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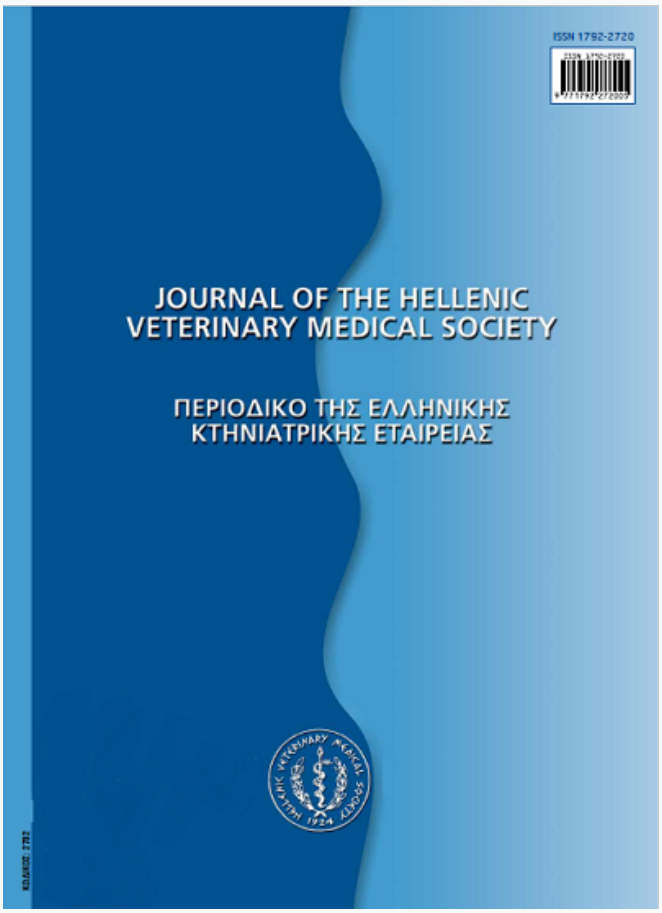

Assessment of some health parameters in West African Pygmy Goats and Cameroon Dwarf Sheep of a Zoo in Greece

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Assessment of some health parameters in West African Pygmy Goats and Cameroon Dwarf Sheep of a Zoo in Greece

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Εκτίμηση μερικών παραμέτρων υγείας σε νανόμορφες αίγες Δυτικής Αφρικής και πρόβατα του Καμερούν ενός Ζωολογικού κήπου στην Ελλάδα

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Abstract

Ten African pygmy goats and five Cameroon sheep from the Attica Zoological Park in Greece were examined for some health parameters including a thorough clinical examination, haematology, serum biochemistry, serological and PCR examination for small ruminant lentivirus, milk bacteriology for common pathogens of clinical or subclinical mastitis and faecal parasitology. These were compared with the existing literature for these two exotic breeds of small ruminants. Haematologic and biochemistry values are compared to existing literature for the pygmy goats whereas this is the first report of such values in Cameroon sheep. All animals proved clinically healthy and were free of common pathogens found in small ruminants in Greece as well as for intestinal and respiratory parasites.

Key words: West African pygmy goats, Cameroon sheep, haematology, serum biochemistry, Greece

Περίληψη

Δέκα αίγες φυλής Μικρόσωμης Αφρικάνικης (pygmy goats) και πέντε πρόβατα φυλής Καμερούν από το Αττικό Ζωολογικό Πάρκο που βρίσκεται στα Σπάτα Αττικής εξετάσθηκαν για κάποιες παραμέτρους υγείας. Συγκεκριμένα, έγινε πλήρης κλινική εξέταση, γενική εξέταση αίματος, βιοχημικές εξετάσεις στον ορό του αίματος, ελέγχθηκε η ύπαρξη ή μη lenti-ιών των μικρών μηρυκαστικών με ορολογικές εξετάσεις και PCR στο ολικό αίμα, έγιναν εξετάσεις στο γάλα για την ύπαρξη παθογόνων μικροοργανισμών που προκαλούν κλινική ή υποκλινική μαστίτιδα, καθώς και παρασιτολογική εξέταση κοπράνων. Τα ευρήματα συγκρίθηκαν με τα δεδομένα της υπάρχουσας βιβλιογραφίας της σχετικής με τις 2 αυτές εξωτικές φυλές μικρών μηρυκαστικών. Τα ευρήματα των αιματολογικών και βιοχημικών εξετάσεων συγκρίθηκαν με εκείνα της υπάρχουσας βιβλιογραφίας για τις νανόμορφες αίγες, κάτι που δεν έγινε για τα πρόβατα της φυλής Καμερούν, καθώς η παρούσα έρευνα είναι η πρώτη αναφορά στην διεθνή βιβλιογραφία σχετικά με τα αιματολογικά και βιοχημικά ευρήματα σε πρόβατα αυτής της φυλής. Όλα τα ζώα που χρησιμοποιήθηκαν σε αυτή τη μελέτη ήταν κλινικά υγιή και βρέθηκαν απαλλαγμένα από παθογόνους παράγοντες που είναι πολύ διαδεδομένοι στα μικρά μηρυκαστικά στην Ελλάδα.

Λέξεις ευρετηρίασης: Νανόμορφες αίγες Δυτικής Αφρικής, πρόβατα Καμερούν, γενική αίματος, βιοχημικές ορού, Ελλάδα

INTRODUCTION

In recent years more and more research is being done on the physiology and normal reference values of many wild, semi-wild or captive-"exotic" ungulates (Sakkinen et al. 2005, Gupta et al. 2007, Masek et al. 2009).

West African pygmy goats (Capra hircus hircus), more correctly called West African Dwarf goats are widely distributed in the coastal countries of West and Central Africa and are found on grasslands or deserts (Mason 1996, Porter 1996). They are also popular in many European zoos as petting animals for visitors, as they are easy to handle and train and are naturally clean and quiet (Castro et al. 1977a). In captivity, they can live usually for up to about 8 to 12 years. This breed is not threatened with extinction and consists of hardy animals managing to exist by feeding on any kind of plant feed vegetation they find in the arid lands in which they live. Additionally, these animals are prolific (Porter 1996) and trypanotolerant (Geerts et al. 2009) which provides them with a great advantage in the rural economy and hygiene of West Africa or any place where trypanosomiasis is a common disease, as it has been suspected that domestic animals may act as potential reservoir hosts of Trypanosoma in Cameroon (Njiokou et al. 2001). Also, as these animals are relatively cheap to maintain, they are suitable for biomedical research (Ragan et al. 1966, Castro et al. 1977a).

So far, few reports for haematological and serum biochemistry values of African pygmy goats have been mentioned in the existing literature (Castro et al. 1977a, Castro et al. 1977b, Castro et al. 1977c, Yamaguchi et al. 1987, Mbassa and Poulsen 1991, Mbuh and Mbwaye 2005). One study of particular importance reports increased osmotic and mechanical fragility of red blood cells (RBC) of pygmy goats in comparison to other goat breeds supporting possible differences in the RBC membrane of this breed (Fairley et al. 1988). Blood from this breed has also been found to differ from other goat breeds in the number of erythrocytes per litre of blood as well as the average leukocyte count (Lohle et al. 1990). An additional publication with research on this breed of goat includes the normal functions of its thyroid gland (Castro et al. 1975).

The Cameroon Dwarf sheep (Ovis aries cameroon dwarf), also called West African Dwarf or Djallonke sheep (Mason 1996), is a prolific and trypanotolerant breed (Njwe and Manjeli 1992, Geerts et al. 2009) that differs in blood polymorphism to other West African breeds (Missohou et al. 1999). They have been bred for thousands of years and are today found in Northwest and Central Africa, from Senegal to Nigeria. As the pygmy goats, they are also not picky with their diet and make the best of what vegetation they can find. One of their characteristics that comes from evolving in the warm climate of Africa is that they do not develop a thick coat of wool as do sheep living in the Northern hemisphere. Their mean milk production per day is 0.31-0.5 Kg (Njwe and Manjeli 1992). To the best of our knowledge no haematology and serum biochemistry reference values exist for this breed of sheep.

Taking into account that: 1) data for reference values in these 2 breeds are scarce, 2) reference values of these animals are necessary, as they are common in many zoological institutions around Europe and 3) reference values are necessary for the assessment of the nutritional, reproductive and health status and for the monitoring of the wellbeing and welfare of captive animals, we chose to carry out this research. A separate and also the primary drive to carry out this study was exploration for exploration's sake – the drive of discovering the natural world.

MATERIALS AND METHODS

Animals and study design

The study was conducted during March 2010 in the Attica Zoological Park, a private Zoo, positioned in the rural area of Spata in the Attiki county of Greece. The goats and sheep of the Park were housed separately in natural-grounded exhibits, the one for the goats being a walk-in for visitors. Although the animals were housed conspecifically, animals freely roaming the grounds such as peacocks and rabbits have always had access to their area. The exhibits are according to standards listed by the European Association of Zoos and Aquaria, of which the Attica Zoological Park is a member.

The animals were bought from private collections in Greece and had been introduced from West Africa 6 years earlier. The goats were inserted to the Park in May 2001 whereas the sheep were introduced in February 2006. Over the years, both the goat and sheep populations average seven animals. Goat kids and lambs are born into the herd and raised on the premises, until they are about one year old, at which age they are sold to private collections in Greece. No additions have been made to the herd from the outside. For the study all the aforementioned animals of the Park were used; ten pygmy goats (one female goat kid, two male goat kids, three bucks and four female goats in milking season) and five Cameroon sheep (one male lamb, two rams and two ewes in milking season). An additional female pygmy goat was present but was not restrained for sampling as the animal was at the final stage of pregnancy. At the time of sampling, all animals were clinically healthy. Also, both flocks had no history of severe illness during the previous years, according to the records of the Zoo veterinarian. Sampling was conducted once for all the animals before the morning feeding.

The goats were regularly dewormed with fenbendazole added in the feedstuffs and vaccinated against clostridial infections. The last treatment with fenbendazole was conducted according to the Zoo's veterinarian about 3-4 months before sampling. The sheep were a year before sampling treated with ivermectin for three consecutive times within a 45-day period because of the presence of sarcoptic mange. All the animals were free of brucellosis. The diet of all the adult animals consisted of alfalfa hay, corn and commercial concentrates. Occasionally they were also fed with vegetables such as carrots and lettuce. Visitors have free access to the petting zoo's enclosures and thus the animals are also fed by them sometimes.

Blood was drawn from the jugular vein of all animals sampled and was deposited in two vials for each animal, 1 with and 1 without anticoagulant; the first with EDTA was used for haematological analysis, while the second was allowed to clot and then was centrifuged at 2,500 g for serum separation. The separated serum was stored at -20°C in Eppendorf tubes up to the time of analysis. Serum samples were examined for biochemical parameters, as well as for small ruminant lentivirus (SRLV) infection. Faecal samples were collected directly from the rectum of each animal and milk was drawn from the mammary glands of any animal in lactation and deposited into aseptic vials. All animals were thoroughly inspected for the presence of ectoparasites.

Analytical methods

Haematological examinations were conducted with an automated hematology analyzer (ADVIA 120, Siemens). Blood biochemistry was conducted with a clinical chemistry analyzer (Flexor E, Vital Scientific).

Serum samples were examined for the presence of SRLV specific antibodies using the CHEKIT-CAEV/MVV ELISA test kit (IDEXX, Switzerland). Detection of the proviral SRLV DNA was performed using DNA extracts from separated peripheral blood mononuclear cells (PBMCs) and nested-PCR (Eltahir et al. 2006) modified by using 0.5 units Platinum® Taq DNA Polymerase (Invitrogen, The Netherlands) per 20 μl assay.

Milk samples were examined for Mycoplasma spp., Staphylococcus spp., Streptococcus spp., Escherichia coli and other Enterobacteriaceae, Pasteurella multocida, Manheimia haemolytica and Pseudomonas aeruginosa.

Faecal samples were examined with sedimentation

Table 1. Haematological values (mean±standard deviation) for different sex and age groups in pygmy goats

Variable	Total (n=10)	Male Adults (n=3)	Female Adults (n=4)	Male Kids (n=2)	Female Kids (n=1)	Adults (n=7)	Kids (n=3)
WBC (103/μl)	14.95±4.21	14.13±3.90	17.75±3.43	13.27±5.11	9.55	16.20±3.83	12.03±4.20
RBC (10^6/μl)	14.52±3.27	17.23±2.25	13.67±0.67	14.98±5.17	8.83	15.20±2.36	12.93±5.09
HGB (g/dl)	12.4±2.69	14.43±1.59	12.18±1.15	11.50±1.70	9.00	13.14±1.72	10.67±1.88
HCT (%)	31.88±5.37	37.20±4.86	27.95±3.97	33.50±0.85	28.40	31.91±6.34	31.80±3.00
PLT (10^3/μl)	531.10±311.39	356.33±281.29	404.00±258.38	879.00±48.08	868.00	383.57±245.77	875.33±34.59
NEUT (10^3/μl)	8.22±3.95	8.73±2.03	10.37±5.01	5.19±1.68	4.19	9.67±3.84	4.85±1.32
LYMPH (10^3/μl)	6.27±2.21	5.06±1,87	6.72±2.23	7.77±3.29	5.07	6.01±2.11	6.87±2.80
MONO (10^3/μl)	0.01±0.00	0.01±0.01	0.01±0.01	0.01±0.00	0.00	0.01±0.00	0.01±0.01
EOS (10^3/μl)	0.39±0.20	0.30±0.02	0.49±0.20	0.23±0.11	0.25	0.45±0.20	0.24±0.08
TS (g/dl)	7.46±0.75	8.00±0.53	7.80±0.28	6.50±0.14	6.40	7.89±0.38	6.47±0.12

(Teleman), flotation with zinc sulfate 33.2% and Ziehl-Neelsen staining methods for the presence of gastrointestinal, liver and respiratory parasites, coccidian, as well as Cryptosporidium spp. oocysts.

Statistical analysis

The arithmetic mean and standard deviation were calculated for each population of goats and sheep. Additionally, the arithmetic mean and standard deviation were calculated for each of the following groups: adult males, adult females, kids, adults and kid males. No arithmetic mean or standard deviation was calculated for lambs and female kids as only one sample for each of these cases existed. Due to the small number of the populations studied we cannot claim the results are statistically important.

RESULTS

All the animals were found free of endo- and ecto-parasites. Also, all the animals were negative for SRLV infection, while all the milk samples were found negative for Mycoplasma spp. and other pathogens.

The values of the haematological parameters calculated in total and for each animal category are given in Table 1 for the pygmy goats and in Table 2 for the Cameroon sheep. In a similar way, the serum biochemistry findings are found in Table 3 for the pygmy goats and in Table 4 for the Cameroon sheep.

DISCUSSION

This study has been conducted to evaluate the health status of a small population of pygmy goats

Table 2. Haematological values (mean±standard deviation) for different sex and age groups in Cameroon sheep

Variable	Total (n=5)	Adult Males (n=2)	Adult Females (n=2)	Male Lambs (n=1)	Adults (n=4)
WBC (103/μl)	6.20±1.07	5.28±0.93	6.87±0.91	6.72	6.07±1.19
RBC (10^6/μl)	12.68±1.35	12.41±1.61	13.51±1.40	11.55	13.00±1.39
HGB (g/dl)	13.38±2.42	13.80±2.12	14.80±0.99	9.70	14.30±1.47
HCT (%)	32.68±4.67	33.50±4.67	35.30±1.70	25.80	34.40±3.05
PLT (10^3/μl)	450.4±319.42	291.50±243.96	381.00±282.84	907.00	336.25±221.75
NEUT (10^3/μl)	1.54±0.49	1.29±0.30	1.40±0.23	2.34	1.35±0.22
LYMPH (10^3/μl)	4.16±1.00	3.35±0.53	5.14±0.63	3.84	4.24±1.14
MONO (10^3/μl)	0.03±0.01	0.03±0.01	0.03±0.01	0.05	0.03±0.01
EOS (10^3/μl)	0.45±0.16	0.60±0.11	0.30±0.04	0.47	0.45±0.18
TS (g/dl)	6.72±0.73	6.70±0.42	7.30±0.14	5.60	7.00±0.43

Table 3. Biochemistry values (mean±standard deviation) for different sex and age groups in pygmy goats

Variable	Total (n=10)	Male Adults (n=3)	Female Adults (n=4)	Male Kids (n=2)	Female Kids (n=1)	Adults (n=7)	Kids (n=3)
TP (g/dl)	7.42±0.70	7.80±0.20	7.85±0.31	6.50±0.28	6.40	7.83±0.25	6.47±0.21
ALB (g/dl)	4.53±0.29	4.63±0.32	4.63±0.30	4.25±0.21	4.40	4.63±0.28	4.30±0.17
BUN (mg/dl)	12.10±1.60	13.33±1.15	12.00±1.83	11.00±1.41	11	12.57±1.62	11.00±1.00
CREA (mg/dl)	0.83±0.31	1.27±0.12	0.65±0.06	0.65±0.07	0.60	0.91±0.34	0.63±0.06
GLU (mg/dl)	118.10±38.18	126.00±27.07	93.25±44.18	147.00±33.94	136.00	107.29±39.07	143.33±24.83
CHOL (mg/dl)	91.50±48.69	36.67±1.53	91.25±27.93	158.00±24.04	121.00	68.29±34.80	145.67±27.30
TRIG (mg/dl)	20.97±10.49	13.67±3.79	21.25±3.86	22.85±21.43	38.00	18.00±5.35	27.9±17.49
T.BIL (mg/dl)	0.40±0.27	0.23±0.06	0.30±0.08	0.75±0.50	0.60	0.27±0.08	0.70±0.36
D.BIL (mg/dl)	<0.01	<0.01	<0.01	0,01	0.01	<0.01	0.01
ALP (U/L)	512.40±591.87	87.33±22.50	221.25±131.65	1164.00±278.60	1649.00	163.86±118.14	1325.7±342.37
ALT (U/L)	17.90±6.05	18.33±1.53	22.00±6.48	13.50±3.54	9.00	20.43±5.06	12.00±3.61
AST (U/L)	86.10±19.11	95.67±6.43	88.75±27.40	77.50±3.54	64.00	91.71±20.07	73.00±8.19
γ-GT (U/L)	20.80±3.91	20.00±1.73	22.25±4.35	21.50±6.36	16.00	21.29±3.45	19.67±5.51
CPK (U/L)	701.10±1516.23	233.33±173.89	1460.75±2362.15	201.00±149.90	66.00	934.71±1797.33	156.00±131.57
PHO (mg/dl)	8.02±2.03	6.63±1.24	7.05±1.00	10.65±0.21	10.80	6.87±1.03	10.70±0.17
Ca^{*} (mg/dl)	4.51 / 9.32±0.57 / 1.11	4.3 / 8.57±0.36 / 0.93	4.15 / 8.85±0.45 / 0.55	5.2 / 10.75±0 / 0.35	5.2 / 10.6	4.21 / 8.72±0.39 / 0.68	5.2 / 10.7±0 / 0.26
K (mEq/dl)	5.26±1.00	4.57±0.80	5.85±0.95	5.30±1.41	4.90	5.30±1.06	5.17±1.03
Na (mEq/dl)	145.20±3.77	145.00±7.21	145.75±2.06	145.00±2.83	144.00	145.43±4.43	144.67±2.08

Table 4. Biochemistry values (mean±standard deviation) for different sex and age groups in Cameroon sheep

Variable	Total (n=5)	Adult Males (n=2)	Adult Females (n=2)	Male Kids (n=1)	Adults (n=4)
TP (g/dl)	7.48±1.39	8.35±1.77	7.45±0.50	5.8	7.9±1.18
ALB (g/dl)	4.58±0.50	4.80±0.85	4.50±0.28	4.3	4.65±0.54
BUN (mg/dl)	14.50±3.74	17.00±5.66	13.50±0.70	11.5	15.25±3.86
CREA (mg/dl)	0.84±0.25	1.05±0.21	0.80±0	0.5	0.93±0.19
GLU (mg/dl)	100.6±25.93	98.00±25.46	84.00±1.41	139	91±16.79
CHOL (mg/dl)	65.60±17.54	63.50±27.58	60.00±12.73	81	61.75±17.65
TRIG (mg/dl)	30.00±11.79	26.00±12.73	26.50±10.61	45	26.25±9.57
T.BIL (mg/dl)	0.36±0.15	0.35±0.07	0.25±0.07	0.6	0.30±0.08
D.BIL (mg/dl)	<0,01	<0,01	<0,01	0.01	<0,01
ALP (U/L)	767.6±706.00	513.00±116.00	395.50±50.20	2021	454.30±99.62
ALT (U/L)	18.20±7.05	24.50±4.95	16.50±2.12	9	20.5±5.57
AST (U/L)	115.8±26.82	121.00±18.38	132.00±11.31	73	126.50±13.99
γ-GT (U/L)	28.60±5.03	26.50±3.54	28.50±7.78	33	27.50±5.07
CPK (U/L)	272.40±144.10	193.00±14.14	315.00±247.50	346	254.00±159.50
PHO (mg/dl)	6.54±2.39	6.35±0.78	4.75±0.35	10.5	5.55±1.05
Ca^{++} (mg/dl)	4.88 / 10.48±0.16 / 0.93	4,85 / 10,25±0.21 / 0.92	5 / 10.2±0 / 1.13	4.7 / 11.5	4.93 / 10.23±0.15 / 0.84
K (mEq/dl)	4.98±0.48	4.60±0.28	5.35±0.21	4	4.98±0.48
Na (mEq/dl)	145.50±1.29	146.00±1.41	145.00±1.41	113	145.50±1.29

and Cameroon sheep reared under the Greek climatic conditions. Taking into account that the data for reference values regarding haematology and serum biochemistry for these two breeds is scarce, this study aimed to make a contribution to the existing veterinary knowledge. However, it is understandable that reference values for these two breeds cannot be drawn from the results in this paper as the number of examined animals is insufficient.

Pathologic situations in these two exotic breeds of sheep and goat listed in the literature include an adenoma in a pygmy goat (Reed and Bauer 2009), Neospora caninum in a stillborn pygmy goat in Pennsylvania (Dubey et al. 1992), Mycbacterium aviun subsp. paratuberculosis in both pygmy goats and Cameroon sheep (Weber et al. 1992) and congenital cystic disease of the liver and kidney in a pygmy goat (Newman et al. 2000). None of these situations or infections has so far been observed in the small ruminants of the Attica Zoological Park.

All the examined animals proved healthy, as was indicated by clinical examinations, as well as by laboratory tests. In fact, they were free of endo- and ecto-parasites due to often animal antiparasitic treatments. Thus, haematological parameters (haematocrit, haemoglobin, eosinophil number) as well as serological parameters that would have been affected in the case of intense parasitic infection (Mbuh and Mbwave 2005, Panousis et al. 2007) were unaffected due to the absence of parasites, particularly the blood-feeding ones.

Gastrointestinal parasitism of small ruminants is very common throughout the year in the semi-extensive system in our country. Animals expel various numbers of parasite eggs into the environment during the year, depending on the area and season. The availability of infective larvae at pasture combined to the malnutrition and immunity, particularly during the periparturient period, plays an important role in the infection of small ruminants (Papadopoulos et al. 2003). In this case, animals were kept inside with minimum grazing and therefore were at no risk of acquiring infective larvae.

Also, the examined milk samples were found free of Mycoplasma and other microorganisms that can cause sheep and goat mastitis. This finding can be attributed to good hygienic conditions in the examined herds (Fthenakis 1994). Especially for the absence of mycoplasmatic infections, it can be supported that the herd was free of mycoplasmosis. Except for good hygiene measures, the absence of mycoplasmatic infections also suggests that the animals had been introduced to Greece free of this infection, as mycoplasmas can be excreted for 1-8 years from an animal infected by this condition (Madanat et al. 2001) and congenital mycoplasmatic infections have also been observed in goat herds (Filioussis et al. 2011). Mycoplasmatic infections have been diagnosed in Cameroon and other African countries (Martrenchar et al. 1995, Ruffin 2001), yet these animals must have belonged to Mycoplasma-free herds.

All the examined animals were found negative for Maedi-Visna infection. Although this infection is very common in Greek flocks (Eltahir et al. 2006), it is not considered very common in the Centro-African countries and usually when it is found it has been introduced by European breeds (Mekonnen et al. 2010). However, the findings of the present study confirm the opinion that this condition is not common in Centro-African small ruminant breeds.

Haematocrit values in Cameroon sheep ranged from 25.8 % in lambs to 35.3 % in adult sheep, while the mean value for all the examined animals was 32.68 %. These values are normal when compared to a similar study in Chios sheep (Panousis et al. 2007). Other haematological parameters of the Cameroon sheep were also within the limits described by the Greek study on Chios sheep (Panousis et al. 2007). According to the best of the authors' knowledge, data for the haematological values in Cameroon sheep are not available in the literature to date.

Haematocrit values in the examined pygmy goats ranged from 27.95 % to 37.5 % (mean 31.88 %). These values were within the normal values established in 1977 by Castro et al (1977c) for pygmy goats of a zoo in the USA. They were also within the normal values for goats suggested by Kramer (2000). However, they were higher than the suggested values by Piccione et al. (2010) in Girgentana goats in Italy and slightly lower than the suggested values by Iriadam (2007) in Turkish Kilis does. White blood cells (WBC) was found within the normal levels (4,000-13,000) for goats established by Kramer (2000) in only 3 out 10 goats of this study, while the rest of the animals had higher values that could be attributed to the stress of catching (Morris 2002). This finding is strengthened by the increase of

neutrophil count over the suggested values (Kramer 2000) in 5 out of the 10 animals, a finding characteristic of stress haemogram in ruminants (Morris 2002).

Biochemical examinations in Cameroon sheep were compared to the normal limits found in the literature for other sheep breeds, as similar studies in this breed of sheep have not been conducted to date. Mean total protein and albumin values were within the normal limits found in a similar study conducted in Greece with Chios sheep (Roubies et al. 2006). Also, mean blood urea nitrogen (BUN) value was within the normal limits cited by Pugh (2002), but a little lower than in the Greek study with Chios sheep (Roubies et al. 2006) and the values cited by Aitken (2007). Mean creatinine value was within the normal limits reported by Aitken (2007), but was slightly lower than the values reported by Pugh (2002) and Roubies et al. (2006).

Mean glucose value was higher than the normal reported values in the literature (Pugh 2002, Roubies et al. 2006, Aitken 2007). Probably this difference was the result of the fact that that most of the examined animals were not milk producing, while also a suckling lamb was included in the study. As it is known milk production leads to a decline in serum glucose, while milk drinking increases it (Hatfield et al. 1999, Roubies et al. 2006). It is interesting that the 2 milk producing animals had values similar to the values reported in the literature for Chios sheep (Roubies et al. 2006).

Mean cholesterol values in Cameroon sheep were within the normal limits reported by Pugh (2002) and Aitken (2007) for the other sheep breeds. Triglyceride levels were slightly lower than in studies with other breeds in different countries. This parameter seems to be different in various sheep breeds (Eshratkhah et al. 2008). Also, mean total, direct and indirect bilirubin values were similar to the values reported by Pugh (2002).

Regarding the mean enzyme activities, alkaline phosphatase (AP), alanine aminotransferase (ALT) and γ-glutamyl transferase (γ-GT) were within the normal values reported by other researchers for other sheep breeds (Roubies et al. 2006, Aitken 2007). However, mean aspartate aminotransferase (AST) and creatine kinase (CK) values were slightly increased compared to the values for other sheep breeds (Roubies et al. 2006, Aitken 2007). Probably these increased values could be the result of the stress after animal catching, as Zhan et al. (1997) have found increased levels of AST, lactate dehydrogenase (LDH), CK in foxes, that were attributed to handling stress.

Mean values of inorganic substances like calcium, phosphate, sodium and potassium were within the normal limits established for other sheep breeds (Pugh 2002, Roubies et al. 2006, Aitken 2007).

Serum biochemistry values in pygmy goats were evaluated for the same parameters, as above for the Cameroon sheep. Mean total protein value was within the normal limits established by Castro et al. (1977a), while mean albumin value was higher compared to the established values for pygmy goats (Castro et al. 1977a), as well as for other goat breeds (Pugh 2002). It is accepted that except for the breed, the rearing conditions can also affect the aforementioned parameters (Roubies et al. 2006). Also, mean BUN and creatinine values were within the normal limits reported in the literature (Castro et al. 1977a, Pugh 2002). Mean serum glucose was slightly increased compared to the normal limits (118 with limits from 80-115 mg/100 ml) established by Castro et al. (1977a). Taking into account, that 2 suckling goat kids were included in the study, as well as a non-milk producing goat and that these animals had high glucose levels (Roubies et al. 2006), it can be concluded that serum glucose values were normal for all the animals.

Mean serum cholesterol was similar to the findings of Castro et al. (1975), in a study conducted also in pygmy goats. However, in the present study, serum cholesterol in females was not found to increase with age, as in the previous study and as also in humans (Castro et al. 1975). Taking into account, that the number of examined samples was limited, we cannot conclude to something different from the findings of Castro et al. (1975) for serum cholesterol in pygmy goats. Also, mean serum triglycerides were within the normal limits reported in the literature for pygmy goats (Daramola et al. 2005), as well as for other goat breeds (Zubcic 2001). Total, direct and indirect bilirubin values were within the established normal limits for goats (Castro et al. 1977a, Pugh 2002).

Serum enzyme activities were increased for AP, ALT, AST and CK and normal only for γ-GT, compared to the established normal values for goats (Pugh 2002). Probably these increased values could be the result of catching stress. High levels of AST, LDH, CK have in other studies been suspected to be

due to handling stress (Zhan et al. 1997). Also, in a study between wild and captive bighorn sheep it was concluded that stress associated with handling and excitability influence physiologic values (Franzmann 1971). This can be strengthened by the fact that the same goats had also a stress haemogram, as has been mentioned above.

Also, within the normal limits cited in the literature were the findings for the inorganic substances (Pugh 2002).

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