Prince (1982) and Jain (1986) regarding total body weight estimates or body surface area.

Mating group effect was highly significant (P<0.001) on RBCs, Hb and Ht% as shown in Table 2. The highest values for RBCs, Hb and Ht% were found in BR ($4.410\times10^6\pm0.02/mm^3$, 11.74±0.028 g/dL and 30.83±0.050%, respectively). These results may be due to the high adaptation of BR rabbits to the Egyptian conditions, as observed by Meshreky *et al*. (2005). All crossbred using BR sires or BR dams gave high values of RBCs, Hb and Ht%.

Among the other crosses, the highest values for RBCs were found in S×FGP ($4.402\times10^6\pm0.018/mm^3$) and FGP×ChG ($4.361\times10^6\pm0.018/mm^3$) and, to a lesser extent, in S×ChG ($4.321\times10^6\pm0.018/mm^3$). The highest Hb value was recorded in S×ChG (11.64±0.028 g/dL). The Hb values were in the same range as given by Jones *et al*. (1975), Fekry and Shebaita (1994), El-Maghawry *et al*. (1994) who reported Hb values between 9.0 -14 (g/100 mL). The FGP×ChG crossbred had higher value of Ht% (30.77±0.050%) than other crossbreds.

Month of kindling effect was significant (P<0.01) in RBCs, Hb and Ht% (Table 2). Highest value of RBCs, Hb and Ht% were recorded in litters kindling in January and lowest values were recorded in litters kindling from May- June. These results agreed with those obtained by Okab and El-Banna (2003). There was a decrease in the number of red blood cells with increasing ambient temperature (Shebaita, 1993). Decreasing Ht% under high ambient temperature conditions may be due to the increase in body water retention and extracellular water (Meshreky *et al*., 2005), or increased plasma volume in hyperthermic animals (Othman, 1990). The decrease in Hb may also be due to the decrease in RBCs in litters born in May-June.

Sex effect was not significant in RBCs, Hb and Ht% as shown in Table 2. This is mainly due to the age of rabbits (6 and 9 wk), far from pubertal stage and from sexual hormone secretion. Since androgen hormone (Darwish and El-Habbak, 2003) and testosterone hormone (Khalil, 1997) increase red blood cells formation rate, through increase of erythropoietin formation rate in kidney, it also increases RBC formation in bone medulla.

Biochemical Parameters:

Age of kits had a highly significant effect (P<0.001) on TG. It also significantly affected Glo and Alb/Glo ratio (P<0.01) and Alb (P<0.05) (Table 3). These results indicate that TP, Alb, Glo, Alb/Glo ratio and TG tended to increase from 6 to 9 wk of age. These results agreed with those obtained by Jain (1986), Chiericato *et al*. (2000), Meshreky *et al*. (2005).

Mating group had a highly significant effect on TP and TG (P<0.001). It also significantly affected Alb (P<0.01), Glo and Alb/Glo ratio (P<0.05) (Table 3). The present range of TP values (5.316 to 5.403 g/dL) was within the range reported by Jain (1986) (2.87 to 10.13 g/dL). Results indicate larger values of TP

Table 2: Least square means and standard errors (least-square means±standard error) of haematological parameters by age of kit, mating group, month of kindling and sex.

	Haematological Parameters[1]		
	RBCs ($\times10^6$/mm^3)	Hb(g/dL)	HT%
Age of kit	***	***	**
6 wk	3.609±0.006^{b}	10.892 ±0.010^{b}	29.707±0.018^{b}
9 wk	4.710±0.006^{a}	11.542 ±0.010^{a}	30.207±0.018^{a}
Mating Group[2]	***	***	***
♂×♀			
BR×BR	4.41±0.018^{j}	11.74±0.028^{a}	30.825±0.050^{a}
ChG×ChG	3.76±0.018^{b}	10.68±0.028^{i}	28.959±0.050^{i}
FGP×FGP	3.84±0.018^{c}	10.74±0.028^{hi}	29.118±0.050^{h}
S×S	3.61±0.018^{a}	10.86±0.028^{g}	29.332±0.050^{g}
BR×ChG	4.24±0.018^{h}	11.42±0.028^{c}	30.313±0.050^{d}
BR×FGP	4.12±0.018^{g}	11.22±0.028^{d}	30.076±0.050^{e}
BR×S	4.25±0.018^{d}	11.46±0.028^{c}	30.375±0.050^{d}
ChG×BR	3.91±0.018^{c}	10.86±0.028^{g}	29.430±0.050^{g}
ChG×FGP	3.85±0.018^{f}	10.80±0.028^{gh}	28.994±0.050^{hi}
ChG×S	4.04±0.018^{g}	11.09±0.028^{e}	29.815±0.050^{f}
FGP×BR	4.13±0.018^{ij}	11.20±0.028^{d}	30.063±0.050^{e}
FGP×ChG	4.36±0.018^{bc}	11.61±0.028^{b}	30.769±0.050^{ab}
FGP×S	3.96±0.018^{e}	10.96±0.028^{f}	29.473±0.050^{g}
S×BR	4.26±0.018^{h}	11.60±0.028^{b}	30.525±0.050^{c}
S×ChG	4.32±0.018^{i}	11.64±0.028^{b}	30.591±0.050^{c}
S×FGP	4.40±0.018^{j}	11.62±0.028^{b}	30.657±0.050 ^{bc}
Month of Kindling	**	**	**
January	4.182±0.009^{c}	11.305±0.014 ^{a}	30.205±0.025 ^{a}
March	4.136±0.009^{b}	11.247±0.014^{b}	30.040±0.025 ^{b}
April	4.069±0.009^{a}	11.169±0.014 ^{c}	29.823±0.025 ^{c}
May-June	4.050±0.009^{a}	11.147±0.014 ^{c}	29.760±0.025 ^{c}
Sex	NS	NS	NS
Males	4.106±0.006	11.215±0.010	29.952±0.018
Females	4.111±0.006	11.218±0.010	29.962±0.018

[1]RBCs: red blood cell count ($\times10^6$/mm^3), Hb (g/dL): haemoglobin concentration measured by gram in decilitre, HT%: haematocrit percentage.

[2]BR: Baladi Red rabbits, ChG: Chinchilla Giganta rabbits, FGP: French Giant Papillon rabbits and S: Simenwar rabbits.

Least- squares means±standard error in the same column within each effect sharing different small letters differ significantly at $P<0.05$.

Significance ***=$P<0.001$; **=$P<0.01$ and NS=Non significant.

Table 3: Least square means and standard errors of biochemical parameters of plasma by age of kit, mating group, month of kindling and sex.

	Biochemical Parameters of Plasma[1]				
	TP(g/dL)	Alb(g/dL)	Glo(g/dL)	Alb/Glo	TG(mg/dL)
Age of kit	***	*	**	**	***
6 wk	4.891±0.001^{b}	3.051±0.001^{b}	1.840±0.001^{b}	1.472±0.001^{a}	15.63±0.003^{b}
9 wk	5.885±0.001^{a}	3.345±0.001^{a}	2.540±0.001^{a}	1.231±0.001^{b}	16.75±0.003^{a}
Mating Group[2]	***	**	*	*	***
♂×♀					
BR×BR	5.348±0.001^{e}	3.123 ±0.003^{f}	2.225±0.004^{a}	1.423± 0.002^{d}	16.02±0.008^{k}
ChG×ChG	5.316±0.001^{f}	3.196±0.003^{cd}	2.120±0.004^{d}	1.524±0.002^{a}	16.20±0.008^{f}
FGP×FGP	5.369±0.001^{d}	3.150±0.003^{ef}	2.219±0.004^{a}	1.446±0.002^{cd}	16.03±0.008^{k}
S×S	5.328±0.001^{e}	3.145±0.003^{ef}	2.183±0.004^{bc}	1.512±0.002^{ab}	16.14±0.008^{h}
BR×ChG	5.376±0.001^{d}	3.199±0.003^{cd}	2.177±0.004^{bc}	1.486±0.002^{bc}	16.06±0.008^{j}
BR×FGP	5.399±0.001^{a}	3.195±0.003^{cd}	2.204±0.004^{ab}	1.463±0.002^{bc}	16.10±0.008^{i}
BR×S	5.389±0.001^{b}	3.123±0.003^{f}	2.176±0.004^{bc}	1.492±0.002^{bc}	16.12±0.008^{h}
ChG×BR	5.401±0.001^{a}	3.238±0.003^{b}	2.163±0.004^{cd}	1.516±0.002^{ab}	16.17±0.008^{g}
ChG×FGP	5.403±0.001^{a}	3.228±0.003^{c}	2.175±0.004^{cd}	1.507±0.002^{ab}	16.37±0.008^{ab}
ChG×S	5.400±0.001^{a}	3.254±0.003^{a}	2.146±0.004^{d}	1.539±0.002^{a}	16.28±0.008^{d}
FGP×BR	5.376±0.001^{d}	3.151±0.003^{ef}	2.225±0.004^{a}	1.416±0.002^{d}	16.22±0.008^{e}
FGP×ChG	5.386±0.001^{bc}	3.163±0.003^{d}	2.223±0.004^{a}	1.453±0.002^{cd}	16.38±0.008^{a}
FGP×S	5.375±0.001^{d}	3.155±0.003^{e}	2.220±0.004^{a}	1.451±0.002^{cd}	16.19±0.008^{fg}
S×BR	5.400±0.001^{a}	3.236±0.003^{b}	2.164±0.004^{bc}	1.510±0.002^{ab}	16.08±0.008^{ij}
S×ChG	5.401±0.001^{a}	3.225±0.003^{c}	2.176±0.004^{ab}	1.446±0.002^{cd}	16.35± 0.008^{bc}
S×FGP	5.398±0.001^{a}	3.197±0.003^{cd}	2.201±0.004^{a}	1.420±0.002^{d}	16.33±0.008^{c}
Month of Kindling	***	*	***	***	***
January	5.06±0.001^{d}	3.158±0.002^{b}	1.902±0.002^{d}	1.523±0.001^{a}	16.90±0.004^{a}
March	5.30±0.001^{c}	3.145±0.002^{b}	2.155±0.002^{c}	1.493±0.001^{b}	16.33±0.004^{b}
April	5.45±0.001^{b}	3.150±0.002^{b}	2.300±0.002^{b}	1.392±0.001^{d}	15.87±0.004^{c}
May-June	5.75±0.001^{a}	3.350±0.002^{a}	2.400±0.002^{a}	1.417±0.001^{c}	15.65±0.004^{d}
Sex	NS	NS	NS	NS	NS
Females	5.390±0.0001	3.200±0.001	2.190±0.001	1.506±0.001	16.19±0.003
Males	5.395±0.0001	3.206±0.001	2.189±0.001	1.510±0.001	16.19±0.003

[1]TP (g/dL): total plasma proteim, Alb (g/dL): albumin concentration of plasma, Glo (g/dL): plasma globulin concentration, TG (mg/dL): plasma triglycerides.

[2]BR: Baladi Red rabbits, ChG: Chinchilla Giganta rabbits, FGP: French Giant Papillon rabbits and S: Simenwar rabbits.

Least square means±standard error in the same column within each effect sharing different superscripts differ significantly at $P<0.05$.

Significance ***: $P<0.001$, **: $P<0.01$, *: $P<0.05$, NS: Non significant.

Table 4: Heterosis and superiority of haematology parameters in crossbred rabbits.

	Heterosis (%)			Superiority (%)		
	RBCs	Hb	HT	RBCs	Hb	HT
BR×ChG	3.79	1.87	1.41	−3.85	−2.73	−1.66
BR×FGP	−0.12	−0.18	0.35	−6.58	−4.43	−2.43
BR×S	5.99	1.42	0.99	−3.63	−2.39	−1.46
ChG×BR	−4.28	−3.12	−1.55	−11.30	−7.50	−4.53
ChG×FGP	1.32	0.84	−0.15	0.26	0.56	−0.43
ChG×S	9.63	2.97	2.30	7.45	2.12	1.65
FGP×BR	0.12	−0.36	0.31	−6.35	−4.60	−2.47
FGP×ChG	14.74	8.40	5.60	−1.13	8.10	5.67
FGP×S	6.31	1.48	0.85	3.13	0.92	0.48
S×BR	6.23	2.65	1.48	−3.40	−1.19	−0.97
S×ChG	17.23	8.08	4.96	14.89	7.18	4.29
S×FGP	15.79	8.50	4.90	14.58	7.00	4.52

and its fractions (albumin and globulin) in crossbred litters than in purebreds. These results agreed with those obtained by Nofal *et al*. (1999); Meshreky *et al*. (2005). Among purebreds, the highest value of TP was recorded in FGP (5.369±0.001 g/dL).

The higher value of Alb found in crossbred rabbits suggests that metabolic rate may be higher in crossbred than in purebred rabbits. The change in albumin level reflects the change in liver function (Azoz and El-Kholy, 2005). Jones and Bark (1979) reported that the liver is the site of albumin synthesis, whereas lymphatic tissues form globulin.

Crossbred animals obtained by mating BR or FGP rabbits with other breeds showed higher values in Glo. The crossing between FGP×BR had the highest value (2.225±0.004 g/dL). Globulin can be taken as a good indicator of immunity response (Ismail *et al*., 2002). There is an inverse relationship between Alb/Glo ratio and immunoglobulin level (Ismail *et al*., 2002). Low Alb/Glo ratios, indicating high immunoglobulin level, were measured in crossbred animals when FGP rabbits were used as sires and, in a lesser extent, when BR were used as sires.

Crossbred rabbits had higher value of TG than purebred. Among purebred, ChG had the highest value of TG (16.20±0.008 mg/dL). FGP×ChG had higher value of TG (16.38±0.008 mg/dL) than other crossbred.

Month of kindling effect was highly significant in TP, Glo, Alb/Glo ratio and TG ($P<0.001$) and significant in Alb ($P<0.05$) (Table 3). The increase in serum total protein and its fractions in hyperthermic animals are in agreement with those reported by Okab and El-Banna (2003); Meshreky *et al*. (2005) who found that plasma protein was higher in summer months than in winter months. In contrast, high TG values were recorded in January and decreased with the rise of temperature. This may be due to the increase in feed consumption during low temperature and to the associated increase in fat metabolism rate.

Heterosis and superiority of haematological and biochemical parameters

Heterosis and superiority of haematological and biochemical parameters in crossbred rabbits are presented in Tables 4 and 5. Positive and negative heterosis or superiority was shown for haematological and biochemical parameters. This means that, depending on the crossing, some haematological and

Table 5: Heterosis and superiority of biochemical parameters in plasma in crossbred rabbits.

	Heterosis (%)				Superiority (%)			
	TP	Alb	Glo	TG	TP	Alb	Glo	TG
BR×ChG	0.83	1.25	0.21	−0.31	0.52	0.09	−2.16	−0.86
BR×P	0.76	1.87	−0.81	0.47	0.56	1.43	−0.94	0.44
BR×S	0.96	−0.35	−1.27	0.25	0.77	−0.70	−2.20	−0.12
ChG×BR	1.29	2.48	−0.44	0.37	0.99	1.31	−2.79	−0.19
ChG×FGP	1.13	1.73	0.25	1.58	0.63	1.00	−1.98	1.05
ChG×S	1.47	2.63	−0.26	0.68	1.35	1.81	−1.69	0.49
FGP×BR	0.33	0.46	0.14	1.22	0.13	0.03	0	1.19
FGP×ChG	0.81	−0.32	2.47	1.64	0.32	−1.03	0.18	1.11
FGP×S	0.50	0.24	0.86	0.65	0.11	0.16	0.05	0.31
S×BR	1.16	3.25	−1.81	0	0.97	2.89	−2.74	−0.37
S×ChG	1.48	1.72	1.14	1.11	1.37	0.91	−0.32	0.93
S×P	0.93	1.57	0	1.52	0.54	1.49	-0.81	1.17

biochemical parameters could be improved, especially if breeds are genetically very different. The superiority of crossbred rabbits in some blood metabolites may be due to their ability to maintain their normal biological functions under Middle Egypt conditions, especially those of Fayoum city.

Correlation coefficients among some haematological and biochemical parameters at 6 wk of age and some productive traits of rabbit breeds at marketing age (10 wk of age) are presented in Table 6. The correlation estimates between TP and FBW, TWG, TFI, carcass weight and dressing percentage were significantly positive. Significant positive correlations were found between TG and FBW, TWG, TFI and carcass weight. Concerning FC, there were significant negative, and so favourable, correlations with TP and TG.

CONCLUSIONS

It may be concluded that the superiority of crossbred rabbits in some blood metabolites could be due to their ability to maintain their normal biological functions under Middle Egyptian conditions, especially those of Fayoum city.

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