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LEVELS OF THYROID HORMONES AND THEIR CORRELATION WITH LIPID AND LIPOPROTEIN CONCENTRATIONS IN BLOOD SERUM OF MALE CAMELS (CAMELUS DROMEDARIUS) IN THE EGYPTIAN OASIS

(With 4 Tables and One Figure)

By

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مستوى هرمونات الغدة الدرقية وارتباطها بتركيزات الدهون والبروتينات الدهنية في مصل دم ذكور الإبل (وحيدة السنم) في الواحات المصرية

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يعتبر الخلل الوظيفي للغدة الدرقية من الحالات المتوطنة في الإنسان والحيوان في منطقة الواحات المصرية نتيجة لنقص اليود بالبيئة المحيطة. وكان الهدف من هذه الدراسة تقدير مستوى هرمونات الغدة الدرقية ومدى إرتباطها مع صورة الدهون والبروتينات الدهنية في مصل دم ذكور الإبل في هذه المنطقة. لذلك تم أخذ عينات دم لفصل المصل من عدد ٩٢ ذكر من الإبل التي تم اختيارها بطريقة عشوائية من بيئتها الطبيعية في بعض المناطق المحيطة بالواحات الخارجة وكانت هذه الإبل سليمة ظاهريا ويتراوح أعمارها من ٢ إلى ١٠ سنوات قسمت إلى ٤ مجموعات (٢-٤ و ٤-٦ و٦-٨ و٨-١٠ سنوات). وأظهرت النتائج أن المتوسط العام لتركيز هرمون التراي أيودوثيرونين (T_3) والثيروكثين (T_4) في مصل الدم كان ١.١٧٩ ± ٠.٠٣٠ مليمول/ لتر و ٨٠.٥٩ ± ٢.٢٧٤مليمول/ لتر على التوالي. ولم يؤثر العمر معنويا على هذه القيم. كما أوضحت النتائج أن المتوسط العام لتركيز الدهون في المصل كان ٣٦٩.٠ ±٧.٥٠٤ مجم/١٠٠مل بالنسبة للدهنيات الكلية و ٠.٨٩٨ ± ٠.٠٢٨ مليمول/ لتر بالنسبة للكوليستيرول الكلي و٠.٦٠٦ ± ٠.٠٢١ مليمول/ لتر بالنسبة للترباجليسرايد. وقد لوحظ أن قيم هذه الدهون كانت أعلى في الأعمار الكبيرة (٨-١٠ سنوات). وقد سجلت المتوسطات العامة للبروتينات الدهنية ٠.٤٦٢ ±٠.٠٢٣ مليمول/ لتر بالنسبة للكوليستيرول عالي الكثافة (HDL-C) و٠.٣١٤ ± ٠.٠١٠ مليمول/ لتر بالنسبة للكوليستيرول منخفض الكثافة (LDL-C) و٠.١٢١ ± ٠.٠٠٤ مليمول/ لتر بالنسبة للكوليستيرول شديدة الانخفاض في الكثافة (VLDL-C). وكان للعمر تأثير معنوي على هذه الأنواع من البروتينات الدهنية حيث كانت قيمها أعلى في الإبل المعمرة (٨-١٠

سنوات) إلا أن قيمه الكوليستيرول منخفض الكثافة كانت أعلى في الإبل التي يتراوح عمرها بين ٤-٨ سنوات. وقد أوضح تحليل الانحدار الخطي ومعادلة الخط المستقيم ومعامل الارتباط عدم وجود علاقة معنوية بين تركيزات التراى أيودوثيرونين وصورة الدهون في مصل الدم. وكذلك الأمر بين تركيز الثيروكثين وكل من الدهون الكلية و HDL-Cو VLDL-C. ولكن كانت هناك علاقة خطية عكسية وارتباط سلبي بين تركيز الثيروكثين وكل من الكوليستيرول الكلي والتراجليسريد وLDL-C. ويمكن أن نستخلص من هذه الدراسة أن تركيز هرمونات الغدة الدرقية منخفضة في إبل الواحات المصرية. ولكن بالرغم من ذلك لاتوجد أعراض ظاهرية لتضخم الغدة الدرقية في هذه الإبل. وبذلك يبدو أن هذه الإبل تعاني من نقص الإفراز الدرقي تحت الإكلينيكي والذي له تأثير بارز على التمثيل الغذائي للدهون.

SUMMARY

Thyroid dysfunction is an endemic condition in man and animals in the Egyptian oasis due to the environmental iodine deficiency. The aim of this work was to estimate the circulating thyroid hormone concentrations and their correlation with lipid and lipoprotein profile in blood serum of male dromedary camels in the Egyptian oasis. Blood for serum collection was sampled from 92 randomly selected apparently healthy male camels (*Camelus dromedarius*), 2-10 years old (divided into 4 groups; 2-4, 4-6, 6-8 and 8-10 years) from their natural habitat in the periurban areas at El-Kharga oasis. The recorded over all mean values of blood serum tri-iodothyronine (T_3) and thyroxine (T_4) concentrations in dromedary camels were 1.179 ±0.03 nmol/l and 80.59 ±2.27 nmol/l respectively. The effect of age of camels was non significant for both T_3 (F=1.446, P=0.235) and T_4 (F=2.014, P=0.096). The over all mean concentrations of blood serum lipids of camels were 369.0±7.504 mg/dl for total lipids, 0.898 ±0.028 mmol/l for total cholesterol and 0.606±0.021 mmol/l for Triglycerides. The effect of age of camels was significant for total lipids (F=3.870, P=0.016), total cholesterol (F=3.987, P=0.011) and triglycerides (F=5.626, P=0.003). It was noticed that old camels (8-10 years) had the highest mean values of these blood serum lipids. The recorded over all mean values for lipoproteins was 0.462±0.023 mmol/l for high density lipoprotein-cholesterol (HDL-C), 0.314 ±0.010 mmol/l for low density lipoprotein-cholesterol (LDL-C) and 0.121± 0.004 mmol/l for very low density lipoprotein-cholesterol (VLDL-C). The age of camels had a significant effect on the mean concentrations of blood serum HDL-C (F=4.051, P=0.009), LDL-C (F=3.698, P=0.024) and VLDL-C (F=5.584, P=0.002). Aged camels (8-10 years) showed the highest values of HDL-C and VLDL-C, whereas

LDL-C was highest in camels aged 4-8 years. The linear regression analysis revealed that the regression factor (R^2) and correlation coefficient (r) between the estimated blood serum T_3 concentrations and lipogram in blood serum of camels was non significant. Also R^2 and r between T_4 and total lipids, HDL-C and VLDL-C were non significant. On the other hand, there was significant inverse linear regression (R^2) and negative correlation (r) between T_4 and each of total cholesterol (R^2=0.167, r = – 0.290, P=0.037), triglycerides (R^2=0.193, r = – 0.375, P=0.021) and LDL-C (R^2=0.196, r = – 0.397, P=0.015). It can be concluded that dromedary camels in the Egyptian oases have low values of circulating thyroid hormones. However, there were no apparent clinical signs of goiter. It seems that these camels are suffering from a state of subclinical hypothyroidism with a pronounced effect on lipid metabolism.

Key words: *Thyroid hormones, lipid, lipoproteins, dromedary camel, Egyptian oasis.*

INTRODUCTION

Dysfunction of the thyroid gland is a common endocrine disorder (Brody, 1999; Laurberg *et al.,* 2000 & 2001; Kelly, 2000; Markou *et al.*, 2001 and Wu, *et al.* 2005). Goiter is endemic among the Egyptian population (Abdou *et al.,* 1967). The condition is severe in human beings in the Egyptian oasis (Coble, *et al.* 1968 and WHO/NI, 1992). Soil, original foods and water in the Egyptian oasis are iodine deficient, which is directly reflected on the iodine concentration in human and animal populations in this area (UNICEF, 1993, Saleh, 2000 and Yousef, 2006).

Hypothyroidism is a graded phenomenon with different levels of severity and wide inter-individual range of clinical and biochemical presentation (Murray, *et al.* 1999). Subclinical thyroid dysfunction is viewed as a risk factor for secondary hyperlipidaemia (Catharine, *et al.* 2000). Half to third of hypothyroid cases in human are manifesting dyslipidaemia, therefore the lipogram panel is considered a useful diagnostic aid for thyroid dysfunction (Caraccio, *et al.* 2002). However, the exact underlying mechanisms, notably their effect on the quantitative and qualitative distribution of lipoproteins, remain to be explored (Walsh, *et al.* 2005 and Iqbal, *et al.* 2006).

Ibrahim, *et al.* (1984) found hypertriglyceridaemia in hypothyroid Nubian goats. Wasfi, *et al* (1987) found poor correlation

between either T_3 or T_4 and cholesterol levels in camels in Saudi Arabia. However, Faye and Bengoumi (1994) reported that camels are more sensitive to iodine deficiency than the other domestic ruminants. Overt hypothyroidism (goiter) and subclinical hypothyroidism has a significant effect on the concentrations of circulating cholesterol and triglycerides in Sudanese camels (Abu Damir *et al.* 1990 and Barsham 2000).

Lipoprotein metabolism is a complicated process and is still somewhat difficult (Fernandez, 2001). Tulenko and Sumner (2002) reported that the main circulating classes of lipoproteins are chylomicrons (very high density lipoprotein cholesterol, VHDL-C), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C) and very low density lipoprotein cholesterol (VLDL-C).

Reports on lipoproteins in camels are scarce. Nazifi, *et al.* (2000) found that blood serum lipids and lipoproteins in camels were lower than those reported for other animal species and they were higher in aged camels than in young individuals. Mohamed *et al.* (2006) found that LDL-C was positively correlated with cholesterol and negatively correlated with triglycerides in camels infected with internal parasites.

The significance of dyslipidemia in subclinical hypothyroidism in livestock remains controversial. The aim of this work was the estimation of thyroid hormone concentrations and their correlation with the lipogram in blood serum of male dromedary camels in iodine deficient areas at the Egyptian oasis.

MATERIALS and METHODS

The study area: The New-Valley governorate (the Egyptian Oasis) covers most of the western Egyptian desert and represents about 46 % of the Egyptian area. This area is 77.8 m altitude and lies between 22° 30′ and 25° 40′ N latitudes and between 29° 42′ and 31° 20′ E longitudes. New-Valley is an arid inland tropical area. Soil nature is sandy limestone with low humus and low annual precipitation. The climate is arid, essentially that of the desert. There is no surface water or rivers. Rainfall is almost negligible. Watering and irrigation depend absolutely on the ground wells.

Animals and sampling: The nature of camels in Egyptian oases is nomadic. Camel owners depend mainly on natural pasture resources to feed their animals. Camels browse freely on ephemeral and perennial plants and bushes belong mainly to Acacia species, German grass

(Haloxylon salicornicum), Kassla (Cyperus conglomeratus), and some times Barseem (Medicago sativa).

This study was carried out during the thermoneutral zone (September-October 2006). Ninety two apparently healthy male camels (*Camelus dromedarius*), 2-10 years old were randomly selected from their natural habitat in the periurban areas at El-Kharga oasis. After faecal and blood parasitological investigations as a routine work in our laboratory, only parasite free camels were selected. The selected camels were classified according to their age into 4 groups: 2-4 years, 4-6 years, 6-8 years and 8-10 years. Blood was drained from the jugular vein into 10-ml capacity vacuum tubes (Venoject, Sterile Terumo Europe, Leuven, Belgium). Blood collection was carried out from camels at the fasting state in the early morning before browsing. Clear sera were separated and kept in deep freeze at -20 °C until used.

Biochemical assay: Blood serum T_3 and T_4 were estimated by standard ELISA techniques using test kits (Bio-Merieux, 69280 Marcy, L'Etoile, France) according to manufacture instructions. Total serum lipid, total cholesterol (TC) and triglycerides (TG) were determined by enzymatic colorimetric assay by using commercial test kits (Sclavo diagnostics, Italy) after the methods described by Stein (1986), Zlatkis and Zak (1969) and Fletcher (1968) respectively. High-density lipoprotein cholesterol (HDL-C) was determined enzymatically in the supernatant after selective phosphotungstic acid-magnesium chloride-induced precipitation of other lipoproteins by using commercial test kits (SERA-PAK plus, Bayer diagnostics) according to Rifai and Warnick (1994). Low-density lipoprotein cholesterol (LDL-C) and Very low-density lipoprotein cholesterol (VLDL-C) were calculated by using the Friedewald formula (Friedewald, *et al.* 1972) as following: LDL-C = TC - (HDL-C + triglycerides/5), VLDL = triglycerides/5.

Statistical analysis: General linear model analysis of variance (GLM-ANOVA) was performed on the pooled data using SPSS package V. 11.5 (SPSS, 2002). The means were compared with comparison-wise standard error (SE) rate after significant F-tests. The interactions between the four age groups were included in the model using pair-wise multiple comparison procedures (Duncan's new multiple range test). Linear regression analysis (LRA) and Pearson product moment correlation (PPMC) were performed on the arranged all-raw data of serum thyroid hormones, lipids and lipoproteins regardless to the effect of age. T_3 and T_4 concentrations were used as dependent variables and the lipogram as independent variables. The data were represented by the

regression equation, regression factor (R^2), degree of correlation (r) and the level of significance (P) of these operations. A statistical difference was considered at probability <5%.

RESULTS

The recorded over all mean values of blood serum tri-iodothyronine (T_3) and thyroxine (T_4) concentrations in dromedary camels (Table, 1) were 1.179 ±0.030 nmol/l (0.552-1.691 nmol/l) and 80.59 ±2.274 nmol/l (35.91-124.1 nmol/l) respectively. The effect of age of camels was non significant for both T_3 (F=1.446, P=0.235) and T_4 (F=2.014, P=0.096).

The over all mean concentrations of blood serum lipids of camels were 369.0 ±7.504 mg/dl (236.3-511.8 mg/dl) for total lipids, 0.898 ±0.028 mmol/l (0.460-1.523 mmol/l) for total cholesterol and 0.606±0.021 mmol/l (0.282-0.986 mmol/l) for triglycerides (Table, 2). The effect of age of camels was significant for total lipids (F=3.870, P=0.016), total cholesterol (F=3.987, P=0.011) and triglycerides (F=5.626, P=0.003). It was noticed that old camels (8-10 years) had the highest mean values of these blood serum lipids.

Table 1: Mean values of blood serum thyroid hormones in camels.

Thyroid hormones	Age (years)				Over all LSM N=92	F test	
	2-4 n=23	4-6 n=23	6-8 n=23	8-10 n=23		F value	P value
T_3 (nmol/l)							
Mean	1.159 [a]	1.261 [a]	1.202 [a]	1.093 [a]	1.179	1.446 [NS]	0.235
SE	0.054	0.056	0.046	0.068	0.030		
Min	0.581	0.614	0.753	0.552	0.552		
Max	1.609	1.691	1.568	1.596	1.691		
T_4 (nmol/l)							
Mean	77.48 [a]	82.61 [a]	87.22 [a]	75.04 [a]	80.59	2.014 [NS]	0.096
SE	3.235	4.884	4.902	4.816	2.274		
Min	57.94	45.82	39.64	35.91	35.91		
Max	109.2	116.1	124.1	114.0	124.1		

NS: non significant at p<0.05. a: there are no significant difference between means in the same row.

Table 2: Mean values of blood serum lipids in camels.

Lipids	Age (years)	Over all	F test

	2-4 n=23	4-6 n=23	6-8 n=23	8-10 n=23	LSM n=92	F value	P value
Total lipids mg/dl							
Mean	351.8 [a]	330.7 [a]	373.8 [a]	419.7 [b]	369.0	3.870*	0.016
SE	10.521	14.145	16.712	12.374	7.504		
Min	259.5	236.3	276.6	294.1	236.3		
Max	451.6	468.7	511.8	509.8	511.8		
Cholesterol mmol/l							
Mean	0.734 [a]	0.872 [a]	0.867 [a]	1.119 [b]	0.898	3.987*	0.011
SE	0.046	0.055	0.048	0.049	0.028		
Min	0.491	0.514	0.460	0.694	0.460		
Max	1.212	1.396	1.295	1.523	1.523		
Triglycerides mmol/l							
Mean	0.497 [a]	0.529 [ab]	0.618 [b]	0.780 [c]	0.606	5.626**	0.003
SE	0.028	0.038	0.032	0.045	0.021		
Min	0.310	0.295	0.334	0.282	0.282		
Max	0.765	0.866	0.876	0.986	0.986		

*,** F value is significant at p<0.05 and 0.01 respectively. Means with different superscript letters (a,b,c) in the same row are significantly different at P<0.05 (Duncan's new multiple range test).

Table 3: Mean values of blood serum lipoproteins in camels.

Lipoproteins	Age (years)				Over all LSM n=92	F test	
	2-4 n=23	4-6 n=23	6-8 n=23	8-10 n=23		F value	P value
HDL-C mmol/l							
Mean	0.379 [a]	0.411 [a]	0.391 [a]	0.667 [b]	0.462	4.051**	0.009
SE	0.030	0.035	0.030	0.052	0.023		
Min	0.191	0.215	0.184	0.260	0.184		
Max	0.732	0.772	0.715	1.127	1.127		
LDL-C mmol/l							
Mean	0.255 [a]	0.356 [b]	0.353 [b]	0.293 [a]	0.314	3.698*	0.024
SE	0.018	0.018	0.019	0.019	0.010		
Min	0.121	0.214	0.194	0.164	0.121		
Max	0.391	0.516	0.516	0.462	0.516		
VLDL-C mmol/l							
Mean	0.099 [a]	0.106 [a]	0.124 [b]	0.156 [c]	0.121	5.584**	0.002
SE	0.005	0.006	0.006	0.011	0.004		
Min	0.054	0.049	0.061	0.068	0.049		
Max	0.139	0.142	0.168	0.31	0.31		

*,** F value is significant at p<0.05 and 0.01 respectively. Means with different superscript letters (a,b,c) in the same row are significantly different at P<0.05 (Duncan's new multiple range test).

Table 4: Linear regression (R^2), correlation coefficient (r) and level of significance (P) between the thyroid hormones and the lipogram in blood serum of camels.

	T_3			T_4		
	R^2	r	P	R^2	r	P
Total lipid	0.012	-0.079	0.143 ^{NS}	0.077	-0.189	0.321 ^{NS}
Cholesterol	0.003	-0.044	0.521 ^{NS}	0.167	-0.290	0.037*
Triglycerides	0.002	-0.035	0.414 ^{NS}	0.193	-0.375	0.021*
HDL-C	$9x10^{-04}$	-0.011	0.732 ^{NS}	0.022	-0.092	0.415 ^{NS}
LDL-C	0.020	-0.099	0.089 ^{NS}	0.196	-0.397	0.015*
VLDL-C	0.0001	-0.021	0.605 ^{NS}	0.002	-0.018	0.562 ^{NS}

^{NS} Non significant; *Significant (P<0.05%)

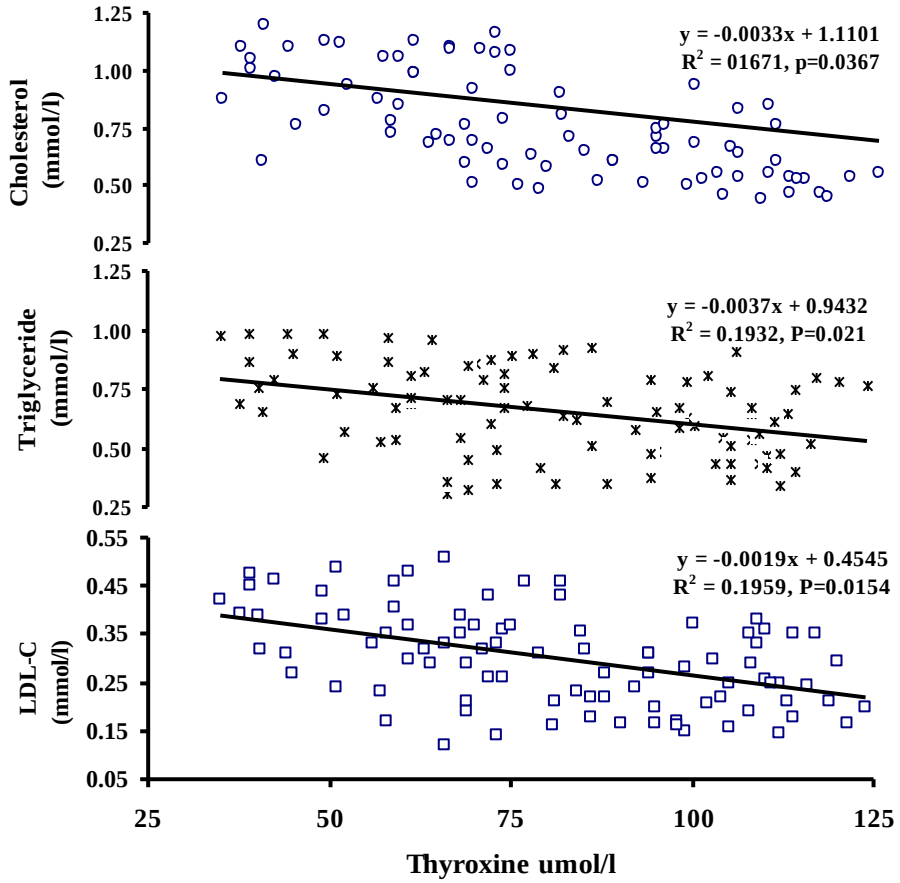

Fig. 1: Linear regression equation, regression factor (R^2) and level of significance (P) between T_4 and each of total cholesterol, triglycerides and LDL-C in blood serum of camels.

The values of blood serum lipoproteins are presented in Table 3. The recorded over all mean values were 0.462±0.023 mmol/l (0.184-1.127 mmol/l) for HDL-C, 0.314 ±0.010 mmol/l (0.121-0.516 mmol/l)

for LDL-C and 0.121± 0.004 mmol/l (0.049-0.31 mmol/l) for VLDL-C. The age of camels had a significant effect on the mean concentrations of blood serum HDL-C (F=4.051, P=0.009), LDL-C (F=3.698, P=0.024) and VLDL-C (F=5.584, P=0.002). Old camels (8-10 years) showed the highest values of HDL-C and VLDL-C, whereas LDL-C was higher in camels aged 4-8 years.

The linear regression and correlation analysis between the thyroid hormones (dependant variables) and the lipogram (in-dependant variables) are represented in Table 4 and Figure 1. The linear equation, regression factor (R^2) and correlation coefficient (r) between the estimated blood serum T_3 concentrations and lipogram in blood serum of camels were non significant. The interaction between T_4 and total lipids, HDL-C and VLDL-C was also non significant. On the other hand, there were significant inverse linear equation and negative correlation between T_4 and total cholesterol ($y = –0.0033x + 1.11$, $R^2=0.167$, $r = –0.29$, $P=0.037$), triglycerides ($y = –0.0037x + 0.943$, $R^2=0.193$, $r = –0.375$, $P=0.021$) and LDL-C ($y = –0.0019x + 0.455$, $R^2=0.196$, $r = –0.397$, $P=0.015$).

DISCUSSION

Under field practice, the judgment of the thyroid state and thyroidal abnormalities in animals is depending mainly on the values of the circulating thyroid hormones (Kaneko, 1997). The thyroid hormones thyroxine (T_4) and triiodothyronine (T_3) increase the metabolic activities of almost all the tissues of the body (Kelly, 2000). About 90% of the hormones secreted by the thyroid gland are T_4 and 10% is T_3. However, most of the T_4 is eventually converted to T_3 in the tissues, so that both are important functionally (Huszenicza, *et al.* 2002 and Ganong, 2003).

The recorded mean values of blood serum T_4 and T_3 concentrations in dromedary camels in the Egyptian oasis were 80.59±2.274 nmol/l (35.91-124.1 nmol/l) and 1.179±0.030 nmol/l (0.552-1.691 nmol/l) respectively. These values were lower than those reported by Wasfi, *et al*. (1987) in Saudi Arabia who recorded values of 17.92±1.19 µg/dl (230.63±15.32 nmol/l) and 9.33±1.15 ng/ml (1.43±0.18 nmol/l) as normal camel serum total T_4 and T_3 levels respectively. The values were also lower than those reported by Abu Damir, *et al*. (1990) for normal and affected camels with clinical and subclinical goiter in the Kordofan region of the Sudan. On the other hand, the mean concentrations of T_4 in the current study were similar to

those reported by Barsham (2000) in goiterogenic areas in Sudan. The author found that the mean concentrations of T_4 (nmol/l) in camels in Idd Elfursan and Zalingei regions in Sudan were 80.48±25.1 and 83.09±25.55 respectively. Lower values were reported by the author for camels in Nyala region which recorded a mean value of 57.37±18.30 nmol/l. Higher mean values of T_3 (nmol/l) were recorded by Barsham (2000) which were 1.68±0.61, 1.62±0.65 and 1.88±1.12 respectively for camels reared in Nyala, Idd Elfursan and Zalingei regions in Sudan. The concentration of the circulating thyroid hormones in camels in this study were slightly higher than those reported in our previous work in the same area (Saleh *et al.* 2003) probably due to the lower number of camels in the earlier study.

Despite of the comparable low values of thyroid hormones in camels in this study with those obtained in goiterogenic areas in Sudan by Abu Damir, *et al* (1990) and Barsham (2000), there were no apparent clinical signs of goiter observed in camels in the Egyptian oasis. Iodine deficiency was early reported in the soil, water, food, human and sheep in the Egyptian oasis area (UNICEF, 1993, Saleh, 2000 and Yousef, 2006). It seems that camels in the Egyptian oasis are either adapted to iodine deficiency in their natural habitat or it can be suggested that these camels are suffering from a state of unapparent or subclinical hypothyroidism which is directly related to the well recognized iodine deficiency in the Egyptian oasis.

Differences in thyroid hormone concentrations within normal camel population can be expected as a result of pregnancy, lactation, season and plain of nutrition as well as dehydration or rehydration (Yagil, *et al*. 1978; Alfuraiji, *et al*. 1994; Abu Damir, 1998; Bengoumi *et al.* 1999 & 2003 and Idris, *et al.* 2006). In the current work, age of camels had no apparent effect on the mean concentrations of thyroid hormones. Similar results were previously cited by Wasfi, *et al.* (1987) and Nazifi and Gheisari (2000).

The over all mean concentrations of blood serum total lipids, cholesterol and triglycerides in camels in this work were lower than those reported for other animal species (Mills and Taylaur, 1971; Bruss, 1997; Kerr, 2002 and Latimer, *et al.* 2003) and slightly lower than those reported previously for camels (Wasfi, *et al.* 1987; Abu Damir, *et al.* 1990; Nazifi and Maleki, 1998; Mohamed and Hussein, 1999; Barsham, 2000; Nazifi, *et al.*, 2000 and Mohamed, *et al.*, 2006). On the other hand the quantitative and qualitative composition of blood serum lipoproteins in the investigated camels differ than those reported by Nazifi *et al.*

(2000), Shehata, *et al.* (2001) and Mohamed *et al.* (2006). These differences in concentrations of blood serum lipids and lipoproteins in normal camels might be related to the variation in the environment, management and feeding behaviour of camels at the different localities (Kerr, 2002 and Latimer, *et al.*, 2003).

The mean values of blood serum lipids and lipoproteins tend to increase with the increase of age of camels except for LDL-C which increased in camels aged 4-8 years. These results agree with the findings of Nazifi, *et al.* (2000) who found that old camels had the highest values of blood serum lipids and lipoproteins. Nevertheless, Shehata, *et al.* (2001) and Baraka and Illek (2003) found that age had no effect on the circulating lipogram in camels.

Thyroid hormones influence the major metabolic pathways and play a crucial role in the regulation of mitochondrial oxidative metabolism of protein, carbohydrate and lipid by increasing the basal energy expenditure (Kaneko, 1997). With specific view to lipid metabolism, thyroid hormones affect synthesis, mobilization and degradation of lipids (Pucci, *et al.*, 2000 and Danese, *et al.*, 2000). The participant effects of thyroid hormones on lipid metabolism include enhanced utilization of lipid substrates, increase in the synthesis and mobilization of triglycerides stored in adipose tissue, increase in the concentration of non-esterified fatty acids and increase of lipoprotein-lipase activity (Miettinen, 1968; McGavin, *et al* 2001; Duntas, 2002; Frank, *et al.*, 2003 a,b & 2004 and Shavdatuashvili, 2005).

In this work there were no regression or correlation between T_3 and serum lipogram in camels Also the regression and correlation between T_4 and total lipids, HDL-C and VLDL-C were non significant. On the other hand, there were significant inverse linear equation, regression factor and negative correlation between T_4 and each of total cholesterol, triglycerides and LDL-C.

Frank et al. (1999; 2003a,b; 2004) reported that higher plasma triglyceride (TG), very low-density lipoprotein (VLDL), and low-density lipoprotein (LDL) concentrations were detected following thyroidectomy in horses suggesting that thyroid hormones play an important role in equine lipoprotein metabolism. On the other hand, Wasfi, *et al* (1987) found poor correlation between either T_3 or T_4 and cholesterol levels in clinically healthy camels suggesting that it is only evident under severely altered thyroid function and not the range of thyroid hormones levels seen in physiological conditions.

Bruss, (1997) reported that lipid disorders exhibit great individual variability and hypercholesterolemia occurs in about 75 percent of hypothyroid animals. The suggested possible mechanisms of hypercholesterolemia in hypothyroid individuals were the decreased conversion of cholesterol into bile acids (Efstathiadou, *et al.,* 2001). Further studies showed that hypothyroidism depressed the synthesis of cholesterol, increased cholesterol absorption, changes in hepatic lipase activity and delayed removal of low density lipoprotein from the plasma (Abrams and Grundy 1981a,b; Danese, *et al.*, 2000; Caraccio, *et al.,* 2002; Walsh, *et al.,* 2005 and Chapidze, *et al.*, 2006).

Hypertriglyceridaemia in hypothyroid individuals is primarily the result of increased triacylglycerols production by the liver, possibly as a consequence of increased hepatic microsomal synthesis of triacylglyserols and/or of a decreased oxidation of fatty acids (Ibrahim, *et al.*, 1984; Meier, *et al.,* 2001; Danese, *et al.,* 2000; Duntas, 2002 and William, *et al.*, 2004). In addition, several studies showed that the decrease of thyroid hormone had an effect on lipoprotein lipase and seems to be of importance on the disturbance in triglyceride metabolism (Valdemarsson, *et al.,* 1983; Duntas, 2002; Ineck and Ng, 2003 and Iqbal, *et al.,* 2006).

It can be concluded that dromedary camels in the Egyptian oasis have low values of circulating thyroid hormones. However, there were no apparent clinical signs of goiter. It seems that these camels are suffering from a state of subclinical hypothyroidism with a pronounced effect on lipid metabolism.

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