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Some blood and milk constituents as affected by breed and pregnancy stage, in rabbits

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SUMMARY - Blood and milk samples were collected from New Zealand White (NZW) and Californian (Cal) lactating does immediately before mating, at day 14 and day 28 of gestation period. The constituents estimated in blood (B) and milk (M) were prolactin, progesterone, total protein, total fat, sugar, calcium (Ca), magnesium (Mg), Sodium (Na), potassium (K), as well as, hemoglobin. Rectal temperature, respiratory and pulse rates were estimated. The results showed that Cal does, generally, exceeded NZW ones significantly (P<0.01 and 0.05) in all traits studied either in blood or in milk, but M/B constituent ratios were inconsistent. All constituents of milk were many folds as much as those for blood, except Na which was about only two thirds of that of blood in milk. The mineral levels decreased gradually in the following order: Na, K, Ca to Mg in blood and Ca, K, Na to Mg in milk, respectively, in the two breeds studied. Each of prolactin and progesterone levels increased as milk yield increased and decreased as pregnancy advanced (and milk yield decreased). Total protein (in B and M) and blood fat decreased, while milk fat, sugar and Na, generally, increased as pregnancy and suckling advanced. The levels of minerals investigated (in B and M) were significantly (P<0.01) affected by pregnancy stage, except blood Mg which was not affected. Haemoglobin decreased and respiratory rate increased (P<0.01) with the advancement of pregnancy stage. Correlation coefficients between each pair of traits studied in blood and milk either within breed or pregnancy stage were mostly not significant and different in sign.

Introduction

It is known that heat and ovulation are induced by mating in rabbit doe and it can be mated directly after kindling and become pregnant nursing female. Subsequently, the hormonal system must be very sensitive to fit with such quick changes in the reproductive status of the doe. The present study aimed to investigate some blood and milk constituents, rectal temperature and respiratory and pulse rates as influenced by pregnancy stage in NZW and Cal rabbits does under the open sided house conditions during February-April period (Spring season), under Egyptian conditions.

Material and methods

The study was conducted in Rabbitry of the Department of Animal Production, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. The study included 8 does of NZW and 8 does of Cal in their fourth parity from February till April (Spring season). Does were individually housed in battery cages supplied with feeders, nipple drinkers and nest boxes and were fed ad libitum. Pellted ration was used and contained 16.3% crude protein, 2.5% crude fat and 14% crude fiber, as well as, a premix of minerals and Vitamins (each kilogram contained 60 g Zn, 60 g Mg, 25 g Fe, 4 g Cu, 3.5 mg I, 100 mg Se and 100 mg Ca; and each 1 gram contained 2000 IU vit. A, 2000 IU vit. D and 400 IU vit. E). Each doe was transferred to bucks cage to be mated and returned to its cage.

Milk samples were taken manually by gently massaging the mammary glands without hormonal treatment after 12 hours of separation of pups from their mothers, while blood samples were withdrawn from the ear vein immediately before mating, at day 14 and day 28 of pregnancy. Blood hemoglobin was estimated directly according to TITETZ (1982). Serum was separated by centrifugation, then the serum and milk were restored at -20 °C till analysis. Serum prolactin and progesterone were determined by the radio immunoassay technique using coated-tube kits and hormones were labeled with I^{125} (Diagnostic Products Corporation, Los Angles, USA). Estimations were carried out for total protein by biuret (ARMSTRONG and CARR, 1964) and for fat by sulfophoshovanillin (FRINGS *et al.*, 1972) in milk and blood samples. The dried samples (milk or blood) were ingested in a muffle furnace at 460 °C to estimate ash content. Sugar was calculated by subtracting the sum of protein, fat and ash from total solids which were estimated before according to LING (1956).

Minerals in milk and blood samples were estimated according to ASSOCIATION OFFICIAL ANALYTICAL CHEMISTS (1980). Each of Na, K, Ca and Mg were determined by atomic absorption spectrometry (PERKIN ELMER, 2380) using air acetylene flame.

Statistical analysis was conducted according to factorial design of 2 breeds X 3 pregnancy stages analysis of variance. Correlation coefficients between each pair of traits studied were also calculated in the two breeds studied according to SNEDECOR and COCHRAN (1982).

Results and discussion

Effects of breed:

Table 1 shows that Cal does exceeded NZW ones in all traits studied in either blood or milk, while the M/B ratios of both estimated constituents were inconsistent. Similar results were reported by RICHARD *et al.* (1973) and BANERJEE (1982) in cows. Each of hemoglobin and pulse rate were higher in Cal than in NZW. Contrarily, rectal temperature and respiratory rate showed opposite trends. The differences due to breed effect in most of the traits were significantly affected by breed as shown in Tables 1 and 2, except fat and sugar (in blood and milk), prolactin and mg in milk and pulse rate which were insignificantly by breed.

Progesterone concentration in Cal milk was nearly two times as much as that of NZW (Table 1). The lowest mineral concentration was Mg either in blood or in milk in two breeds. However, mineral levels decreased gradually in the following order: Na, K, Ca and Mg in blood and Ca, K, Na and Mg in milk, respectively,in the two breeds studied. This difference might be due to the different nature of blood and milk i.e. specific gravity, osmotic equilibrium, viscosity, pH and function. From another point of view, all estimated constituents in milk were many folds as much as those of blood, except Na in which was about 2/3 of that of blood in the two breeds. BANERJEE (1982) recorded that 500 volumes of blood flow through the mammary gland for each volume of milk synthesized, which indicated that when blood is converted to milk by mammary glands, most components become more in milk than in blood. RICHARD *et al* (1973) clarified that the mammary secretory cell cannot synthesize minerals and accordingly milk minerals are supplied from the blood. Specifically, it could be stated that the increase of Ca in milk than in blood explains its importance for the growing pups, while the Na increase in blood is suitable for its several functions. The observed differences between the two breeds in blood and milk components might be due mainly to genotype.

Effects of pregnancy stage:

Each of prolactin and progestrone concentrations increased from mating to day 14 of gestation, then decreased at day 28 of pregnancy either in blood or in milk with significant ($P<0.01$ and <0.05) differences, except prolactin which insignificantly differed (Tables 1 and 2). Similar findings were reported by FUCHS *et al* (1984) and HABEEB and El-MASRY (1991) in NZW does. With the increase in milk yield, hormone levels increased, while with the advancement of pregnancy and the decrease in milk yield, hormone levels decreased. BANERJEE (1982) reported that prolactin is directly related to lactation, while progestrone is related to pregnancy and declined in the initiation of lactation. Progestrone is responsible for the development of the alveoli and epithelial cells (ARTHUR and JAMES, 1963), prepares uterus for implantation of fertilized ova and inhibits the uterine contractions during the first few days of pregnancy (BRYAND-GREEN *et al.*, 1982 and YOUNGLAI, 1986).

Protein and fat (in blood and milk), generally, decreased by pregnancy advancement, but milk fat increased at day 28 of pregnancy (Table 1). The differences due to pregnancy were highly significant ($P<0.01$). Similar results for the two constituents in milk were reported by ABDEL-FATTAH (1985) in Giza White rabbits, while ARTHUR and JAMES (1963) found that milk fat is the most variable constituent. The high milk fat level at day 28 of pregnancy may have been due to the low milk yield (LEBAS, 1972 and FAO, 1986). The present findings might be in accordance with fetus and nursing pup requirements.

Blood sugar significantly ($P<0.01$) decreased during pregnancy, but a little increase was observed at day 28 either in blood or in milk (Table 1). Similar findings in rabbit milk were reported by Cowie (1969) and ABDEL-FATTAH (1985). Differences in blood sugar during pregnancy in the present work might be due to foetal consumption and conversion of glucose to lactose for milk. The highly significant ($P<0.01$) effect of pregnancy stage on M/B sugar ratio indicates lactose importance for suckling pups.

The four investigated minerals (in blood and milk) were significantly affected ($P<0.01$) by pregnancy stage (Tables 1 and 2), except blood Mg which was not affected. Ca (in blood and milk) and milk K decreased at day 14 and increased at day 28 of pregnancy, but each of Mg (in blood and milk), blood Na and K decreased, while milk Na increased by pregnancy advancement. PEAKER and TAYLOR (1975) found that milk Na decreased from day 11 to day 14 of lactation then increased, whereas K and lactose showed contrary trends, in Dutch rabbits. RICHARD *et al.* (1973) reported that milk is in osmotic equilibrium with blood and lactose accounts for almost one third of the osmotic pressure of milk. The same authors added that milk yield was depressed near the end of lactation with lower levels of lactose and K and elevated levels of Na and Ca which give the salty taste of milk with advancement of lactation. The observed mineral differences in the present study might be in accordance with foetal and suckling pup requirements.

Highly significant (P<0.01) decrease in blood hemoglobin and decrease in respiratory rate were recorded with advancement in pregnancy stage (Tables 1 and 2). Similar findings for those of hemoglobin were observed by HABEEB and EL-MASRY (1991) and attributed that to depletion of some iron and hem groups of doe for fetuses RBC's synthesis. However, changes in each of blood hemoglobin, pulse rate, respiratory rate and rectal temperature were inconsistent. It is worthy to illustrate that all constituent levels studied were higher in milk than in blood, except Na. Great quantity of blood converted to milk by mammary glands (RICHARD *et al.*, 1973).

Relationships:

Correlation coefficients between each pair of traits studied in blood and milk either for breed or pregnancy stage were calculated as shown in Tables 3 and 4. However, the results varied either within the two breeds used or from pregnancy stage to another. Accordingly, it was observed that the same association estimates were inconsistent in sign, value and significance either for breed or for pregnancy stage. These findings may be due mainly to breed, pregnancy stage and the changeable requirements of fetuses and suckling pups. However, the results illustrated before showed that there is no definite trend for the relationships between each pair of traits studied in blood and milk either for breed or for pregnancy stage.

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Table 1. Blood (B) and milk (M) traits (X±SE) as affected by breed and prgnancy stage.

Items	Facors				
	Breed		Pregnancy stage		
	NZW	Cal	At mating	Day 14	Day 28
Prolactin (ng/ml)					
B	1.946±0.201a	2.950±0.178b	2.369±0.222a	2.775±0.262a	2.200±0.294a
M	21.542±0.869a	22.542±1.063a	19.125±0.898b	25.937±1.074a	20.312±0.789b
M/B	8.280±0.641a	14.267±1.881b	9.631±1.286a	10.881±1.332a	13.307±2.642a
Progesterone (ng/ml)					
B	2.601±0.446a	4.300±0.642b	0.911±0.191b	4.737±0.650a	4.703±0.668a
M	4.746±1.164a	9.067±0.806b	2.381±0.516b	10.019±1.360a	8.319±1.135a
M/B	2.704±0.387a	3.483±0.670a	4.046±0.839a	3.274±0.716ab	1.961±0.211b
Total protein (g/l)					
B	55.125±1.067a	59.792±1.237b	61.250±0.124a	57.625±1.511b	53.500±1.180c
M	110.167±4.365a	120.167±2.855b	124.563±3.099a	117.125±5.054a	103.938±4.240b
M/B	2.006±0.045a	2.014±0.071a	2.039±0.049a	2.039±0.081a	1.952±0.082a
Total fat ((g/l)					
B	2.513±0.116a	0.742±0.121a	3.081±0.145a	2.438±0.068b	2.363±0.143b
M	130.417±2.995a	132.333±4.082a	133.687±3.549a	119.063±4.587b	141.375±2.892a
M/B	50.118±2.509a	54.560±2.865a	45.201±2.963b	49.313±2.181b	62.205±3.135a
Sugar (g/l)					
B	1.071±0.029a	1.146±0.037a	1.213±0.030a	1.031±0.043b	1.081±0.037b
M	18.625±0.734a	20.792±0.782a	19.312±0.978a	19.687±1.056a	20.125±0.889a
M/B	18.236±0.467a	17.571±0.771a	15.910±0.677b	19.144±0.809a	18.656±0.611a
Calcium (g/l)					
B	0.076±0.001a	0.091±0.001b	0.085±0.002a	0.079±0.002b	0.087±0.002a
M	4.821±0.017a	4.925±0.021b	4.944±0.026a	4.806±0.021b	4.869±0.022c
M/B	54.487±0.830a	63.474±0.853b	58.596±1.243b	61.721±1.658a	56.625±1.457b
Magnesium (g/l)					
B	0.024±0.001a	0.030±0.001b	0.029±0.002a	0.027±0.002a	0.025±0.002a
M	0.345±0.006a	0.347±0.009a	0.371±0.009a	0.361±0.006a	0.319±0.007b
M/B	12.205±0.510a	15.076±0.497b	13.458±0.623a	14.046±0.746a	13.416±0.769a
Sodium (g/l)					
B	1.650±0.017a	1.766±0.021b	1.802±0.020a	1.721±0.018b	1.602±0.017c
M	0.093±0.019a	1.051±0.024b	0.860±0.015a	1.018±0.019b	1.098±0.019c
M/B	0.600±0.020a	0.569±0.017b	0.477±0.006a	0.591±0.008b	0.686±0.009c
Potassium (g/l)					
B	0.087±0.003a	0.110±0.003b	0.115±0.003a	0.091±0.004b	0.089±0.004b
M	1.631±0.025a	1.716±0.025b	1.761±0.010a	1.509±0.013a	1.751±0.019b
M/B	15.826±0.363a	19.250±0.684b	15.437±0.330a	17.048±0.661b	20.128±0.814c
Hemoglobin (g/l)	112.083+1.998a	114.250+1.193a	120.313+1.448a	114.125+1.158b	105.063+1.188c
Rectal temperature (C)	40.246+0.060a	39.421+0.057b	39.769+0.155a	39.806+0.096a	39.925+0.120a
Respiratory rate (rpm)	115.083+1.151a	71.417+2.003b	88.250+6.078b	94.250+6.342a	97.250+5.258a
Pulse rate (ppm)	139.708+0.826a	141.167+2.137a	141.689+2.488a	140.125+1.837a	139.500+1.565a

Means bearing different letters within the same classification, differed significantly ($P<0.05$).

Table 2. Analysis of variance for blood and milk components as affected by breed, pregnancy stage and their interaction.

SOV	DF	Prolactin			Progesterone			Protein			Hemo-globin
		B	M	M/B	B	M	M/B	B	M	M/B	
Breed (A)	1	** 12.100	NS 3.000	** 430.142	** 34.646	** 224.035	NS 7.293	** 261.333	* 1220.083	NS 0.001	NS 56.333
Pregnancy stage (P)	2	NS 1.398	** 211.896	NS 55.920	** 77.373	** 257.268	NS 17.768	** 240.583	** 1745.646	NS 0.040	** 941.271
A x P	2	NS 1.298	NS 8.313	NS 64.557	NS 11.553	* 46.536	NS 5.859	NS 19.083	NS 23.521	NS 0.063	** 120.896
Error	42	0.820	14.298	46.166	3.796	11.900	6.748	22.696	273.321	0.087	20.619

(Mean squares)

Table 2. Continued.

SOV	DF	Fat			Sugar			Calcium			Tempe-rature
		B	M	M/B	B	M	M/B	B	M	M/B	
Breed (A)	1	NS 0.630	NS 44.083	NS 236.785	NS 0.068	* 56.333	NS 5.313	** 0.00255	** 0.130	** 969.212	** 8.168
Pregnancy stage (P)	2	** 2.498	** 2055.563	** 1307.709	** 0.140	NS 2.646	** 48.644	** 0.00029	** 0.076	** 105.635	NS 0.106
A x P	2	NS 0.568	NS 390.021	NS 142.440	NS 0.004	NS 5.646	NS 6.664	NS 0.00001	NS 0.016	NS 21.333	** 0.283
Error	42	0.222	220.381	121.117	0.021	14.738	8.048	0.00002	0.005	12.569	0.063

(Mean squares)

Table 2. Continued.

SOV	DF	Magnisum			Sodium			Potasium			Respera-tion rate	Pulse
		B	M	M/B	B	M	M/B	B	M	M/B		
Breed (A)	1	** 0.00035	NS 0.001	** 98.929	** 0.162	** 0.166	** 0.011	** 0.0061	** 0.087	** 140.665	** 22881.33	NS 25.521
Pregnancy stage (P)	2	NS 0.00056	** 0.012	NS 1.985	** 0.162	** 0.235	** 0.175	** 0.0033	** 0.325	** 90.908	** 336.00	NS 20.313
A x P	2	NS 0.00006	** 0.007	NS 1.406	NS 0.003	NS 0.004	NS 0.002	NS 0.0001	NS 0.002	* 12.103	NS 96.58	NS 64.771
Error	42	0.00003	0.001	6.507	0.002	0.001	0.001	0.0001	0.002	2.974	49.54	64.955

(Mean squares)

** $P<0.01$, * $P<0.05$, NS Not significant.

Table 3. Correlatio coefficients between each par of traits studied in blood and milk of Cal does at mating (0), day 14 (14) and day 28 (28) of pregnancy satges.

Milk	Stages	Blood								
		Prolactin	Progest	Protein	Sugar	Fat	Ca	Mg	Na	K
Prolactin	0	-0.490								
	14	0.331								
	28	-0.877								
Progesteron	0	0.452	0.603							
	14	0.754	-0.591							
	28	-0.210	-0.103							
Protein	0	0.405	0.042	0.465						
	14	0.749	-0.715	0.675						
	28	0.437	-0.305	0.390						
Suger	0	0.097	0.663	0.018	0.471					
	14	-0.307	0.438	0.329	0.453					
	28	-0.288	-0.056	0.607	0.410					
Fat	0	0.662	0.211	0.303	-0.060	0.164				
	14	-0.162	0.169	0.363	0.152	-0.119				
	28	-0.737	-0.425	0.439	0.007	0.687				
Ca	0	-0.067	-0.158	0.547	-0.104	0.226	0.293			
	14	0.014	0.208	-0.152	-0.028	-0.197	0.459			
	28	0.051	0.841	-0.357	0.560	-0.198	-0.424			
Mg	0	-0.267	-0.485	-0.281	-0.302	0.296	-0.629	0.915		
	14	-0.638	0.268	-0.209	0.412	0.281	0.346	0.434		
	28	0.324	0.678	0.002	0.404	-0.206	-0.480	0.507		
Na	0	-0.144	0.582	0.132	0.496	-0.565	0.673	-0.398	0.170	
	14	-0.511	0.576	-0.051	0.630	0.000	0.524	0.533	-0.014	
	28	0.712	0.322	-0.581	-0.210	-0.587	0.212	-0.145	0.000	
K	0	0.645	0.216	0.034	0.095	0.055	0.418	-0.649	-0.171	0.307
	14	-0.218	0.006	-0.553	-0.334	-0.219	-0.242	0.080	-0.224	-0.761
	28	0.146	0.057	-0.291	0.236	-0.329	-0.209	-0.206	-0.037	-0.512
Hemoglobin	0	-0.790	-0.090	-0.085	-0.144	0.015	0.145	0.473	0.249	-0.390
	14	-0.099	0.044	0.379	-0.049	0.474	0.441	0.026	0.062	0.156
	28	0.106	0.618	-0.464	0.239	-0.230	-0.181	0.309	-0.119	-0.120

All estimates >0.834 are significant at P<0.01, all estimates >0.707 are significant at P<0.05, otherwise are insignifican.

Table 4. Correlatio coefficients between each par of traits studied in blood and milk of NZW does at mating (0), day 14 (14) and day 28 (28) of pregnancy satges.

		Blood								
Milk	Stages	Prolactin	Progest	Protein	Sugar	Fat	Ca	Mg	Na	K
Prolactin	0	0.427								
	14	0.143								
	28	-0.464								
Progesteron	0	0.547	-0.780							
	14	0.051	0.431							
	28	0.295	0.589							
Protein	0	0.494	-0.217	0.229						
	14	0.218	-0.140	0.252						
	28	-0.403	-0.112	0.164						
Suger	0	-0.390	-0.326	0.302	0.614					
	14	-0.263	-0.207	0.171	0.846					
	28	0.084	-0.178	-0.466	0.869					
Fat	0	-0.612	0.121	0.447	0.230	-0.313				
	14	0.752	-0.099	0.042	-0.109	0.223				
	28	-0.680	-0.468	-0.142	0.295	0.258				
Ca	0	0.423	-0.009	-0.338	-0.395	0.472	-0.079			
	14	0.487	0.112	-0.260	-0.696	0.365	-0.488			
	28	0.607	0.337	0.273	-0.384	-0.189	-0.577			
Mg	0	0.588	-0.204	-0.015	0.382	-0.508	0.242	-0.088		
	14	0.411	0.805	0.035	-0.276	0.417	-0.512	0.347		
	28	-0.578	-0.454	0.173	-0.299	0.539	0.289	0.518		
Na	0	0.236	0.519	-0.464	-0.413	0.116	-0.451	0.352	0.180	
	14	-0.201	-0.610	-0.244	0.579	-0.689	0.533	-0.048	0.394	
	28	-0.183	0.192	-0.199	-0.226	0.200	0.221	-0.453	0.106	
K	0	0.428	-0.188	0.224	0.498	-0.732	-0.052	-0.194	-0.808	0.225
	14	-0.021	-0.230	-0.387	0.260	-0.004	0.584	-0.302	0.859	0.765
	28	0.310	0.340	-0.695	0.356	0.334	0.146	-0.393	0.697	0.149
Hemoglobin	0	-0.389	-0.617	0.807	0.750	-0.266	0.122	-0.431	-0.535	0.446
	14	-0.151	-0.684	0.382	0.514	-0.541	0.519	-0.514	0.177	0.469
	28	0.073	-0.353	-0.120	0.548	-0.088	0.090	0.361	0.018	-0.048

All estimates >0.834 are significant at P<0.01, all estimates >0.707 are significant at P<0.05, otherwise are insignifican.