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Serum lipids and lipoproteins and their correlations with thyroid hormones in clinically healthy goats

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ABSTRACT

Blood samples were collected from the jugular vein of 162 Iranian male goats of different age groups (<1, 1-2, 2-3, 3-4, 4-5 and >5 years). Variations in the serum concentrations of cholesterol, triglyceride, total lipids, very low density lipoproteins (VLDL-cholesterol), low density lipoproteins (LDL-cholesterol) and high density lipoproteins (HDL-cholesterol) and their correlation with the concentrations of tri-iodothyronine (T3) and thyroxine (T4) were investigated. The concentrations of triglyceride, VLDL-cholesterol, T4 and T3 in the different age groups were significantly different ($P<0.05$). With an increase in age there were significant decreases in the triglyceride, VLDL-cholesterol, T4 and T3 concentrations. There were no significant correlations between thyroid hormones (T3 and T4) and serum cholesterol, triglyceride, total lipids and lipoproteins (HDL, LDL and VLDL).

Key words: goat, lipid, lipoprotein, thyroid hormones, serum

Introduction

Studies on cholesterol, triglyceride and lipoproteins in domestic animals have made it clear that species variations exist, and that even within species significant differences occur. There is little information about serum lipids

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in goats, apart from the report on serum concentration of lipids in normal goats by BENNIS et al. (1992). Changes in the concentrations of serum T4 and T3 of goats in different physiological conditions have been investigated earlier (ANDERSON and HAMESS, 1975; CASTRO et al., 1975; WENTZEL et al., 1979; AGRAWAL and BHATTACHARYYA, 1981; KUHN and BURVENICH, 1986; McDONALD et al., 1988; BHATTACHARYYA et al., 1990; DUTTA et al., 1996; MANALU et al., 1997). Serum cholesterol was consistently negatively correlated with serum thyroxine and tri-iodothyronine levels (VALDERMARSSON et al., 1983; LARSSON, 1988). There is a paucity of information about the effects of hypo- and hyper-thyroidism on the serum cholesterol, triglyceride and phospholipid concentrations of Nubian goats (IBRAHIM et al., 1984). The present study was therefore conducted to estimate the normal values of serum lipids and lipoproteins (cholesterol, triglyceride, total lipids, HDL-cholesterol, LDL-cholesterol and VLDL-cholesterol) and their correlation with thyroid hormones in clinically healthy male goats, as no information is currently available.

Materials and methods

This study was performed using blood samples from 162 Iranian male goats in six age groups (<1, 1-2, 2-3, 3-4, 4-5 and >5 years) at the Animal Husbandry Unit, located south of Shiraz, Iran. Animals were fed with hay (mainly alfalfa and grass) from the pasture near the husbandry unit. This unit is supervised by an experienced veterinarian. The animals were clinically healthy and free from internal and external parasites. They were treated with febendazole (Damloran Co., Borujerd, Iran) (10 mg/kg) 30 days prior to the study. Prevention of internal and external parasites is routine practice in this unit. Each goat had a separate file including all necessary records and the characteristics of the goats, including age, sex, etc. The blood samples were taken from the jugular vein into vacutainers (Becton Dickinson Co., New Jersey, U.S.A.). The serum was separated by centrifugation at 750×g for 15 min and stored at -20 °C until used. The serum was analysed for cholesterol by a modified Abell-Kendall/Levey-Brodie (A-K) method (BURTIS and ASHWOOD, 1994), triglyceride by the enzymatic procedure of McGOWAN et al. (1983) and total lipids by the method

described by ZOLLNER and KIRSCH (1962). Lipoproteins were isolated using a combination of precipitation and ultracentrifugation. HDL-cholesterol was measured by the precipitation method. In the first step, the precipitation reagent (sodium phosphotungstate with magnesium chloride) was added to serum to aggregate non-HDL lipoproteins, which were sedimented by centrifugation (10000×g for 5 min). The residual cholesterol was then measured by the enzymatic method (BURTIS and ASHWOOD, 1994). LDL-cholesterol was calculated as the difference between cholesterol measured in the precipitate and in the HDL fraction. VLDL-cholesterol was estimated as one-fifth of the concentration of triglycerides (FRIEDEWALD et al., 1972). T4 and T3 were measured by radioimmunoassay kits in Namazi Medical Research Center, Shiraz, Iran. The areas of validation for T3 and T4 assays included limits of detection, precision in standard curve following sample dilution, and inter-assay and intra-assay coefficients of variation results were considered. Data were expressed in SI units and analysed by analysis of variance and regression analysis, using SPSS/PC software and Duncan's multiple range test to detect significant differences between the means (NORUSIS, 1993). All values were expressed as mean±standard error (SEM) with $P<0.05$.

Results

The mean ± standard error of the serum lipids, lipoproteins and thyroid hormones of Iranian male goats in different age groups is presented in Table 1.

Correlation coefficients between serum lipids and lipoproteins, and thyroid hormones (T3 and T4) of Iranian male goats in different age groups, are presented in Table 2. The concentrations of triglyceride, VLDL-cholesterol, T4 and T3 in the different age groups were significantly different ($P<0.05$). Age had a significant effect on the serum lipids and lipoproteins of the goats, as with an increase in age of animals there was a decrease in the triglyceride ($P<0.05$; $r=-0.82$), VLDL-cholesterol ($P<0.05$; $r=-0.82$), T3 ($P<0.05$; $r=-0.92$) and T4 ($P<0.05$; $r=-0.88$) concentrations. There were no significant correlations between thyroid hormones (T3 and T4) and serum cholesterol, triglyceride, total lipids and lipoproteins (HDL, LDL and VLDL) (Table 2).

Table 1. Mean (± SEM) of serum lipids, lipoproteins and thyroid hormones of Iranian male goats in different age groups (n=162)

Age (Yrs)	N° of goats	Cholesterol (mmol/L)	Triglyceride (mmol/L)	Total lipid (g/L)	HDL-cholesterol (mmol/L)	LDL-cholesterol (mmol/L)	VLDL-cholesterol (mmol/L)	T3 (nmol/L)	T4 (nmol/L)
<1	23	2.32 ± 0.32	0.43^{a} ± 0.05	2.86 ± 0.20	1.00 ± 0.09	1.14 ±0.31	0.08^{a} ± 0.01	1.41^{a} ± 0.08	72.45^{a} ± 4.63
1-2	18	2.37 ± 0.17	0.15^{b} ± 0.10	2.06 ± 0.12	1.37 ± 0.09	0.98 ± 0.12	0.03^{b} ± 0.02	1.22^{b} ± 0.10	66.66^{b} ± 6.43
2-3	35	2.33 ± 0.13	0.15^{b} ± 0.02	2.46 ± 0.19	1.18 ± 0.06	1.08 ± 0.09	0.03^{b} ± 0.004	1.34^{c} ± 0.05	67.95^{b} ± 2.57
3-4	38	2.24 ± 0.15	0.22^{b} ± 0.04	2.76 ± 0.19	1.01 ± 0.08	1.15 ± 0.11	0.04^{c} ± 0.008	1.16^{b} ± 0.08	54.95^{d} ± 5.14
4-5	32	2.04 ± 0.13	0.17^{b} ± 0.03	2.14 ± 0.14	0.99 ± 0.06	0.97 ± 0.10	0.03^{b} ± 0.006	1.57^{d} ± 0.16	64.60^{b} ± 7.07
>5	16	2.28 ± 0.24	0.11^{b} ± 0.03	2.52 ± 0.26	1.10 ± 0.09	1.13 ± 0.18	0.02^{d} ± 0.006	1.00^{c} ± 0.04	42.08^{c} ± 3.47

Values with different superscripts in a column differ significantly ($P<0.05$).
HDL, high density lipoprotein; LDL, low density lipoprotein; VLDL, very low density lipoprotein; T3, tri-iodothyronine; T4, thyroxine

Table 2. Correlation coefficients between serum lipids and lipoproteins, and thyroid hormones (T_3 and T_4) of Iranian male goats in different age groups (n=162)

Age (Yrs)		Cholesterol	Triglyceride	Total lipids	HDL-cholesterol	LDL-cholesterol	VLDL-cholesterol
<1	T_3	0.1318	0.1005	0.1324	-0.0985	0.1855	0.1005
	T_4	0.0336	-0.1358	0.0471	0.1114	0.0070	-0.1358
1-2	T_3	0.1195	0.1121	0.1527	-0.0822	0.2024	0.1121
	T_4	0.0528	-0.1224	0.0527	0.1058	0.0090	-0.1224
2-3	T_3	0.1226	0.1097	0.1465	-0.0917	0.1976	0.1097
	T_4	0.0497	-0.1302	0.0843	0.1128	0.0100	-0.1302
3-4	T_3	0.1328	0.1107	0.1227	-0.0859	0.1833	0.1107
	T_4	0.0378	-0.1298	0.0726	0.1093	0.0120	-0.1298
4-5	T_3	0.1243	0.1056	0.1364	-0.1021	0.1747	0.1056
	T_4	0.0415	-0.1331	0.0629	0.1173	0.0090	-0.1331
>5	T_3	0.1287	0.1109	0.1395	-0.0953	0.1809	0.1109
	T_4	0.0398	-0.1245	0.0537	0.1164	0.0102	-0.1245

There were no significant correlations between thyroid hormones (T_3 and T_4) and serum cholesterol, triglyceride, total lipids and lipoproteins (HDL, LDL and VLDL).
HDL, high density lipoprotein; LDL, low density lipoprotein; VLDL, very low density lipoprotein; T3, tri-iodothyronine; T4, thyroxine

Discussion

The concentration of serum cholesterol in Iranian male goats was higher than the value reported by PUGLIESE et al. (1982) and lower than the value in cows (BARTLEY, 1989). OSHIRO et al. (1979) reported that the concentration of serum cholesterol in goats was lower than the value in cows. The concentration of triglyceride in the serum of Iranian goats was lower than the value reported by PUGLIESE et al. (1982). The concentration of total lipids in the serum of Iranian goats was lower than the values reported by PUGLIESE et al. (1982) and CASTRO et al. (1977), but similar to the value reported by PRASAD and RAJYA (1979). There is no previous information about the serum lipoproteins of goats. The concentration of lipoproteins (HDL, LDL and VLDL) in the serum of goats was higher than the values reported for camels (NAZIFI et al., 2000).

Age had a significant effect on the serum concentration of triglyceride and VLDL-cholesterol of Iranian goats, the values being lower in older animals. BENNIS et al. (1992) reported that in kids, the concentration of all lipids was similar to mature goats. HUGI and BLUM (1997) reported in calves that cholesterol concentration increased transiently with age, but triglycerides did not show a consistent change. BRAUNWALD (1995) and KLEINVELD (1996) reported that in humans there was a statistically significant increase in the concentrations of serum cholesterol and triglyceride in advanced age. NOGUCHI (1993) reported that in humans the concentrations of LDL and VLDL increased and the concentration of HDL decreased with increasing age.

The concentration of serum T4 in Iranian male goats was lower than the values reported by CASTRO et al. (1975) and KALLFELZ and ERALI (1973) and similar to the value reported for cows (BARTLEY, 1989). The concentration of T3 in the serum of Iranian goats was lower than the values reported for goats (CASTRO et al., 1975; REAP et al., 1978).

Age had a significant effect on the serum concentration of T3 and T4 of Iranian goats, the values being lower in older animals. According to KUMAR and RATTAN (1992), in the sera of buffalo heifers during the first month of life, T4 and T3 levels were higher than those of the other developmental stages and age groups. The serum T3 level in buffalo calves

within 6-9 months of age was lower than that of the other age groups and developmental stages. AGARWAL et al. (1992) reported that thyroid hormone concentrations in calves at birth were 4 to 5 times higher than those of their dams. The levels in calves declined thereafter but remained almost twice those in dams. In contrast to our results, AGARWAL et al. (1986) reported that there were no significant differences in thyroid hormone concentrations among camels aged 1-4, 4-8 or >8 years. Similarly, WASFI et al. (1987) and AGARWAL et al. (1989) reported that the concentrations of thyroid hormones were not correlated with age.

The serum cholesterol level generally varies inversely with thyroid activity. The net effect of thyroid hormone on cholesterol metabolism is to increase the rate of its catabolism by the liver, thereby lowering the cholesterol (BARTLEY, 1989). GUEORGUIEVA and GUEORGUIEVA (1997) reported that in dairy cows serum cholesterol was consistently negatively correlated with serum T4 and T3 levels. An increase in VLDL-cholesterol is commonly associated with hypothyroidism (BARTLEY, 1989). In contrast to above opinion, WASFI et al. (1987) reported that the concentrations of thyroid hormones were not correlated with cholesterol levels. In our study there was no correlation between thyroid hormones (T3 and T4) and serum cholesterol concentration, where this agreed well with the result previously obtained by WASFI et al. (1987). In contrast to our results, IBRAHIM et al. (1984) reported that in Nubian goats, hyperthyroidism decreased serum triglyceride, cholesterol and phospholipid concentrations. Also, hypothyroidism increased serum triglyceride. In Iranian goats there were no correlations among thyroid hormones and triglyceride, total lipids, HDL-cholesterol, LDL-cholesterol and VLDL-cholesterol. The explanation for these findings is not possible at this moment in time. The cause of these findings is unclear and, there is no earlier report in this respect.

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SAŽETAK

Istraživanje je provedeno na 162 jarca različite dobi (<1, 1-2, 2-3, 3-4, 4-5 i >5 godina). Istražene su promjene u koncentraciji serumskog kolesterola, triglicerida, ukupnih lipida, kolesterola vrlo niske gustoće, kolesterola niske gustoće, kolesterola visoke gustoće, kao i njihov odnos prema koncentraciji trijodtironina (T3) i tiroksina (T4). Koncentracija triglicerida, kolesterola vrlo niske gustoće, T4 i T3 bila je različita u životinja različitih dobnih skupina ($P<0,05$). Povećanjem dobi utvrđen je i značajan pad koncentracije triglicerida, kolesterola vrlo niske gustoće, T4 i T3. Nije utvrđena značajnija povezanost između tireoidnih hormona (T3 i T4) te kolesterola, triglicerida, ukupnih lipida i lipoproteina.

Ključne riječi: koza, lipidi, lipoproteini, hormoni štitnjače, serum