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ALUMINUM LEVELS IN CATS AND DOGS

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Abstract

Aluminum is the third most abundant element in the Earth's crust and makes for durable, light and corrosion resistant objects. Aluminum is also an excellent conductor of electricity. It has thus made its way into items all around us. Its bioavailability grew as its uses increased, being utilized as an additive in processed food, cosmetics and pharmaceutical products. Aluminum may contribute to several neurological and haematological disorders. This study aimed to study the aluminum levels in hair samples taken from cats and dogs. The study took into consideration the animals' habitat, gender and age. Hair samples were analyzed via ICP-MS. Mean aluminum levels were higher in dogs (136.66 mg•kg^{-1}) compared to cats (94.31 mg•kg^{-1}). Both cats and dogs that lived outdoors registered higher Al levels than animals living indoors, but no statistical significance was found.

***Key words**: aluminum, cats, dogs, habitat, hair.*

INTRODUCTION

Aluminum is a nonessential, toxic element. It is the third most abundant element in the Earth's crust, comprising about 8%. (Alfrey, 1983; Greger, 1993; Greger & Sutherland, 1997; Shakhashiri, 2008) Because of its ubiquitousness, exposure is high. (Alfrey, Hegg, & Craswell, 1980) Its bioavailability grew as its uses increased. Oral exposure is most frequent, from aluminum cans, containers, cooking utensils, and food additives. (Alfrey, 1983; Nayak, 2002; Reilly, 2002) Antiperspirants, antacids, and vaccines also represent exposure sources, as well as aluminum made electrical devices, airplanes, boats, cars. (Sorenson, Campbell, Tepper, & Lingg, 1974; Greger & Sutherland, 1997; Reilly, 2002; Shaw & Tomljenovic, 2013)

Aluminum may contribute to neurological, haematological, and respiratory disorders. (Ganrot, 1986; al-Masalkhi & Walton, 1994; Mahieu, del Carmen Contini, Gonzalez, Millen, & Elias, 2000; Yokel, 2000; Shaw & Tomljenovic, 2013)

Hair samples have been used to assess environmental exposure to toxic elements (Ashraf, Jaffar, Khurshid, & Ehsan, 1995; Morton, Carolan, & Gardiner, 2002; Pereira, Ribeiro, & Gonçalves, 2004), as they are non-invasive to collect and non-perishable (Esteban & Castano, 2009; Khalique, et al., 2005; Dunicz-Sokolowska, Graczyk, Radomska, Długoszek, Wlazak, & Surkont, 2006) Wilhelm et al. (1989), after performing a study, concluded that hair analysis is of limited value for the diagnosis of aluminium exposure, and bone analysis is more suitable for the assessment of the individual body burden. In a 2013 review, Wolowiec et al. concluded that hair mineral analysis is a good method to investigate the organism's mineral status; however, they observed a need to standardize sample preparation procedures.

This study aimed to assess the levels of aluminum in hair samples taken from cats and dogs living both indoors and outdoors.

MATERIALS AND METHODS

The study was conducted on clinically healthy animals. For analysis, hair samples were taken from 23 dogs and 17 cats. The animals' habitat, gender and age were taken into account, as shown in Table 1. Thus, of the 17 cats, 9 lived indoors and 8 lived outdoors, 8 were males and 9 were females, 9 were below the age of five and 8 were above the age of five. Of the 23 dogs, 11 lived indoors and 12 lived outdoors, 9 were males and 14 were females, and 7 were below the age of five and 16 were above the age of five.

Hair samples were collected from the flank region and stored in paper envelopes.
The samples were then washed, dried and weighed at 0.5 g. 5 ml HNO_3 and 1 ml HCl were added in the digestion process.
Samples were lastly diluted to 10 ml with ultrapure water before being analyzed *via* ICP-MS for aluminum levels.
Statistical analysis was performed using the VassarStats: Website for Statistical Computation (http://vassarstats.net).

Table 1. Studied animals broken down into categories

Specie		Cats	Dogs
Habitat	Indoor	9	11
	Outdoor	8	12
Gender	Males	8	9
	Females	9	14
Age	Below 5 years	9	7
	Above 5 years	8	16
Total		17	23

RESULTS AND DISCUSSIONS

Mean aluminum levels for cats are shown in Figure 1.

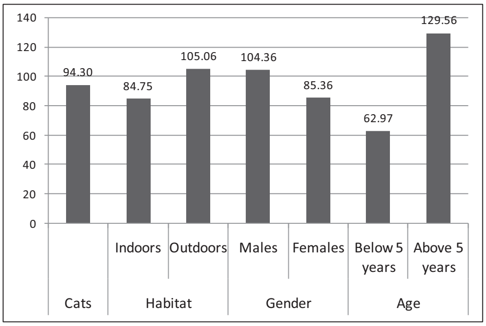

Figure 1. Mean aluminum cat levels (mg•kg^{-1})

The cat hair samples reached an overall mean level of 94.30 mg•kg^{-1}. When broken down into categories, no statistical significance was found between either of the studied categories.
Even so, cats that lived outdoors registered a higher aluminum concentration when compared to indoor cats (105.06 *vs*. 84.75 mg•kg^{-1}). Male cats (104.36 mg•kg^{-1}) had higher levels compared to females (85.36 mg•kg^{-1}).
Cats below the age of five (62.97 mg•kg^{-1}) registered lower levels of aluminum compared to cats above the age of five (129.56 mg•kg^{-1}).

Mean aluminum levels for dogs are shown in Figure 2.

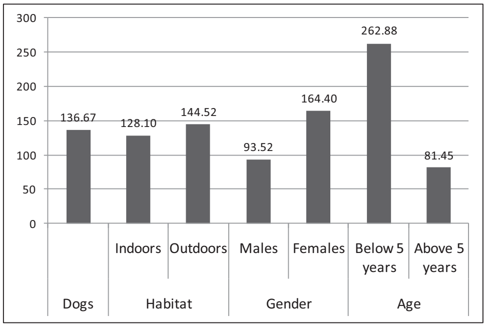

Figure 2. Mean aluminum dog levels (mg•kg^{-1})

Dogs registered an overall level of aluminum of 136.67 mg•kg^{-1}.
No statistical significance was either found when comparing different dog categories.
However, dogs that lived indoors (128.10 mg•kg^{-1}) registered lower concentration than dogs that lived outdoors (144.52 mg•kg^{-1}). Males (93.52 mg•kg^{-1}) registered lower concentrations compared to females (164.40 mg•kg^{-1}). Dogs below the age of five (262.88 mg•kg^{-1}) registered higher concentrations compared to dogs above the age of five (81.45 mg•kg^{-1}).
When comparing dogs *vs*. cats, dogs below the age of five registered statistically significant higher levels of aluminum ($p < 0.05$) compared to cats below the age of five (262.88 mg•kg^{-1} *vs*. 62.97 mg•kg^{-1}). Other comparisons between the two species rendered no statistical significance. However, cats registered a lower overall level compared to dogs (94.30 *vs*. 136.67 mg•kg^{-1}). Indoor cats (84.75 mg•kg^{-1}) registered a lower level compared to indoor dogs (128.10 mg•kg^{-1}). Outdoor cats (105.06 mg•kg^{-1}) registered a lower level compared to outdoor dogs (144.52 mg•kg^{-1}). Male cats (104.36 mg•kg^{-1}) registered higher levels compared to male dogs (93.52 mg•kg^{-1}). Female cats (85.36 mg•kg^{-1}) registered lower levels compared to female dogs (164.40 mg•kg^{-1}). Cats above the age of five (129.56 mg•kg^{-1}) registered higher levels compared to dogs above the age of five (81.45 mg•kg^{-1}).
Kosla & Skibniewska (2010) studied the aluminum hair concentrations in dogs from Warsaw and observed a level of 93.80 ± 72.81 mg•kg^{-1} in the investigated population. They

noticed significant higher levels in dogs from the city environment compared to dogs from the breeding kennel and dogs kept at home, and also a positive dependence of age and aluminum content in the hair.

Tomza-Marciniak et al. (2012) found a level of 1.649 mg•kg^{-1} aluminum in the serum of pet dogs.

CONCLUSIONS

A statistical significance was found ($p < 0.05$) when comparing dogs below the age of five to cats below the age of five, the former registering higher levels.

Although no significant correlation was found, the higher levels of aluminum registered in both cats and dogs that were living outdoors, compared to those living indoors, indicate that environmental pollution may be a cause for aluminum bioaccumulation.

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