

## BRIEF COMMUNICATION

**Serum thyroxine concentrations in clinically healthy pet guinea pigs (*Cavia porcellus*)**Kerstin Müller<sup>1</sup>, Elisabeth Müller<sup>2</sup>, Ruth Klein<sup>2</sup>, Leo Brunnberg<sup>1</sup><sup>1</sup>College of Veterinary Medicine, Small Animal Clinic, Freie Universität Berlin, Berlin, Germany and <sup>2</sup>LABOKLIN GmbH & Co. KG, Bad Kissingen, Germany**Key Words***Cavia porcellus*, guinea pig, serum, T4, thyroxine**Correspondence**Kerstin Müller, College of Veterinary Medicine, Small Animal Clinic, Freie Universität Berlin, Oertzenweg 19b, 14163 Berlin, Germany  
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**Background:** Guinea pigs (*Cavia porcellus*) are often presented as patients in veterinary practice. Nevertheless, only limited information is available about endocrine diseases or thyroxine reference values for the species.**Objective:** The aim of this study was to determine serum thyroxine concentrations in a well-defined population of clinically healthy pet guinea pigs.**Methods:** Between October 2007 and July 2008, serum samples were collected from 40 clinically healthy guinea pigs of different sexes, ages, and breeds that were presented to our clinic for a general health check or for castration. Pregnant females were excluded from the study. Thyroxine concentration was measured using a chemiluminescence test (Immulite 2000 Canine Total T4).**Results:** Thyroxine concentrations ranged from 14.2 to 66.9 nmol/L (1.1–5.2 µg/dL) with a median value of 27.0 nmol/L (2.1 µg/dL). Females ( $n = 16$ ) had significantly ( $P = .039$ ; Mann–Whitney  $U$ -test) lower thyroxine values than castrated males ( $n = 8$ ), whereas no differences were found between females and intact males ( $n = 16$ ) or between intact and castrated males. No significant correlation was found between thyroxine concentration and age.**Conclusion:** This is the first report of serum thyroxine reference values for a well-defined population of healthy pet guinea pigs as measured by a chemiluminescence assay. The results were higher than those previously reported for this species and emphasize the importance of using appropriate reference intervals for the diagnosis of hyperthyroidism.

Recently, anecdotal reports about the supposedly common incidence of hyperthyroidism in pet guinea pigs have been published.<sup>1,2</sup> The diagnosis was based on clinical signs of hyperactivity, increased appetite, loss of body weight, tachycardia, alopecia, and later, reduced appetite and diarrhea. Some animals were reported to have polyuria and polydipsia. Thyroxine serum concentrations  $> 15.4$  nmol/L ( $> 1.2$  µg/dL) were considered diagnostic.<sup>1</sup> We found 2 studies that reported serum thyroxine values in guinea pigs; however, only a few laboratory guinea pigs were studied, the investigated animals were either very young (45–62 days)<sup>3</sup> or only females of unknown age,<sup>4</sup> and the data were determined by radioimmunoassay (RIA).<sup>3,4</sup> Therefore, the aim of this study was to establish thyroxine reference values using a well-defined group of apparently

healthy pet guinea pigs and a standard chemiluminescent competitive immunoassay.

From October 2007 to July 2008, blood samples from clinically healthy guinea pigs of different ages and sexes presented to the Small Animal Clinic at the Freie Universität Berlin for a general health check and/or castration were collected between 10 AM and 12 PM. Food was not withheld before blood collection. Only animals considered clinically healthy were included in the study. Clinical health was assessed by a thorough physical examination and the absence of any signs of disease, especially hyperactivity, increased or reduced appetite, weight loss, haircoat changes, diarrhea, cardiac murmurs, polyuria, and polydipsia. Animals with any sign of disease as well as pregnant females were excluded.

**Table 1.** Body weight and age of the pet guinea pig population.

Sex	N	Body Weight (g)			Age (months)		
		Median	Minimum	Maximum	Median	Minimum	Maximum
Female	16	848	420	1090	48	6	108
Male	16	920	370	1450	42	3	72
Castrated male	8	1070	830	1200	54	12	72
All animals	40	900	370	1450	48	3	108

From each guinea pig, 0.5–1.0 mL of blood was taken from the lateral saphenous vein using a 22 G needle. The blood was collected into a 1.3 mL tube without any anticoagulant. Samples were allowed to clot at room temperature for 30 minutes and then centrifuged for 10 minutes at 11,360g (Heraeus Pico 21, Thermo Electron Corporation, Karlsruhe, Germany). The serum was separated and stored at  $-45^{\circ}\text{C}$  for up to 6 months before analysis.

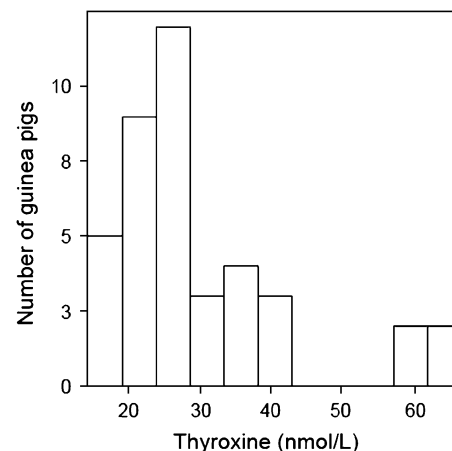
A solid-phase chemiluminescent competitive immunoassay was used for analysis of serum thyroxine concentration according to the manufacturer's instructions of (Immulite 2000 Canine Total T4, Diagnostic Products Corporation, Los Angeles, CA, USA). According to the manufacturer, the lowest detectable amount of thyroxine with this test is 1.5 nmol/L, the highest 193.1 nmol/L. The intra-assay coefficient of variation (CV) was 6.59%, as determined by assaying a single serum sample from 1 of the guinea pigs in the study (thyroxine concentration 34.2 nmol/L [2.66  $\mu\text{g}/\text{dL}$ ]) 10 times. The interassay CV ( $n=10$ ) was 8.3% for the same sample stored in aliquots at  $-20^{\circ}\text{C}$  and analyzed daily for 10 days. Quality control was performed every morning by measuring a high (21.2 nmol/L) and a low (70.8 nmol/L) control serum (Canine Control Set, K9CON, Siemens Healthcare Diagnostics, Eschborn, Germany). The distribution of the data for normality was tested using a Kolmogorov–Smirnov test (corrected after Lilliefors).<sup>5</sup> Thyroxine values were reported as median, minimum, and maximum values (SPSS 15.0, SPSS Inc., Chicago, IL, USA). A Mann–Whitney *U*-test was used to evaluate statistical differences between sex classes and husbandry conditions (indoor vs outdoor; housed individually vs in a group), and a Spearman's test was used to evaluate correlation between thyroxine and age, body weight, and month of sample collection (12 groups).

All animals included in the study ( $n=40$ ) were apparently clinically healthy. The owners kept the guinea pigs as pets indoors ( $n=19$ ) or outdoors ( $n=21$ ), and as a single pet ( $n=4$ ) or in groups ( $n=36$ ). Diet was hay, fresh vegetables, and in some instances, additional pel-

lets or other dried food. Guinea pig breeds included smooth-haired ( $n=20$ ), Abyssinian ( $n=16$ ), Peruvian ( $n=2$ ), English crested ( $n=1$ ), and Rex ( $n=1$ ). Age, sex, and body weight of the investigated animals were tabulated (Table 1). The guinea pigs were sampled in January (1), March (6), April (4), May (3), July (2), September (1), October (15), November (6), and December (2).

The thyroxine values were not normally distributed (Kolmogorov–Smirnov test, corrected after Lilliefors,  $P<.001$ , Figure 1). No differences in thyroxine concentration were observed between females and intact males, or between intact and castrated males (Mann–Whitney *U*-test,  $P=.335$  and  $.177$ , Table 2). However, females had significantly lower thyroxine values than castrated males ( $P=.039$ ). Living indoors or outdoors had no significant effect on the thyroxine values of the investigated guinea pigs (Mann–Whitney *U*-test,  $P=.684$ ). No correlation was found between age ( $r=-.253$ ;  $P=.116$ ), body weight ( $r=.075$ ;  $P=.647$ ), or month of sampling ( $r=.104$ ;  $P=.523$ ) and thyroxine concentration.

To our knowledge, this is the first report of thyroxine reference values for a well-defined population of

**Figure 1.** Histogram of serum thyroxine concentrations in clinically healthy guinea pigs ( $n=40$ ).

**Table 2.** Serum thyroxine concentrations in healthy pet guinea pigs (SI and conventional units).

Sex	N	Thyroxine (nmol/L)			Thyroxine (µg/dL)		
		Median	Minimum	Maximum	Median	Minimum	Maximum
Female	16	25.7	14.2	64.4	2.0	1.1	5.0
Male	16	28.3	14.2	57.9	2.2	1.1	4.5
Castrated male	8	34.1	19.3	66.9	2.7	1.5	5.2
All animals	40	27.0	14.2	66.9	2.1	1.1	5.2

healthy pet guinea pigs as measured by a chemiluminescence assay. Naturally occurring hyperthyroidism in rodents or rabbits has not been reported in the scientific literature, but there are anecdotal reports about clinically apparent hyperthyroidism in pet guinea pigs.<sup>1,2</sup> The number of investigated healthy guinea pigs in our study, compared with the recommended sample size for establishing reference values in humans or laboratory animals, was quite low. Possible bias may result from overrepresentation of smaller subgroups (eg, based on sex or age), and which should be taken into consideration when using these values.

Different analytic methods can be used for the measurement of serum thyroxine. Because chemiluminescence was used in a previous report of thyroxine values in guinea pigs<sup>1</sup> and is widely used in many laboratories for determination of thyroxine concentrations in other animal species, we also used a chemiluminescence assay. Compared with RIA, thyroxine results using chemiluminescence are 30–40% lower in dogs, cats, and horses, but it has the advantage of not using radioactive isotopes.<sup>6</sup> The thyroxine concentrations in our study (14.2–66.9 nmol/L) were considerably higher than those previously reported for guinea pigs by Ewringmann and Glöckner<sup>1</sup> (6.4–15.4 nmol/L). These authors also used a chemiluminescence method, but gave no information about the number, origin, age, sex, or health status of the investigated individuals. Therefore, the validity of and cause for the lower values in that study remains unknown. One possible explanation is that sick guinea pigs were sampled. In humans,<sup>7</sup> cats,<sup>8,9</sup> dogs,<sup>10</sup> and rats<sup>11</sup> it has been shown that systemic nonthyroidal illness can cause a decrease in serum thyroxine concentration in euthyroid individuals (euthyroid sick syndrome). Slightly higher thyroxine values than those in our study were reported by Castro et al<sup>3</sup> for 44–65-day-old guinea pigs sampled following decapitation and analyzed using RIA. In contrast, thyroxine concentrations twice as high as ours were obtained by Anderson et al<sup>4</sup> in 10 anesthetized nonpregnant female guinea pigs of unknown age, also using RIA. These differences emphasize the fact that reference

values used to interpret individual patient data must be based on identical laboratory methods and provide population data, including health status, sex, and age, of the investigated study group. The storage of our samples for up to 6 months should not have influenced the results because thyroxine in frozen serum is stable for years.<sup>12</sup>

Sex differences in thyroxine concentration have been reported for rats, where males had higher serum thyroxine values than females.<sup>13</sup> In our study, the serum thyroxine concentrations of female guinea pigs were significantly lower than for castrated but not for intact males. We also found no correlation between thyroxine and age. In contrast, thyroxine values in rats declined with age.<sup>13,14</sup>

The serum thyroxine values obtained in this study will be a helpful tool in the diagnosis of thyroid disorders in guinea pigs. The results of our study and others<sup>3,4</sup> suggest that the previously reported reference values<sup>1</sup> for thyroxine in guinea pigs are too low and would result in an overestimation of the incidence of hyperthyroidism. Measurement results should only be compared with reference values established using the same analytical method and in each laboratory. Additionally, more data are needed about the incidence and the clinical appearance of hyperthyroidism in guinea pigs.

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