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Changes in selected hematology and serum biochemistry in Turkish Angora cats (*Felis catus*) during growth period

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ABSTRACT

The purpose of the present study was to determine the changes in selected hematology and serum biochemistry of Angora cats (*Felis catus*) during growth period. A total of 32 Angora cats (16 adults and 16 kittens) were used in this study. Blood samples were collected from the animals, and were analyzed for white blood cells, red blood cells, hemoglobin, packed cell volume, mean corpuscular volume (MCV), mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, granulocytes, monocytes and lymphocytes numbers. In the serum, alanine aminotransferase, aspartate aminotransferase (AST), alkaline phosphatase (ALP), gamma glutamyl transferase (GGT), lactate dehydrogenase (LDH), creatinine kinase (CK), total cholesterol, glucose, triglyceride, urea, creatinine, total protein, albumin, Ca, Mg, Pi levels were determined. Monocyte level was found higher, and ALP, LDH, CK activities and Pi levels were lower in adult cats as compared to the kittens. MCV was lower and GGT and AST activities, and glucose level were higher in kittens of 1.5-3 months old than in kittens of >3 months. Concentrations of total cholesterol and Mg were higher in kitten (1.5-3 months old) than in adult cats. In conclusion, age related effects on hematological and biochemical blood parameters have been determined for the first time in Angora cats.

Keywords

Angora cats, Biochemical parameters, Hematological values

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INTRODUCTION

Angora cats (*Felis catus*) are distinct breed found in Turkey; the breed has been originated from the area around Ankara (formerly Angora). The Angora cats have colored eyes; the eyes may have shade of blue, gold or odd-eyed. Apparently, the cats have been used in the development of other modern breeds and are distributed throughout the world (Arikan et al., 2003).

Blood is considered as an important material for evaluation of health status in animals. In applied medicine, both hematological and biochemical analyses are complementary to clinical examination. These analyses may provide significant information that are needed in early diagnosis, etiology and prognosis of disease, and monitoring of treatment-response (Karagül et al., 2000; Turgut, 2000).

Alterations in hematological and biochemical blood parameters under the influence of breed, sex, age, season, gestation and several diseases have been demonstrated in several domestic animal species (Eksen et al., 1992; Awah and Nottidge ,1998; Strasser et al., 2001; Altunok et al., 2007). Differences have been reported to exist among different age groups of cattle; for example, differences in activities of alanine aminotransferase (ALT), aspartate aminotransferase (AST) and alkaline phosphatase (ALP) have been described by Sharma and Bisoi (1995). Çınar et al. (2010) reported plasma cholesterol levels to be decreased and total protein levels to be increased in adult Kangal dogs as compared to juvenile Kangal dogs. In a previous study conducted in sheep, it was ascertained that some blood parameters (erythrocyte, hemoglobin, hematocrit, glucose, urea, creatinine, albumin and triglyceride levels) were higher, while

some other blood parameters (globulin and iron levels) were lower in yearling lambs as compared to adult animals (Yiğit et al., 2002). Arikan et al. (2001) reported that there are differences in some blood parameters between animal breeds.

Although blood parameters have been studied in several animal species (Gaikwad et al., 1992; Yiğit et al., 2002; Çınar et al., 2010), hematological and biochemical blood parameters have not been investigated in Angora cats during growth period. Therefore, this study was aimed at determining reference values for biochemical and hematological blood parameters in different age groups of Angora cats.

MATERİALS AND METHODS

Animals and sample collection: A total of 64 blood samples were collected from 16 kitten aging 1.5, 3, 4.5, 6, 7.5, 10.5 months, and 16 adult cats aging 1-3 years. Animals were vaccinated and fed with dry commercial cat food during the study period. The animal care and protocol used were reviewed and approved by the Ethics Committee of the Kirikkale University (28.04.2008/19).

Blood samples were taken from Vena cephalica antebrachii into test tubes containing anticoagulant (EDTA) for biochemical analysis.

Hematology and serum biochemistry: The anticoagulated blood samples were used to determine leucocytes (WBC) and erythrocytes (RBC) numbers, hemoglobin concentration (Hb), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), granulocytes (GRA), monocyte (MON), and lymphocyte (LYM) numbers by using commercial test kits using blood counting machine (MS9-3 Melet Schloesing Laboratory, France). All samples were evaluated in the same day.

Non-anticoagulated blood samples were kept at room temperature for 1h to ensure complete clotting. Then, serum was separated from non-anticoagulated blood samples by centrifugation at 1,600x*g* for 10 min. The serum samples were stored at -30°C until analyzed. In the serum, ALT, AST, ALP, gamma glutamyl transferase (GGT), lactate dehydrogenase (LDH) and creatinine kinase (CK), total cholesterol, glucose, triglyceride, urea, creatinine, total protein, albumin, calcium (Ca), magnesium (Mg), inorganic phosphate (Pi) levels were measured. Analysis was carried out using commercial test kits (Biolabo, France) using spectrophotometer (Shimadzu UV-1700, Japan).

Statistical analysis: The hematological and biochemical data were evaluated independently by general linear model of ANOVA (SAS, Version 8.02, SAS Institute Inc, Cary, NC, USA) procedure. Differences between each group was compared by using LSD multiple comparisons test when appropriate. All results were expressed as the mean±SEM for each group, and were considered statistically significant at the $p<0.05$ significance level.

RESULTS AND DISCUSSION

In the present study, certain hematological and biochemical parameters during growth period in Angora cats were determined; the data have been presented in **Table 1** and **Table 2**. The WBC were higher, RBC, Hb and PCV levels were lower in kittens of 1.5-3 months age as compared to the kittens older than 3 months ($p<0.05$). The changes observed in RBC and WBC values did not comply with previous findings reported by Egbe-Nwiyi et al. (2000). On the other hand, increasement of RBC observed in this study was in agreement with the results previously detected in Saanen and Kilis goats (Iriadam, 2004; Elitok, 2012). Furthermore, decrease in WBC values complied with the results previously reported by Yiğit et al. (2002) and Elitok (2012).

The comparison of the values of hemoglobin in kitten and adult cats demonstrated an increase with age, as described by Egbe-Nwiyi et al. (2000), Iriadam (2004), Elitok (2012) and Njidda (2013). This difference between kitten and adult cats was considered as an indicator of higher oxygen transport capacity of the blood in adult animals.

In this study, hematocrit levels were found to be increased with age. These findings were in agreement with the reports of Elitok (2012) and Iriadam (2004) in goats. Higher hematocrit levels demonstrate either an increase in the number of circulating RBC or decrease in the volume of plasma in the blood circulation. Hematological parameters, particularly hematocrit and Hb levels, have been found to be related to altitude and the nutritional status of the animal (Adejumo, 2004; Isidahomen et al., 2010; Addas et al., 2010).

In the present study, the comparison of 1.5 to 3 month old kittens with adult cats demonstrated an increase ($p<0.05$) with age in monocyte levels, which is in

Table 1. Mean±SEM values for selected hematological parameters in kitten and adult Angora cats (n=16).

Parameters	Kitten			Adult	*p*-value
	1.5-3 month	4.5-6 month	7.5-10.5 month	(1-3 years)	
WBC (x10³/µL)	17.23 ± 1.53[a]	13.71 ± 1.25[b]	11.49 ± 0.70[b]	12 ± 0.47[b]	$p<0.05$
LYM (x10³/µL)	4.42 ± 0.44	3.89 ± 0.30	4.12 ± 0.32	4.08 ± 0.20	NS
MON (x10³/µL)	0.33 ± 0.04[b]	0.44 ± 0.06[b]	0.32 ± 0.01[b]	0.64 ± 0.06[a]	$p<0.05$
GRA (x10³/µL)	5.96 ± 0.31[b]	7.05 ± 0.25[a]	5.25 ± 0.29[b]	5.24 ± 0.22[b]	$p<0.01$
RBC (x10⁶/µL)	6.16 ± 0.17[c]	7.47 ± 0.28[d]	8.74 ± 0.29[a]	8.33 ± 0.31[ab]	$p<0.05$
MCV (fL)	43.86 ± 0.52[b]	47.36 ± 1.38[a]	48.84 ± 0.73[a]	42.16 ± 1.32[b]	$p<0.01$
PCV (%)	27.37 ± 1.05[c]	34.7 ± 2.15[b]	42.87 ± 1.83[a]	35.19 ± 1.29[b]	$p<0.01$
MCHC (g/dL)	31.05 ± 0.33[b]	32.99 ± 0.95[a]	27.76 ± 0.72[c]	33.56 ± 0.38[a]	$p<0.05$
MCH (pg)	13.7 ± 0.11[b]	14.24 ± 0.25[a]	13.62 ± 0.28[b]	14.01 ± 0.19[ab]	$p<0.05$
Hb (g/dL)	7.66 ± 0.20[b]	11.19 ± 0.46[a]	11.78 ± 0.40[a]	11.97 ± 0.47[a]	$p<0.001$

NS = not significant [a,b,c] = The letter in the same line means significantly different.

Table 2. Mean±SEM values for selected biochemical parameters in kitten and adult Angora cats (n=16).

Parameters	Kitten			Adult	*p*-value
	1.5-3 month	4.5-6 month	7.5-10.5 month	(1-3 years)	
ALT (IU/L)	25.79 ± 1.64	26.17 ± 3.12	31.12 ± 2.56	33.39 ± 5.75	NS
AST (IU/L)	35.81 ± 2.47[a]	26.08 ± 2.51[b]	26.13 ± 1.75[b]	30.88 ± 2.13[ab]	$p<0.01$
ALP (IU/L)	96.89 ± 11.75[a]	92.22 ± 14.96[a]	81.69 ± 10.21[a]	40.00 ± 5.36[b]	$p<0.05$
GGT (IU/L)	16.09 ± 2.46[a]	7.61 ± 1.22[bc]	9.42 ± 1.11[b]	4.33 ± 0.29[c]	$p<0.01$
LDH (IU/L)	276.24 ± 30.64[a]	274.90 ± 29.79[a]	260.75 ± 33.18[a]	167.73 ± 24.76[b]	$p<0.05$
CK (IU/L)	218.04 ± 22.55[a]	173.71 ± 16.86[ab]	196.78 ± 16.58[a]	133.27 ± 10.17[b]	$p<0.05$
Glucose (mg/dL)	115.10 ± 4.14[a]	90.46 ± 7.39[b]	91.11 ± 4.29[b]	110.84 ±7.64 [a]	$p<0.05$
T. Cholesterol(mg/dL)	158.78 ± 4.08[a]	142.03 ± 7.50[ab]	128.39 ± 6.34[b]	132.54 ± 7.10[b]	$p<0.01$
Triglyceride (mg/dL)	58.50 ± 4.86	45.25 ± 4.25	55.69 ± 6.66	50.47 ± 6.96	NS
Creatinine (mg/dL)	1.27 ± 0.1[ab]	1.06 ± 0.06[b]	1.39 ± 0.09[a]	1.48 ± 0.11[a]	$p<0.05$
Urea (mg/dL)	26.35 ± 2.61	28.03 ± 3.30	26.35 ± 2.49	28.24 ± 2.33	NS
Total Protein (g/dL)	5.92 ± 0.21[b]	6.92 ± 0.16[a]	6.68 ± 0.22[a]	6.77 ± 0.14[a]	$p<0.05$
Albumin (g/dL)	3.04 ± 0.11[b]	3.22 ± 0.11[ab]	3.49 ± 0.08[ac]	3.23 ± 0.13[bc]	$p<0.01$
Ca (mg/dL)	11.23 ± 0.19[a]	9.99 ± 0.23[b]	10.62 ± 0.18[ab]	10.52 ± 0.28[b]	$p<0.05$
Pi (mg/dL)	8.61 ± 0.23[a]	7.62 ± 0.24[b]	8.09 ± 0.39[ab]	6.51 ± 0.42[c]	$p<0.05$
Mg (mg/dL)	2.59 ± 0.08[a]	2.40 ± 0.08[ab]	2.25 ± 0.06[b]	2.36 ± 0.07[b]	$p<0.05$

NS = not significant [a,b,c] = The letter in the same line means significantly different.

agreement with the findings of Egbe-Nwiyi et al. (2000) in goats. In contrast, in a study carried out in Kilis goats, no difference was determined in between juvenile and adult animals for monocyte values (Iriadam, 2004).

When the kitten and the adult Angora cats were compared for MCV, it was ascertained that kittens older than 4.5 months of age had higher MVC values ($p<0.01$). Similar to the present study, a research carried out in Saanen goats demonstrated that MCV decreased progressively with age (Elitok, 2012).

It was detected that the majority of biochemical blood parameters in young animals differred from the normal reference values, as reported for adult animals by Boediker (1991) and Egli and Blum (1998). Age-dependent differences were known to exist between animals due to major changes that might be occured prior to puberty (Meyer and Harvey, 2004).

A number of enzymes are clinically useful in recognition and monitoring of particular disease processes (Dufour et al., 2001). In the present study, in all age groups, AST activity was determined to fall, as reported by Turgut (2000). While serum AST activity was significantly higher in 1.5 to 3 months old kittens as compared to other juveniles ($p<0.01$), the values measured in 1 to 3 years old cats was observed to be close to those measured in the 1.5 to 3 months old kittens. The high activity of AST might be attributed to increased enzyme activity arising from endogenous production (Zanker et al., 2001).

In this study, serum ALP activity was found to be significantly higher in kitten cats as compared to adult cats ($p<0.05$). In growing animals, the bone ALP

isoenzyme is predominant. In kittens and puppies younger than six months of age, serum ALP activity has been reported to be high (Turgut, 2000). The high ALP activity observed in young animals might be attributed to the bone ALP isoenzyme being predominant, and bone ALP isoenzymes passing into the plasma as a result of high osteoblastic activity (Ettinger and Feldman, 2010).

In the present study, it was determined that, the serum GGT activities measured in the kitten and adult Angora cats were within the reference value ranges that was previously reported by some researchers (Karagül et al., 2000; Turgut, 2000). It was ascertained that, in comparison to adults, the GGT activity in kittens was significantly higher (p<0.01). A previous study reported that hepatic GGT level decreased with age, following an increase for a short time after birth (Turgut, 2000).

In dogs, total serum LDH activity decreased with age (Karagül et al., 2000). CK is an enzyme specific to muscle tissue. Previous research has shown that serum CK activity varies with age in healthy dogs, and that the activity of day-old puppies is five times higher than that of adult dogs (Karagül et al., 2000). Similarly, in the present study, it was observed that serum LDH and CK activities were significantly higher in kittens as compared to adult cats (p<0.05).

Analysis of biochemical values such as glucose, total protein and cholesterol are essential in diagnosing the various nutritional, pathological and metabolic disorders (Daramola et al., 2005). It has been indicated that serum glucose levels may vary with age in animals (Iriadam, 2004).

In this study, the serum glucose levels measured in the Angora cat were found to fall as compared to reference value ranges previously reported for cats (Karagül et al., 2000; Turgut, 2000), and values measured in 1.5 to 3 months old kittens were higher than those measured in other kittens (p<0.01). Decrease in glucose level with age can be related to the weakened regeneration of glucose in the liver (Church, 1993).

Serum cholesterol levels in this study were ascertained to be present within the range, as reported by Turgut (2000). Furthermore, the serum cholesterol levels of the kittens was ascertained to be significantly higher than those of adult cats (p<0.01). The high cholesterol levels measured in juvenile animals have been attributed to the cholesterol intake during the growth period having a long-lasting effect on metabolic pathways, including those for cholesterol and lipoproteins, and it has been suggested that the defence system of new-born animals feeding on milk could be stronger against atherosclerosis (Mott, 1990; Lanting and Beorsma, 1996).

In this study, serum creatinine levels were found to be present within the reference value ranges reported for cats by some researchers (Karagül et al., 2000; Turgut, 2000). The total body skeletal muscle mass, glomerular filtration rate and tubular reabsorption and secretion are the possible factors, which may affect creatinine levels (Guignard and Drukker, 1999; Otukesh et al., 2011). The serum creatinine levels of 7.5 to 10.5 months old kittens and 1 to 3 years old adult cats being higher than those of 4.5 to 6 months old cats has been attributed to the development of the total body skeletal muscle mass (Mert, 1996). Similar results were reported by Elitok (2012) in a study carried out in Saanen goats. High creatinine levels in adult animals were considered to be related to the protein metabolism of a larger skeletal muscle mass (Meyer and Harvey, 2004).

Total protein and albumin levels are biochemical parameters, which may alter with age (Mohri et al., 2007). In the present study, serum total protein and albumin levels were present within the reference value ranges as previously reported for cats by some researchers (Karagül et al., 2000; Turgut, 2000). The increase in observed total protein values with age was attributed to the decrease in body fluids or the increase in the level of gamma globulins (Çimtay and Şahin, 2000).

In this study, serum Ca, Pi and Mg levels were observed to have decreased with age (p<0.05), and while the Ca levels fell within the reference value range reported by Turgut (2000), the Pi and Mg levels were found to be within the reference value ranges, as reported by Karagül et al. (2000). It was reported that intestinal absorption of Ca decreased with age (Karagül et al. (2000). The serum Pi level is regulated by the kidneys and alters with age. It has been indicated that, when compared to adults, serum Pi concentrations are higher in growing animals (Turgut, 2000). Çimtay and Şahin (2000) have reported an inverse correlation between serum Pi levels and age. Similarly, the results of this study demonstrated that serum Pi levels were decreased with age. It is considered that, young animals having higher serum Pi levels as compared adults; this may arise from the bone tissue development of young animals occurring at a higher rate (Turgut, 2000).

CONCLUSION

This study showed that serum GGT, LDH, CK activities, glucose, total cholesterol, Ca, Pi, Mg, WBC levels were decreased, while total protein, MON, RBC, PCV, Hb levels were increased with age in Angora cats. The data of this study will be the base reference values for hematological and biochemical blood parameters in kitten and adult Angora cats. It is believed that the results of this study will contribute to future physiology and biochemistry research to be carried out with Angora cats, as well as the comparison of altered values, which may emerge during the course of diseases, with normal reference values.

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