Selected Blood Serum Elements in Van (Turkey) Cats

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Abstract

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The Turkish Van cat originates from eastern Turkey. One of the characteristic features of Van cats is the colour of their eyes, which can be both eyes blue, both eyes amber or one eye blue and the other amber. Serum essential trace, macro and industrial element concentrations of Van cats (n = 47) according to sex, age, hair length and eye colour differences were investigated. Serum aluminium, arsenic, boron, barium, cobalt, chromium, copper, gallium, indium, iron, lead, lithium, manganese, nickel, selenium, silver, sulphur, strontium, vanadium and zinc were measured with ICP-OES plasma optical atomic emission spectrometer. In result, serum aluminium, barium, copper, manganese and strontium levels in male cats were found higher ($p < 0.05$) than in female cats. Serum aluminium, copper, manganese, strontium and zinc amounts of blue-blue eyed cats were found higher ($p < 0.05$) than amber-amber, amber-blue and blue-amber eyed cats, and serum lithium of blue-amber eyed cats was higher ($p < 0.05$) than blue-blue eyed cats. There were no statistically significant differences ($p > 0.05$) found in the age and hair length groups. Our results indicate that several of the blood serum elements of Van cats may be related to their eye colours and sex differences.

Van cat, trace, macro-elements, industrial elements, serum

The Turkish Van cat originates from eastern Turkey and should not be confused with the Turkish Angora cat. One of the characteristic features of Van cats is the colour of their eyes. They are classified into three groups according to the colour of their eyes: both eyes blue; both eyes amber (yellow and its tones); and one eye blue and the other amber (dischromatopsy). Van cats generally have semi-long (native population may have hair of various length), white (some cats may have coloured parts in their body), silky fur, long body, tiger-like walk and a fox-like tail. Van cat has been introduced to the world by Europeans since 1950s. Body mass of female and male Van cats is generally about 2 900, and 3 600 grams, respectively. These cats love to swim and play with water, and they are the only cat species with this feature. Blue eyed Van cats usually show turquoise blue; amber colour shows many differences in tones. The tones are amber, light amber, yellow and green almond. Although very rare, sometimes brown colour can be seen. Blue eyed cats are classified as blue eyed short, velvet furred cats and blue eyed long silky furred cats (Gure 1993; Odabasioglu and Ates 2000).

In the periodic table, 109 elements are listed (Emsley 1998) and 27 are considered essential for the healthy growth of mammals. Of these, 16 are generally accepted trace elements and occur at concentrations of less than 1% in the body. Persistent deficiencies or excesses of essential trace elements cause many biochemical, structural and functional pathologies. Trace elements in the biological systems have mainly four basic functions; they can be components of body fluids, factors in the enzymatic reactions, structural components

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of non-enzymatic macromolecules, and they can serve to bind, transport, and release oxygen. Some trace elements are very important in the biological system such as cobalt (Co, it plays a role in the erythropoiesis, granulopoiesis and glucose homeostasis), copper (Cu, it is very important in the antioxidant system and erythropoiesis), manganese (Mn, it functions both as an enzyme activator and as a constituent of metalloenzymes), selenium (Se, it has a very important role in the antioxidant, immune and reproductive systems) and zinc (Zn, it is essential for the function of more than 90 enzymes). Literary sources associated with serum trace element levels of cats are very limited. Arsenic (As), boron (B), Co, chromium (Cr), Cu, iron (Fe), lead (Pb), lithium (Li), Mn, nickel (Ni), Se, vanadium (V) and Zn are identified as essential trace elements (Keen and Graham 1989; McDowell 1992; Karagul et al. 2000). Sulphur (S), a macro element, is found in many parts of the body such as hair, horn, cornea and some enzymes (Karagul et al. 2000). Silver (Ag, used in jewellery, mirrors, electrical industry and veterinary medicine), aluminium (Al, used in vehicle, aircraft, construction industry and used to make cans), barium (Ba, used in drilling fluids for oil and gas exploration, paints and glass), gallium (Ga, used in light-emitting diodes and microwave equipment), indium (In, used in transistors) and strontium (Sr, used in special glass for television) are used in the industry (Emsley 1998; Kaya and Akar 2002). When mammals are exposed to high levels of some essential and industrial elements, toxicosis, teratogenity and mutagenity may occur (Kaya and Akar 2002).

The aim of this study was to determine the contents of important trace elements (As, Co, Cr, Cu, Fe, Pb, Mn, Ni, Se, S, V, Zn) and industrial elements (Ag, Al, B, Ba, Ga, In, Li and Sr) in the serum of Van cats. Some element levels were researched in this study for the first time. Furthermore, serum element levels of Van cats were compared in relation to the sex, age, hair length and eye colour differences.

Materials and Methods

To determine selected serum element concentrations of Van cats, 47 animals were used (Van cat house, Yuzuncu Yil University, Van, Turkey). Cats were fed standard canned food (LA-CAT, Israel). Cats were divided into four groups based on sex (female; male), age (1 - 2; 3 - 4; and > 5 years old), eye colour (blue-blue; amber-blue; blue-amber; and amber-amber, eyes described from left to right) and hair length (short; long). Blood samples were collected from each cat in the morning (10:00 h) by puncture of the cephalic vein. Serum samples were separated by centrifugation (3000 rpm, 15 minutes), and stored at -80 °C until analysis. Serum Ag, Al, As, B, Ba, Co, Cr, Cu, Fe, Ga, In, Li, Mn, Ni, Pb, S, Se, Sr, V and Zn levels were measured with ICP-OES plasma optical atomic emission spectrometer (ICP-OES, Inductively coupled plasma optical emission spectrometer, VARIAN simultaneous AXIEL VISTA).

All the values are expressed as mean ± SE. The results of groups were analyzed by Tukey multiple range test (SPSS for Windows, release 10.0). In all cases, probability of error of less than 0.05 was chosen as the criterion of statistical significance.

Results

Serum Al, Ba, Cu, Mn and Sr concentrations of male cats were found higher ($p < 0.05$) than those of female cats (Table 1). Serum Al, Cu, Mn, Sr and Zn of blue-blue eyed cats were found higher ($p < 0.05$) than in amber-amber, amber-blue and blue-amber eyed cats, and serum Li level of blue-amber eyed cats was higher ($p < 0.05$) than in blue-blue eyed cats (Table 4). There was no statistically significant difference found in the age and hair length groups (Table 2 and 3).

Discussion

Concentrations of macro elements in biological tissues are present in grams per kilogram, while trace elements are present in amounts of milligrams per kilogram or less (Milne 1994). Trace elements play an important role in many essential metabolic functions and their importance in the biochemistry science has increased. Recent researches have renewed

Table 1. Serum element levels of Van cats according to sex differences (mean ± SE)

Indicators mg/l	Female (n = 29)	Male (n = 18)	Total (n = 47)
Ag	0.0038 ± 0.0007	0.0064 ± 0.0015	0.0048 ± 0.0007
Al	122.17 ± 40.499 b	434.53 ± 77.646 a	241.84 ± 44.401b
As	0.2582 ± 0.0702	0.1780 ± 0.0509	0.2275 ± 0.0475
B	0.5114 ± 0.0204	0.4783 ± 0.0141	0.4987 ± 0.0137
Ba	0.2408 ± 0.0413 b	0.4693 ± 0.0706 a	0.3283 ± 0.0402 b
Co	0.0269 ± 0.0054	0.0245 ± 0.0072	0.0259 ± 0.0043
Cr	0.5763 ± 0.0742	0.6438 ± 0.1183	0.6021 ± 0.6380
Cu	2.1241 ± 0.3916 b	4.4144 ± 0.5853 a	3.0012 ± 0.3647 b
Fe	5.5740 ± 0.6168	6.8028 ± 0.7661	6.0446 ± 0.4834
Ga	0.5336 ± 0.0893	0.3961 ± 0.1205	0.4810 ± 0.0718
In	0.7193 ± 0.0745	0.6841 ± 0.1262	0.7059 ± 0.0659
Li	0.3936 ± 0.0058	0.3807 ± 0.0062	0.3886 ± 0.0043
Mn	0.0189 ± 0.0058 b	0.0624 ± 0.0120 a	0.0356 ± 0.0065 b
Ni	0.7833 ± 0.1364	0.9451 ± 0.1689	0.8453 ± 0.1009
Pb	0.0854 ± 0.0280	0.1486 ± 0.0390	0.1096 ± 0.0230
S	1041.6 ± 34.457	1043.5 ± 28.488	1042.4 ± 23.681
Se	0.6471 ± 0.1314	0.6205 ± 0.1044	0.6369 ± 0.0896
Sr	1.0055 ± 0.2860 b	2.9696 ± 0.5006 a	1.7577 ± 0.2933 b
V	0.0605 ± 00182	0.0552 ± 0.0098	0.0585 ± 0.0118
Zn	4.1481 ± 0.4003	6.6522 ± 1.4919	5.1071 ± 0.6383

a, b; differences in the same row are statistically significant ($p < 0.05$)

Table 2. Serum element levels of Van cats according to age of years differences (mean ± SE)

Indicators mg/l	1-2 years old (n = 18)	3-4 years old (n = 20)	> 5 years old (n = 9)
Ag	0.0035 ± 0.0010	0.0057 ± 0.0013	0.0053 ± 0.0016
Al	212.19 ± 66.709	260.98 ± 74.554	258.62 ± 102.93
As	0.2473 ± 0.1036	0.2748 ± 0.0577	0.0828 ± 0.0340
B	0.4628 ± 0.0252	0.5118 ± 0.0148	0.5413 ± 0.0355
Ba	0.3134 ± 0.0664	0.3394 ± 0.0651	0.3336 ± 0.0853
Co	0.0271 ± 0.0080	0.0227 ± 0.0044	0.0309 ± 0.0132
Cr	0.5745 ± 0.0901	0.6190 ± 0.1164	0.6200 ± 0.1261
Cu	2.9508 ± 0.5983	3.0691 ± 0.5746	2.9512 ± 0.8534
Fe	7.2735 ± 1.0594	5.3546 ± 0.5884	5.1199 ± 0.5168
Ga	0.4472 ± 0.1273	0.4495 ± 0.0935	0.6184 ± 0.1916
In	0.5975 ± 0.0750	0.7173 ± 0.1168	0.8971 ± 0.1643
Li	0.3901 ± 0.0087	0.3846 ± 0.0058	0.3947 ± 0.0073
Mn	0.0317 ± 0.0103	0.0387 ± 0.0113	0.0363 ± 0.0123
Ni	0.6626 ± 0.1352	1.0988 ± 0.1878	0.6473 ± 0.1030
Pb	0.1305 ± 0.0496	0.8129 ± 0.0222	0.1310 ± 0.0497
S	1015.4 ± 36.659	1051.2 ± 29.352	1076.7 ± 78.930
Se	0.6870 ± 0.2023	0.5763 ± 0.0871	0.6715 ± 0.1592
Sr	1.6015 ± 0.4553	1.8762 ± 0.4905	1.8071 ± 0.6494
V	0.0681 ± 0.0268	0.0514 ± 0.0122	0.0547 ± 0.0170
Zn	5.0350 ± 0.6888	5.5707 ± 1.3661	4.2211 ± 0.4567

There are no statistically significant differences ($p > 0.05$)

Table 3. Serum element levels of Van cats according to hair length differences (mean ± SE)

Indicators mg/l	Short-hair (n = 29)	Long-hair (n = 18)	Total (n = 47)
Ag	0.0052 ± 0.0010	0.0041 ± 0.0011	0.0048 ± 0.0007
Al	202.85 ± 53.327	304.65 ± 77.504	241.84 ± 44.401
As	0.2630 ± 0.0694	0.1702 ± 0.0529	0.2275 ± 0.0475
B	0.5177 ± 0.01963	0.4681 ± 0.0153	0.4987 ± 0.0137
Ba	0.2992 ± 0.0481	0.3913 ± 0.0699	0.3283 ± 0.0402
Co	0.0278 ± 0.0052	0.0229 ± 0.0074	0.0259 ± 0.0043
Cr	0.6029 ± 0.0783	0.6007 ± 0.1115	0.6021 ± 0.6380
Cu	2.9225 ± 0.4646	3.1279 ± 0.6045	3.0012 ± 0.3647
Fe	5.5887 ± 0.4616	6.7789 ± 1.0170	6.0446 ± 0.4834
Ga	0.5238 ± 0.0992	0.4118 ± 0.0989	0.4810 ± 0.0718
In	0.7486 ± 0.0826	0.6370 ± 0.1100	0.7059 ± 0.0659
Li	0.3912 ± 0.0059	0.3844 ± 0.0060	0.3886 ± 0.0043
Mn	0.0289 ± 0.0077	0.0462 ± 0.0115	0.0356 ± 0.0065
Ni	0.8227 ± 0.1332	0.8801 ± 0.1571	0.8453 ± 0.1009
Pb	0.1137 ± 0.0325	0.1032 ± 0.0305	0.1096 ± 0.0230
S	1050.7 ± 22.1759	1028.9 ± 51.3818	1042.4 ± 23.681
Se	0.6395 ± 0.1265	0.6328 ± 0.1195	0.6369 ± 0.0896
Sr	1.4661 ± 0.3518	2.1953 ± 0.5108	1.7577 ± 0.2933
V	0.0655 ± 0.0180	0.0471 ± 0.0105	0.0585 ± 0.0118
Zn	4.2777 ± 0.3698	6.4434 ± 1.5315	5.1071 ± 0.6383

There are no statistically significant differences ($p > 0.05$)

Table 4. Serum element levels of Van cats according to eye colour differences (mean ± SE)
Eye colours (left eye – right eye)

Indicators mg/l	Amber - Amber (n = 15)	Amber - Blue (n = 14)	Blue - Amber (n = 12)	Blue - Blue (n = 6)
Ag	0.0049 ± 0.0010	0.0041 ± 0.0012	0.0051 ± 0.0021	0.0056 ± 0.0024
Al	205.08 ± 78.691 b	179.96 ± 69.458 b	183.30 ± 77.812 b	595.23 ± 128.41 a
As	0.1812 ± 0.0692	0.1958 ± 0.0512	0.3966 ± 0.1467	0.0787 ± 0.0299
B	0.4978 ± 0.0171	0.4955 ± 0.0259	0.5147 ± 0.0403	0.4762 ± 0.0150
Ba	0.3121 ± 0.0770	0.3045 ± 0.0741	0.2725 ± 0.0694	0.5359 ± 0.1007
Co	0.0202 ± 0.0052	0.0211 ± 0.0062	0.0359 ± 0.0106	0.0318 ± 0.0185
Cr	0.7695 ± 0.1511	0.5435 ± 0.0773	0.5691 ± 0.1191	0.3866 ± 0.0976
Cu	2.6826 ± 0.6498 b	2.1814 ± 0.4838 b	3.0854 ± 0.7890 b	5.5425 ± 0.9096 a
Fe	5.0956 ± 0.5487	7.1997 ± 1.3442	5.5740 ± 0.6830	6.6628 ± 0.6952
Ga	0.4715 ± 0.1064	0.5964 ± 0.1453	0.4072 ± 0.1698	0.3827 ± 0.1638
In	0.7184 ± 0.0958	0.5211 ± 0.1050	0.9536 ± 0.1485	0.6106 ± 0.2064
Li	0.3862 ± 0.0041 ab	0.3857 ± 0.0088 ab	0.4041 ± 0.0105 a	0.3700 ± 0.0100 b
Mn	0.0305 ± 0.0106 b	0.0250 ± 0.0100 b	0.0259 ± 0.0103 b	0.0922 ± 0.0217 a
Ni	1.0111 ± 0.1563	0.6724 ± 0.1365	0.9288 ± 0.2860	0.6669 ± 0.2283
Pb	0.1007 ± 0.0316	0.1017 ± 0.0442	0.1398 ± 0.0616	0.0900 ± 0.0464
S	1044.8 ± 20.005	985.36 ± 49.116	1106.1 ± 60.522	1041.9 ± 60.981
Se	0.5605 ± 0.1254	0.5848 ± 0.1203	0.8688 ± 0.2752	0.4819 ± 0.1315
Sr	1.4451 ± 0.5079 b	1.4423 ± 0.4851 b	1.4273 ± 0.5292 b	3.9361 ± 0.8028 a
V	0.0275 ± 0.0093	0.0496 ± 0.0126	0.1048 ± 0.0393	0.0638 ± 0.0158
Zn	4.3625 ± 0.7021 b	4.1733 ± 0.4590 b	4.7222 ± 0.5136 b	10.093 ± 4.2292 a

a, b; differences in the same row are statistically significant ($p < 0.05$)

interest in trace elements such as Cu, Cr, Se and Zn. The deficiency of Cr, Fe, Se and Zn is especially important in mammals. Trace element status affects growth and reproduction (Se, Zn), immune functions (Fe, Se, Zn), lean body mass (Cr), bone density (Cr, Cu, Zn), cognitive functions (Se, Zn), insulin sensitivity (Cr) and oxidative stress (Cu, Fe, Se, Zn) (Roussel 2000). High levels of certain elements (especially industrial elements) cause toxicosis, teratogenity and mutagenity, and conversely, deficiency of elements may also cause serious disorders in mammals. Trace element deficiencies lead to impaired growth, immune function disorders, increased oxidative stress, decreased cognitive functions, enhance glucose intolerance and loss of bone density (Roussel 2000; Kaya and Akar 2002). Some serum element levels such as Cu, Pb, Se and Zn are affected by the geographical area. In addition to this, food process, dietary interactions, drug interactions, genetic disorders and diseases affect serum element levels, as well (Keen and Graham 1989; McDowell 1992).

Serum Pb and Zn levels found in our study are in agreement with other authors' reports (Altintas and Fidanci 1993; Karagul et al. 2000). Contrary to this, serum Zn level was found higher than in adult short-haired (Ozpinar et al. 1995) and other adult cats (Palm et al. 1985; Van den Broek et al. 1992; Piechotta and Kolb 1994; Yuksek 2000). Serum Fe and Se levels in this study were found higher than in adult cats and short-haired kittens (Kaneko 1989; Fox et al. 1993; Wedekind et al. 2003). Serum Cu level in our study was found higher than in cats (Palm et al. 1985; Kaneko, 1989; Van den Broek et al. 1992; Piechotta and Kolb 1994; Fascetti et al. 2002) and Van cats (Yuksek 2000). These contradictory results may be mainly due to differences in the geographical area, diets and analytical methods. In the present study, serum element concentrations were determined with the ICP-OES plasma optical atomic emission spectrometer, which is used for the determination of elements nowadays (Garavaglia et al. 2002; Peltz-Csaszma et al. 2005). In other studies, element levels were measured with the atomic absorption spectrophotometer or fluorometry (Palm et al. 1985; Van den Broek et al. 1992; Fox et al. 1993; Yuksek 2000; Fascetti et al. 2002; Wedekind et al. 2003).

In the present study, serum Al, Cu, Mn and Sr levels in male cats were found higher than in female cats. However, Zn level showed no significant difference between male and female cats. Contradictory results were reported on Cu and Zn levels of mammals when comparing males and females. Higher plasma Cu level was reported in male cats than in females (Fascetti et al. 2002). Contrary to this, significantly higher serum Cu level in female humans than in males was reported (Helgeland et al. 1982). On the other hand, it was reported that plasma Zn and Cu values showed no sex-dependence in cats (Van den Broek et al. 1992). Zn level showed no statistically significant difference between male and female cats in this study. Conversely, higher serum Zn values in male humans were reported when compared to females (Helgeland et al. 1982).

Serum Li level was found under the toxic concentration of lithium in cats (Dieringer et al. 1992).

In the present research, serum Al, Cu, Mn, Sr and Zn levels of blue-blue eyed cats were found higher than amber-amber, amber-blue and blue-amber eyed cats, and serum Li level of blue-amber eyed cats was higher than in blue-blue eyed cats. To our knowledge, no data have been published on serum element levels in cats according to eye colours. Differences of eye colours may depend on genetic differences within the Van cat breed. The genetic structure of Van cats is being investigated within our project, and this research is the primary study (Altunok et al. 2004). Moreover, we found no literature on assessments of other essential trace and industrial elements.

It is concluded that some serum essential trace and industrial elements were firstly determined in Van cats. Serum Al, Cu, Mn and Sr levels differed significantly in male and

female cats, and differences of eye colours were connected with serum Al, Cu, Mn, Sr and Zn concentrations.

Hodnoty vybraných prvků krevního séra vanských koček ve vztahu k pohlaví, věku, délce srsti a barvě oka

Plemeno kočky Turecká Van pochází z jižního Turecka. Jedním z charakteristických znaků je jejich barva očí; mohou mít obě oči modré, obě oči jantarové, nebo jedno oko modré a druhé jantarové. Ve vztahu k rozdílu pohlaví, věku, délky srsti a barvy očí byly v séru koček Van (n = 47) sledovány hladiny stopových, makro- a průmyslových prvků. Množství hliníku, arsenu, bóru, baria, kobaltu, chrómu, mědi, gallia, india, železa, olova, lithia, manganu, niklu, selenu, stříbra, síry, stroncia, vanadu a zinku bylo stanovováno pomocí ICP-OES plazmového optického atomového emisního spektrometru. U kocourů byly oproti kočkám detekovány vyšší koncentrace hliníku, baria, mědi, manganu a stroncia ($p < 0,05$). U modrookých koček bylo zjištěno více hliníku, mědi, manganu, stroncia a zinku ve srovnání s kočkami s jantarovýma a různě barevnýma očima ($p < 0,05$). Kočky s jedním okem jantarovým a druhým modrým měly v séru vyšší obsah lithia než kočky modrooké ($p < 0,05$). Nebyly zjištěny žádné statisticky významné rozdíly ($p > 0,05$) v závislosti na věku a délce srsti.

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