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RESEARCH ARTICLE

Blood parameter examination in mountain quails (*Oreortyx pictus* Douglas, 1829) at the end of the breeding season

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ABSTRACT

In this publication various serum biochemistry and haematology parameters were determined from blood samples obtained from captive adult individuals of an exotic quail species, the mountain quail (*Oreortyx pictus*, Douglas, 1829). Venipuncture was performed in the second half of the breeding season from six roosters (males) and seven hens (females). During the examination, in addition to the haematological elements, basic parameters of serum enzyme levels, the products of protein metabolism, uric acid and the most important ions were monitored. The results are presented as a reference in future diagnostic tests for certain diseases. The blood parameters of the bird species examined in this study have not yet been published earlier.

KEYWORDS

mountain quail, *Oreortyx pictus*, serum biochemistry parameters, haematology, reference interval, benchmark

INTRODUCTION

The mountain quail (*Oreortyx pictus*) is a stocky, medium-sized galliform bird with a 26–28 cm body length, belonging to the New World quail family taxonomically. The average body weight is 235 g for roosters and 230 g for hens (Madge et al., 2010). The sexes are very similar in appearance, with the most noteworthy way to distinguish sexes is through practice and by a trained eye in the case of fully coloured birds. In the plumage of the female, the tips of the bluish-grey feathers on the back of the neck partially change to graphite grey, while in roosters this colouration is absent (Ridgway, 1984).

Outside of the breeding season, the species lives in small groups, and in nature, a population density of 9–30 individuals per 100 ha was counted. Pairs leave the group in the spring and occupy their nesting sites and breeding grounds (Brennan et al., 1987).

This omnivorous species shows a strong seasonality in food selection. At the end of summer, autumn and partly in the winter months, these birds feed on a principally

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plant-based diet. The literature highlights a significant consumption of *Lithophragma* species (sp.), *Stellaria* sp., *Erodium* sp., *Trifolium* sp., *Rhus* sp. However, during the chick-rearing period insects make up a significant portion of the diet of these birds (Madge et al., 2010).

There is little information available in the literature about the reproductive biology of the mountain quail. Researchers have found that almost 2/3 of the nests of birds living in open areas are in vegetation comprised of bushy conifers (Reese et al., 2005). The clutch consists of 6–10 light cream-brown, droplet-shaped eggs (Madge et al., 2010). However, another study reports a clutch size of 6–15 eggs (Budeau, 2012). The average has been found to be 10.2. An author reports an average hatching rate of 8.3 chicks and moreover, as an interesting fact, he also reports the observation that males hatched in 45.3% of the investigated nests. In instances where more roosters hatched, the clutch size was also larger (11 eggs) and produced more chicks in general (Delehanty, 1995). Another author has provided data describing the case of a one-year-old male that incubated 13 eggs without hens and raised all the chicks (Dijcks, 2012). In general, the hatching time for this species is between 24 and 25 days (Nazifi et al., 2011).

In the literature there is no blood parameter data available for this species, nor for related New World species. Regarding species of the taxonomic order *Galliformes*, there is some data available for other, distantly related species. In a study of 88 males and 143 female Chukar partridge (*Alectoris chukar*, Gray, 1830), some biochemical parameters were documented (cholesterol, triglyceride, total protein, uric acid, creatinine, glucose, total bilirubin, calcium, phosphorus, ALKP, AST, LDH) from blood collected from the jugular vein (Table 1, Robbins, 1984).

The Japanese quail (*Coturnix japonica*, Temminck & Schlegel, 1849) bred for economic and laboratory purposes is anAsiatic taxon of the Old World quail family., Blood parameters from 42 roosters and 53 hens have been recorded and are now shown in Table 2 (Agina et al., 2017).

Various blood parameters from other *Galliform* species, such as the Indian peafowl (*Pavo cristatus*, Linnaeus, 1758), rock partridge (*Alectoris graeca*, Meisner, 1804) and the guinea fowl (*Numida meleagris*, Linnaeus, 1758) have already been quantified and are presented in Table 3 (Balasch et al., 1973).

Table 1. Various biochemical parameters in the Chukar partridge (*Alectoris chukar*) (Robbins, 1984)

Parameters	Units	Males	Females
Total protein	g^*L^{-1}	46.3	45.8
AST	U^*L^{-1}	372.1	394.2
ALKP	U^*L^{-1}	1041.08	1612.25
Total	μmol^*L^{-1}	2.9	7.8
Glucose	$mmol^*L^{-1}$	15.95	16.47
Triglyceride	$mmol^*L^{-1}$	1.35	1.86
Total cholesterol	$mmol^*L^{-1}$	4.02	3.94
Uric acid	μmol^*L^{-1}	169.5	179.3
Creatinine	μmol^*L^{-1}	16.9	23.2
Phosphorus	$mmol^*L^{-1}$	3.94	3.62
Total calcium	$mmol^*L^{-1}$	2.23	2.29
LDH	U^*L^{-1}	1878.92	1987.13

Table 2. Various biochemical parameters of the Japanese quail (*Coturnix japonica*) (Agina et al., 2017)

Parameters	Units	Value
Albumin	g^*L^{-1}	32.5
Globulin	g^*L^{-1}	19.4
Total protein	g^*L^{-1}	5.19
AST	U^*L^{-1}	59.99
ALT	U^*L^{-1}	20.85
ALKP	U^*L^{-1}	107.54
Total bilirubin	μmol^*L^{-1}	40.53
Total cholesterol	$mmol^*L^{-1}$	3.8
Uric acid	μmol^*L^{-1}	952.87
Creatinine	μmol^*L^{-1}	38.4

MATERIALS AND METHODS

In the private collection of the first author, in the second half of the breeding season, on June 20th, 2023, the sampling of sexually mature birds (6 roosters and 7 hens) (Fig. 1) was carried out as part of a clinical examination at the request of the owners. The individuals included in the study were clinically healthy, showing no signs of disease. To set the standard blood parameters for the species, blood was also collected in tubes with a coagulation inhibitor (K3-EDTA, Sarstedt AG & Co.) and a serum separator (Sarstedt AG & Co.) vial as well. The blood sample was taken from the jugular vein under inhalation anaesthesia (a mixture of 5V/V%

Table 3. Various blood parameters of certain *Gallifomes* (Balasch et al., 1973)

Parameters	Units	Indian peafowl (*Pavo cristatus*)	Rock partridge (*Alectoris graeca*)	Guinea fowl (*Numida meleagris*)
Total protein	$g\ L^{-1}$	43.6	49.0	35.2
Glucose	$mmol\ L^{-1}$	17.52	16.16	15.96
Uric acid	$\mu mol\ L^{-1}$	184.98	335.47	398.52

Fig. 1. Adult mountain quail (*Oreortyx pictus*)

Fig. 2. Venipuncture performed from the cervical vein in mountain quail (*Oreortyx pictus*)

isoflurane and 95V/V% oxygen in the induction phase, and a mixture of 2V/V% isoflurane and 98V/V% oxygen inhaled through a mask during maintenance) (Fig. 2). The blood sample obtained from one of the females coagulated in the tube and in this case, only the measurements from the serum tube were included. To determine the individual blood parameters, the samples were sent to the laboratory of the Department of Clinical Pathology and Oncology at the University of Veterinary Medicine, Budapest.

The biochemical tests were carried out using the Beckman Coulter Olympus AU400 and AU480 automatic machines, the detailed data for each analyte (manufacturer, reagent identifier) are given in Table 4. For the calculation of the reference ranges, the Reference Value Advisor V 2.1 program was utilized.

The quails included in the study were kept with their mates in pairs, each pair in a breeding cage with a floor area of 100 × 65 cm, a 75 cm high grid floor with a plank covering on it. All animals hadhatched on the farm of the owner, where blood sampling was performed. The quails were three years old and the birds consumed hen feed (⅓ millet, ⅓ cracked wheat, ⅓ setaria and fresh green feed) ad libitum. Each day they were given a handful of freshly collected green plants and a slice of apple as a supplement. Fresh water and lime grit were available ad *libitum* to all the pairs. It must be mentioned that mountain quail is kept on exotic pheasant and partridge farms, and only some farms with a few pairs are known in Central Europe. As far as we know, the birds included in this study comprise the most significant breeding colony of this species in Hungary.

RESULTS AND DISCUSSION

The test results of the blood samples taken from the mountain quails as part of the routine clinical examination are summarized in Tables 5 and 6.

Almost significant difference was found only in the platelet count between the sexes. For roosters it was $9.73 \times 10^{9*}L^{-1}$, while for hens it was almost double, $17.31 \times 10^{9*}L^{-1}$ ($P = 0.051$).

Table 4. Summary of the blood parameters and the measurement methods

Parameters	Units	Measurement methods
Haematocrit	%	micro-haematocrit method, 10,000 g, 5 min
White blood cells count	$x10^{9*}L^{-1}$	smear analysis
Thrombocyte count	$x10^{9*}L^{-1}$	smear analysis
Heterophil granulocyte segmented %	%	smear analysis
Albumin	g^*L^{-1}	Beckman Coulter, OSR6102
Globulin	g^*L^{-1}	calculated value (TP-Alb)
Total protein (TP)	g^*L^{-1}	Beckman Coulter, OSR6132
AST	U^*L^{-1}	Beckman Coulter, OSR6109
ALT	U^*L^{-1}	Beckman Coulter, OSR6107
ALKP	U^*L^{-1}	Dialab, D95560
GGT	U^*L^{-1}	Dialab, D95604
GLDH	U^*L^{-1}	Diasys, 124119910021
Bile acid total	μmol^*L^{-1}	Diasys, 122389910930
Total bilirubin	μmol^*L^{-1}	Beckman Coulter, OSR6112
α-amylase	U^*L^{-1}	Beckman Coulter, OSR6182
Lipase	U^*L^{-1}	Dialab, D01440
Glucose	$mmol^*L^{-1}$	Beckman Coulter, OSR6121
Triglyceride	$mmol^*L^{-1}$	Beckman Coulter, OSR61118
Total cholesterol	$mmol^*L^{-1}$	Beckman Coulter, OSR6116
Uric acid	μmol^*L^{-1}	Dialab, D95459
Creatinine	μmol^*L^{-1}	Dialab, D95595
Inorganic phosphate	$mmol^*L^{-1}$	Beckman Coulter, OSR6122
Total calcium	$mmol^*L^{-1}$	Dialab, D01376
Sodium	$mmol^*L^{-1}$	Backman Coulter ISE
Potassium	$mmol^*L^{-1}$	Backman Coulter ISE
Chloride	$mmol\ L^{-1}$	Backman Coulter ISE
Iron	μmol^*L^{-1}	Beckman Coulter, OSR6186
Magnesium	$mmol^*L^{-1}$	Beckman Coulter, OSR6189
CK	U^*L^{-1}	Beckman Coulter, OSR6179
LDH	U^*L^{-1}	Beckman Coulter, OSR6126

Of the various proteins measured through serum biochemistry, such as albumin, globulin, the ratio of these two and total protein, values showed no essential differences in the examined individuals of the two sexes. Our total protein values for mountain quails were similar to those in another study in which similar parameters of the Chukar partridge were examined (Table 1) (Robbins, 1984).

In one publication, an AST value of 59.99 U^*L^{-1} had been determined for Japanese quail (Agina et al., 2017) and in the mountain quails examined in this study, the average

Table 5. The results of serum biochemistry and clinical chemistry parameters parameters measured in mountain quail (*Oreortyx pictus*)

	Alb g L^{-1}	Glob g L^{-1}	Alb/ Glob	TP g L^{-1}	AST U L^{-1}	ALT U L^{-1}	ALKP U L^{-1}	GGT U L^{-1}	GLDH U L^{-1}	Bile acid total µmol L^{-1}	α-amylase U L^{-1}	Lipase U L^{-1}	G mmol L^{-1}	TG mmol L^{-1}	Total cholesterol mmol L^{-1}	Uric acid µmol L^{-1}	Urea mmol L^{-1}	Creatinine µmol L^{-1}	iP mmol L^{-1}	Ca mmol L^{-1}	Na mmol L^{-1}	K mmol L^{-1}	Na/K	Cl mmol L^{-1}	Mg mmol L^{-1}	CK U L^{-1}	LDH U L^{-1}
n	13	13	13	13	13	13	13	13	13	11	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	12	13
Mean	20.05	24.24	0.85	44.28	432.31	2.38	829.69	4.12	3.91	92.83	371.00	17.46	19.97	1.05	3.57	293.82	0.86	36.62	0.76	2.79	156.42	2.06	78.42	110.80	1.16	2745.92	473.92
SD	1.65	4.28	0.16	4.37	105.36	2.59	225.35	1.62	2.08	44.53	52.36	6.20	2.45	0.11	0.61	129.12	0.21	11.62	0.62	0.18	6.99	0.38	14.70	4.54	0.13	1219.37	101.84
Median	19.90	21.60	0.870	43.80	0.8	0.5	834.0	1.10	1.32	3.85	368.0	19.0	20.50	1.050	3.60	1.84	0.80	40.0	0.382	2.90	158.50	2.00	74.050	111.20	1.178	4.2	462.0
Minimum	17.2	19.9	0.63	39.1	0.8	0	447	0.33	0	3.00	292	10	12.8	0.86	2.5	1.78	0.6	7	0	2.5	144.1	1.5	60.96	103.3	0.93	4.0	247
Maximum	23.4	33	1.11	53.8	0.8	1.1	1,232	1.76	3.25	4.74	453	29	22.7	1.25	4.7	1.89	1.3	49	0.923	3	166.9	2.7	108.8	117.5	1.3	4.5	663
Lower limit of reference	16.16	10.20	0.469	33.99	284.1	0.7	299.4	1.79	0.93	35.03	247.8	2.9	9.72	0.786	2.14	146.48	0.36	9.3	0.021	2.36	139.98	1.17	43.829	100.11	0.864	991.8	234.3
Upper limit of reference	23.93	33.25	1.235	54.58	926.8	36.7	1360.0	10.02	10.54	275.86	494.2	32.0	23.32	1.317	5.00	942.03	1.36	50.8	3.406	3.22	172.86	2.95	113.009	121.49	1.355	7345.1	713.6

Table 6. Some haematological values of the examined mountain quail (*Oreortyx pictus*)

	Haematocrit	White blood cells count x10^9/L	Thrombocyte count x10^9/L	Heterophil granulocyte segmented %	Small lymphocyte %	Lymphobast %	Monocyte %	Heterophil: segmented abs	Small lymphocyte abs	Lymphoblast abs	Monocyte abs
N	12	12	12	12	12	10	11	12	12	10	12
Mean	28.3	1.44	12.69	63.59	25.51	3.05	7.09	3.94	0.97	0.23	0.67768
SD	2.6	1.60	11.25	66.15	27.65	2.75	6.50	2.95	0.94	0.15	0.12395
Median	28	0.79	7.16	11.24	11.13	2.21	8.44	3.37	0.21	0.27	1.24212
Minimum	25	0.26	3.3	38.9	10.3	0	0	0.8	0.72	0	0
Maximum	33	2.70	25.7	80.7	46.7	6.7	28.2	11.8	1.31	0.9	3.8634
Lower limit of reference	23.7	0.70	0	37.85	0.02	0	0	0	0.07	0	0
Upper limit of reference	35.9	32.33	29.09	89.34	51.00	8.30	26.72	11.67	2.94	1.37	3.52320

of AST was 443.42 U^*L^{-1} in females and 419.33 U^*L^{-1} in males. The considerably higher values could be due to the fact that our birds had to be caught in the aviary and transported to our clinic, which could put strain on their skeletal muscles. Based on the literature, and on the fact that the serum level of AST can also increase due to skeletal muscle impairment (Gaál, 1999), the fact of capture and/or transport in wild and exotic birds must be taken into consideration at the testing and evaluation of this enzyme.

With the exception of one rooster (11 U^*L^{-1}), the ALT values that were between 1 and 3 U^*L^{-1} in both females and males (hens averaged 1.71 U^*L^{-1}, while roosters averaged at 1.6 U L^{-1}).

Furthermore, a higher alkaline phosphatase value (885.71 U^*L^{-1}) was measured in laying quails as compared to roosters (764.33 U L^{-1}), which may be related to the greater need for minerals in egg production, as hens extract these from the easily accessible skeletal stores. In the literature this parameter was 107.54 U^*L^{-1} in Japanese quails, and 1041.08 U^*L^{-1} and 1612.25 U^*L^{-1} in male and female Chukar partridges respectively (Robbins, 1984; Agina et al., 2017). In the latter species, as in our study, a higher value was recorded in in hens.

The total cholesterol values determined were roughly the same as data previously published in other related species (Robbins, 1984; Agina et al., 2017).

The higher values recorded for inorganic phosphate (0.23 $mmol^*L^{-1}$) and total calcium (0.11 $mmol^*L^{-1}$) in hens were attributed to the fact that sampling took place in the egg-laying season.

Even though the main limitation of the study was the small number of samples (haematology – 6 roosters and 6 hens, blood serum chemistry – 6 roosters and 7 hens), our data can be utilized as a reasonable starting point when considering blood parameters in clinically healthy individuals of this species as the only such data available in the literature.

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