Scand. J. Lab. Anim. Sci. No. 3 . 1995 . Vol. 22

Haematologic and clinical chemical values in 3 and 6 months old Göttingen minipigs

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Introduction

Knowledge of the normal haematology and clinical chemistry is essential when selecting the appropriate animal model for a particular study in biomedical research. Reference values have been published for Yucatan miniature swine (*Radin et al.* 1986, *Parson & Wells* 1986, *Rispat et al.* 1993) and for breeds of domestic swine (*Jain* 1986, *Kaneko* 1989). In the present study reference values have been established for nineteen haematological and twenty-six clinical chemical parameters for Göttingen minipigs. The analyses were performed at Scantox, Lille Skensved, Denmark in accordance with the principles of Good Laboratory Practice (GLP) according to OECD principles of GLP, May 1981, Doc C(81)30 (Final)Annex 2.

Materials and methods

Animals, housing and health status

Sixty Göttingen minipigs (Ellegaard Göttingen Minipigs, Dalmose) were used, i.e. fifteen males and fifteen females at the age of three months, and fifteen males and fifteen females at the age of six months. The average body weight of three months old males and females is about 7.5 kg and 7.7 kg, respectively. The average body weight of six months old males and females is about 12.4 kg and 13.1 kg, respectively. The animals were kept in barrier unit with a 3-room staff shower and a glutaraldehyde lock for the introduction of materials. The ventilation system was equipped with a 99.99 % absolute microfilter and air was changed 7–20 times per hour. The temperature was 18–24° C and relative humidity was 60–70 %. The animals were fed a commercial minipig diet (SDS, Essex, UK) and chlorine decontaminated water. The colony was regularly health monitored according to ScandLAS guidelines for health monitoring of pig breeding colonies (*Hem et al.* 1994). No agents listed in these guidelines had been found. The colony was genetically monitored according to *Ellegaard & Hansen* (1994).

Blood sampling

The minipigs were given the analytical numbers 1–60 according to a randomization scheme, and blood samples from twenty animals were taken on each of three consecutive days. The animals were fasted overnight before blood samples were taken, but water was available.

The blood samples were drawn from the bijugular trunk while the animals were restrained in dorsal recumbency. For haematology 3 ml EDTA stabilized blood and for the coagulation tests 2 ml citrate stabilized blood were taken. For the blood glucose analyses 20 µl blood were taken with micropipette with dry Na-heparin, and 5 ml blood samples were taken into plain glasses for serum. The blood samples for serum were kept at room temperature for 2–3 hours before centrifugation. Centrifugation took place at 1268 G for 10 minutes. The serum was frozen and stored in the freezer at approx. – 18° C for later laboratory analyses, except the serum for LDH which was stored at + 4° C for maximally two days before analysis.

Three samples with some haemolysis were discarded, and new samples were taken.

Analytical methods

The haematological parameters were determined using Cobas Minos (Roche, Montpellier, France). The reticulocyte count was performed using a brilliant cresyl blue stain, and for the blood smears for differential leucocyte count May-Grünwald Giemsa smear staining was used. The coagulation times were determined using IL Test™ on Automated Coagulation Laboratory (ACL™, Milano, Italy).

Serum clinical chemical analyses were performed using Cobas Mira (Roche, Tegimenta, Switzerland) and reagents from Roche (Basle, Switzerland) apart from analyses of serum ornithine carbamyl transferase which were performed using a method described by *Ceriotti* (1974), and analyses of serum sodium, potassium and chloride which were performed using an ion selective electrode (Ilyte, Milano, Italy). Serum protein electrophoresis was performed using agarose gels, Multiphor II (Pharmacia, Uppsala, Sweden) and LKB-UltroScan XL (Uppsala, Sweden).

Table 1
Red blood cell parameters for male and female Göttingen minipigs, three and six months of age, N = 15

Parameter	Unit	Values	Males	Females	Males	Females
Haemoglobin	mmol/l	Mean ± S.D.	7.45 ± 0.35	7.40 ± 0.54	7.89 ± 0.51	7.66 ± 0.56
		Range	6.90-8.20	6.40-8.00	7.00-8.70	6.50-8.50
Red blood cell count	10^{12}/l	Mean ± S.D.	8.01 ± 0.44	8.06 ± 0.68	7.92 ± 0.56	8.03 ± 0.58
		Range	7.21-8.64	7.34-9.25	7.11-8.85	6.91-8.81
Haematocrit	ml/100 ml	Mean ± S.D.	36.80 ± 1.52	36.67 ± 2.29	38.20 ± 1.82	37.60 ± 2.41
		Range	34.00-40.00	32.00-40.00	35.00-41.00	33.00-41.00
Reticulocyte count	%	Mean ± S.D.	1.31 ± 0.50	1.71 ± 0.75	1.65 ± 0.85	1.09 ± 0.54
		Range	0.40-2.20	0.80-3.00	0.60-3.60	0.20-2.20
Reticulocyte count	10^{12}/l	Mean ± S.D.	0.10 ± 0.04	0.13 ± 0.06	0.13 ± 0.07	0.09 ± 0.04
		Range	0.03-0.18	0.06-0.25	0.05-0.32	0.02-0.16
Mean cell volume	fl	Mean ± S.D.	46.03 ± 2.59	45.75 ± 4.25	48.39 ± 3.07	46.88 ± 2.29
		Range	43.20-52.70	40.00-54.50	43.10-54.60	44.00-53.50
Mean cell haemoglobin	fmol	Mean ± S.D.	0.94 ± 0.06	0.93 ± 0.10	1.00 ± 0.09	0.97 ± 0.06
		Range	0.90-1.10	0.80-1.10	0.90-1.20	0.90-1.10
Mean cell haemoglobin concentration	mmol/l	Mean ± S.D.	20.25 ± 0.51	20.18 ± 0.52	20.66 ± 0.67	20.37 ± 0.31
		Range	19.50-21.10	19.50-21.10	19.70-22.10	19.70-20.80

Table 2
White blood cell parameters for male and female Göttingen minipigs, three and six months of age, N=15

Parameter	Unit	Values	Males 3 months	Females 3 months	Males 6 months	Females 6 months
White blood cell count	10^9/l	Mean ± S.D.	11.95 ± 2.45	11.36 ± 1.37	8.68 ± 1.50	8.60 ± 2.18
		Range	7.20-16.50	8.90-13.40	6.60-13.10	4.40-12.80
Segmented neutrophils	%	Mean ± S.D.	27.20 ± 9.66	27.87 ± 13.17	32.53 ± 6.77	29.07 ± 8.46
		Range	13.00-43.00	10.00-60.00	23.00-50.00	14.00-44.00
Segmented neutrophils	10^9/l	Mean ± S.D.	3.27 ± 1.41	2.93 ± 1.31	2.85 ± 0.85	2.52 ± 1.02
		Range	1.36-6.27	1.20-5.49	1.75-4.55	0.77-4.99
Band neutrophils	%	Mean ± S.D.	1.33 ± 0.98	1.53 ± 1.19	1.60 ± 1.12	0.93 ± 0.96
		Range	0.00-3.00	0.00-4.00	0.00-4.00	0.00-3.00
Band neutrophils	10^9/l	Mean ± S.D.	0.17 ± 0.15	0.18 ± 0.15	0.14 ± 0.10	0.08 ± 0.09
		Range	0.00-0.50	0.00-0.53	0.00-0.39	0.00-0.23
Lymphocytes	%	Mean ± S.D.	68.80 ± 10.28	67.60 ± 13.88	61.80 ± 7.84	66.07 ± 8.78
		Range	52.00-84.00	36.00-87.00	41.00-73.00	51.00-82.00
Lymphocytes	10^9/l	Mean ± S.D.	8.19 ± 2.02	7.98 ± 1.38	5.34 ± 0.99	5.65 ± 1.44
		Range	5.33-12.35	5.68-10.44	3.73-7.73	2.68-8.19
Eosinophils	%	Mean ± S.D.	0.87 ± 1.25	0.93 ± 1.53	1.33 ± 1.18	2.13 ± 2.26
		Range	0.00-4.00	0.00-5.00	0.00-4.00	0.00-8.00
Eosinophils	10^9/l	Mean ± S.D.	0.10 ± 0.15	0.10 ± 0.17	0.12 ± 0.11	0.19 ± 0.23
		Range	0.00-0.44	0.00-0.49	0.00-0.36	0.00-0.89
Basophils	%	Mean ± S.D.	0.67 ± 0.90	0.53 ± 0.74	0.73 ± 0.88	0.33 ± 0.62
		Range	0.00-3.00	0.00-2.00	0.00-3.00	0.00-2.00
Basophils	10^9/l	Mean ± S.D.	0.08 ± 0.12	0.07 ± 0.10	0.06 ± 0.07	0.02 ± 0.04
		Range	0.00-0.43	0.00-0.27	0.00-0.23	0.00-0.11
Monocytes	%	Mean ± S.D.	1.13 ± 1.25	1.53 ± 1.51	2.00 ± 1.07	1.47 ± 1.19
		Range	0.00-4.00	0.00-5.00	1.00-4.00	0.00-3.00
Monocytes	10^9/l	Mean ± S.D.	0.14 ± 0.15	0.20 ± 0.21	0.17 ± 0.09	0.14 ± 0.13
		Range	0.00-0.48	0.00-0.66	0.08-0.38	0.00-0.35

Table 3
Platelet counts, coagulation times and fibrinogen levels in male and female Göttingen minipigs, three and six months of age, N=15

Parameter	Unit	Values	Males 3 months	Females 3 months	Males 6 months	Females 6 months
Platelet count	10^9/l	Mean ± S.D.	513.1 ± 88.34	490.3 ± 115.2	349.3 ± 79.47	364.5 ± 51.72
		Range	413.0-684.0	275.0-721.0	148.0-426.0	278.0-454.0
Activated partial thromboplastin time	sec.	Mean ± S.D.	45.86 ± 5.77	44.08 ± 9.99	42.65 ± 8.17	43.22 ± 9.83
		Range	34.40-58.20	26.90-59.40	30.20-55.40	27.70-66.20
Thrombin time	sec.	Mean ± S.D.	25.80 ± 4.12	28.36 ± 5.00	23.91 ± 3.59	23.69 ± 4.55
		Range	20.90-35.60	19.60-38.00	19.60-31.50	17.00-31.10
Prothrombin time	sec.	Mean ± S.D.	11.71 ± 0.34	11.54 ± 0.46	11.94 ± 0.62	11.65 ± 0.41
		Range	11.10-12.30	10.20-12.00	10.90-13.00	10.80-12.40
Fibrinogen	g/l	Mean ± S.D.	6.50 ± 1.30	5.37 ± 0.66	6.85 ± 1.24	4.80 ± 0.59
		Range	5.08-9.06	4.47-6.61	5.42-9.18	3.50-5.61

Statistics

Data were processed to give group mean values, standard deviations and minimum and maximum. Outliers which were defined as values outside means ± three standard deviations were identified and excluded from the statistical analysis.

The data processing was made with SAS® procedures (version 6.08) described in SAS/STAT® User's Guide (1989).

Results

Reference values for 19 haematological and 26 clinical chemical parameters for male and female Göttingen minipigs, 3 and 6 months of age, are shown in tables 1–4. For each parameter mean values, standard deviations and lowest and highest values are shown.

Three female six months old minipigs had very high total creatine kinase values. Their lactate dehydrogenase, aspartate aminotransferase and alanine aminotransferase levels were also high (Table 5). The minipigs were litter mates.

Apart from these values the only outliers excluded from the statistical analysis were one value for each of the parameters: White blood cell count, neutrophils, triglycerides, alkaline phosphatase, potassium and α_1-globulin.

Discussion

In general the haematological and clinical chemical parameters were comparable with those reported for other breeds of miniature and domestic swine (*Parson & Wells* 1986, *Radin et al.* 1986, *Kaneko* 1989, *Rispat et al.* 1993). Minor differences can be explained by experimental conditions (environment, diet, housing etc.) and the methods of analysis used.

An increase in haemoglobin, haematocrit, mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC) from three to six

Table 4
Clinical chemical values for male and female Göttingen minipigs, three and six months of age, N = 15

Parameter	Unit	Values	Males 3 months	Females 3 months	Males 6 months	Females 6 months
Alanine aminotransferase	µkat/l	Mean ± S.D.	1.12 ± 0.16	1.00 ± 0.17	0.92 ± 0.07	0.96 ± 0.27
		Range	0.85-1.55	0.66-1.38	0.80-1.02	0.67-1.76
Ornithine carbamyl transferase	IU/l	Mean ± S.D.	4.49 ± 0.28	4.13 ± 0.53	4.43 ± 0.44	4.79 ± 0.74
		Range	4.00-4.94	3.34-5.44	3.61-5.08	3.62-6.43
Sorbitol dehydrogenase	µkat/l	Mean ± S.D.	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01
		Range	0.00-0.03	0.00-0.03	0.00-0.02	0.00-0.03
Aspartate aminotransferase	µkat/l	Mean ± S.D.	0.38 ± 0.13	0.34 ± 0.09	0.36 ± 0.10	0.34 ± 0.07
		Range	0.22-0.78	0.22-0.53	0.21-0.57	0.23-0.47
Alkaline phosphatase	µkat/l	Mean ± S.D.	4.29 ± 0.92	3.88 ± 1.11	3.49 ± 0.75	2.71 ± 0.98
		Range	2.22-5.39	2.23-6.64	2.46-5.77	1.85-5.87
Bilirubin (total)	µmol/l	Mean ± S.D.	2.69 ± 0.49	2.27 ± 0.74	2.32 ± 0.48	1.87 ± 0.56
		Range	1.90-3.50	1.60-3.90	1.60-3.10	0.70-3.10
Gamma-glutamyl transferase	µkat/l	Mean ± S.D.	0.80 ± 0.10	0.79 ± 0.12	0.89 ± 0.12	0.77 ± 0.18
		Range	0.66-1.01	0.64-1.15	0.67-1.19	0.59-1.28
Cholesterol	mmol/l	Mean ± S.D.	1.72 ± 0.33	2.40 ± 0.49	1.33 ± 0.20	1.96 ± 0.43
		Range	1.33-2.63	1.71-3.40	1.01-1.78	1.45-3.05

months of age could be seen in minipigs of both sexes. An increase in these parameters from weaning to nine months of age is generally noted in breeds of miniature as well as domestic swine (*Jain* 1986).

Rispat et al. (1993) found mean haemoglobin and mean haematocrit values of 8.91 mmol/l and 47 ml/100 ml respectively in Yucatan micropigs with a mean age of 20 weeks. The mean values for MCV, MCH and MCHC were 63.96 fl, 1.22 fmol and 19.04 mmol/l. *Radin et al.* (1986) reported mean values for haemoglobin and haematocrit of 9.25 mmol/l and 45 ml/100 ml respectively in Yucatan miniature swine with a mean age of 15.6 months. The MCV was 64.4 fl, MCH 1.33 fmol and MCHC 20.62 mmol/l.

The white blood cell count, the percentage of neutrophils and the percentage of monocytes were low in the microbiologically defined minipigs compared to the values for conventionally reared pigs (*Jain* 1986). Others have studied the influence of exposure of pigs to environmental bacteria by comparing the haematology of "minimal disease" and conventionally reared bacon pigs (*Mc Taggert & Rowntree* 1969). They

Table 4, cont.
Clinical chemical values for male and female Göttingen minipigs, three and six months of age, N=15

Parameter	Unit	Values	Males 3 months	Females 3 months	Males 6 months	Females 6 months
Protein (total)	g/l	Mean ± S.D.	58.43 ± 3.97	57.58 ± 3.63	61.02 ± 3.33	61.66 ± 3.60
		Range	52.10-65.00	50.90-62.70	53.90-68.50	54.10-67.70
Albumin	%	Mean ± S.D.	57.27 ± 3.01	56.69 ± 2.43	55.75 ± 1.76	54.04 ± 3.40
		Range	51.90-62.80	51.20-60.90	52.80-58.90	48.40-60.60
Albumin	g/l	Mean ± S.D.	33.44 ± 2.66	32.64 ± 2.58	34.01 ± 1.94	33.26 ± 1.98
		Range	29.32-38.03	28.89-37.15	30.20-37.81	30.69-37.37
α_1-globulin	%	Mean ± S.D.	3.83 ± 1.27	3.39 ± 0.78	3.73 ± 0.76	3.39 ± 0.51
		Range	2.70-6.70	2.30-5.20	2.60-5.50	2.60-4.50
α_1-globulin	g/l	Mean ± S.D.	2.23 ± 0.72	1.95 ± 0.48	2.27 ± 0.45	2.07 ± 0.33
		Range	1.64-4.01	1.37-3.17	1.68-3.34	1.70-2.85
α_2-globulin	%	Mean ± S.D.	18.00 ± 2.23	18.55 ± 2.41	16.63 ± 2.32	17.60 ± 3.05
		Range	15.00-23.60	14.30-22.00	11.50-20.30	9.30-21.50
α_2-globulin	g/l	Mean ± S.D.	10.49 ± 1.23	10.64 ± 1.20	10.16 ± 1.56	10.84 ± 1.94
		Range	8.52-13.33	8.69-12.95	6.98-12.81	6.21-13.57
β-globulin	%	Mean ± S.D.	12.30 ± 1.49	12.71 ± 1.38	13.66 ± 1.45	13.53 ± 1.20
		Range	9.10-14.70	10.30-16.00	11.70-17.30	11.00-15.20
β-globulin	g/l	Mean ± S.D.	7.19 ± 1.02	7.33 ± 0.99	8.33 ± 0.97	8.35 ± 0.94
		Range	4.76-8.36	5.35-9.68	6.96-10.73	6.53-10.09
γ-globulin	%	Mean ± S.D.	8.60 ± 2.00	8.67 ± 1.56	10.21 ± 1.32	11.12 ± 2.86
		Range	5.20-11.20	6.50-11.90	8.40-12.20	5.90-16.50
γ-globulin	g/l	Mean ± S.D.	5.07 ± 1.41	5.02 ± 1.11	6.24 ± 0.98	6.91 ± 2.04
		Range	2.82-6.85	3.31-7.46	4.58-8.22	3.43-11.02
Albumin/globulin ratio		Mean ± S.D.	1.35 ± 0.17	1.32 ± 0.13	1.26 ± 0.09	1.19 ± 0.17
		Range	1.08-1.69	1.05-1.56	1.12-1.43	0.94-1.54

Table 4, cont.
Clinical chemical values for male and female Göttingen minipigs, three and six months of age, N = 15

Parameter	Unit	Values	Males 3 months	Females 3 months	Males 6 months	Females 6 months
Creatine kinase	µkat/l	Mean ± S.D.	5.99 ± 2.25	5.17 ± 2.20	7.89 ± 4.85	9.38 ± 3.88
		Range	3.43-10.41	2.37-10.21	3.32-22.62	3.42-17.65
Lactate dehydrogenase	µkat/l	Mean ± S.D.	16.68 ± 2.34	17.45 ± 2.32	13.59 ± 2.03	15.27 ± 5.39
		Range	12.98-19.99	12.38-20.88	11.11-17.63	10.97-29.65
Amylase	IU/l	Mean ± S.D.	49.04 ± 11.59	50.08 ± 13.97	49.33 ± 10.53	52.17 ± 15.23
		Range	19.43-69.52	17.13-66.78	29.48-66.93	17.89-72.40
Triglycerides	mmol/l	Mean ± S.D.	0.40 ± 0.07	0.59 ± 0.12	0.36 ± 0.07	0.47 ± 0.12
		Range	0.26-0.50	0.36-0.76	0.23-0.47	0.31-0.67
Carbamide	mmol/l	Mean ± S.D.	2.49 ± 0.56	2.37 ± 0.59	2.12 ± 0.50	2.35 ± 0.59
		Range	1.17-3.39	1.63-3.59	1.24-2.83	1.68-4.06
Creatinine	µmol/l	Mean ± S.D.	103.1 ± 16.25	97.60 ± 10.80	109.7 ± 10.21	95.73 ± 10.22
		Range	82.00-145.0	83.00-122.0	92.00-131.0	76.00-114.0
Glucose (whole blood)	mmol/l	Mean ± S.D.	3.47 ± 0.43	3.71 ± 0.42	3.17 ± 0.38	3.16 ± 0.35
		Range	2.77-4.32	2.96-4.32	2.41-3.89	2.70-4.17
Sodium	mmol/l	Mean ± S.D.	143.8 ± 2.48	143.9 ± 2.62	143.2 ± 1.18	144.1 ± 1.76
		Range	140.4-148.3	140.0-148.9	140.8-145.3	141.4-148.2
Potassium	mmol/l	Mean ± S.D.	4.89 ± 0.48	5.00 ± 0.60	4.58 ± 0.42	4.72 ± 0.58
		Range	3.81-5.91	3.91-6.06	3.85-5.08	3.77-6.05
Calcium	mmol/l	Mean ± S.D.	2.78 ± 0.09	2.76 ± 0.13	2.66 ± 0.11	2.71 ± 0.12
		Range	2.54-2.94	2.51-2.97	2.50-2.91	2.51-2.96
Inorganic phosphorous	mmol/l	Mean ± S.D.	2.73 ± 0.23	2.78 ± 0.17	2.58 ± 0.16	2.73 ± 0.14
		Range	2.46-3,27	2.54-3.10	2.23-2.84	2.48-3.04
Chloride	mmol/l	Mean ± S.D.	100.9 ± 1.99	101.5 ± 1.15	101.5 ± 2.18	102.6 ± 1.98
		Range	97.50-103.9	100.1-103.7	98.40-106.4	99.20-105.2

Table 5
Abnormally high clinical chemical serum values for three female litter mates, 6 months of age

Parameter	Unit	Minipig No.	Values
Creatine kinase	μkat/l	46	525.40
		17	293.80
		24	318.00
Lactate dehydrogenase	μkat/l	46	48.41
		17	24.10
		24	29.65
Aspartate aminotransferase	μkat/l	46	3.27
		17	1.94
		24	2.16
Alanine aminotransferase	μkat/l	46	4.95
		17	2.92
		24	1.76

found that the white blood cell count was 23 % higher in conventionally reared pigs. The difference was principally due to a high number of neutrophils, but monocytes, eosinophils and basophils were also more numerous in the conventionally reared pigs.

The white blood cell count was lower at the age of six months than at the age of three months in the minipigs. This is also seen in other miniature swine. The white blood cell count increases from weaning to three months of age, whereafter it declines progressively to stabilize at the age of about three years (*Jain* 1986).

The platelet count was lower in the six months old minipigs than in those which were three months of age. Similar findings have been reported for other miniature swine breeds. A progressive decrease can be expected from weaning till nine months of age (*Jain* 1986).

The coagulation times in the minipig are rather similar to the coagulation times in man. The range for the activated partial thromboplastin time in the six months old minipigs was 28–66 sec., the range for man is 27–35 sec., the range for the thrombin time and the prothrombin time in minipigs were 17–32 sec. and 11–13 sec., respectively, the ranges in man are 18–25 sec. and 12–15 sec., respectively. The thrombin time was longer in three than in six months old minipigs.

Creatine kinase (CK), or creatine phosphokinase, exists in three principal isoenzymatic forms in the minipig, CK-MM which dominates in skeletal muscle, CK-MB in heart muscle and CK-BB in brain. In the three female litter mates which had increased CK-values the lactate dehydrogenase, the aspartate aminotransferase and the alanine aminotransferase levels were also high. The same pattern of high serum enzyme levels was seen in a male litter mate and in a female from another sow mated with the same boar (data not shown). Four weeks later repeated blood samples showed that the parameters were still high, although somewhat lower (data not shown). Seven weeks later a blood sample from one of the animals showed normal values. All the enzymes which were elevated are found in skeletal as well as cardiac muscle in pigs. The fact that the cases could be traced back to a single

boar might possibly indicate a genetic background.

Ornithine carbamyltransferase and sorbitol dehydrogenase were measured because they are the most liver specific enzymes in the minipig. Glutamine dehydrogenase is a third relatively liver specific enzyme, whereas in pigs the activity of alanine aminotransferase, which is a liver specific enzyme in many other species, e.g. rats, rabbits, dogs and man, is higher in cardiac and skeletal muscle than in liver (*Boyd* 1983).

There were only minor sex differences. It was characteristic, however, that serum total cholesterol and triglyceride levels were higher in the females than in the males. In Yucatan miniature swine total cholesterol and triglyceride levels were also found to be higher in the females (*Parson & Wells* 1986, *Rispat et al.* 1993). In both sexes of the Göttingen minipig the levels tended to decrease with age. Serum cholesterol levels are highly influenced by the diet, and minipigs with high dietary conditioned cholesterol levels are used in arteriosclerosis research.

Compared with Yucatan miniature swine the serum total protein levels were rather low in the Göttingen minipigs (*Radin et al.* 1986, *Parsons & Wells 1986, Rispat et al.* 1993), mainly due to lower albumin levels. There was an increase in γ-globulin with age in the minipigs. Compared with conventionally reared domestic pigs the serum globulin levels are, however, low in the microbiologically defined minipigs (*Hannon et al.* 1990).

The Göttingen minipig is rapidly becoming established as an animal of choice for a wide range of biomedical research. The values obtained in the present study can serve as a basis for comparison and reference, and thereby facilitate the use of the minipigs.

Summary

Blood samples were collected from sixty healthy Göttingen minipigs, fifteen males and fifteen females at the age of three months and fifteen males and fifteen females at the age of six months. The samples were taken at the breeder's facilities. The samples were analysed for nineteen haematological and twenty-six clinical chemical parameters. Means, standard deviations and lowest and highest values are presented. In general the parameters were comparable with those reported for other breeds of miniature and domestic swine. The white blood cell count, the percentages of neutrophils and monocytes and serum globulin levels were lower in these microbiologically defined minipigs compared with conventionally reared pigs and minipigs. Three litter mates had a complex of abnormally high serum creatine kinase, lactate dehydrogenase, aspartate aminotransferase and alanine aminotransferase levels.

Resumé

Blodprøver blev taget fra tres raske Göttingen minigrise, femten tre måneder gamle og femten seks måneder gamle hanner og femten tre måneder gamle og femten seks måneder gamle hunner. Prøverne blev taget i avlerens faciliteter. Prøverne blev analyseret for nitten hæmatologiske og seksogtyve klinisk kemiske parametre. Middelværdier, standardafvigelser og laveste og højeste værdier er angivet. I det store og hele var parametrene sammenlignelige med værdier rapporteret for andre små griseracer og grise landracer. Antallet af hvide blodlegemer, procenterne af neutrofile og monocyter og serum globulin niveauerne var lavere hos disse mikrobiologisk definerede minigrise end hos konventionelt opdrættede grise og minigrise. Tre kuldsøskende havde et kompleks af abnormt høje serum kreatin kinase, laktat dehydrogenase, aspartat aminotransferase og alanin aminotransferase niveauer.

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