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Reference values for some haematological, haematochemical, and electrophoretic parameters in the Girgentana goat

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Abstract: The purpose of this study was to determine haematological, haematochemical, and electrophoretic reference values for the Girgentana goat in order to form a basis for clinical interpretation. The study included 348 female Girgentana goats aged from 1 to 6 years. The animals were divided into 3 groups: goats aged 1-2 years (group A), goats aged 3-4 years (group B), and goats aged 5-6 years (group C). Blood samples were collected from each animal every morning at the same time (0800) by means of jugular venipuncture, and red blood cell (RBC), white blood cell (WBC), neutrophil (NEU), lymphocyte (LYM), monocyte (MONO), eosinophil (EOS), and basophil (BASO) counts, and haemoglobin (Hb), packed cell volume percent (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and red cell distribution width (RDW) were recorded. Additionally, the concentration of some haematochemical parameters, including alanine-aminotransferase (ALT), aspartate-aminotransferase (AST), γ-glutamine-transferase (γ-GT), creatinine, β-hydroxybutyrate, urea, non-esterified fatty acids (NEFA), potassium, sodium, and chloride, and the electrophoretic profile (albumin, α1-globulins, α2-globulins, β–globulins, γ–globulins, total proteins and albumin:globulins ratio) were determined. Statistical analysis (one-way analysis of variance [ANOVA]), followed by Bonferroni's test, showed that there were significant differences only in RBC, MCV, EOS, ALT, AST, creatinine, γ-GT, sodium, urea, NEFA, γ–globulins, and the albumin:globulins ratio ($P < 0.05$ was considered statistically significant). The values determined in the present study contribute to the knowledge of the reference ranges for the Girgentana goat and can be used for monitoring health and disease diagnosis.

Key words: Age, electrophoretic parameters, haematochemical parameters, haematological parameters, Girgentana goat

Introduction

Determination of the main haematological and haematochemical parameters of animals helps veterinarians to confirm clinical diagnoses, estimate the severity of cases, administer appropriate treatment, and evaluate outcomes (1). To interpret data correctly, the results obtained in the laboratory must be compared with values corresponding to the reference values of clinically healthy animals, which serve as a guide to the clinician in evaluating

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parameters (2). It is unequivocal that a large number of factors, such as species status, breed, sex, age, nutrition, illness, and seasonal variations, can affect the pattern of these values (3-5).

The significance of determining haematological and biochemical indices in animals is well documented (6-8), and changes in these parameters have been studied in cattle (9), sheep (10), and goats (11,12). There is great variation in the haematological and biochemical parameters observed between goat breeds (13-15), and in this regard it may be difficult to formulate a universal metabolic profile for goats. These differences further underline the need to establish appropriate physiological baseline values for various breeds, which could help in the realistic evaluation of management practices, nutrition, and health status. For this purpose we focused on the Girgentana goat, a highly prolific breed.

The Girgentana goat is an indigenous breed in the areas near Agrigento in Sicily (Italy). The breed most probably originated in Afghanistan and the Himalayas (16); its characteristic features are long, corkscrew horns and high milk yield, which in the past helped the breed to expand its range of distribution (17). Girgentana goat numbers are now so greatly reduced (18,19) that several research institutes have been proposing further studies aimed at safeguarding and valorising the breed. To the best of our knowledge references for the haematological, haematochemical, and electrophoretic profile of the Girgentana goat do not as yet exist.

Thus, the purpose of the present study was to determine haematological, haematochemical, and electrophoretic reference values for the Girgentana goat in order to form a basis for clinical interpretation.

Materials and methods

The study was conducted in Sicily, Italy (lat 37°19′19″N, long 13°35′23″E), at an altitude of about 230 m asl. The climate of this area is Mediterranean; minimum and maximum mean annual temperatures are 8.1 °C and 30.9 °C, mean annual rainfall is 22.54 mm, and mean annual relative humidity is 61.23%.

The study included female Girgentana goats (n = 348), ranging between 1 and 6 years of age. They were non-pregnant dry goats. The animals were obtained from 3 different herds under similar management and feeding conditions: 108 goats were taken from the 1st herd, 115 goats were taken from the 2nd herd, and 125 goats were taken from the 3rd herd. All animals were well fed, clinically healthy, and free of internal and external parasites. They were treated for endoparasite control twice a year and their health status was regularly monitored by veterinarians. Coprological examinations were carried out using the flotation method and all the animals had negative results.

Concerning nutrition, all the animals had free access to water and to good-quality alfalfa hay (90.0% DM, 15.8 CP % DM, 50.4 NDF % DM, 31.6 ADF % DM, 5.8 lignin % DM, and 2.2 EE % DM). Concentrate (23% oats, 36% corn, 38% barley, and 3% mineral and vitamin supplements) was provided once daily (200 g per animal per day).

The goats were divided into 3 groups: 162 goats aged 1-2 years with a body weight of 30 ± 2 kg (group A), 99 goats aged 3-4 years with a body weight of 38 ± 3 kg (group B), and 87 goats aged 5-6 years with a body weight of 45 ± 5 kg (group C).

In group A (n = 162) haematological, haematochemical, and electrophoretic parameters were measured in 162, 120, and 46 goats, respectively. In group B (n = 99) haematological, haematochemical, and electrophoretic parameters were measured in 99, 61, and 26 goats, respectively. In group C (n = 87) haematological, haematochemical, and electrophoretic parameters were measured in 87, 52, and 15 goats, respectively.

All goats were sampled once and blood samples were collected from each animal every morning (starting at 0800 and finishing at 1100) by jugular vein puncture into vacutainer tubes: 1 tube contained EDTA for haematological analyses and the other tubes for haematochemical and electrophoretic analyses did not contain anticoagulant.

Samples containing EDTA were refrigerated and analysed within 48 h. Blood samples underwent a complete blood count. Red blood cell (RBC), white blood cell (WBC), neutrophil (NEU), lymphocyte (LYM), monocyte (MONO), eosinophil (EOS), and basophil (BASO) counts, and haemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular

haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and red cell distribution width (RDW) were assessed using a CELL DYN R3500® multiparametric automatic haematology analyser (Abbott, Abbott Park, IL, USA), while packed cell volume percent (PCV) was determined using a microhaematocrit centrifuge.

The other samples were centrifuged at 3000 rpm for 10 min within 2 h of collection, and the obtained sera were separated, stored at –20 °C, and analysed within 1 week. Alanine-aminotransferase (ALT), aspartate-aminotransferase (AST), γ-glutamine-transferase (γ-GT), creatinine, β-hydroxybutyrate, urea, non-esterified fatty acids (NEFA), potassium, sodium, and chloride activity in the sera were analysed with commercially available kits (SEAC, Firenze, Italy) via a Slim SEAC UV spectrophotometer (Firenze, Italy). Table 1 summarises the analytical methods used to determine the haematochemical analytes.

Table 1. Summary of analytical methods used to determine the haematochemical parameters.

Parameters	Analytical method
ALT	Ultraviolet kinetic method
AST	Ultraviolet kinetic method
γ-GT	Colorimetric kinetic method
Creatinine	Colorimetric kinetic method
β-hydroxybutyrate	Colorimetric enzymatic method
Urea	Ultraviolet kinetic method
NEFA	Colorimetric kinetic method
Potassium	Turbidimetric method
Sodium	Colorimetric method
Chloride	Colorimetric method

Serum concentrations of albumin, globulins (α1-globulins, α2-globulins, β-globulins, γ-globulins), total proteins, and the albumin:globulins ratio were assessed by means of an automated multiparametric agarose gel electrophoresis system (Hydrasys, Sebia, France).

The effect of age on all the parameters studied was examined using one-way analysis of variance (ANOVA). P values <0.05 were considered statistically significant. Bonferroni's multiple comparison test was used for post hoc comparison. All results are expressed as mean ± standard error of the means (SEM). Data were analysed using STATISTICA v.5.5 software (StatSoft Inc, Tulsa, OK, USA).

Results

Table 2 shows the mean ± SEM values of the haematological parameters in groups A, B, and C. The mean ± SEM values of the haematochemical and electrophoretic parameters in groups A, B, and C are presented in Tables 3 and 4. One-way ANOVA showed that there was a significant effect of age on the following haematological parameters: RBC ($F_{(2,345)}$ = 3.19, P = 0.04), MCV ($F_{(2,345)}$ = 5.70, P = 0.003), and EOS ($F_{(2,345)}$ = 6.60, P = 0.0003). In contrast, the effect of age on WBC, NEU, LYM, MONO, BASO, PCV, Hb, MCH, MCHC, and RDW was not significant.

One-way ANOVA showed that there was a significant effect of age on the following haematochemical parameters: ALT ($F_{(2,230)}$ = 25.24, P < 0.0001), AST ($F_{(2,230)}$ = 3.54, P < 0.0001), γ-GT ($F_{(2,230)}$ = 37.26, P < 0.0001), creatinine ($F_{(2,230)}$ = 14.07, P < 0.0001), urea ($F_{(2,230)}$ = 11.00, P = 0.008), NEFA ($F_{(2,230)}$ = 23.10, P = 0.001), and sodium ($F_{(2,230)}$ = 10.42, P < 0.0001). The effect of age on β-hydroxybutyrate, potassium, and chloride was not significant.

One-way ANOVA showed that there was a significant effect of age only on the following electrophoretic parameters: γ-globulins ($F_{(2,84)}$ = 5.66, P = 0.004) and the albumin:globulins ratio ($F_{(2,84)}$ = 4.48, P = 0.003). The effect of age on albumin, α1-globulins, α2-globulins, and β-globulins was not significant.

Discussion

The data obtained in the present study are within the physiological range for goats (20,21). The values determined in the present study contribute to our knowledge of the reference ranges (some of which were affected by age) for the Girgentana goat; thus, it becomes necessary to consider age in the evaluation of the haematological, haematochemical, and electrophoretic profiles of this breed.

The results of the present study indicate that the 1- to 2-year-old goats had more erythrocytes than the 3- to 4-year-old goats, in contrast to other studies (15)

Table 2. Haematological values of the Girgentana goat of the 3 groups of the study.

Parameters	n	Mean ± SEM	Coefficient of variation (%)	Percentiles		
				75%	Median	25%
RBC (M/μL)						
Group A	162	15.80 ± 0.11	8.89	16.85	15.90	14.80
Group B	99	15.32 ± 0.15*	9.80	16.30	15.40	14.20
Group C	87	15.58 ± 0.17	10.28	16.90	15.60	14.60
WBC (K/μL)						
Group A	162	10.60 ± 0.25	30.44	12.80	10.20	8.19
Group B	99	10.41 ± 0.33	32.34	12.80	10.40	7.78
Group C	87	11.13 ± 0.47	39.95	12.80	11.00	8.70
NEU (K/μL)						
Group A	162	4.60 ± 0.18	50.43	6.15	3.87	2.96
Group B	99	4.42 ± 0.22	50.29	5.48	3.89	2.75
Group C	87	4.95 ± 0.37	70.96	8.92	4.46	3.32
LYM (K/μL)						
Group A	162	4.94 ± 0.15	40.98	5.89	4.73	3.49
Group B	99	5.08 ± 0.24	48.55	6.33	4.40	3.19
Group C	87	5.11 ± 0.22	41.92	6.41	4.69	3.63
MONO (K/μL)						
Group A	162	0.58 ± 0.04	96.29	0.58	0.42	0.31
Group B	99	0.54 ± 0.03	63.57	0.63	0.44	0.31
Group C	87	0.53 ± 0.04	80.70	0.59	0.42	0.32
EOS (K/μL)						
Group A	162	0.40 ± 0.02	92.54	0.55	0.30	0.13
Group B	99	0.27 ± 0.02*	81.20	0.36	0.20	0.12
Group C	87	0.45 ± 0.03	97.81	0.64	0.27	0.14
BASO (K/μL)						
Group A	162	0.09 ± 0.01	184.56	0.10	0.05	0.03
Group B	99	0.07 ± 0.004	67.44	0.09	0.06	0.04
Group C	87	0.09 ± 0.01	110.82	0.09	0.07	0.04
PCV (%)						
Group A	162	25.34 ± 1.66	83.67	25.60	23.85	21.90
Group B	99	23.97 ± 0.32	13.56	26.30	23.40	21.40
Group C	87	23.94 ± 0.35	13.93	26.30	23.70	21.40
Hb (g/dL)						
Group A	162	10.14 ± 0.09	12.39	10.90	10.20	9.32
Group B	99	9.98 ± 0.15	15.27	10.90	9.88	8.89
Group C	87	10.22 ± 0.19	17.67	11.30	9.86	8.92
MCV (fL)						
Group A	162	15.04 ± 0.12	10.24	16.00	14.75	14.10
Group B	99	15.72 ± 0.17*	11.35	16.50	15.50	14.30
Group C	87	15.37 ± 0.15	9.33	16.30	15.30	14.30
MCH (pg)						
Group A	162	6.41 ± 0.03	7.59	6.60	6.37	6.13
Group B	99	6.51 ± 0.05	8.95	6.88	6.38	6.06
Group C	87	6.53 ± 0.07	10.79	6.70	6.41	6.04
MCHC (g/dL)						
Group A	162	43.00 ± 0.35	10.51	45.05	41.95	39.90
Group B	99	42.80 ± 0.60	11.76	43.60	40.20	38.60
Group C	87	42.80 ± 0.60	13.28	43.40	41.10	39.20
RDW (%)						
Group A	162	37.37 ± 0.39	13.37	40.15	37.95	34.20
Group B	99	36.41 ± 0.48	13.16	40.30	36.90	32.50
Group C	87	36.89 ± 0.46	11.68	40.00	37.00	33.60

Significances: *vs. Group A; °vs. Group B

Table 3. Haematochemical values of the Girgentana goat of the 3 groups of the study.

Parameters	n	Mean ± SEM	Coefficient of variation (%)	Percentiles		
				75%	Median	25%
ALT (U/L)						
Group A	120	18.66 ± 0.49	28.67	21.00	18.00	15.00
Group B	61	16.77 ± 0.72	33.54	19.00	16.00	13.00
Group C	52	24.68 ± 1.14*°	32.67	28.50	19.00	21.00
AST (U/L)						
Group A	120	87.96 ± 3.76	46.64	96.00	84.00	73.00
Group B	61	78.21 ± 2.94	29.40	92.00	73.00	61.00
Group C	52	96.41 ± 5.23°	38.74	113.00	89.00	72.00
γ-GT (U/L)						
Group A	120	36.63 ± 0.99	29.64	42.00	35.00	31.00
Group B	61	40.61 ± 1.13	21.75	46.00	38.00	35.00
Group C	52	25.24 ± 1.10*°	31.20	28.00	25.00	22.00
Creatinine (mg/dL)						
Group A	120	0.80 ± 0.02	29.64	0.94	0.84	0.76
Group B	61	0.72 ± 0.03	36.17	0.91	0.75	0.61
Group C	52	0.95 ± 0.02*°	15.98	1.04	0.93	0.87
β-hydroxybutyrate (mmol/L)						
Group A	120	0.32 ± 0.02	74.21	0.43	0.25	0.16
Group B	61	0.42 ± 0.05	105.17	0.46	0.32	0.21
Group C	52	0.30 ± 0.04	94.73	0.37	0.19	0.15
Urea (mg/dL)						
Group A	120	43.27 ± 0.92	22.92	48.00	43.00	37.00
Group B	61	35.69 ± 1.22*	25.49	39.00	35.00	30.00
Group C	52	43.90 ± 2.17°	31.33	56.00	39.00	32.00
NEFA (mmol/L)						
Group A	120	0.32 ± 0.02	69.24	0.35	0.30	0.20
Group B	61	0.62 ± 0.03*	48.64	0.80	0.60	0.50
Group C	52	0.43 ± 0.05°	76.68	0.40	0.40	0.25
Potassium (mmol/L)						
Group A	120	5.76 ± 0.13	25.98	6.60	5.50	4.60
Group B	61	5.84 ± 0.20	27.00	6.85	5.60	4.50
Group C	52	6.30 ± 0.20	23.53	7.10	6.40	5.00
Sodium (mmol/L)						
Group A	120	135.80 ± 0.82	6.62	140.00	137.00	133.00
Group B	61	141.30 ± 1.00*	5.55	144.00	140.00	136.00
Group C	52	136.70 ± 0.55°	2.95	138.50	136.00	135.00
Chloride (mmol/L)						
Group A	120	103.90 ± 0.56	4.22	105.00	104.00	102.00
Group B	61	106.60 ± 1.45	7.48	108.00	105.00	101.00
Group C	52	103.40 ± 1.09	4.62	105.00	103.00	101.00

ignificances: *vs. Group A; °vs. Group B

Table 4. Electrophoretic values of the Girgentana goat of the 3 groups of the study.

Parameters	n	Mean ± SEM	Coefficient of variation (%)	Percentiles		
				75%	Median	25%
Albumin						
Group A	46	3.08 ± 0.11	25.61	3.47	3.24	2.67
Group B	26	3.23 ± 0.08	13.14	3.53	3.20	2.89
Group C	15	2.77 ± 0.09	13.43	2.94	2.66	2.54
α1-globulins						
Group A	46	0.68 ± 0.06	59.82	0.73	0.50	0.53
Group B	26	0.61 ± 0.02	22.14	0.71	0.57	0.50
Group C	15	0.78 ± 0.03	17.65	0.89	0.71	0.66
α2-globulins						
Group A	46	1.00 ± 0.03	20.77	1.12	1.02	0.88
Group B	26	0.96 ± 0.03	20.96	1.06	0.96	0.88
Group C	15	0.99 ± 0.05	20.12	1.05	0.99	0.86
β–globulins						
Group A	46	0.51 ± 0.04	53.50	0.57	0.46	0.38
Group B	26	0.56 ± 0.04	40.79	0.68	0.48	0.39
Group C	15	0.50 ± 0.02	16.10	0.56	0.49	0.43
γ–globulins						
Group A	46	1.91 ± 0.12	43.88	2.34	1.95	1.47
Group B	26	1.84 ± 0.16	44.50	2.42	1.73	1.14
Group C	15	2.66 ±0.18*°	27.11	2.97	2.74	2.37
Total Proteins						
Group A	46	7.04 ± 0.17	16.52	7.60	7.20	6.60
Group B	26	7.21 ± 0.13	9.60	7.80	7.05	6.65
Group C	15	7.73 ± 0.20	10.13	8.00	7.70	7.40
Albumin/Globulins						
Group A	46	0.85 ± 0.05	45.28	1.04	0.77	0.60
Group B	26	0.86 ± 0.05	30.07	1.02	0.84	0.67
Group C	15	0.58 ±0.04*°	31.64	0.62	0.54	0.47

Significances: *vs. Group A; °vs. Group B

that reported higher RBC values in adult West African Dwarf goats than in young West African Dwarf goats. Additionally, age-related changes in MCV were observed, but the trend was not similar to that reported in other studies (22), as MCV was lowest in the neonatal goats and increased with age in relation to the decrease in the erythrocyte count. Reference values determined in the present study correspond to those described for goats by other researchers (23). Lower eosinophil numbers were observed in group B than in groups A and C, probably due to changes in immunological response correlated to age (21).

Some of our haematochemical analytes were similar to the reference values reported for other goat breeds (24), while others differed (12). According to previous studies (25), most of the haematochemical

parameters presently studied were affected by age. The activity of such enzymes as ALT, AST, and γ-GT, used as indicators of physical stress, were higher in group C than in the youngest goats (24). According to Mbassa and Poulsen (25), creatinine levels increased in the oldest Girgentana goats and urea levels were higher in young Girgentana goats than in adult goats. Although an increase in NEFA and sodium concentrations was not recorded in neonates of other breeds (26), these parameters were observed to increase in group B versus group A, and decrease in group C versus group B, but these values were within the physiological range for goats (20).

In animals serum proteins change with age and in the very old; thus, age is an important consideration in the interpretation of serum proteins (20). We observed a significant increase in the relative amount of γ-globulins that was associated with a significant decrease in the albumin:globulins ratio in adult Girgentana goats, as reported by Jain (27).

The difference observed between our values for the Girgentana goat and the values previously obtained for different breeds might be due to various differences in environmental and management factors, or to age. The data obtained in the present study are the first reference values to be published for the Girgentana goat breed and can increase our understanding of this breed's parameters, which will help veterinarians to interpret laboratory data appropriately. These analytes observed in the present study can be used for monitoring health status, diagnosing diseases, and improving the management and conservation of the breed. Furthermore, our results show that there were significant differences in some of the parameters that were related to age; therefore, any alterations in haematological, haematochemical, and electrophoretic parameters must be assessed in relation to age.

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