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GROWTH PERFORMANCE AND METABOLIC PROFILE OF EGYPTIAN CATTLE AND BUFFALO CALVES

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SUMMARY

Sixty male calves (29 Egyptian cattle calves, CC and 31 buffalo calves, BC) were used in this study to compare their growth performance and metabolic activity. The calves were about 8 months old and their average initial body weight were 110.5 ±2.50 and 126.5 ±2.53 Kg, for CC and BC, respectively. Calves of each species were housed separately and raised under similar managerial conditions. Growth traits of the calves were determined over a year divided into three equal growth stages. The results indicated insignificant differences between these two species in weight gain, daily weight gain (DWG) and relative growth rate (RGR) in the whole experimental period. However, BC had significantly ($P < 0.05$) higher DWG and RGR than CC in the 2nd stage while at the 3rd stage these traits became relatively higher in CC. The results emphasized the periodicity pattern of growth performance in both species. On the overall average, BC were faster gainers than the CC (0.85 *vs.* 0.81 kg/day). Feed efficiency values for BC and CC were almost similar throughout the whole experimental time.

The overall mean of tested blood parameters showed that CC had higher values than BC for total lipids (331.9 *vs.* 228.3 mg/dl), total cholesterol (106.5 *vs.* 71.7 mg/dl), inorganic phosphorous (7.5 *vs.* 7.1 mg/dl), T_4 (5.3 *vs.* 4.7 ug/dl), T_3 (240.3 *vs.* 193.0 ng/dl), insulin (32.3 *vs.* 26.3 µIU/ml). Meanwhile, BC attained higher values ($P < 0.05$) than CC for hemoglobin, (12.9 *vs.* 11.9 g/dl), total protein (9.1 *vs.* 7.9 g/dl), globulins (3.6 *vs.* 2.4 g/dl), glucose (48.4 *vs.* 39.2 mg/dl), blood urea nitrogen (44.5 *vs.* 34.7 mg/dl), creatine (5.9 *vs.* 3.6 U/L), creatinine (1.6 *vs.* 1.2 mg/dl), calcium (10.6 *vs.* 9.5 mg/dl), zinc (72.7 *vs.* 56.0 µg/dl) and glucagon (26.3 *vs.* 25.0 pmol/L). Both species had similar values of packed cell volume (36.5 *vs.* 36.2%), copper (87.4 *vs.* 86.7 µg/dl) and albumin (5.4 *vs.* 5.4 g/dl). The relative estimates of blood parameters to DWG of calves indicated the achievement of higher protein turnover in BC and higher potentiality of CC in utilizing dietary energy per unit of DWG compared to BC.

It could be concluded that hemoglobin was the best predictor of weight gain with an accuracy (R^2) of 38.5 and 52.2% in CC and BC, respectively, while (R^2) for T_4, the 2nd best predictor, were 10.3 and 7.5%, respectively.

Keywords: Egyptian cattle, buffalo, growth, metabolic profile

INTRODUCTION

The actual growth achieved by any breed is the outcome of its genetic potentiality under the prevalent environmental conditions. Growth performance of animals is greatly affected by many factors such as: breed, sex, age, nutrition, hormonal regulation and turnover of blood metabolites.

Buffaloes are raised in Egypt primarily for milk and secondarily for meat production. Buffalo males are known to be less efficient in fattening than Egyptian cattle. Mostageer *et al.* (1989) stated that cattle and buffaloes contribute 50.1% and 31% of the total red meat production in Egypt. Little is known about the accurate differences between the Egyptian cattle and buffalo calves regarding their physiological traits related to growth performance, feed efficiency and metabolic activity aspects. Blood metabolites and hormones play an important role in regulation and control of growth. Therefore, the early prediction of an expected animal's growth rate using blood metabolites is of practical value.

The objective of this study was to evaluate possible species difference between the Egyptian cattle and buffalo male calves in growth performance and efficiency. This would imply tracing the levels of some blood metabolites as indicators to explain growth differences and to reveal the efficiency of both species in utilizing their blood metabolites.

MATERIALS AND METHODS

Experimental animals and management

Sixty male calves (29 Egyptian cattle calves, CC and 31 Egyptian buffalo calves, BC) were used in this study. The calves were about eight months old with an average of body weight of 110.5 ±2.50 and 126.5 ±2.53 Kg, for CC and BC, respectively. Calves of both species were raised in a commercial farm under similar management into separate open sheds. Animals were fed according to their average body weight with rations composed of a concentrate feed mixture (CFM), green fooder and rice straw. The CFM was offered at the rate of one kg daily for each 50 Kg body weight. Along with CFM, each head was offered about 6 Kg berseem (*Trifolium alexandrinum*) in winter, which was substituted by similar amount of corn fodder (*Zea maize*) during summer and rice straw was offered *ad lib* for calves. Such amounts of feeds were sufficient to cover the nutritional requirements according to Ghoneim (1964). Drinking water was adequately available as free access for animals. Chemical analysis and nutritive value of feedstuffs are presented in Table 1.

Table 1. Chemical analysis (as fed) and nutritive value of feedstuffs

Item	CFM	Clover	Rice straw	Corn fooder
Chemical analysis (%):				
Dry matter	92.76	19.40	92.3	79.90
Organic matter	84.94	13.60	81.2	17.84
Crude protein	15.20	2.80	3.2	1.2
Crude fiber	8.09	6.10	37.8	6.09
Ether extract	3.40	0.20	1.3	0.32
NFE	58.25	4.50	38.9	10.23
Ash	7.82	2.80	18.8	8.70
***Nutritive value (%)**				
TDN	62.92	9.17	----	13.3
DCP	12.10	2.00	----	1.8

* Calculated according to Ghoneim (1964)

Growth traits and blood analysis

Growth traits of the experimental calves were determined for one year divided into three equal growth stages: from 8-12, 12-16 and 16-20 months of age. The animals were weighed each month in the morning before access to feed and water. Relative growth rate (RGR) of each calf was determined as the percentage of the daily weight gain (DWG) divided by the initial live body weight (LBW) for each growth stage. Feed efficiency for each growth stage was measured as kg gain in weight per kg total digestible nutrients (TDN) of the consumed feedstuffs.

Twenty CC and BC (10 of each) were randomly chosen and used for collecting blood samples at monthly intervals. Aliquot of whole blood samples were used immediately for determination of hemoglobin (Hb) and packed cell volume (PCV%). The rest of blood samples were immediately centrifuged for plasma separation and stored at -20°C until analysis. Ready made kits were used for determination of the following blood plasma constituents according to the procedure outlined by the manufacturer: glucose (GLU), total protein (TP), albumin (ALB), blood urea nitrogen (BUN), creatine (CR), creatinine (CRT), total lipids (TL), total cholesterol (TC), calcium (Ca) and phosphorus (P). Plasma concentration of zinc (Zn) and copper (Cu) were determined using the technique of atomic absorption. Direct radioimmunoassay technique was adopted for determination of plasma triiodothyronine (T_3), thyroxine (T_4), insulin (INS) and glucagon (GCN) using kits of "Diagnostic Products Corporation, Los Angeles, USA". Relative estimates of the tested blood parameters to DWG of calves were calculated as the ratio of each parameter per unit of DWG.

Statistical analysis

Data were analyzed by least squares analysis of variance using the General Linear Model procedure of the Statistical Analysis System SAS, (1990). The model was as follows:

$$Y_{ijk} = \mu + S_I + P_J + SP_{IJ} + e_{ijk}$$

Where Y_{ijK} is the observation taken on the IJ *th* animals, μ is the overall mean, S_I is the effect of the species, P_J is the effect of growth stage, SP_{IJ} is the interaction effect of species and growth stage and e_{ijk} is the random error.

RESULTS AND DISCUSSION

Growth performance

The results in Table 2 indicate that, at the same age, BC had higher LBW than CC. The differences in LBW between the two species were statistically different (P<0.05) during the three growth stages. Ragab and Abd El-Salam (1962) reported similar LBW for CC and BC at 12 and 24 months of age, being 221.5 and 416.2 kg for CC and 221.7 and 409.8 kg for BC, respectively. They found that RGR of CC was slightly higher than BC at 12 and 24 months of age. The differences in weight gain, DWG and RGR between these two species did not reach any level of significance for the whole experimental period. However, it was noticeable that BC had a significantly (P <0.05) higher weight gain, DWG and RGR than CC in the 2nd stage of the growth period. During the 3rd stage of the studied growth periods these traits became relatively higher in CC. Omar *et al.* (1993) found that the DWG was signficantly (P < 0.05) higher in buffalo than in cattle calves (0.78 vs. 0.71 Kg/day), the authors attributed the differences in DWG to the animal species rather than the initial LBW.

In the present study, the early growth stage showed higher RGR than the late two growth stages for both species which indicate that young animals grow faster than those advanced in age. Moreover, CC proved to have insignificantly greater RGR than BC during the 1st and 3rd stages and generally in the whole studied growth period. The magnitude of results might emphasize the periodicity pattern of growth performance in both species.

Efficiency of feed utilization

The daily consumption of TDN per head along the whole period was relatively greater for BC than that of CC (Table 2). This increased intake of TDN by BC may be attributed to their greater capacity of forestomach and higher maintenance requirements than CC. This finding agrees with those of Nigm *et al.* (1984) and Omar *et al.* (1993). The feed efficiency values for BC and CC were almost similar throughout the whole experimental period. Efficiency of feed utilization for both species was relatively better at the 1st stage of growth than the other subsequent stages. Omar *et al.* (1993) found that buffaloes showed slightly better feed conversion than CC during a fattening period of 7 months suggesting that BC utilized the low quality roughages more efficiently than cattle calves.

It could be seen in Table 2 that BC were faster gainers than CC during the whole experimental period (0.85 *vs.* 0.81 kg/day) despite that the two species had comparable values of feed efficiency. The present DWG of BC was greater than that obtained by El-Kholy *et al.* (1997) and Ashour *et al.* (2000) being 0.64 and 0.43 kg/day, respectively. This difference in DWG estimates may be attributed to the managerial practices particularly feeding plan.

Table 2. Least squares means of growth traits of cattle (CC) and buffalo (BC) calves at the three stages

Item	Growth stages	CC	BC	Difference (CC-BC)
LBW (kg)	Initial	110.5 ± 2.50	126.5 ± 2.53	- 16.0
	1st	204.3 [b] ± 3.86	220.1 [a] ± 3.55	- 15.8
	2nd	280.5 [b] ± 4.32	320.2 [a] ± 5.43	- 39.7
	3rd	423.5 [b] ± 6.29	451.8 [a] ± 9.68	- 28.3
Gain in weight (kg)	1st	93.8 ± 1.01	93.6 ± 0.97	+ 0.2
	2nd	76.1 [b] ± 1.13	100.1 [a] ± 1.09	- 24.0
	3rd	143.7 ± 1.13	131.6 ± 1.09	+ 12.1
Total gain (kg)	Whole period	313.0 ± 5.56	325.3 ± 8.90	- 12.3
DWG (kg / day)	1st	0.73 ± 0.03	0.73 ± 0.03	0.0
	2nd	0.59 [b] ± 0.03	0.78 [a] ± 0.04	- 0.19
	3rd	1.12 ± 0.04	1.03 ± 0.04	+ 0.09
DWG (kg / day)	Whole period	0.81 ± 0.01	0.85 ± 0.02	- 0.04
RGR (%)	1st	0.66 ± 0.02	0.58 ± 0.02	+ 0.08
	2nd	0.29 [b] ± 0.02	0.36 [a] ± 0.02	- 0.07
	3rd	0.40 ± 0.02	0.32 ± 0.02	+ 0.08
RGR (%)	Whole period	0.73	0.67	+ 0.06
Daily feed intake (kg TDN)	1st	3.20	3.47	- 0.27
	2nd	4.98	5.36	- 0.38
	3rd	6.78	6.87	- 0.09
Daily feed intake (kg TDN)	Whole period	4.60	4.92	- 0.32
Feed efficiency	1st	0.23	0.21	+ 0.02
kg gain / kg TDN	2nd	0.12	0.15	- 0.03
	3rd	0.17	0.15	+ 0.02
Feed efficiency	Whole period	0.18	0.17	+ 0.01

Means in the same line with different superscripts differ significantly (P<0.05).

Blood parameters

Hematological values

Table 3 shows the means of PCV% for CC (36.50) and BC (36.21) during the experimental period. No changes were observed in the percentages of PCV% throughout the experimental period for both species. However, relative estimates of PCV% to DWG tended to decrease insignificantly with advance in the growth for both species and it was greater for CC than that for BC. Estimates of PCV% in the two species are in agreement with those found by Shafie and Badreldin (1962) who found that PCV% values in BC and CC were 36.8% and 36.6%, respectively.

Hemoglobin (Hb) concentrations increased from 10.08 up to 14.02 g/dl in CC with a mean value of 11.88 g/dl and from 9.84 up to 15.74 g/dl in BC with an average of 12.80 g/dl (Table 3). Differences in Hb values were significantly ($P < 0.01$), affected by species (S), growth stage (P) and their interaction. Relative estimates of Hb to DWG were generally stable for both species. These findings are in agreement with those obtained by Shafie and Badreldin (1962) who found that Egyptian buffalo had higher Hb value than Egyptian cattle (14.6 *vs.* 12.4 g/dl). They concluded that the higher Hb value in buffaloes than in cattle contributed to the increased metablic heat production of buffalo by raising the oxygen tension of blood.

Nitrogen metabolism indices

Concentrations of TP were significantly ($P<0.01$) higher in BC than in CC allover the growth period (Table 4) by an average of 14.8%. This was mainly due to the higher globulin fraction in BC since ALB concentrations were almost constant for both species. Relative estimates of TP ,its fractions, to DWG were about the same and decreased slightly with the advance of growth for both species. The higher TP values in blood of BC may be due to; either increased rate of protein turnover or its slower clearance. The present averages of TP of BC are in agreement with Fayed (1995). Meanwhile, TP averages in BC were greater than those obtained by Youssef (1992). In contrary, Shafie and Badreldin (1962) found that TP of both CC and BC were equal (7.9 g/dl). Similar to our findings these authors found that both species had almost the same average of ALB (3.8 vs. 3.9 g/dl). Topps and Thompson (1984) stated that the concentration of blood ALB was considered as a reflection of the animal's ability to synthesize and store protein.

In the present study, the greater globulin values (obtained by subtraction) in BC indicate that their immune system was more efficient and sensitive than that of CC. Albumin/Globulin (A/G) ratio was more greater in CC (2.8) than in BC (1.8). The reported ratios in BC by Fayed (1995) were between 0.4 to 0.8. These higher A/G ratios in both species indicate that ALB values were clearly higher than globulin values, especially in cattle. The high values of ALB were parallel to that of total proteins.

Concentrations of BUN were similar among the growth stages for both CC and BC (Table 4). The overall mean of BUN of BC was higher by 28.1% than that of CC. Relative estimates of BUN to DWG were slightly greater in BC than in CC. The present values in BUN concentration in BC are within the range obtained by Fayed (1995).

Generally, results of nitrogen metabolism in the present study revealed that BC have greater concentrations of TP, its fractions and BUN than CC. This finding may reflex progressive turnover of plasma protein in BC rumen in comparison with CC. However, it is interesting to find out that relative estimates of these parameters to DWG of calves were mostly similar in both species indicating the possibility of prediction body gain of the farm animal on terms of metabolic activity per unit of DWG.

Energy metabolism indices

As shown in Table 5 GLU concentrations were similar at the start of growth period for both species but it became greatly higher in BC than CC during the second and third stages of growth period. The overall mean of blood GLU concentration of BC was higher by 23.4% than that of CC. Relative estimates of GLU to DWG were steadily decreasing for both species to reach similar values at the 3rd stage of growth. Similar results of higher values of GLU in BC than CC were found by Shafie and Badreldin (1962) which agree with that obtained in the present study.

Concentrations of TL were considerably higher in CC (45.4%) than in BC (Table 5). However, CC maintained the level of TL up to the second stage of growth while, in BC it increased steadily up to the third stage. Relative estimates of TL to DWG were slightly greater in CC than in BC and it were steadly decreasing for both species with the advancement of age.

Table 3. Least squares means of PCV(%), concentrations of Hb and their relative estimates to DWG of cattle and buffalo calves at growth stages

Item	Cattle				Buffalo				±SE	F-probability		
	Growth stage			Overall	Growth stage			Overall				
	1	2	3	mean	1	2	3	mean		S	P	S*P
PCV %	35.24	36.67	37.31	36.50	35.87	34.63	37.87	36.21	0.63	0.32	7.55**	2.92 *
Relative to DWG	0.59	0.52	0.42	0.50	0.54	0.44	0.39	0.45	0.011	0.26 NS	7.11**	3.87 *
Hb (g/dl)	10.08	10.90	14.02	11.88	9.84	12.11	15.74	12.88	0.36	9.39 **	106.2**	4.02 **
Relative to DWG	0.17	0.15	0.16	0.16	0.15	0.15	0.16	0.16	0.005	1.28 NS	10.9 **	3.63 *

** Highly significant (P < 0.01), * Significant (P < 0.05), NS = Not significant, S= species, P= stages

Table 4. Least squares means of blood proteins and their relative estimates to DWG of cattle and buffalo calves at growth stages

Item	Cattle				Buffalo				±SE	F-probability		
	Growth stage			Overall	Growth stage			Overall				
	1	2	3	mean	1	2	3	mean		S	P	S*P
Total protein (g/dl)	7.74	7.80	8.06	7.89	9.15	8.96	9.08	9.06	0.36	38.5 **	0.36 NS	0.36 NS
Relative to DWG	0.13	0.11	0.09	0.11	0.14	0.11	0.09	0.11	0.003	0.56 NS	9.62 **	3.36 *
Albumin (g/dl)	5.25	5.46	5.43	5.38	5.42	5.46	5.45	5.44	0.03	4.69 *	6.99 **	3.10 *
Relative to DWG	0.09	0.08	0.06	0.07	0.08	0.07	0.06	0.07	0.001	0.88 NS	9.91 **	3.26 *
A / G ratio	2.61	3.19	2.69	2.82	1.76	1.88	1.88	1.84	0.26	25.7 **	1.07 NS	0.65 NS
BUN (mg/dl)	30.26	36.63	36.58	34.71	44.02	44.73	44.58	44.45	1.65	45.9 **	2.41 *	1.62 NS
Relative to DWG	0.50	0.51	0.42	0.48	0.66	0.56	0.64	0.55	0.02	0.15 NS	6.86 **	1.18 NS

** Highly significant (P < 0.01), * Significant (P < 0.05), NS = Not significant, S= species, P= stages

Table 5. Least square means of blood glucose, total lipids, cholesterol, creatine and creatinine and their relative estimates to DWG of cattle and buffalo calves at growth stages

Item	Cattle				Buffalo				±SE	F-Probability		
	Growth stage			Overall	Growth stage			Overall				
	1	2	3	Mean	1	2	3	Mean		S	P	S*P
Glucose (mg/dl)	40.29	32.03	44.03	39.23	41.29	50.27	52.68	48.41	3.56	10.8 **	3.29 *	2.86 *
Relative to DWG	0.68	0.45	0.50	0.53	0.62	0.62	0.55	0.59	0.04	0.76 NS	9.67 **	5.78 **
Total lipids (mg/dl)	342.6	362.0	312.9	331.9	215.4	232.5	235.3	228.3	18.62	50.8 **	1.26 NS	1.11 NS
Relative to DWG	5.56	5.07	3.53	4.63	3.22	2.91	2.44	2.82	0.24	6.06 **	10.1 **	5.14 **
Cholestrol (mg/dl)	96.14	100.7	119.1	106.5	58.09	74.22	80.52	71.7	4.11	88.3 **	13.5 **	1.13 NS
Relative to DWG	1.63	1.40	1.35	1.45	0.86	0.94	0.83	0.87	0.06	5.34 *	7.03 **	6.39 **
Creatine (U/l)	4.18	3.11	3.56	3.60	7.33	6.02	4.50	5.87	0.47	35.8 **	6.80 **	3.35 *
Relative to DWG	0.07	0.04	0.04	0.05	0.11	0.08	0.05	0.06	0.006	0.03 NS	6.77 **	1.84 NS
Creatinine (mg/dl)	1.13	1.32	1.22	1.22	1.22	1.54	2.12	1.64	0.07	34.5 **	17.8 **	14.2 **
Relative to DWG	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.001	0.15 NS	5.0 **	4.28 **

** Highly significant (P < 0.01), * Significant (P < 0.05), NS = Not significant.S= species, P= stages

Table 6. Least square means of blood calcium, inorganic phosphorus, zinc and copper and their relative estimates to DWG of cattle and buffalo calves at growth stages

Item	Cattle				Buffalo				±SE	F- Probability		
	growth stage			Overall mean	Growth stage			Overall mean				
	1	2	3		1	2	3			S	P	S*P
Calcium (mg/dl)	9.42	9.56	9.56	9.52	8.50	11.18	9.81	10.58	0.45	0.59 NS	3.62 *	2.93 *
Relative to DWG	0.16	0.14	0.11	0.13	0.13	0.14	0.10	0.12	0.006	0.81 NS	8.39 **	3.71 *
Phosphorus (mg/dl)	6.22	7.08	8.78	7.48	5.91	6.60	8.56	7.14	0.52	0.62 NS	13.7 **	0.03 NS
Relative to DWG	0.10	0.10	0.10	0.10	0.09	0.08	0.09	0.09	0.007	0.72 NS	7.60 **	3.56 *
Ca / P ratio	1.67	1.84	2.27	1.96	1.75	1.95	1.17	1.58	0.45	0.56 NS	0.08 NS	1.11 NS
Zinc (μg/dl)	77.33	49.66	44.12	56.00	74.86	76.80	67.79	72.67	5.74	10.9 **	5.80 **	3.45 *
Relative to DWG	1.32	0.70	0.50	0.81	1.13	0.96	0.70	0.91	0.09	0.40 NS	5.32 **	1.59 NS
Copper (μg/dl)	86.41	82.21	92.88	87.44	95.14	89.73	78.16	86.73	4.63	0.02 NS	0.77 NS	4.42 **
Relative to DWG	1.44	1.15	1.05	1.20	1.45	1.13	0.81	1.10	0.06	1.05 NS	10.7 **	2.66 NS

** Highly significant ($P < 0.01$), * Significant ($P < 0.05$), NS = Not significant, S= species, P= stages

Table 7. Least square means of blood metabolic hormones and their relative estimates to DWG of cattle and buffalo calves at growth stages.

Item	Cattle				Buffalo				SE	F- Probability		
	growth stage			Overall mean	Growth stage			Overall mean				
	1	2	3		1	2	3			S	P	S*P
Insulin (μIU /ml)	30.39	38.12	29.46	32.28	24.23	30.21	26.59	26.27	1.57	15.7 **	8.77 **	1.16 NS
Relative to DWG	0.51	0.54	0.33	0.45	0.36	0.38	0.27	0.33	0.02	3.43 *	7.68 **	4.49 **
Glucagon (Pmol/L)	21.64	27.63	25.98	24.98	25.55	25.18	28.29	26.27	1.87	0.57 NS	1.79 NS	1.30 NS
Relative to DWG	0.36	0.39	0.30	0.35	0.38	0.32	0.29	0.34	0.02	0.19 NS	6.60 **	1.41 NS
INS / GCN ratio	1.57	2.05	1.57	1.71	1.06	1.57	1.09	1.23	0.23	6.17 **	2.62 NS	0.05 NS
T_4 (μg/dl)	6.86	5.48	3.93	5.25	3.33	3.86	6.24	4.67	0.39	9.16 **	0.78 NS	32.9 **
Relative to DWG	0.11	0.08	0.04	0.08	0.05	0.05	0.06	0.06	0.004	4.03 *	10.5 **	10.5 **
T_3 (ng/dl)	188.7	289.0	242.5	240.3	166.8	221.8	190.4	193.0	11.96	19.3 **	16.1 **	1.42 NS
Relative to DWG	3.18	4.08	2.75	3.29	2.47	2.80	1.97	2.37	0.17	1.63 NS	4.13 **	3.26 *
T_3 / T_4 ratio	0.028	0.141	0.062	0.046	0.050	0.058	0.031	0.041	11.96			

** Highly significant ($P < 0.01$), * Significant ($P < 0.05$), NS = Not significant, S= species, P= stages

An opposite trend of T_4 concentrations was observed within the studied growth period between the species where T_4 levels of CC declined as growth advanced while, it increased in BC. On the other side, T_3 concentration in both species increased sharply during the 2nd stage of the growth period then it decreased during the 3rd stage. T_3 concentrations were generally higher by about 25% in CC blood than that in BC. Relative estimates of T_4 to DWG in CC were decreasing with growth development whereas they were constant in BC. Relative estimates of T_3 to DWG generally showed similar pattern in both species being higher in the mid term of growth period and it was slightly higher in CC than in BC. Average of T_4 concentration in BC was in agreement with Youssef (1992), while the average of T_3 in both CC and BC was higher than that obtained by Youssef (1992). The higher T_3 in CC may support the previous finding indicating the superiority of CC in energy metabolism as compared with BC.

The correlations among blood parameters

In both species, most correlation between blood parameters were not significant. However, In both species, there were highly significant ($P < 0.01$) correlation coefficients between Hb and each of PCV, CRT, P, as well as T_4. Also, highly significant ($P < 0.01$) correlation coefficients were found between each of TC and T_4, CR and P as well as T_4 and P. These coefficients were confirmed by the significant overall estimates.

In CC, there were highly significant ($P < 0.01$) correlations between Hb and each of TC, BUN, ALB and Zn, and between ALB and each of BUN, TL, TC and P and between TC and each of TL, P and Zn. Further correlations were detected between GLU and INS and between BUN and P.

In BC, highly significant ($P<0.01$) correlations were recorded between Hb and both of CR and Cu, between T_4 and CR, between T_3 and TP, between INS and TC and between P and Ca.

From the previous results it could be concluded generally that there are strong relationships between blood Hb and some of blood components which anticipate in animal energy metabolism. Also, these results indicated that the metabolic relationships were different among the studied species indicating variability in the turnover of blood metabolites. This finding may reveal that the species difference in weight gain depends mainly on the parameters that regulate and control metabolic process activity rather than the availability of metabolic substrates in blood.

Relation between blood parameters and metabolic body weight

The correlation coefficients between blood parameters and metabolic body weight (MBW) indicated that in both species there is a significant ($P <.0.01$) relationship between MBW and each of PCV, Hb, TC and T_4. In addition, CC were characterized by highly significant ($P<0.01$) correlation between MBW and each of ALB and Zn. In BC, the correlation were significant ($P<0.05$) between MBW and each of GLU, CR, CRT, Ca and Cu. The statistical analysis revealed that Hb content was the best predictor of body weight with (R^2) accuracy of 38.5% and 52.2% in CC and BC, respectively. Seerly *et al.* (1972) reported that it is possible to depend on Hb value for selection within breed under hot desert climate or for importing high producing breeds to arid and semi-arid areas for increasing productivity in these regions.

Concentration of T_4 appear to be the second best predictor of body weight in both species since its R^2 represented about 10.3 and 7.5% of the total variance in CC and BC, respectively. Both Hb and T_4 concentrations in blood accounted for about (R^2) 48.8% and 59.7% of the total variance in CC and BC, respectively. Blood Hb and T_4 has valuable functions in metabolic process efficiency and consequently the increase in body weight gain.

From the above-mentioned results, it can be concluded that among all blood parameters, some are more important and related to the species difference in growth performance. These energy utilization components can be listed according to their importance as follow: Hb, T_4, TC and ALB in CC and Hb, T_4, TC, and GLU in BC. Among these metabolites, Hb content is the most useful variable for predicting growth performance in both species, while T_4 concentration is the second best predictor.

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